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

SAFETY MEASURES

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

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

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

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

**WARNING**

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

Warning symbol for general danger to personnel.

Warning symbol for electrical danger to personnel.

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

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

**WARNING**

This A.V.R. can be incorporated in a machine marked C.E. This manual is be given to the end user.

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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.
New functionalities:
The table below describes the list of major changes on EasyReg 2.60 and the D510C firmware 2.30.

<table>
<thead>
<tr>
<th>Evolutions/Improvements</th>
<th>Easyreg 2.60</th>
<th>Firmware 2.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add of a function to measure the generator electrical internal angle via an optional incremental encoder</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Enhancement of the Grid code function by integrating complete LVRT profile and maximum acceptable current</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Compatibility with an optional data recorder</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Extension of reactive power regulation to higher power generators (up to 32MVA)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Modification of the default values of the Start on threshold function</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Implementation of « Generator » &amp; « Network » convention for data reading and displaying on monitor tab</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Add of soft-start function on Excitation current regulation mode</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Correction of unexpected overvoltage detection during the genset shutting down</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Add of help windows describing the CT location in the generator’s connection diagram</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Management of voltage regulation for alternator configured PF&lt;sub&gt;rated&lt;/sub&gt;=1 combined with reactive droop compensation activated</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Suppression of +/-10V functionality on the analog inputs</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improvement of Easyreg interface (labels &amp; displays)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Add of a data export in CSV format</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Add of the new generators frame LSA46.3, LSA49.3 and LSA52.3 in the database</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
1 - PRESENTATION

1.1 - Operation

A schematic diagram of the D510C appears below.
### D510 C
### A.V.R.

<table>
<thead>
<tr>
<th>Terminals</th>
<th>Signals</th>
<th>Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>Power supply</td>
<td><img src="image1" alt="Power supply diagram" /></td>
</tr>
<tr>
<td>X2</td>
<td>- Auxiliary winding input</td>
<td></td>
</tr>
<tr>
<td>Z1</td>
<td>- PMG input</td>
<td></td>
</tr>
<tr>
<td>Z2</td>
<td>- SHUNT input</td>
<td></td>
</tr>
</tbody>
</table>

| L1        | Mains voltage measurement | ![Mains voltage measurement diagram](image2) |
| L2        | | |

| U         | Alternator voltage measurement | ![Alternator voltage measurement diagram](image3) |
| V         | For single-phase: use V and W | |
| W         | | |

| IU = (s1, s2) | Alternator current measurement | ![Alternator current measurement diagram](image4) |
| IV = (s1, s2) | | |
| IW = (s1, s2) | | |

| AI1       | Analog inputs: | ![Analog inputs diagram](image5) |
| AI2       | External setting | |

| DI1       | Digital inputs: | ![Digital inputs diagram](image6) |
| DI2       | U=U and PF/kVAR regulation | |

| B+        | DC power supply | ![DC power supply diagram](image7) |
| B-        | | |
### D510 C
#### A.V.R.

<table>
<thead>
<tr>
<th>Terminals</th>
<th>Signals</th>
<th>Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>F+ F-</td>
<td>Field excitation: 6 A up to 15 A/10 s</td>
<td><img src="F+" alt="Scheme Diagram" /> <img src="F-" alt="Scheme Diagram" /></td>
</tr>
<tr>
<td>CTP</td>
<td>Temperature sensors</td>
<td>![Scheme Diagram](PT100 CTP 4k75)</td>
</tr>
<tr>
<td>PT100_1</td>
<td></td>
<td><img src="PT100" alt="Scheme Diagram" /></td>
</tr>
<tr>
<td>PT100_2</td>
<td></td>
<td><img src="PT100" alt="Scheme Diagram" /></td>
</tr>
<tr>
<td>PT100-3</td>
<td></td>
<td><img src="PT100" alt="Scheme Diagram" /></td>
</tr>
<tr>
<td>CAN_H</td>
<td>CAN BUS</td>
<td>![Scheme Diagram](µP CAN Transceiver)</td>
</tr>
<tr>
<td>CAN_L</td>
<td></td>
<td><img src="%C2%B5P" alt="Scheme Diagram" /></td>
</tr>
<tr>
<td>USB_D+</td>
<td>USB 2.0 communication port</td>
<td>![Scheme Diagram](µP USB Controller)</td>
</tr>
<tr>
<td>USB_D-</td>
<td></td>
<td><img src="%C2%B5P" alt="Scheme Diagram" /></td>
</tr>
</tbody>
</table>
### D510 C
A.V.R.

**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.
1.2 - Characteristics
The different functions of the D510C are:
- Voltage regulation
- Regulation of the power factor (PF)
- Regulation of the reactive power
- Manual regulation (Iexc)

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

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

  - Inductive P.F. \([0; \pi/2]\) 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 \((Q = \sqrt{3}*U*I*sin \varphi)\) at a fixed value.

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

These functions are selected when setting the AVR parameters.

1.3 - Specifications
1.3.1 - Characteristics

<table>
<thead>
<tr>
<th>Name</th>
<th>Minimum value</th>
<th>Maximum value</th>
<th>Adjustable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery power supply</td>
<td>11 V</td>
<td>30 V</td>
<td>-</td>
</tr>
<tr>
<td>Alternator frequency</td>
<td>10 Hz</td>
<td>100 Hz</td>
<td>Yes</td>
</tr>
<tr>
<td>Mains frequency</td>
<td>10 Hz</td>
<td>100 Hz</td>
<td>-</td>
</tr>
<tr>
<td>Single-phase mains voltage</td>
<td>50 V</td>
<td>530 V</td>
<td>-</td>
</tr>
<tr>
<td>Mains voltage ratio</td>
<td>1</td>
<td>100</td>
<td>Yes</td>
</tr>
<tr>
<td>Excitation current</td>
<td>0 A</td>
<td>6 A</td>
<td>-</td>
</tr>
<tr>
<td>Max. excitation current</td>
<td>0 A</td>
<td>15 A/10s</td>
<td>-</td>
</tr>
<tr>
<td>Single-phase alternator voltage</td>
<td>0 V</td>
<td>530 V</td>
<td>-</td>
</tr>
<tr>
<td>Three-phase alternator voltage</td>
<td>0 V</td>
<td>530 V</td>
<td>-</td>
</tr>
<tr>
<td>Alternator current input</td>
<td>1 A</td>
<td>5 A</td>
<td>Yes</td>
</tr>
<tr>
<td>Alternator I u</td>
<td>0 A</td>
<td>5000 A</td>
<td>-</td>
</tr>
<tr>
<td>Alternator I v</td>
<td>0 A</td>
<td>5000 A</td>
<td>-</td>
</tr>
<tr>
<td>Alternator I w</td>
<td>0 A</td>
<td>5000 A</td>
<td>-</td>
</tr>
</tbody>
</table>
## Electric Power Generation

### Installation and maintenance

**D510 C**

**A.V.R.**

### 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
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
2 - HUMAN-MACHINE INTERFACE
The D510C human-machine interface consists of 3 elements:
- The USB link
- The I/O
- The LEDs

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.

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

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

2.3 - Digital I/O

<table>
<thead>
<tr>
<th>E/S</th>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI1</td>
<td>Pull up input</td>
<td>To be connected to 0V</td>
</tr>
<tr>
<td>DI2</td>
<td>Pull up input</td>
<td></td>
</tr>
<tr>
<td>DO1</td>
<td>Opened collector</td>
<td>Max current: 60mA Voltage: 0 - 24V</td>
</tr>
<tr>
<td>DO2</td>
<td>Dry contact</td>
<td>6A, 30Vdc/250V AC (on resistor)</td>
</tr>
<tr>
<td>AL1</td>
<td>Opened collector</td>
<td>Max current: 60mA Voltage: 0 - 24V</td>
</tr>
<tr>
<td>AL2</td>
<td>Opened collector</td>
<td></td>
</tr>
</tbody>
</table>

2.4 - LEDs
The LEDs serve to inform the user whether the AVR is working correctly or not.
2.5 - Wiring scheme

**AVR connections**

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

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

3/ Battery: ensure the polarity is correct when connecting

4/ Voltage sensing:
- mains voltage: L1 and L2
- alternator voltage:
  - single-phase: V and W
  - three-phase: U, V and W

5/ Current transformer(s):
- placing in parallel and measurement:
  - CT on U
- measurements: CTs on V and W

6/ Temperature sensor:
- PTC: see mounting above
- PT100: see mounting above

7/ USB port

8/ Digital I/O
3 - SETTING THE FUNCTION PARAMETERS
EasyReg is a Leroy Somer Software which allows to:
- Easily configure the digital regulator D510C
- Monitor several important parameters such as alternator output voltage, excitation current, active and reactive power, etc…
- Optimize the regulation loop
- Set the AVR parameters.
- Configure the inputs and outputs.
- Display faults and parameter measurements.
It is the interface between the user and the digital AVR.

3.1 - Installation
Double click on the installer EasyReg and follow the installation instructions.

3.2 - Startup
Connect the AVR to the computer with a USB cable. Check that the blue «USB» LED is on.
To start the software, go to «Start», «Programs» then «EasyReg».

3.3 - Appearance
The regulator is connected to the PC via standard USB cable, the blue LED (labeled LED) of the regulator is then ON and the information «D510C CONNECTED» is displayed on the screen left bottom.
There are four options when using this software:
- New configuration
- Open a configuration from a file
- Open a configuration from the pre-programmed AVR.
- Create customised configuration (Expert mode)

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

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

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

**3.3.1 - Languages and modes**

**3.3.1.1 - Languages**

Three languages are available on EasyReg: French, English and German.
3.3.1.2 - Modes
Two operation modes are possible:
- Standard mode by default
- Expert mode which offers additional functions

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

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

Click on « Copy code » and email the PC code to: SupportClientSillac.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».
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.
• 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.
**Options**

- **Temperature sensing**
  - PTC
  - PT100

- **Current transformer(s) (CTs)**
  - Number: 1, 3
  - Ratio: IN Sensing, IN/2 Sensing, IN/4 Sensing

- **Generator voltage transformer (P.T.)**
  - Primary U (kV): 0.692
  - Secondary U (kV): 400

- **Bus voltage transformer**
  - Primary U (kV): 11.20
  - Secondary U (kV): 400

- **Step-up transformer**
  - Primary U (kV): 0.692
  - Secondary U (kV): 11.20

To obtain the following options, tick the boxes:

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

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

After entering the data in this page, go to the second page by clicking «Next». In some cases, you will need to adjust the workscreen in order to access the «Next» button.
3.3.3.2 - Regulation mode
After entering the «Alternator Configuration» part settings, fill in the «Regulation Mode» part.

4 types of regulation are offered:
- Voltage
- Power factor (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.**
A - Voltage regulation
This page consists of two parts:
- Voltage Regulation
- Underspeed settings
Setting the parameters for this part starts with the «Voltage regulation» page and ends with the «Underspeed settings» page.

A1 - Voltage regulation
This page is split into two parts:
- Settings
- Options

A1.1 - Settings

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

   Expert Mode: The adjustment range can be extended to ± 30%.
2. To set the voltage externally, tick the box, define by what means (POT, 0-10 V, etc) this setting will be made as well as the selected input (AI1 or AI2), then enter the desired setting range.

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

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

This function is only available if a CT is used. It can be adjusted up to 10% maximum.
A1.2 - Options

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

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

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

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

To go to the next step «Underspeed settings», click «Next».
A2 - Underspeed settings
This page is split into three parts:
- Starting
- Underspeed
- Engine

A2.1 - Starting

Factory setting: disabled
To adjust Soft-start, check the box and select the duration between 0.1 s and 120 s (1 step = 0.1 s).
Clicking on the question mark give help information on this function.
The Soft-start reset delay (default 20s), can be adjusted from 5s to 20s.
A2.2 - Underspeed

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

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

2. Enter the gradient value between 1.0 and 3.0 U/F (1 step = 0.1 U/F). Factory setting: 1/U/F.
A2.3 - Motor help

1. If the LAM function is required, tick the box and select its value between 0% and 30% (1 step = 1%).
Recommended setting: LAM 9% - U/F 1.7%

2. If you wish to have a gradual increase, tick the box and select the value between 0.1 s/10 Hz and 30.0 s/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.
B - Regulation of the power factor

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

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

B1 - Digital inputs

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

B2 - Settings

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

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

Database not recommended area

Forbidden area

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

**Warning:** When a value is outside the database recommended area, a message appears as indicated below.
2. To set the power factor externally, tick the box, select the source (POT, 0-10 V, etc) for this setting and also the input (AI1 or AI2). One of the inputs may be greyed-out if it is already being used by another function.

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

Save (see section 3, «Save» section).
Load the settings into the AVR by clicking the following button:
C - Regulation of the reactive power kVAR
Caution, regulation of the reactive power PF, and the quadrature droop can only be enabled if there is a CT on phase U and it has been configured.

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

C1 - Digital inputs

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

C2 - Settings

Select the value of the reactive power according to the load. This value depends on the alternator type.
It is possible to set a fix value or use a remote adjustment in a predefined range.

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

Please verify the Qmax value of generator
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.

Save (see section 3, «Save» part).

Load the settings into the AVR by clicking the appropriate button:
D - Manual regulation: Iexc
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.
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.
3.3.3 - Faults and digital outputs
This page is split into three parts in standard mode:
- Assignment of faults
- Assignment of digital outputs
- Faults options

- Assignment of faults and digital outputs
The main faults can be supervised by assigning them to digital outputs.

NOTA: The fault « Unbalance current » is only selectable if 3 CT are checked.
This page offers the possibility of assigning faults and operating modes to 4 outputs (AL1, AL2, D01 and D02).

Example of settings:
- Assignment of «Overvoltage» fault to AL1
- Assignment of «PT100-1 overtemperature» fault to AL2 with the maximum temperature set at 200°C
- Assignment of «Loss of voltage sensing» fault to D01
- Assignment of «PF/kVAR» digital output to D02
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.

- **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.
- [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:

- [Expert mode] rotating diode bridge fault
Activate/deactivate the rotating diodes state supervision of exciter.

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

- [Expert mode] Generator current limitation
Set this function.

- [Expert mode] CAN network configuration
Enable CAN.
Set the data transfer rate.
Choose the regulator identifier.
Select the broadcast protocol (J1939 and/or Owner CAN).
In the case of Owner CAN, choose the parameters to broadcast.

kVAR convention: when generator convention is selected then the kVAR is considered negative when generator is consuming reactive power and vice versa.
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.
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.
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.
Transient test
It is possible to configure a transient test in order to evaluate the regulation performances.

The Expert mode offers other functions.

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

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

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

[Expert mode] Fault reset
It is possible to clear fault display by clicking on the button .

[Expert mode] PID
The digital potentiometer is replaced by the PID numerical values in READ/WRITE mode.
**Warning:** A wrong setting of the PID can damage the alternator.

**PID setting methodology:**
Please use Transient Test:

1. **Initial conditions:**
   - Proportionnal = 10
   - Integral = 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.
The table below summarises the effects which may be influenced by the PID actions.

<table>
<thead>
<tr>
<th>PID controller</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportional action</td>
<td>Speed</td>
</tr>
<tr>
<td>Integral action</td>
<td>Accuracy</td>
</tr>
<tr>
<td>Derivative action</td>
<td>Stability</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Generator model</th>
<th>LSAS4 MZL 105.4P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal voltage (V)</td>
<td>11 000</td>
</tr>
<tr>
<td>Nominal frequency (Hz)</td>
<td>50.0</td>
</tr>
<tr>
<td>Apparent power (kVA)</td>
<td>3 129</td>
</tr>
<tr>
<td>Field excitation system</td>
<td>AREP</td>
</tr>
<tr>
<td>Nominal field excitation current (A)</td>
<td>5.7</td>
</tr>
<tr>
<td>Field inductor resistance (Ohms)</td>
<td>6.50</td>
</tr>
<tr>
<td>PF Ref</td>
<td>0.90</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Regulation</th>
<th>Voltage</th>
<th>PF</th>
<th><strong>Iexc</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportional</td>
<td>60</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Integral</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Derived</td>
<td>1 200</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>Gain</td>
<td>80</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

- **Voltage for this particular case**:
  - Proportional: 60
  - Integral: 3
  - Derivative: 1200
  - Gain: 80

- **PF and kVAR by default**:
  - Proportional: 10
  - Integral: 1
  - Derivative: 20
  - Gain: 50

- **Iexc by default**:
  - Proportional: 100
  - Integral: 10
  - Derivative: 500
  - Gain: 100

- Select also the negative forcing, the compensation VBus if needed.
- Reselect the scale of gains PID to 1/1 or 1/50 depending on the alternator size.
3.4.4 - Tab « Protections and limitations »

3.4.4.1 - General
- The page appears in two parts:
  • the left part is relative to 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.

![Schematic diagram showing Protections and limitations](image)

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:
In our case we can configure the values:

<table>
<thead>
<tr>
<th>Limitations and protections</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading PF limit</td>
<td>0.50</td>
</tr>
<tr>
<td>Lagging PF limit 1</td>
<td>0.75</td>
</tr>
<tr>
<td>Lagging PF limit 2</td>
<td>0.70</td>
</tr>
<tr>
<td>Leading kVAR limit (%)</td>
<td>-60%</td>
</tr>
<tr>
<td>Lagging kVAR limit 1 (%)</td>
<td>62%</td>
</tr>
<tr>
<td>Lagging kVAR limit 2 (%)</td>
<td>55%</td>
</tr>
<tr>
<td>Overvoltage level (%)</td>
<td>11%</td>
</tr>
<tr>
<td>Delay (s)</td>
<td>10s</td>
</tr>
</tbody>
</table>

3.4.4.3 - Under-excitation Limitation

<table>
<thead>
<tr>
<th>Under excitation limitations</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>iexc run limitation (A)</td>
<td>2.2</td>
</tr>
<tr>
<td>iexc reset limitation (A)</td>
<td>2.5</td>
</tr>
<tr>
<td>Under-excitation delay (s)</td>
<td>2.0</td>
</tr>
</tbody>
</table>

3.4.4.4 - Over-excitation Limitation

<table>
<thead>
<tr>
<th>Over excitation limitations</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>iexc run limitation (A)</td>
<td>11.0</td>
</tr>
<tr>
<td>iexc reset limitation (A)</td>
<td>10.0</td>
</tr>
<tr>
<td>iexc shutdown (A)</td>
<td>0.5</td>
</tr>
<tr>
<td>iexc short-circuit (A)</td>
<td>0.4</td>
</tr>
<tr>
<td>Short-circuit delay (s)</td>
<td>5.0</td>
</tr>
</tbody>
</table>

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.
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 Leroy-Somer is 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.

**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.

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.
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.
Warning: the secondary of the CT must not be connected to the ground.
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
6 - FAULT FLOW CHARTS

Absence of voltage

- Check the power supply is present on the AVR
  - Green "POWER ON" LED active
  - Check the regulation mode
    - Yes
    - No
  - Check the wiring and the supply voltage between 12 and 30 Volts

- Check whether the measured voltage ≤ 7% of UN
  - Yes
  - No
  - Start voltage regulation

- ≥ 7%
  - Check the exciter field connections
    - Fault
      - Modify the exciter field wiring or replace it if faulty
  - ≤ 7%
    - Check the polarity of the exciter field
      - Fault
        - Modify the wiring, then reboot the machine if necessary
    - Check the diode bridge
      - Fault
        - Replace the diode bridge if faulty
      - OK
        - Replace the AVR
        - Generator and control running
Voltage too high/Red LED activated VOLT

Check the value of the AVR Internal or external reference connected to the analogue input

OK

Fault

Fault

Measure the electrical continuity of voltage sensing U V W

OK

Fault

Measure the voltage sensing (U, V and W)

OK

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

Fault

OK

Modify the wiring

Replace the AVR

Generator and control running
Voltage too low/Red LED on VOLT

- Check the speed of rotation
  - OK
  - Fault
  - Adjust the generator speed of rotation

- Monitor the load applied to the alternator
  - OK

- Check the exciter field
  - OK
  - Fault
    - ≤ 7%
      - Replace the rotating diodes
    - ≥ 7%
      - Replace the AVR

- Check whether the remanent voltage is ≤ 7% of UN
  - Fault
  - OK

- Monitor the load applied to the alternator
  - OK

- Check and if necessary adjust the position of the U/F activation knee-point
  - OK

- Replace the exciter field
  - Fault

- Readjust the load
  - OK

Generator and control running
Incorrect regulation or Voltage unstable

- Check the stability of the speed
  - OK
  - Fault

  - Check the D500 configuration (type of alternator and PID)
    - OK
    - Fault

    - Check whether the load is balanced
      - OK
      - Fault

      - Stabilise the load
        - Unstable
        - Fault

      - Replace the exciter field
        - Fault

      - Replace the rotating diodes
        - Fault

      - Replace the D500 configuration
        - Adjust the PID

- OK

Generator and control running
Response time too long

Does the speed regulator respond quickly enough?

OK

Fault

Adjust the speed stability of the prime mover

Fault

Adjust the PID parameters of the controller in Expert mode

Fault

Adjust the AVR stability potentiometer in Easyreg

Fault

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

OK

OK

Start generator and control running
Considerable drop in voltage, on-load

1. Check the D500 configuration (LAM, U/F, etc)
   - OK
     - Check the generator load level
       - OK
         - Check the quadrature droop parameter settings
           - OK
             - Check the wiring of the voltage reference U/V/W
               - OK
                 - Check the position and location of the CT on phase U
                   - OK
                     - Modify PID parameters of the D510C
                       - Start generator and control running

2. Check the value of the CT and the ratio setting
   - Fault
     - Decrease the load

3. Adjust the quadrature droop (factory setting 3%)
   - OK
     - Modify the wiring

4. Decrease the load
   - Modify the wiring
KVAR phase imbalance or Incorrect PF regulation

Not enabled
Enable KVAR or PF regulation (yellow LED on)

Fault
Check whether quadrature droop has been enabled

Enabled
Check that KVAR or PF mode has been enabled (yellow LED on)

Fault
Quadrature droop disabled

OK
Check the no-load voltages are matched before connecting

OK
Check the wiring of the voltage sensing U/V/W

OK
Check the position of the CT on phase U (P1 at source end) and the output connections (S1-S2)

OK
Replace the D510C AVR

Fault
Match the voltages

Fault
Modify the wiring

OK
Start generator and control running

Fault
Modify the wiring

Fault
Modify the wiring

Fault
Modify the wiring

OK
Match the voltages

Fault
Modify the wiring
PF or KVAR range incorrect

Fault

Enable KVAR or PF regulation (yellow LED on)

Check that KVAR or PF mode has been enabled

OK

Fault

Check the selection mode (internal or external)

Enable the setting mode

OK

OK

Replace the AVR

Fault

Check and modification of the setting range and limits

Start generator and control running
Voltage matching impossible

Check that there is a mains voltage on terminals L1 and L2 of the D510C

- OK

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

- OK

Replace the AVR

- OK

Start generator and control running

Fault

Check and modify, if necessary, the wiring of the digital input DI1 DI2

Fault

Check the wiring of the mains voltage on terminals L1, L2

- OK

Modify the wiring

OK
LED status

- **Green "POWER ON" LED active**: Board supplied with power
- **Hz Red LED on**: Speed drop
- **Volts Red LED on**: Problem of overvoltage or undervoltage
- **Exc Red LED on**: Problem of over-excitation or under excitation
- **Manu yellow LED on**: Manual mode enabled
- **PF/KVAR Yellow LED on**: Regulation of the power factor or reactive power enabled
- **Manu Yellow LED on**: Alternator/mains voltage matching
- **Blue USB LED on**: EasyReg software/D510C communication
7 - SPARE PARTS

7.1 - Designation

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>First installation kit</td>
<td>4814176</td>
</tr>
<tr>
<td>Replacement kit</td>
<td>4818634</td>
</tr>
<tr>
<td>Adaptation kit ±10V</td>
<td>5090072</td>
</tr>
</tbody>
</table>

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 A.V.R.

To ensure correct operation and the safety of our machines, 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.
Disposal and recycling instructions
We are committed to limit the environmental impact of our activity. We continuously survey our production processes, material sourcing and products design to improve recyclability and diminish our footprint.

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

Recyclable materials
Our alternators are mainly built out of 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 products dismounting upon request.

Waste & hazardous materials
The following components and materials need a special treatment and need to 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 plastic type information.

All materials listed above need special treatment to separate waste from reclaimable material and should be handed to specialized disposal companies.

The oil and grease from the lubrication system should be considered as a hazardous waste and has to be handled according to local legislation.
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 know alternators operation inside out, providing the best value service to optimize your cost of ownership.

Where we can help:

- **Consulting & specification**
- **Maintenance contracts**
- **Remanufacturing**
- **System upgrade**
- **Monitoring**
- **System audit**
- **Commissioning**
- **Training**
- **Genuine spare parts**
- **Repair services**

Contact us:

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**China:** +86 591 88373036  
**India:** +91 806 726 4867  
**Middle East:** +971 4 811 8483

Scan the code or go to:  
www.lrsm.co/support