DVC 350

Digital Voltage Controller

Designer's handbook

4189341291D

Improve
Tomorrow

1. About the Designers handbook

1.1 Intended users of the Designer's handbook

The manual is for the person who designs the control system and electrical system where the DVC 350 is installed.

1.2 Notation and symbols

Symbols for hazard statements

DANGER!

This shows dangerous situations.

If the guidelines are not followed, these situations will result in death, serious personal injury, and equipment damage or destruction.

WARNING

This shows potentially dangerous situations.

If the guidelines are not followed, these situations could result in death, serious personal injury, and equipment damage or destruction.

CAUTION

This shows low level risk situation.

If the guidelines are not followed, these situations could result in minor or moderate injury.

NOTICE

This shows an important notice

Make sure to read this information.

Symbols for general notes

NOTE This shows general information.

More information
This shows where you can find more information.

Example

This shows an example.

How to ...
This shows a link to a video for help and guidance.

1.3 Warnings and safety

General safety guidelines

There can be live parts without protection in the DVC 350, and hot surfaces, during operation. When protection devices are removed, defective installation or incorrect operation occurs, they can be dangerous for personnel and can cause damage to equipment.

Only approved and qualified personnel can do work related to transportation, installation, commissioning and maintenance (see IEC 364, CENELEC HD 384 or DIN VDE 0100, and national specifications for installation and how to prevent accidents).

Safety guidelines during installation

- Installation of the DVC 350 must comply with the supplied documentation.
- The DVC 350 must not be damaged or changed.
- Do not touch the electronic components or live parts. The DVC 350 has parts which are sensitive to electrostatic stress.

Safety guidelines during electrical connection

- The instructions given in this manual must always be followed.
- The manufacturer of the installation or the machine is responsible for obeying the limits given in the EMC legislation .
- Work on a powered DVC 350 must comply to national rules.
- The AC and DC AVR power supplies, which are used to create the field current, should be protected by fast-blow fuses or circuit-breakers.

For EU applications: Instrument transformers shall provide basic insulation as specified by the requirements of IEC 61869-1, " Instrument transformers – Part 1: General requirements " and IEC 61869-2, " Additional requirements for current transformers"

For US applications: Instrument transformers shall provide basic insulation as specified by the requirements of IEEE C57.13, "Requirements for Instrument Transformers," and IEEE C57.13.2, "Conformance Test Procedure for Instrument Transformers."

1.4 Legal information

Disclaimer

DEIF A/S reserves the right to change any of the contents of this document without prior notice.

The English version of this document always contains the most recent and up-to-date information about the product. DEIF does not take responsibility for the accuracy of translations, and translations might not be updated at the same time as the English document. If there is a discrepancy, the English version prevails.

Third party equipment

DEIF takes no responsibility for the installation or operation of any third party equipment, including the **genset**.

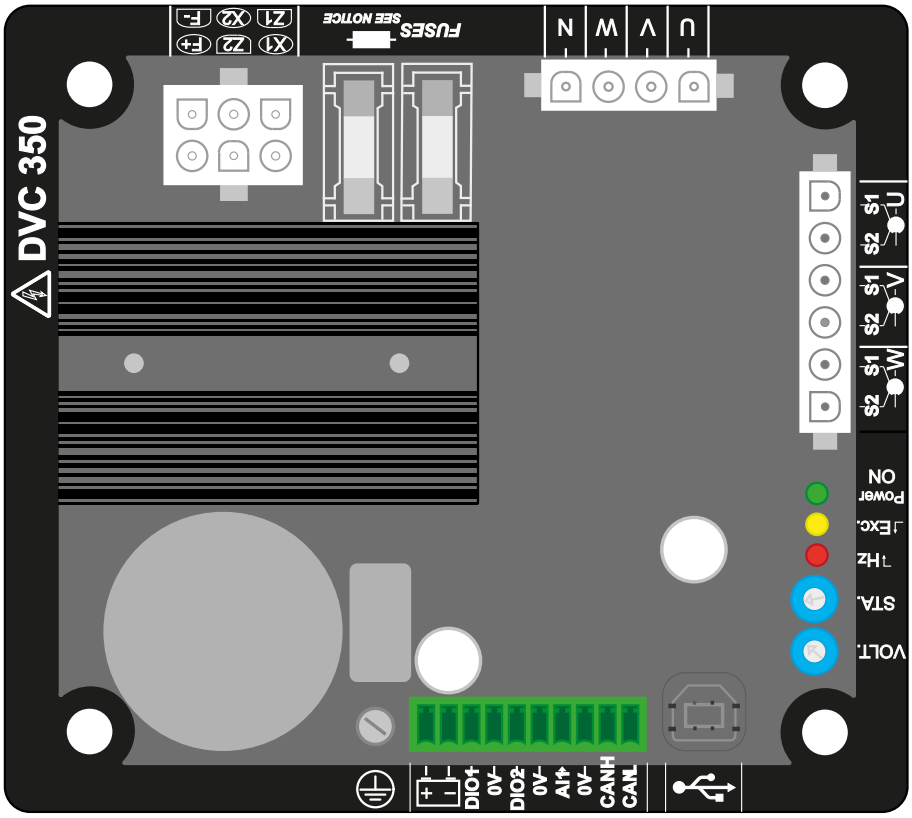
Copyright

2. About the DVC 350

2.1 Product overview

2.1.1 Product description

The DVC 350 is a digital automatic voltage regulator (AVR). It can regulate alternators with a field current of less than 5 A in continuous operations, and 10 A maximum if a short-circuit occurs for 10 seconds maximum.



More information
See the **DVC 350 Data sheet** for the all the technical values.

The DVC 350 is made for alternators with SHUNT, AREP (auxiliary winding) or PMG (permanent magnet) excitation types. It adjusts the excitation current in the exciter field to give the needed alternator output.

The DVC 350 has many protections and functions to keep the alternator operating in full safe operation.

The utility software, DEIF EasyReg Advanced, gives a visual interface to configure values and parameters through the USB port.

You can mount the DVC 350 in a generator terminal box or a control cabinet.

NOTICE
Installation It must be installed in compliance with local protection and safety standards, especially those specific to electrical installations with a maximum voltage of 300 V AC phase/neutral.

The DVC 350 has:

- Digital and analogue I/O for control of the regulation modes, operating information, correcting references
- Communication modes for remote parameter setting
- USB connection
- CAN bus for regulation

2.1.2 Applications

The DVC 350 can be used in applications either with an AGC controller or as a standalone AVR.

When used with an AGC controller, the AGC can control all of the features and receive fault information directly with the CAN bus communication in a similar way to an Engine Control Unit (ECU).

Example applications with AGC

Figure 2.1 AGC with DVC 350

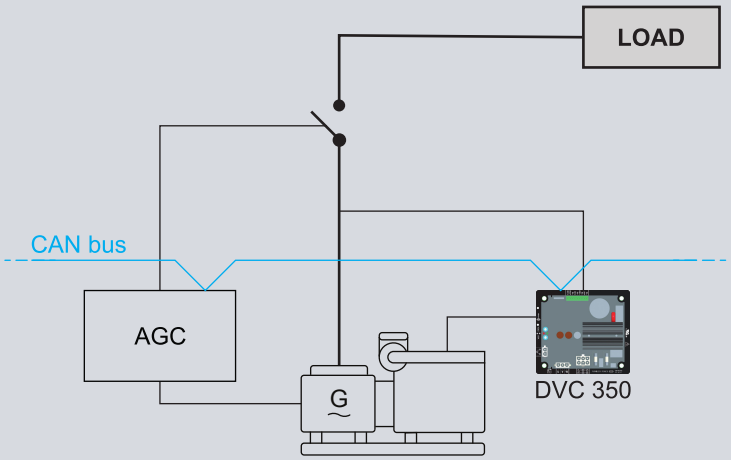
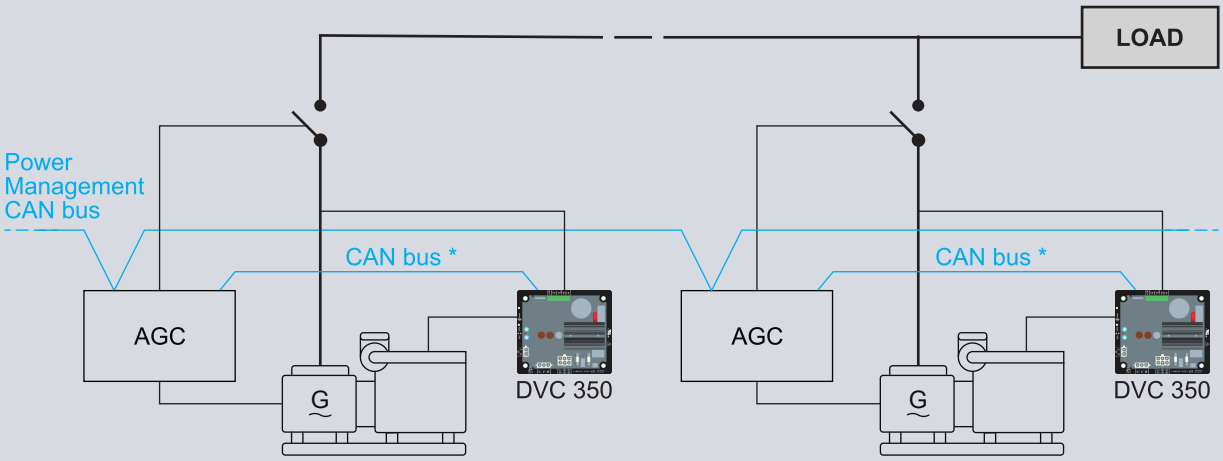
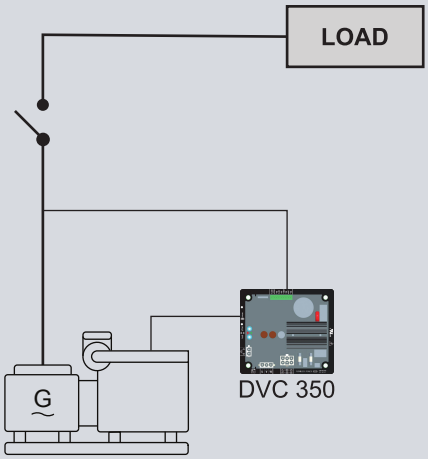


Figure 2.2 Multiple AGCs with DVC 350s



Note * With the J1939 protocol, the AGC can communicate to the ECU and DVC 350 on the same CAN bus port. See **Configure the DVC 350 with AGC, About the DVC 350 with the AGC, Communication options** in this document for more information.

Example stand-alone application

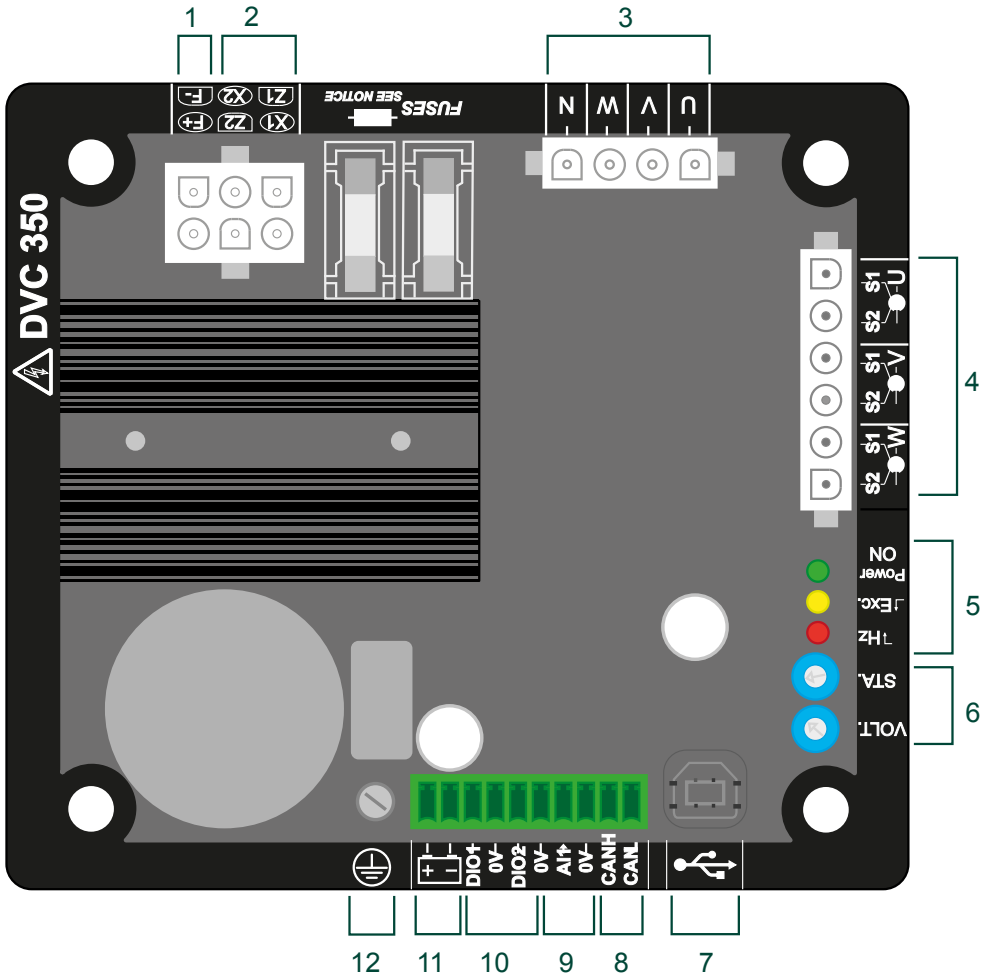


2.1.3 Extended features with AGC

CAN bus

A dedicated J1939 CAN bus connection provides efficient and exclusive communication between the DVC and the controller. This makes it possible to, for example, quickly and easily swap between nominal voltage or frequency settings for a generator.

2.1.4 Terminal description



1. Excitation:
   - **F-**
   - **F+**
2. Power supply:
   - **AREP:**X1, X2, Z1, Z2
   - **PMG:**X1, X2, Z2
   - **SHUNT:**X1, X2
3. Alternator voltage sensing
4. Alternator current measurements (parallel operation CT)
5. LED indication
6. Potentiometers:
   - **STA.:**PID global gain or reactive droop compensation
   - **VOLT.:**Voltage
7. USB port
8. CAN port
9. Analogue input
10. 2 digital inputs or outputs
11. DC auxiliary supply
12. Ground

The DVC 350 does not have black start functionality, therefore DC auxiliary power supply is mandatory.

2.1.5 Regulation modes

The DVC 350 is a digital voltage regulator used to control the alternator from the field current or the output voltage regulation loops. The regulation mode is configured by parameter-setting, digital inputs, or using the communication mode.

The regulation modes are:

- Voltage regulation, with or without reactive droop compensation or line droop compensation. *
- Regulation of the field current (manual mode), which gives direct control of the field current value.

NOTE * You cannot enable the reactive droop and the line droop compensation at the same time.

With the DVC 350 you can:

- Adjust the reference for the regulation mode in progress with an analogue input (4 to 20 mA, 0 to 10 V, ±5 V and ±10 V, and potentiometer)
- Limit the minimum field current supplied to the exciter field
- Monitor the maximum stator current limit
- Detect loss of voltage sensing
- Withstand a sudden short-circuit for 10 seconds maximum in AREP or PMG

You can have the different trips, regulation modes and measurement data sent to the 2 digital outputs.

2.1.6 Operating values

- **Alternator voltage sensing:**
  - 3 phases with neutral or 2 phases
  - Three-phase range: 0 to 530 V AC
  - Consumption < 2 VA
- **Stator current measurement with CTs:**
  - 3 phases measurement
  - Range: 0 to 5 A
  - Consumption < 2 VA
- **Power supply AC:**
  - 4 terminals for PMG, AREP, SHUNT
  - Range: 50 to 277 V AC
  - Max. consumption < 3000 VA
- **Power supply DC (auxiliary power supply):**
  - Range: 50 to 400 V DC
  - Max. consumption: 3000 VA
- **Field excitation**
  - Rated 0 to 5 A
  - Short-circuit 10 A max.
  - Field winding resistance > 4 Ω
- **Frequency**
  - Range 10 to 100 Hz
- Regulation accuracy: ±0.25 % of the average of the three phases on a linear load with harmonic distortion less than 5 %
- Voltage adjustment range: 0 to 150 % of the rated voltage
- Reactive droop adjustment range: -20 % to 20 %
- Under-frequency protection: integrated, adjustable threshold, slope adjustable from 0.5 to 3 x V/Hz in steps of 0.1 V/Hz
- Excitation ceiling: adjustable by configuration of 3 points
- Environment: ambient temperature from -40 °C to +70 °C, relative humidity of less than 95 %, non-condensing, mounted in a cabinet or in a terminal box
- Configuration of the AVR parameters with the software EasyReg Advance supplied with the product or using the communication interfaces

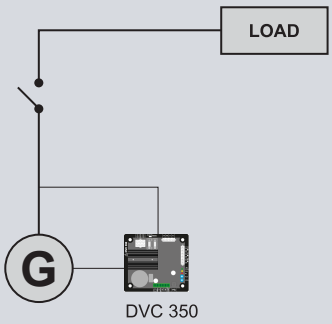
2.3 Running modes

2.3.1 Regulation modes

The configuration of the regulation mode is not the same for the different alternator operations (stand-alone or parallel between machines). Each regulation mode will need different functions enabled.

The following schematics are given for information only, and they do not include voltage sensing transformers. If necessary, a transformer for measuring the alternator current is included, but this depends on the regulation mode.

Example 1: Alternator only connected to a load



The AVR is operating in voltage regulation mode only.

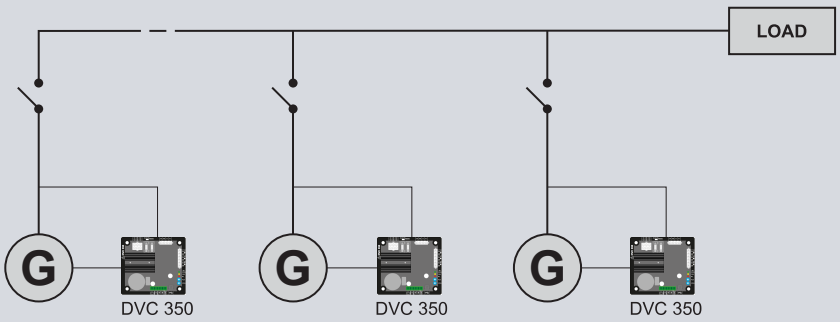
- There is no need to measure the alternator current.
- It is not possible to give an indication of power rating.
- You can only enable line droop compensation if there are long distance connections. This is to make sure there is a minimum voltage at the load terminals.* In all other conditions, you cannot enable the line droop compensation or the reactive droop compensation.

Field current regulation is optional.

- Permanently set the reference so that it matches the existing load, so it will not damage the load or the machine (risk of over-voltage or under-voltage and risk of over excitation).

NOTE * One alternator current measurement transformer is necessary.

Example 2: Alternator connected to other alternators and a load



The AVR is operating in voltage regulation mode only.

- To divide the load reactive power equally between all of the running machines, enable the reactive droop compensation. Set the voltage droop in accordance with the percentage of the rated reactive load applied to the machine. If the DVC 350 is a stand-alone unit, the alternator current measurement is mandatory on the

alternator current measurement input. If the DVC 350 is connected to an AGC, then the CT input on the DVC is not necessary.

Field current regulation is optional.

- Permanently set the reference so that it matches the existing load, so it cannot damage the load or the machine (risk of over-voltage or under-voltage and over excitation).

NOTE You cannot enable the line droop compensation if the reactive droop compensation is enabled.

NOTICE
Switching regulation mode Switching from one regulation mode to another is bumpless.

2.3.2 Regulation mode priority

The regulation modes have a priority order (from highest priority to lowest priority):

1. Field current
2. Voltage

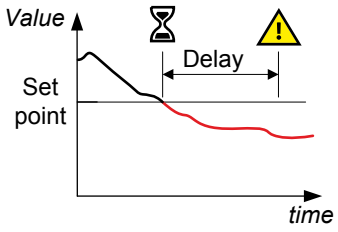
2.4 Protections

2.4.1 Under-voltage (ANSI 27)

```
Protections / Machine fault
```

The **Under-voltage** protection is activated if the generator voltage is less than the set point percentage after the time delay ends.

This fault is active only if the regulation is enabled and the soft start ramp achieved.



NOTE The set point is a percentage of the actual set point value.

Table 2.1 Default settings

Parameter	Range	Default
Set point	0.00 to 100.00 %	85.00 %
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.2 Over-voltage (ANSI 59)

```
Protections / Machine fault
```

The **Over-voltage** protection is activated if the generator voltage is higher than the set point percentage after the time delay ends.

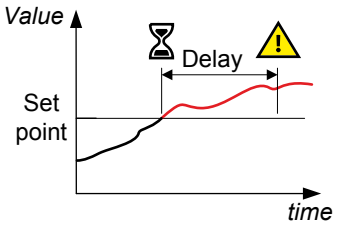


Table 2.2 Default settings

Parameter	Range	Default
Set point	50.00 to 200.00 %	115.00 %
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.3 Under-frequency (ANSI 81L)

```
Protections / Machine fault
```

The **Under-frequency** protection is activated if the generator frequency is less than the set point after the time delay ends.

The protection is active only if the regulation is enabled.

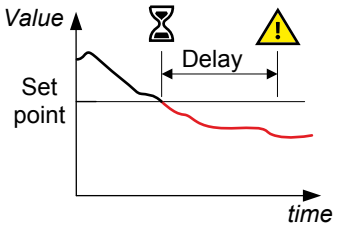


Table 2.3 Default settings

Parameter	Range	Default
Set point	0.00 to 400.00 Hz	47.00 Hz
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.4 Over-frequency (ANSI 81H)

```
Protections / Machine fault
```

The **Over-frequency** protection is activated if the generator frequency is higher than the set point after the time delay ends.

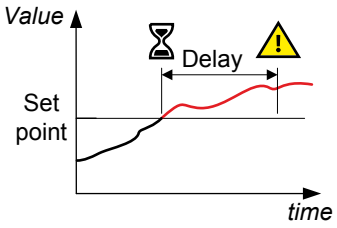


Table 2.4 Default settings

Parameter	Range	Default
Set point	45.00 to 450.00 Hz	53.00 Hz
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.5 Diode faults

If the pole ratio (number of exciter poles divided by the number of poles of the generator) is known, the percentage of harmonics supervised by the AVR is the sum of the two harmonics closer of the ratio. For example, for an exciter of 16 poles, and a generator of 6 poles, the pole ratio is 2.66, so the percentage of harmonics 2 and 3 are summed.

If the pole ratio is unknown, the percentage of harmonics supervised by the AVR is the sum of all of harmonics.

2.4.6 Open diode fault

```
Protections / Machine fault
```

The **Open diode fault** protection is activated if the percentage of the field current harmonics is higher than the set point after the time delay ends.

This protection is only active if the regulation is enabled.

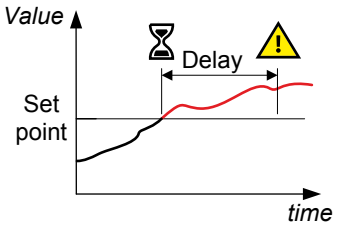


Table 2.5 Default settings

Parameter	Range	Default
Set point	1.00 to 50.00 %	5.00 %
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action

Parameter	Range	Default
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.7 Shorted diode fault

```
Protections / Machine fault
```

The **Shorted diode fault** protection is activated if the percentage of the field current harmonics is higher than the set point percentage after the time delay ends.

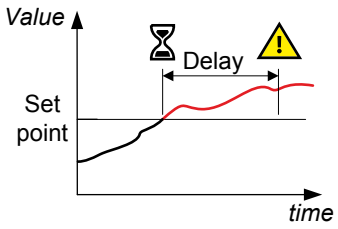


Table 2.6 Default settings

Parameter	Range	Default
Set point	1.00 to 100.00 %	10.00 %
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.8 Motor start fault

```
Protections / Machine fault
```

The **Motor start fault** protection is activated if the generator voltage is less than the rated voltage after the time delay ends.

The timer starts when excitation starts.

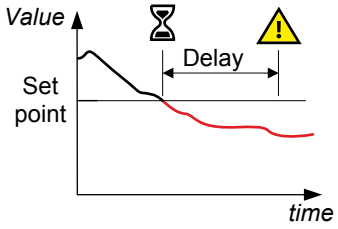


Table 2.7 Default settings

Parameter	Range	Default
Delay	Not configurable	30.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.9 Loss of sensing

```
Protections / Regulator fault
```

The **loss of sensing** protection is activated if the generator voltage is less than the set point percentage after the time delay ends.

This protection is deactivated during the short circuit, the soft start and when the voltage is regulated as specified by the U/f slope.

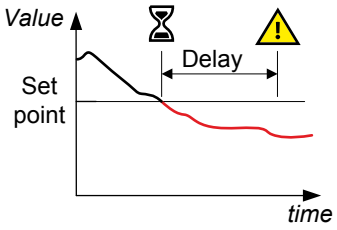


Table 2.8 Default settings

Parameter	Range	Default
Set point	0.00 to 100.00 %	20.00 %
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.10 Short circuit

```
Protections / Regulator fault
```

The **Short circuit** protection is activated if the generator current measurement is higher than the set point of the rated stator current after the time delay ends.

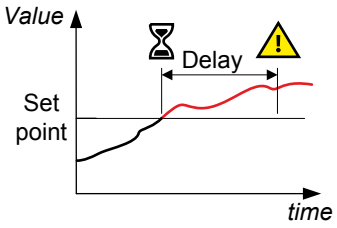


Table 2.9 Default settings

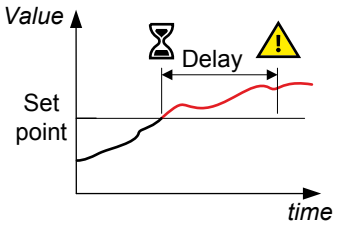
Parameter	Range	Default
Set point	0.00 to 500.00 %	200.00 %
Delay	0.00 to 3600.00 s	10.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

2.4.11 Unbalanced voltage

`Protections / Regulator fault`

The **Unbalanced voltage** protection is activated if the percentage of unbalance is equal to or higher than the set point percentage after the time delay ends.

This function is deactivated during the soft start.



Calculation

Calculation of the voltage unbalance as specified by the NEMA standard.

$$\text{Unbalance percentage} = \frac{\text{Maximum generator voltage}}{\text{Average of generator voltage}} \times 100$$

Table 2.10 Default settings

Parameter	Range	Default
Set point	0.00 to 200.00 %	20.00 %
Delay	0.00 to 3600.00 s	1.00 s
Action	No action, Stop regulation, Shutdown current, Field current before fault	No action
Auto-reset	Not enabled, Enabled	Not enabled
Activation	Not enabled, Enabled	Not enabled

3. Get started with DEIF EasyReg Advanced

3.1 About the utility software

The DEIF EasyReg Advanced is the utility software for the DVC 350.

It is easy to configure the parameter settings for the alternator, regulation, limits, and protection devices. You can also access log information and trending data with the utility software.

3.2 Set up

3.2.1 Download

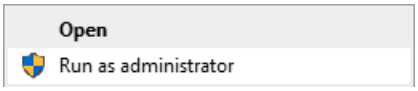
You can download DEIF EasyReg Advanced from the DEIF homepage.

1. Go to Power efficiency (deif.com)
2. Go to the support section in the top menu bar and click on software in downloads
3. Go to the software downloads list
4. Select DVC 350 EasyReg Utility Software
   - This page shows you the current software version and changelog.
   - You can also access the previous version(s) changelog(s) and license agreement.
5. Submit your email address and follow the instructions to download the software.

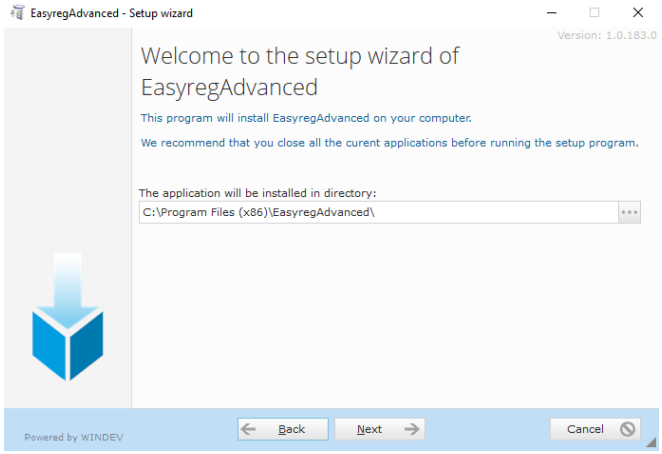
3.2.2 Install

NOTICE
Compatibility DEIF EasyReg Advanced is compatible with computers running Windows 7 or Windows 10 operating systems.

To install the utility software on your computer:

1. Run the installer as **Administrator** for your computer.
   - 

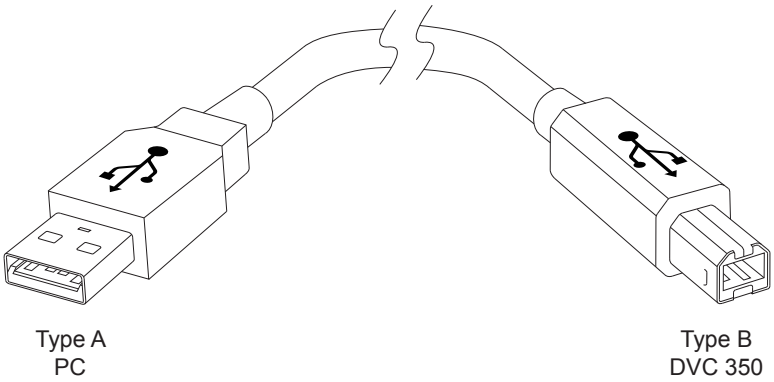
   - You must install the software with Administrator rights.
2. Select the installation language.
3. Select the installation type:
   - **Quick installation**
     - All files and folders are automatically created in the default locations.
   - **Custom installation**
     - You can choose the installation directory.



4. A summary is shown when the installation is complete.
   - You can manage the shortcuts created and start the software.

3.2.3 Connect

To connect the DVC 350 to your computer you will need a USB Type A to Type B cable.



To use the utility software with your DVC 350:

1. Connect the USB cable (shown above) to the DVC 350 and to your computer.
2. Start the DEIF EasyReg Advanced utility software.
3. The utility software tries to communicate with the DVC 350.
4. When the communication is established, **DVC 350 CONNECTED** is shown in the bottom left of the software.

3.2.4 Launch

Launch **DEIF EasyReg Advanced** from the installed location.

Example of a desktop shortcut:

3.3 Software access levels

DEIF EasyReg Advanced has two access levels. When you start the utility software you are asked to select one of the access levels.

Standard

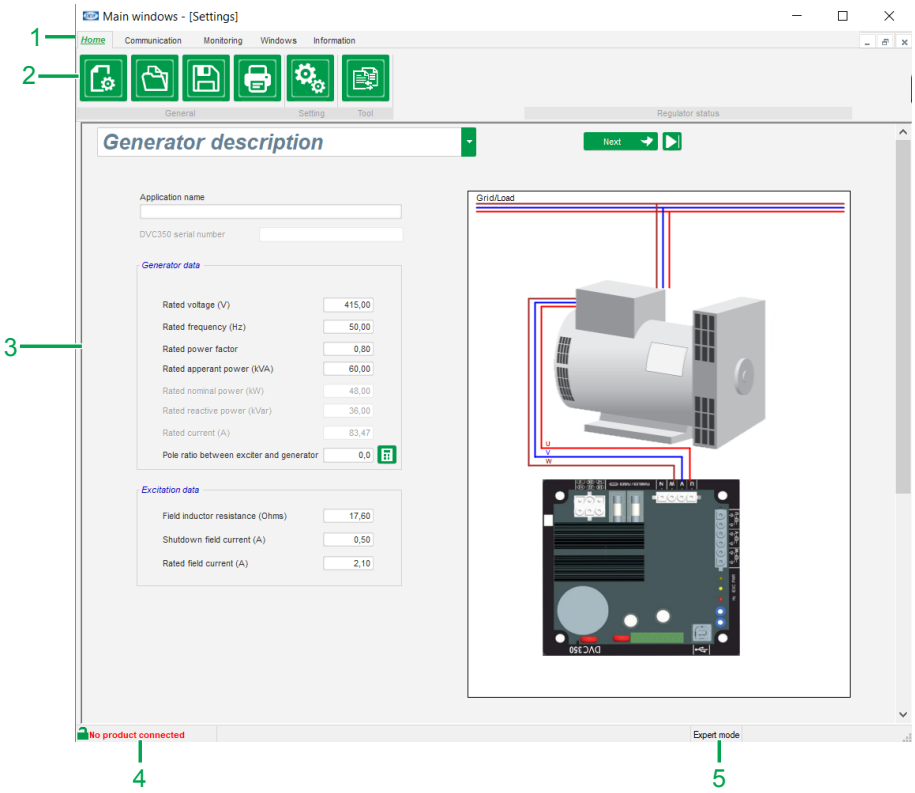
For read only access to the parameters and monitoring.

Expert

For full access to the different functions of the regulator and for creating a configuration.

4. DEIF EasyReg Advanced

4.1 General layout



No.	Item	Notes
1	Tabs	Shows the different tabs available.
2	Options	Shows the options in the selected tab.
3	Window	Window for the option selected.
4	Connection status	Shows if the DVC 350 is connected to the utility software.
5	Access level (mode)	Shows which access level was selected.

Navigate the different configuration pages

The configuration settings are configured on different pages.

You can use either the *Selection list* or *Navigation options* to go to the different configuration pages.

Figure 4.1 Selection list

Figure 4.2 Navigation options

Additional options

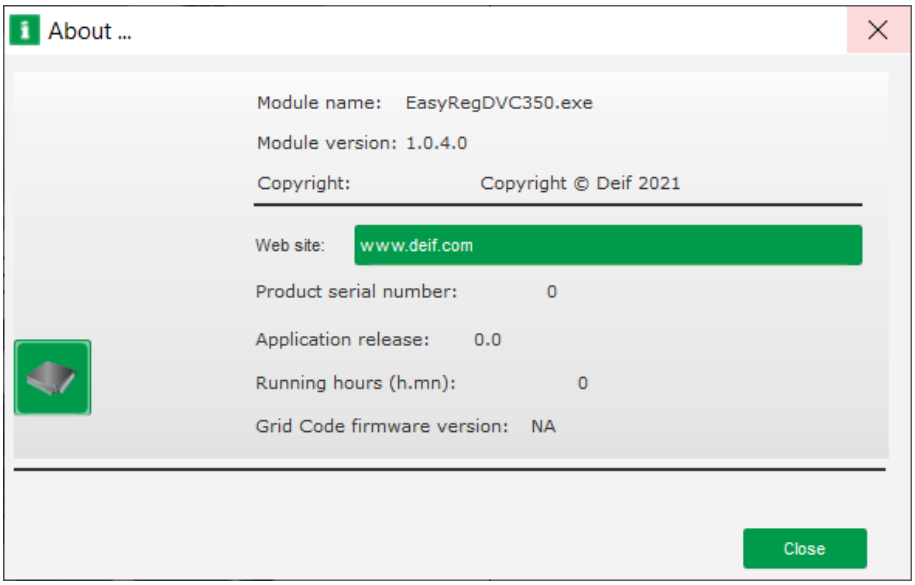
There are additional options available for some of the settings.

	Help	Opens the help for the setting.
	Calculator	Calculator for the setting.
	Direct upload	Uploads the setting to the DVC 350.

NOTE Not all settings have these options.

About information

Select the **Information** tab and then the option **Information** to see the about window:



This window shows:

- Software version
- Running hours counter in hours and minutes *
- Firmware upgrade

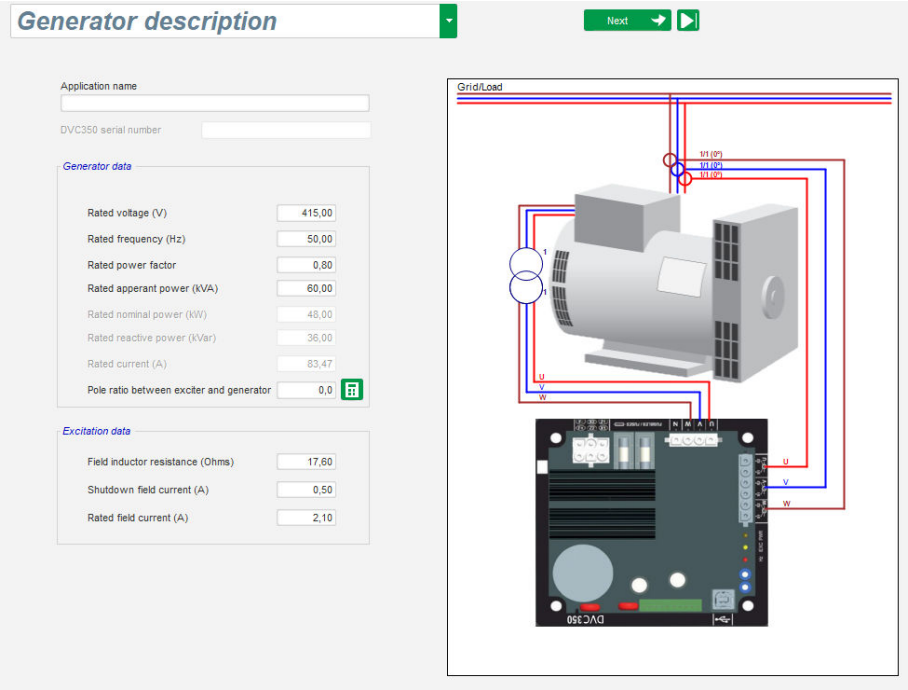
NOTE * This counter is updated at an interval of 10 minutes and only when the voltage regulation set point is reached.

To upgrade firmware, select the **Firmware** option and select a firmware file.

4.2 Configuration

4.2.1 Generator description

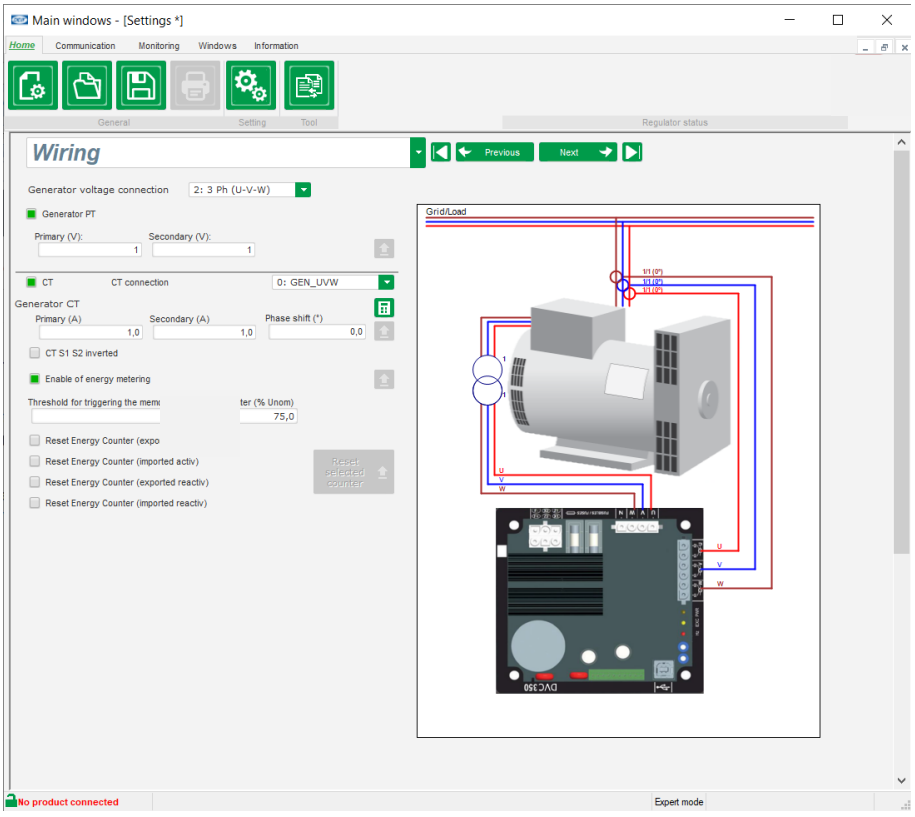
This page configures the electrical properties of the alternator and the field excitation settings.



4.2.2 Wiring

This page configures the wiring for the measurement inputs (alternator voltage and current).

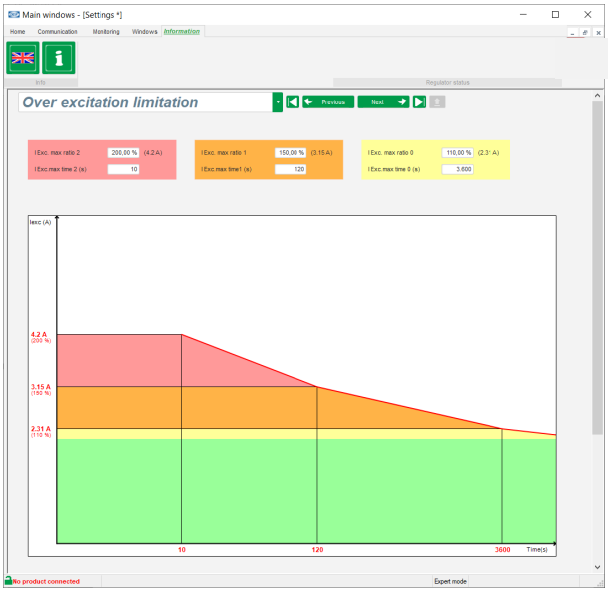
The preview drawing for the wiring configuration automatically changes when the settings are changed.



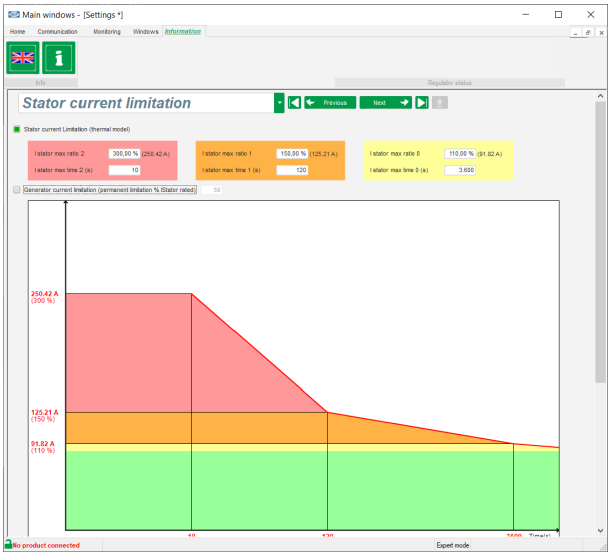
4.2.3 Limitations

The limitation pages configure the parameter settings for the stator current limits and the over excitation limits.

Over excitation limitation

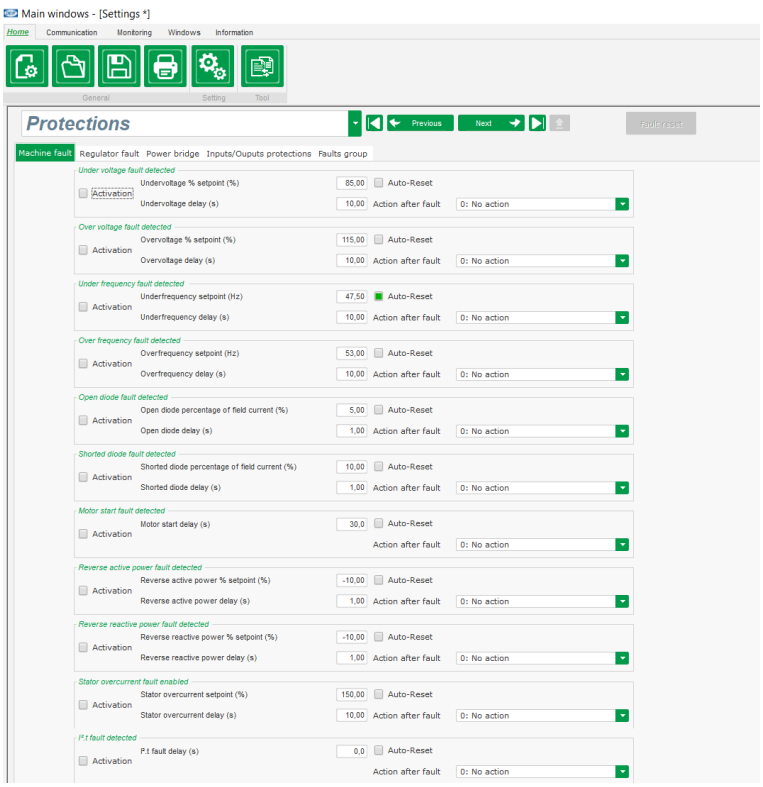


Stator current limitation



4.2.4 Protections

This page configures the protections given by the DVC 350.



There are 4 types of protections:

1. Machine faults (generator)
2. Regulator faults
3. Power bridge
4. Inputs/Outputs protections

All protections have the same settings:

- An activation of the protection
- A threshold
- A delay
- An action when the delay is over.

Actions after fault options

- 0: No action
  - The regulation will continue.
- 1: Stop regulation
  - The excitation is then stopped.
- 2: Shutdown current
  - Regulation in field current mode at shutdown value.
- 3: Field current before fault
  - No bump in the regulation.

Auto-reset option

Each protection has an auto-reset option:

- If selected and the fault disappears then regulation will go back to the automatic mode.
- If not selected then the fault action continues.

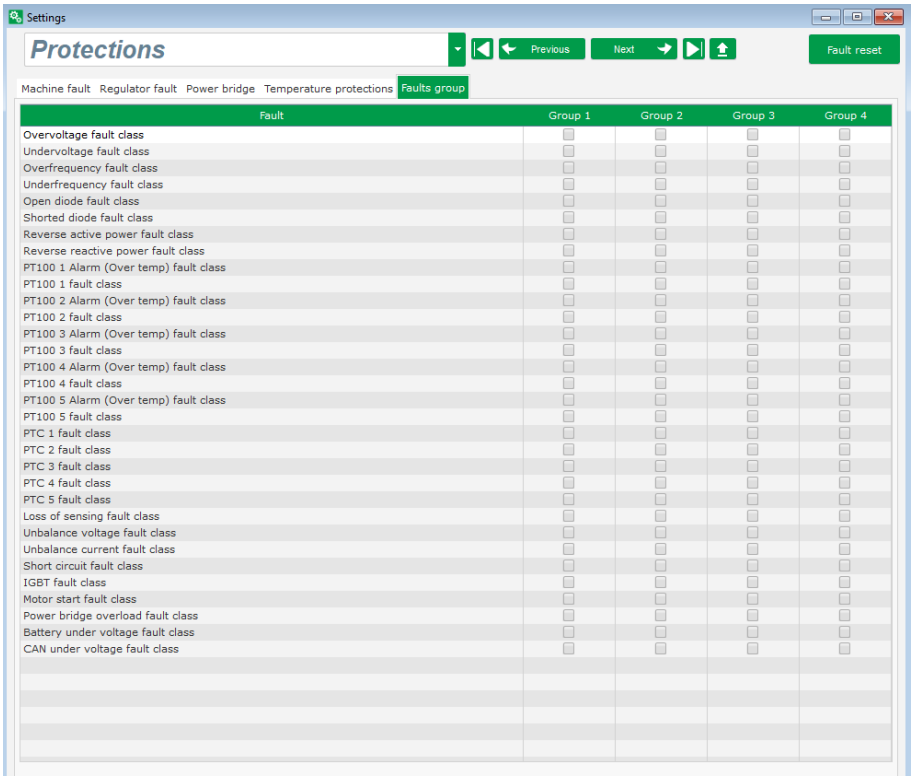
Faults group

You can put the faults in to a fault group:

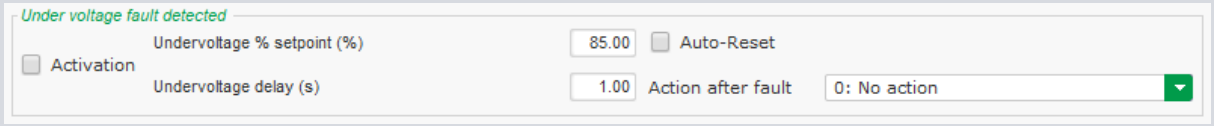
- Group 1
- Group 2
- Group 3
- Group 4

If a fault is activated in the group, the output for that group is also activated.

You can use the group output status with a digital output.



Example: Under-voltage protection

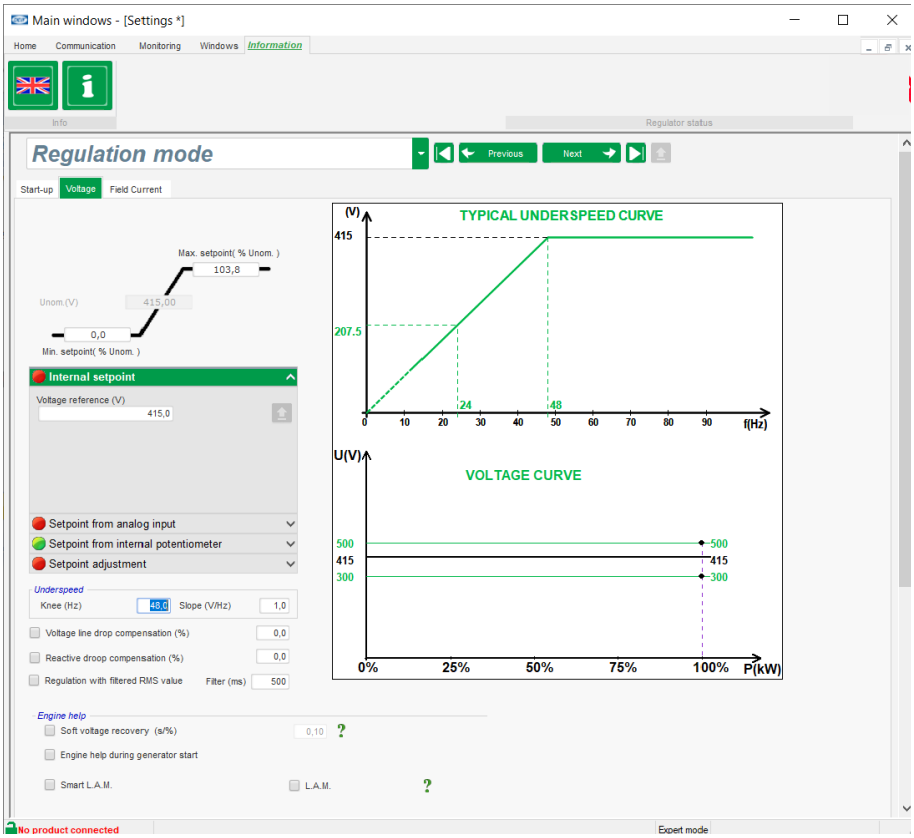


Activate protections are shown in green.

In this example, the **Under-voltage** protection is activated if the percentage of under voltage is less than or equal to 85 % for a minimum of 1 second.

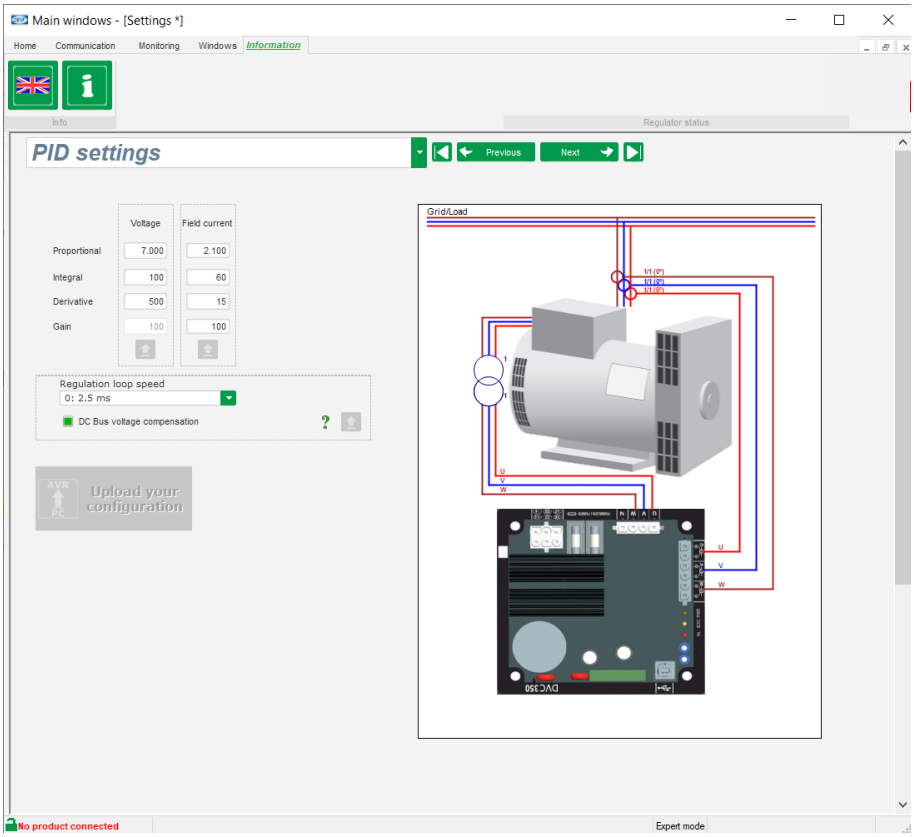
4.2.5 Regulation mode

This page configures the regulation parameter settings. This includes active regulations, references, and their adjustments.



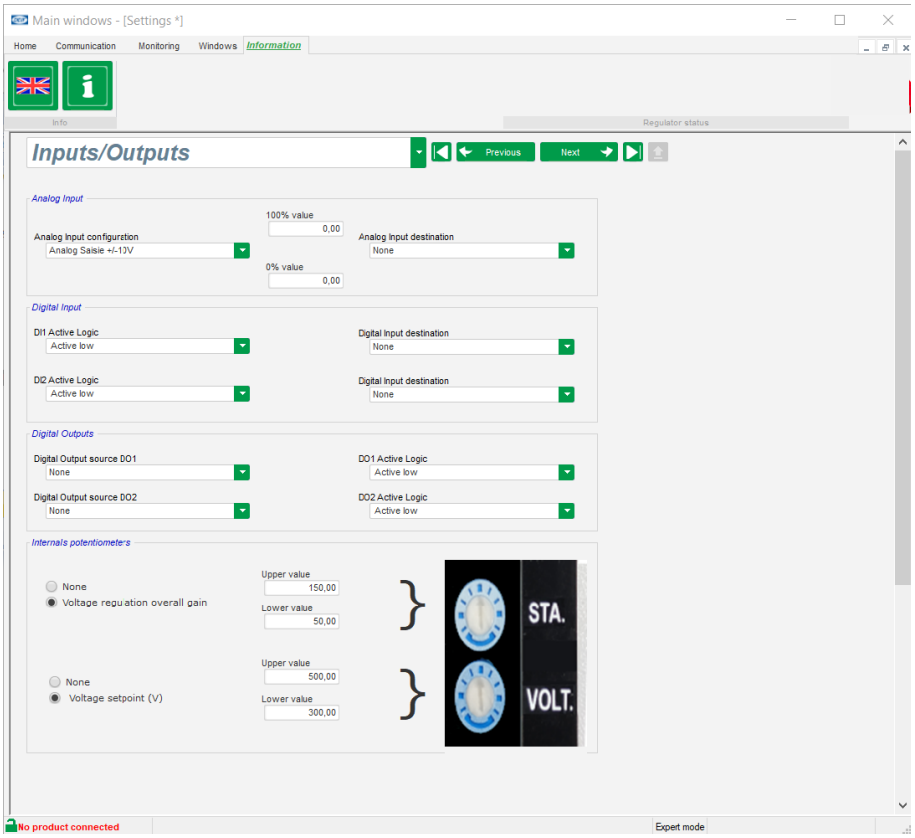
4.2.6 PID settings

This page configures the PID settings.



4.2.7 Inputs/outputs

This page configures the analogue input, the digital inputs and outputs, and the internal potentiometers.

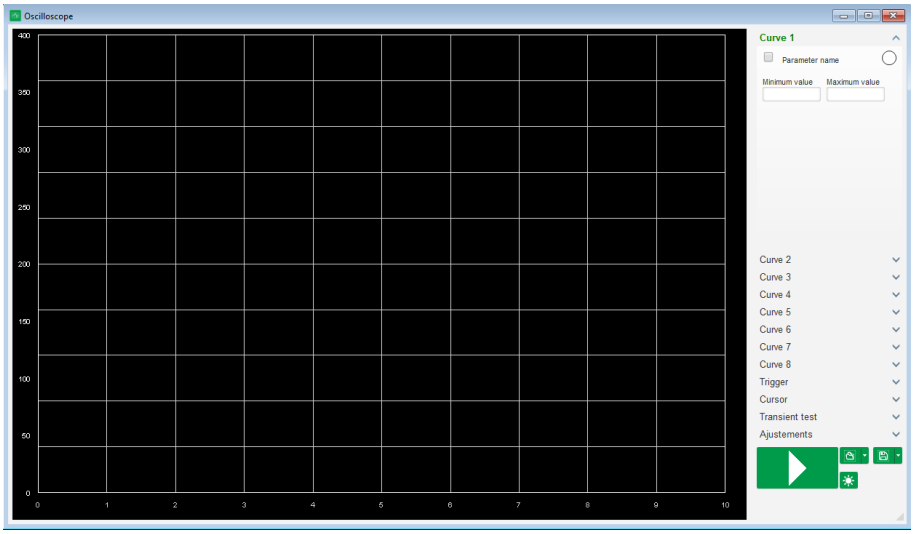


4.3 Oscilloscope

4.3.1 Oscilloscope window

Click on the oscilloscope symbol  in the *Monitoring* tab to see the oscilloscope window.

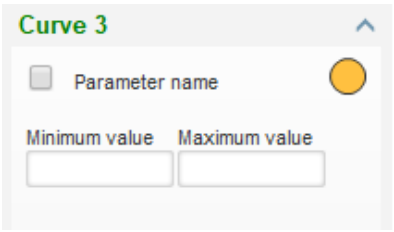
This window is used to trace the evolution of the measured values. It is possible to trace up to 8 parameters at the same time.



4.3.2 Curves

Each curve has these settings:

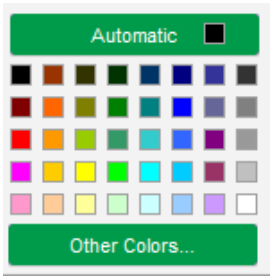
- Parameter name
- Minimum value
- Maximum value
- Colour



Each curve has its own axis, which is the same colour as the curve.

Select the coloured circle to change the colour.

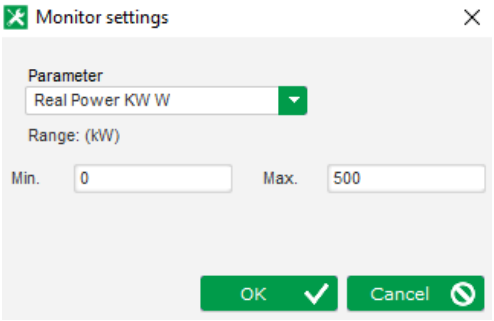
Select a predefined colour or create your own colour in **Other colors**.



Select **Parameter name** to add or change a parameter.

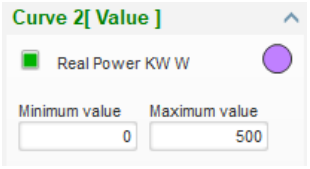
Select the parameter from the drop-down list. You can select an analogue or digital value.

Select **OK** to use the parameter.



You can change the minimum and maximum values.

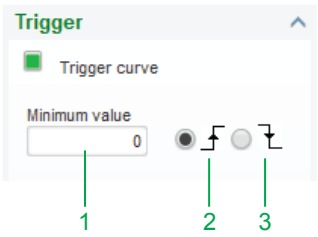
The curve is automatically adjusted when the values are changed.



When the oscilloscope is on, you can see the measured value under **Instant values**.

4.3.3 Trigger

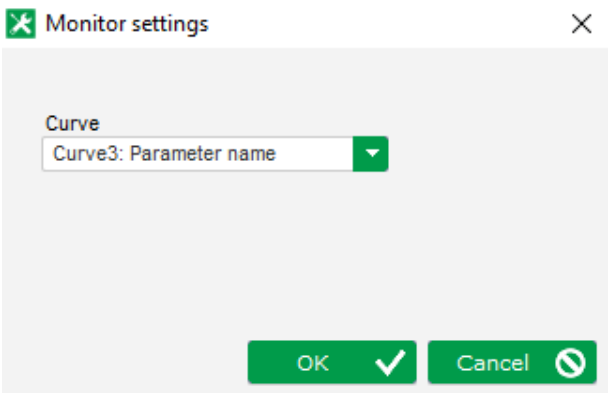
The trigger is used to start an oscilloscope operation, when the selected parameter value is higher than the trigger value entered. The operation is an overshoot either up (up arrow) or down (down arrow).



No.	Notes
1	Trigger value.
2	Up.
3	Down.

Select **Trigger** and select the curve.

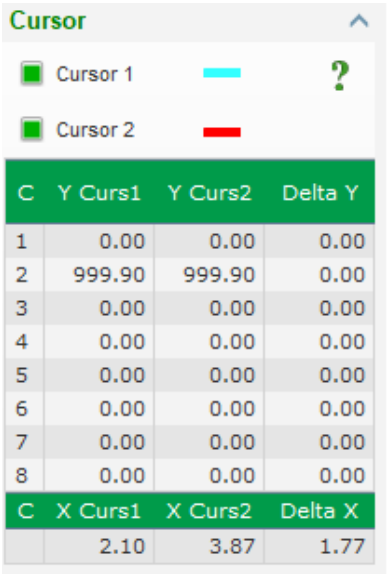
- Enter the threshold value.
- Select the overshoot direction (up or down).
- To start the trigger, select **GO**.
- To cancel the trigger, deselect the curve.



4.3.4 Cursors

You can use the two cursors to measure data on the curves.

The difference between the two values of Y is shown in **Delta Y** column for each curve. The two Y values are where the curves intersect the two cursors. The difference between the two values of X is shown in **Delta X** column(time in seconds) and is the time between the two cursors.



C	Y Curs1	Y Curs2	Delta Y
1	0.00	0.00	0.00
2	999.90	999.90	0.00
3	0.00	0.00	0.00
4	0.00	0.00	0.00
5	0.00	0.00	0.00
6	0.00	0.00	0.00
7	0.00	0.00	0.00
8	0.00	0.00	0.00
C	X Curs1	X Curs2	Delta X
	2.10	3.87	1.77

4.3.5 Transient test

The transient test is used to check the PID response when you change the voltage reference. The test has a maximum of 5 steps, and each step can have a different reference value.

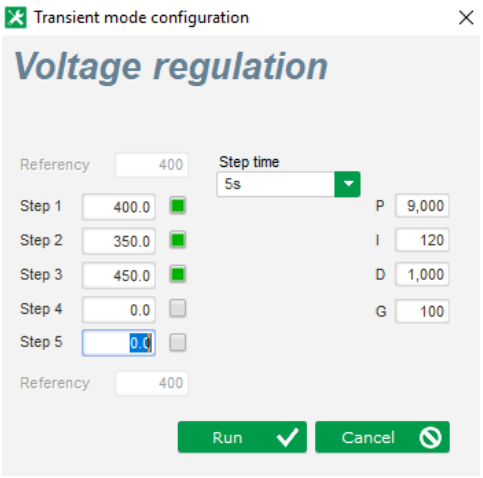
You can change the PID values directly in the transient test window, and don't have to go to the PID settings page to change the values.

Select **Start a transient test** to configure the options:

- Select the tick box for each of the steps you want to include in the test.
- For each selected step, give a reference value.
- Give a step time between each step.

You can change the PID values to adjust the gains.

Select **Run** to start the test.



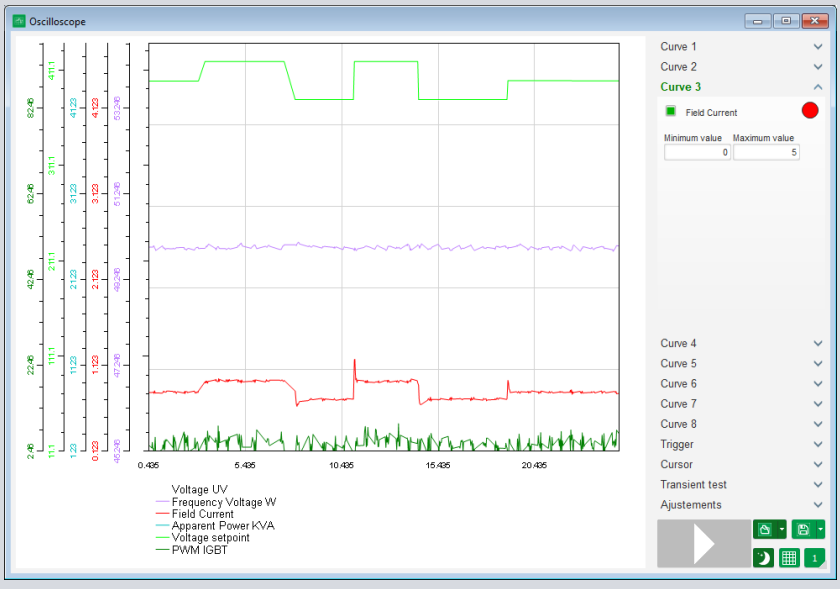
For the steps in progress the reference value will change to green.

Select **Stop the transient test** to stop the test at all times. The display then goes back to the original reference.

You cannot do the transient tests if the control reference input is controlled by an analogue input, as this control mode has priority.

During the transient test, values that are more than the specified maximum limit or less than the minimum limit will not be used.

Example

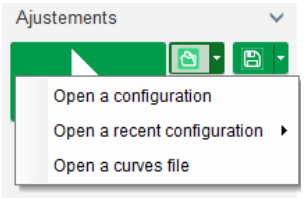


4.3.6 Open a curve or an oscilloscope configuration

You can only open files created with DEIF EasyReg Advanced.

Select the **Open** down arrow at the bottom right to open either a configuration or a curves file.

When a curve file is opened, the curve configuration in progress is replaced by the saved curve configuration.



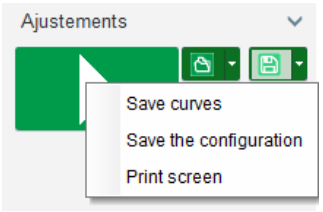
4.3.7 Save a curve or an oscilloscope configuration

Select the **Save** down arrow at the bottom right to:

- Save the curves file
- Save the configuration
- Print screen

save either a configuration or a curves file.

Print screen lets you to save an image of the oscilloscope.

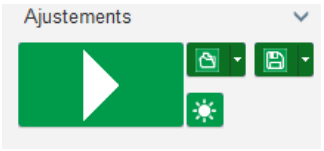


4.3.8 Change the plotting area background

You can change the oscilloscope background colour.

Select **Light** for a white background.

Select **Dark** for a black background.



4.3.9 Zoom feature

You can zoom in (or out) on the oscilloscope plotting area.

First select in the oscilloscope plotting area.

- Hold the **Ctrl** key and use the mouse wheel:
  - Both the X and Y axes are then changed.
- Hold the **Alt** key and move the mouse wheel:
  - Only the X axis is changed, the scales on the Y axis stay the same.
- Hold the **Shift** key and move the mouse wheel:
  - Only the Y axis is changed, the scales on the X axis stay the same.

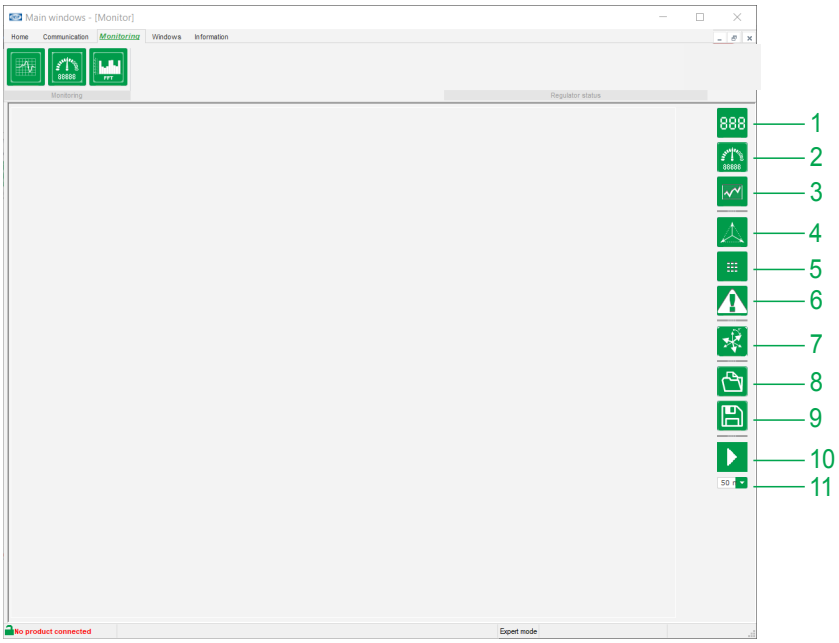
4.4 Monitor

4.4.1 Monitor window

Click on the monitor symbol 

in the *Monitoring* tab to see the monitor window.

The monitor window is used to display parameters. You can configure which parameters to display and how you want to monitor the parameters, for example with gauges, graphs and display units. You can add, move, change or delete parameters in the monitor window.



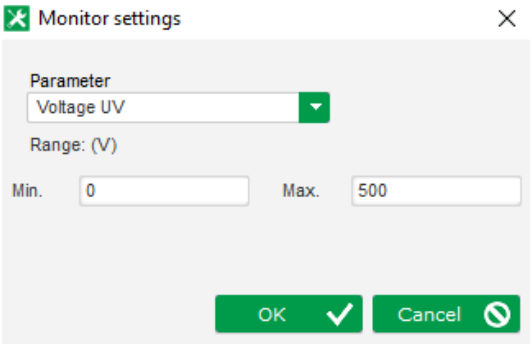
No.	Item
1	New display
2	Gauge
3	Single curve graph
4	Fresnel diagram
5	I/O status
6	AVR status
7	CT phase shift adj.
8	Open a monitor configuration
9	Save a monitor configuration
10	Start monitor
11	Sampling speed

4.4.2 Add a display

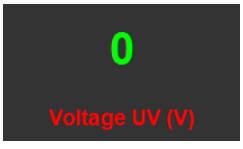
You can add a new display for a parameter.

Select the **New Display**  icon.

Select the parameter you want from the drop-down list.



This parameter is either an analogue or a digital value.



Select **OK** to see the selected parameter.

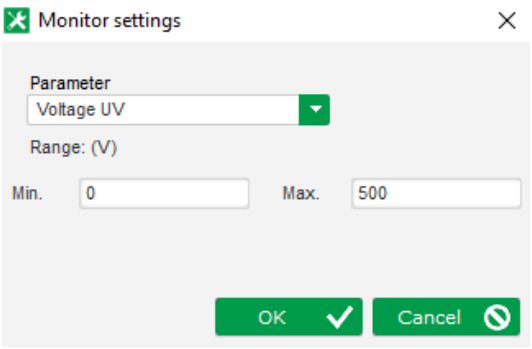
The display is added to the monitor in the next free slot. The slots are placed from left to right and then from the top to the bottom.

4.4.3 Add a curve

You can add a new curve for a parameter.

Select the **New curve** icon.

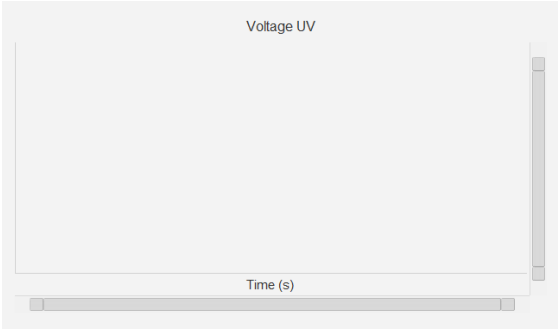
Select the parameter you want from the drop-down list.



You can select an analogue or a digital value.

Select **OK** to see the selected parameter.

The curve is added to the monitor in the next free slot.

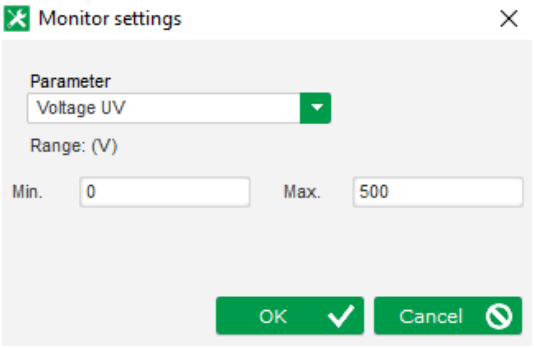


4.4.4 Add a gauge

You can add a new gauge for a parameter.

Select the **New gauge** icon.

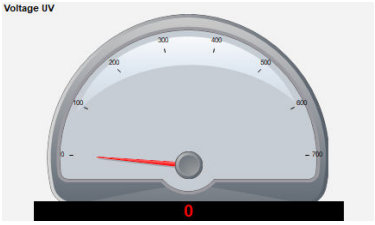
Select the parameter you want from the drop-down list.



You can select an analogue or a digital value.

Select **OK** to see the selected parameter.

The gauge is added to the monitor in the next free slot.

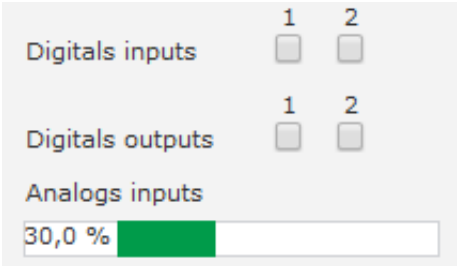


4.4.5 Add inputs/outputs

You can add an inputs/outputs panel. *

Select the **Inputs/outputs Analogs/Digitals** icon.

The inputs/outputs panel is added to the monitor in the next free slot.



NOTE * You can only add one inputs/outputs panel to the monitor.

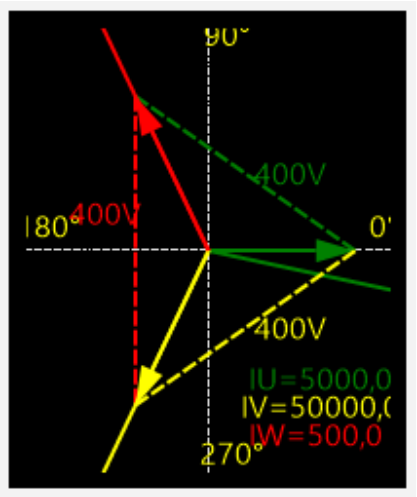
4.4.6 Add Fresnel diagram

This panel is the alternator Fresnel diagram with current, voltage and current phase shift values for each phase.

You can add a new Fresnel diagram for a parameter. *

Select the **Fresnel diagram** icon.

The panel is added to the monitor in the next free slot.



NOTE * You can only add one Fresnel diagram to the monitor.

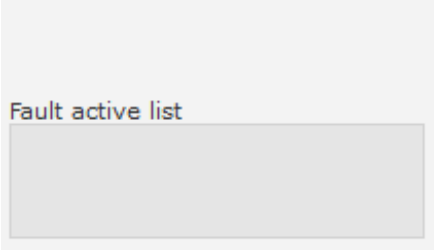
4.4.7 Add AVR status and faults

This panel shows the DVC 350 operating information, the regulation mode in progress, and a list of active faults.

You can add the AVR status and faults panel.

Select the **AVR status** icon.

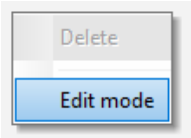
The panel is added to the monitor in the next free slot.



4.4.8 Edit mode: Resize or delete panels

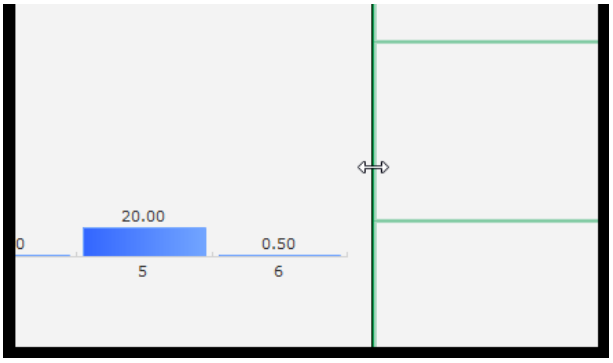
To change to **Edit mode**:

Right click in the monitor area and select **Edit mode**.
A grid is then shown in the monitor area.

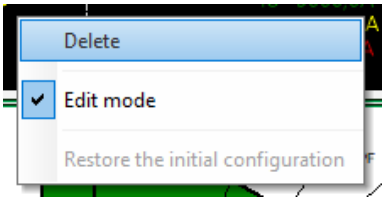


To resize a panel:

- Move over a side or the bottom right corner of the panel.
- Select and drag to resize the panel.

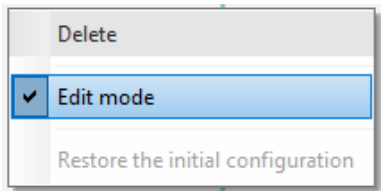


Right click on a panel and select **Delete** to remove that panel.



To leave **Edit mode** either:

- Right click in the monitor area and select **Edit mode** again to stop editing.
- Press **Esc** on your keyboard to stop editing.



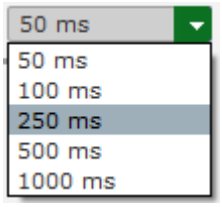
4.4.9 Start or stop monitor

To start monitoring select the start icon.

To stop monitoring select the stop icon.

You can change how frequently the monitor window is refreshed.

Use the drop-down list to select a new refresh time.

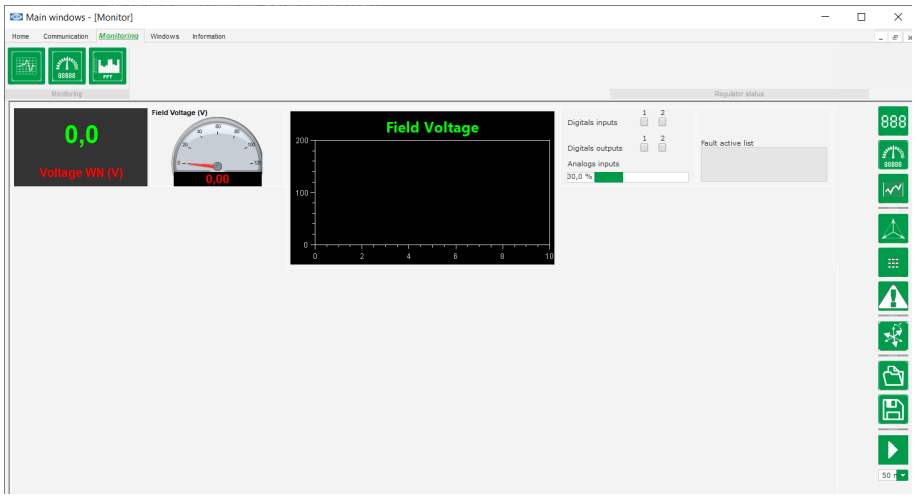


4.4.10 Save a monitor configuration

Select **Save**  to save the monitor configuration.

4.4.11 Open a monitor configuration

Select **Open**  to open a monitor configuration.

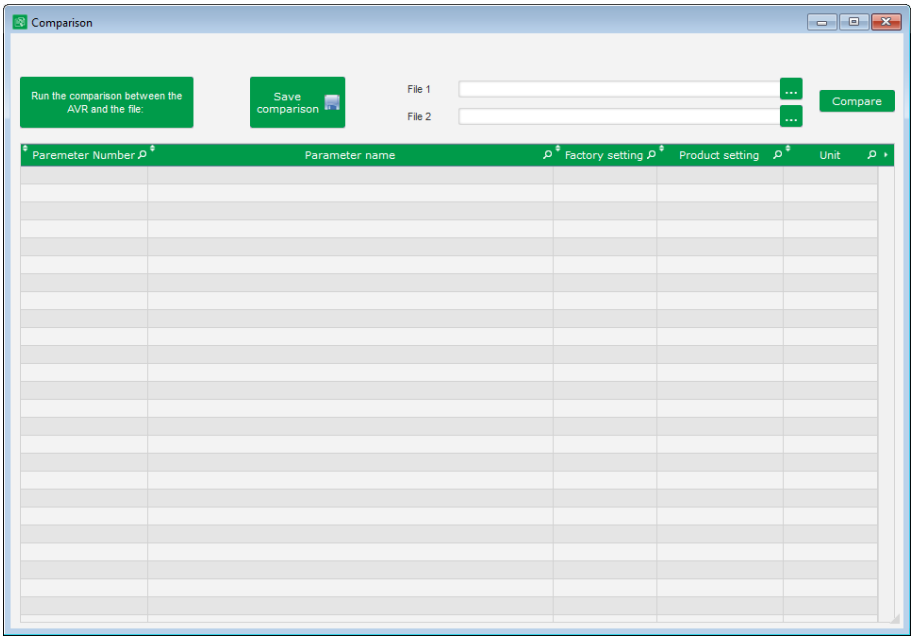


4.5 Comparison window

Click on the comparison symbol  in the *Home* tab to see the monitor window.

This window is used to compare configuration settings.

You can compare the DVC 350 configuration with a file, or you can compare two configuration files.



Compare the DVC 350 with a configuration file

Select **...** under File 1 and select a configuration file.

Select **Run the comparison between the AVR and the file**.

Differences between the configuration file and the DVC 350 are shown in a list.

Paremeter Number	Parameter name	Open file value	AVR Value	Unit
002.010	Stator current Limit Enable	Active	Not active	
005.019	DI3 Destination	0	2003	
005.022	DI6 Destination	2003	0	
016.005	Generator rated current (calculated)	86.60254037844	86.6	A

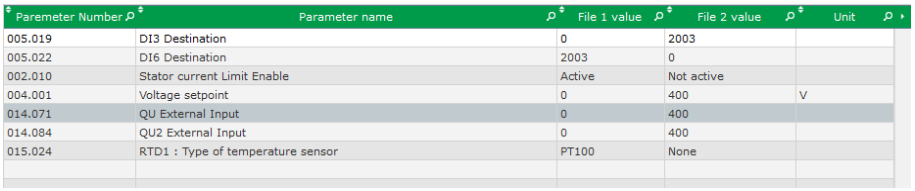
Compare two configuration files

Select **...** under File 1 for the first configuration file.

Select **...** under File 2 for the second configuration file.

Select **Compare**.

Differences between the two files are shown in a list.

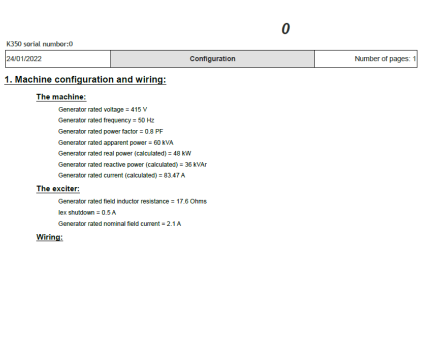


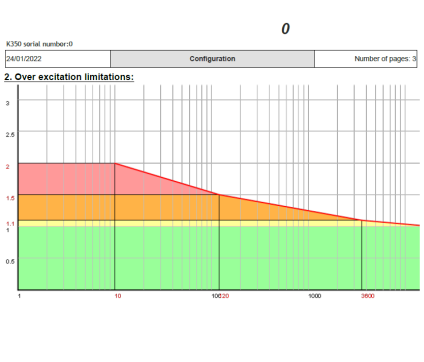
Paremeter Number	Parameter name	File 1 value	File 2 value	Unit
005.019	DI3 Destination	0	2003	
005.022	DI6 Destination	2003	0	
002.010	Stator current Limit Enable	Active	Not active	
004.001	Voltage setpoint	0	400	V
014.071	QU External Input	0	400	
014.084	QU2 External Input	0	400	
015.024	RTD1 : Type of temperature sensor	PT100	None	

4.6 Create a PDF report

You can create a PDF report of the configuration settings.

Select **Print** in the **Home** option.



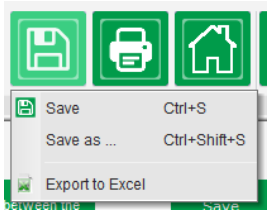


4.7 Export to Excel

You can export the configuration settings as an Excel spreadsheet.

Select **Save** in the **Home** option.

Select **Export to Excel** .



The file created contains each parameter with:

- Identifier (ID)
- Parameter name
- Minimum value
- Maximum value
- Value measured
- Default value
- Unit

Id	Parameter name	Minimum value	Maximum value	Value	Initial value	Unit
000.000	Monitor Menu					
000.001	U	0	100000	0	0	V
000.002	I	0	10000	0.0	0	A
000.003	P	0	1000000	0	0	kW
000.004	PF	-1	1	0.000	0	PF
000.005	F	0	500	0.0	0	Hz
000.006	U21	0	100000	0	0	V
000.007	U32	0	100000	0	0	V
000.008	U13	0	100000	0	0	V
000.009	I1	0	10000	0.0	0	A
000.010	I2	0	10000	0.0	0	A
000.011	I3	0	10000	0.0	0	A
000.012	Q	0	1000000	0	0	kVAR
000.013	S	0	1000000	0	0	kVA
000.014	If	0	50	0.00	0	A
000.015	Vf	0	500	0.0	0	V
000.016	Vbus	0	500	0.0	0	V
001.000	SystemData					
001.001	Voltage UN	0	100000	44	0	V
001.002	Voltage VN	0	100000	44	0	V
001.003	Voltage WN	0	100000	45	0	V
001.004	Voltage UV	0	100000	77	0	V
001.005	Voltage VW	0	100000	77	0	V
001.006	Voltage WU	0	100000	77	0	V
001.007	Line Current U	0	10000	5.2	0	A

5. Configure the DVC 350

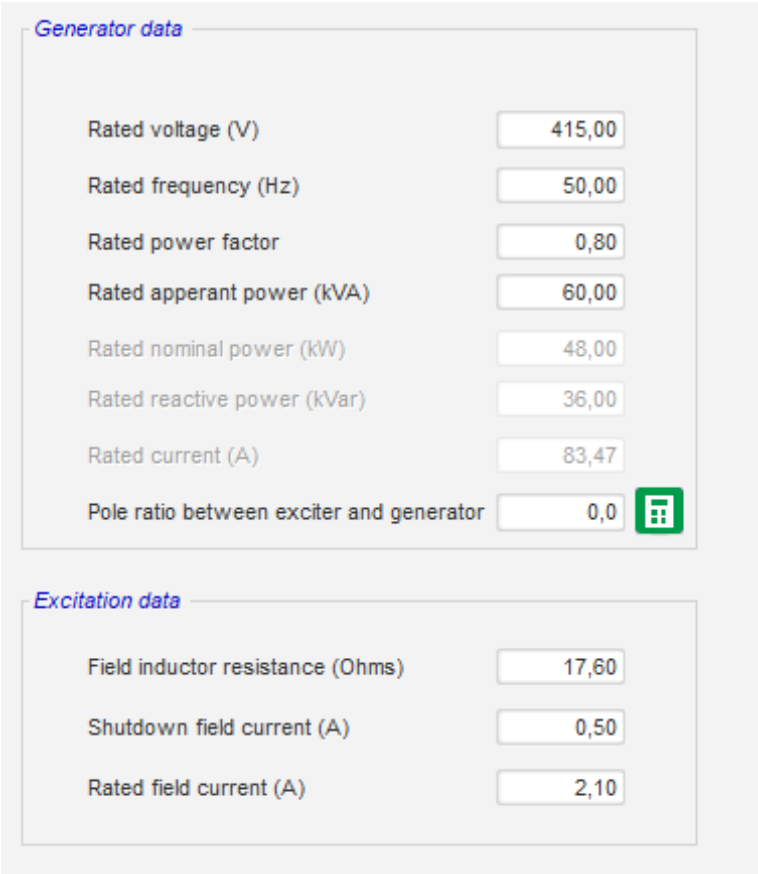
5.1 Generator description

Generator data

Describe the alternator electrical properties: voltage (in Volts), frequency (in Hz), power factor and apparent power (in kVA).

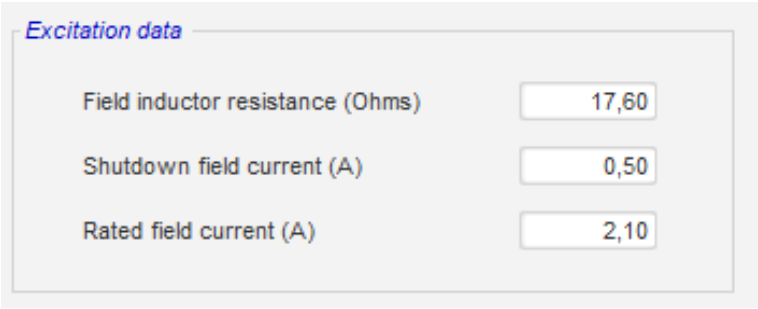
Fields: nominal power, reactive power and rated current are calculated automatically.

Pole ratio for diode fault (exciter poles number divided by generator poles number).



Excitation data

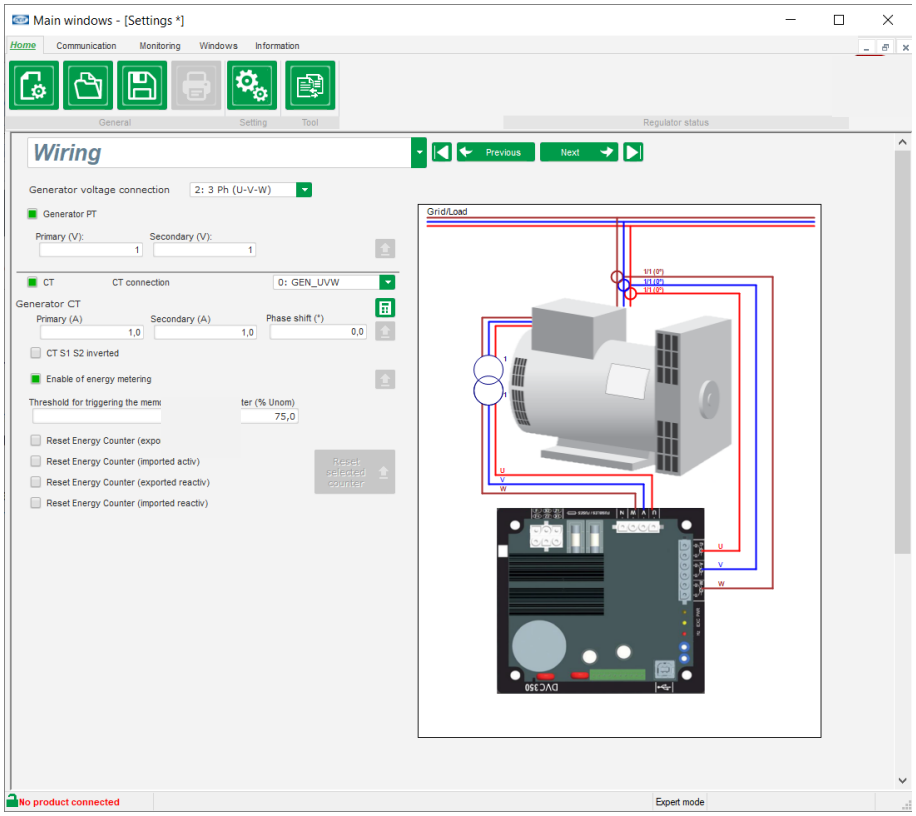
Describe the field excitation properties: field inductor resistance (in Ω), shutdown field current (in Amps), and rated field current (in Amps).



5.2 Wiring

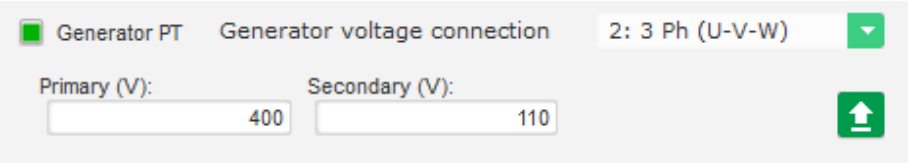
Configure the wiring connections between the DVC 350 and the alternator.

The wiring preview changes when the settings change.



Alternator voltage measurement PTs

- Give the primary and secondary winding voltages (in Volts).
- Give the type of measurement: phase-neutral, phase-phase, 3 phases or 3 phases and neutral using the drop-down menu.



Alternator current measurement CTs

- Give the primary and secondary winding currents (in Amps).
- Give the CT configuration using the drop-down menu.

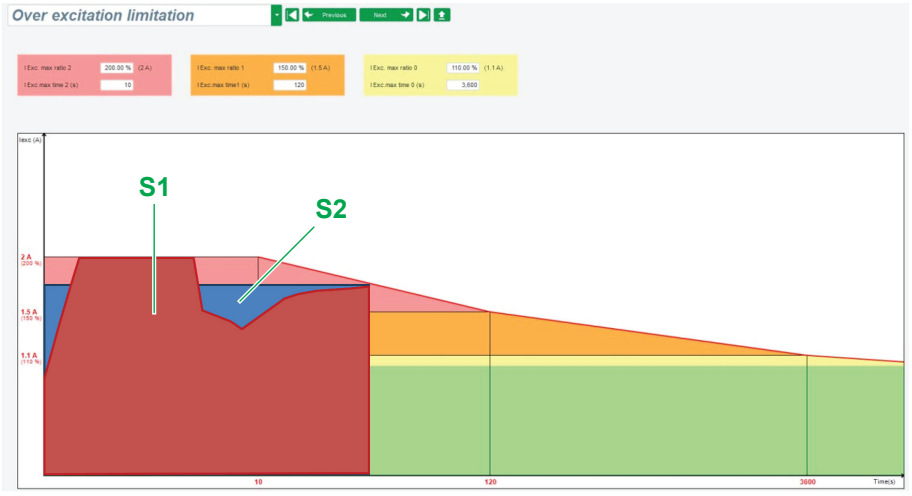
NOTE The phase shift value should be set during tests and commissioning. It is used to compensate for the phase difference caused by the CTs and VTs.

When the CT only measures part of the generator total current, use the advanced CT configuration mode to complete the configuration.

5.3 Limitations

5.3.1 Over excitation limitation

The over excitation limitation is divided into 3 parts. The parts are specified by 3 adjustment values. To determine these values refer to the machine capability.



The standard adjustment values are:

- 2 times the rated field current for 10 seconds for the stator short-circuit.
- 1.5 times the rated field current for 10 seconds up to 120 seconds.
- 1.1 times the rated field current for 10 seconds up to 3600 seconds.

When the field current is more than the value of the rated current, a counter is triggered.

The **S1** “field current measurement x time” area (shown in red) is then compared with the **S2** “maximum field current x time” area (shown in blue).

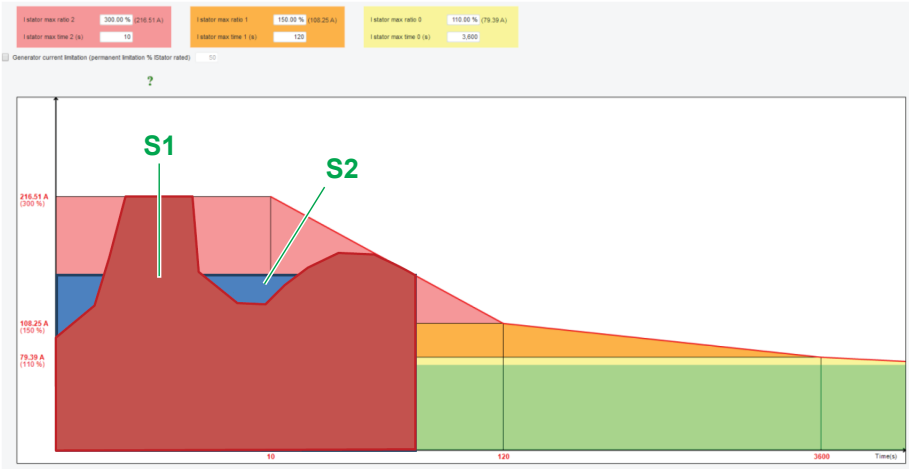
If **S1** equals **S2**, the limit is active and the DVC 350 limits the field current to 99 % of the rated current (and the regulation mode reference is not tracked).

NOTE If the limit is active, in order to protect the machine, it is only possible to have a current higher than 99 % of the rated current after 24 hrs.

5.3.2 Stator current limitation

The stator current limitation only works in the voltage regulation mode, and with a CT configured to measure the stator current.

The stator current limitation is divided into 3 parts. The parts are specified by 3 adjustment values. To determine these values refer to the machine capability.



The standard adjustment values are:

- 3 times the rated stator current for 10 seconds for the stator short-circuit.
- 1.5 times the rated stator current for 10 seconds up to 120 seconds.
- 1.1 times the rated stator current for 10 seconds up to 3600 seconds.

When the stator current is more than the value of the rated current, a counter is triggered.

The **S1** "stator current measurement x time" area (shown in red) is then compared with the **S2**“maximum stator current x time” area (shown in blue).

If **S1** equals **S2**, the limitation is active and the DVC 350 enables the over-current fault and the red LED flashes to indicate an irregular operation.

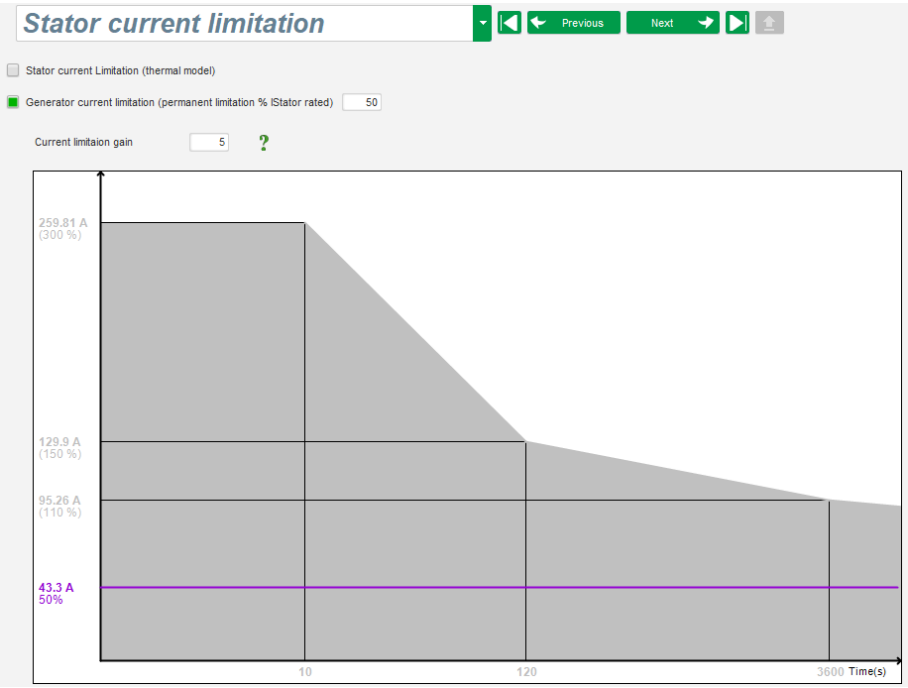
5.3.3 Generator current limitation

You can also enable **Generator current limitation**. The generator current limitation is found in the window for the stator current limitation.

This is a permanent limitation percentage (%) of IStator rated (A).

In this example, it is 50 % (43.3 A), as shown by the purple line.

It is necessary to adjust the current limitation gain to improve the regulation stability during the motor starting sequence.



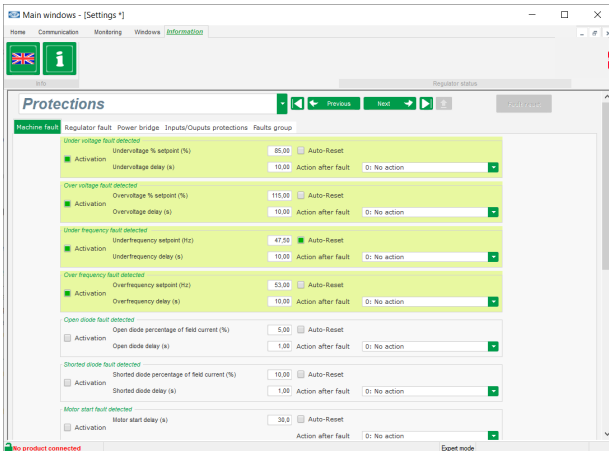
5.4 Protections

5.4.1 Protections

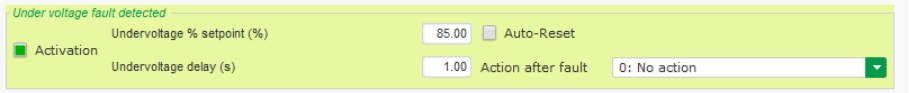
Configure the protections given by the DVC 350.

Examples:

- Over-voltage
- Under-voltage
- Over-frequency



To enable a protection, select **Activation** and then configure the settings.



Active protections are shown in green.

More information
See **Protections** in **About the DVC 350** for more information about each of the protections, their setting ranges, and their default settings.

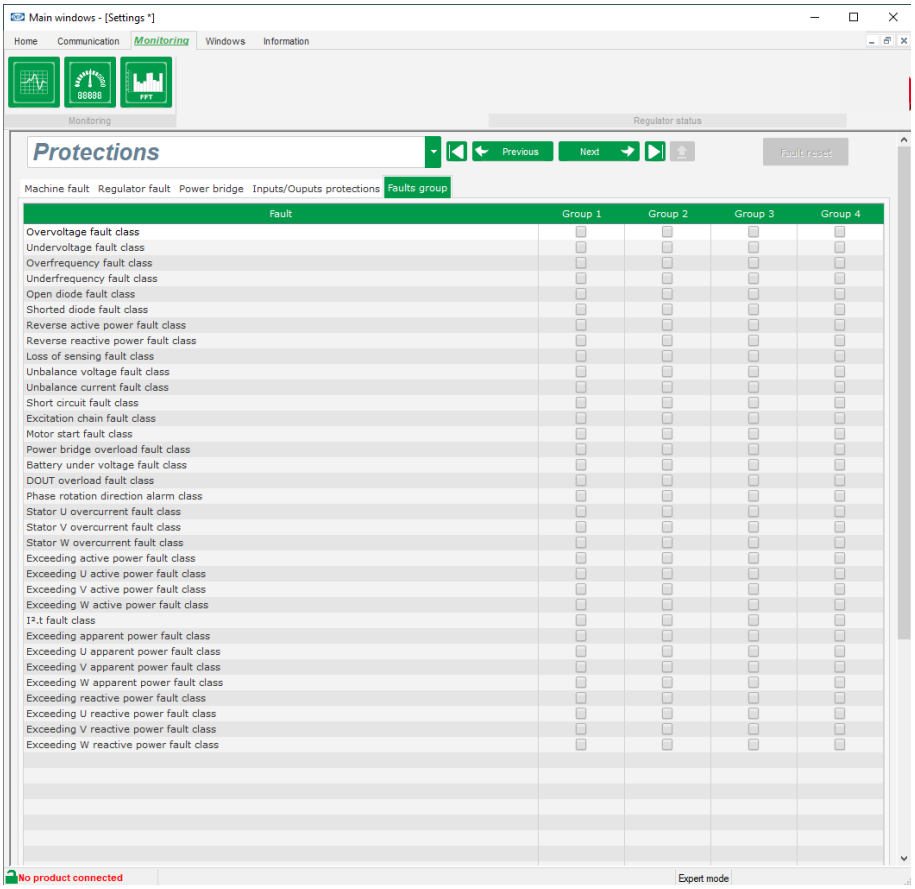
5.4.2 Faults group

You can put faults in to a fault group:

- Group 1
- Group 2
- Group 3
- Group 4

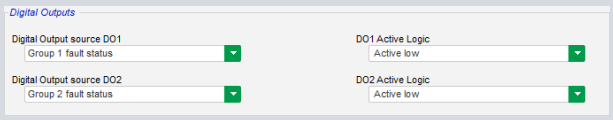
If a fault is activated in the group, then the entire group is activated.

You can use the group output status as the output for a digital output.



Example with a digital output

The output from **Group 1 fault status** is used as the output on **DO1** and the output from **Group 2 fault status** is used on **DO2**:



5.5 Regulation mode

5.5.1 Determine the regulation mode

The configuration of the regulation mode depends on the alternator operation:

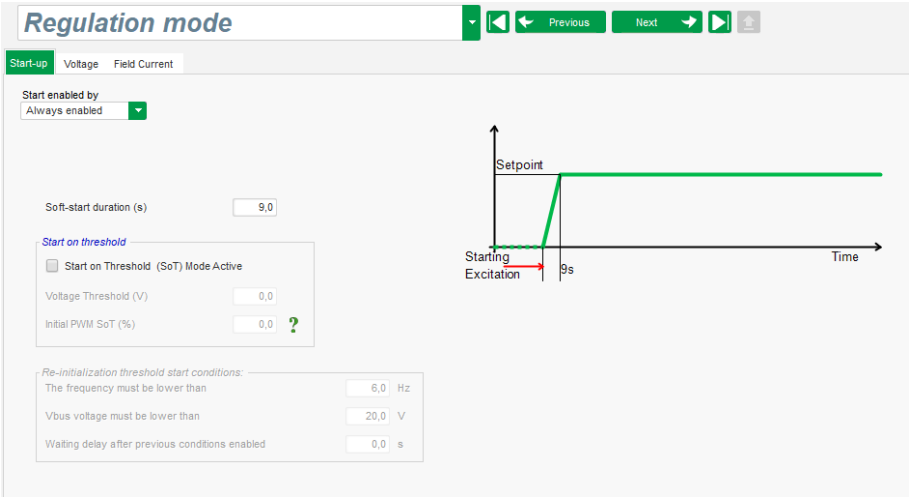
- Stand-alone.
- Parallel between machines.

More information
If the alternator is not connected to the grid, continue configuration from **Regulation mode, Field current (manual mode)**.

5.5.2 Start-up

Select how the start-up is enabled from the drop-down list:

- **DI1** or **DI2** (digital input).
- **Always enabled**.
  - For a start without external orders, select **Always enabled**.



A voltage build-up is done through the soft start and the start on threshold functions.

Soft start

The soft-start duration (s) is the time it takes to get to the voltage set point (or the excitation current set point) of the generator.

To start immediately, put **0** s in the ramp time.

Start on threshold

Start on threshold is the first part of the excitation ramp (if start on threshold is activated).

To use the start on threshold, select the **Start on Threshold (SoT) mode Active** and configure the values:

- **Initial PWM SoT (%)**: the percentage of the available voltage (rectified from the excitation AC supply) that is applied to the exciter stator until the voltage gets to the voltage threshold.
- **Voltage Threshold (V)**: when the machine gets to the threshold, the voltage regulation is activated.

Re-initialization threshold start conditions

To stop excitation and begin the start on threshold, these start conditions must be correct:

1. Frequency less than the fixed frequency
2. DC bus voltage less than the fixed voltage level
3. A waiting delay after validating the first two conditions

5.5.3 Voltage regulation

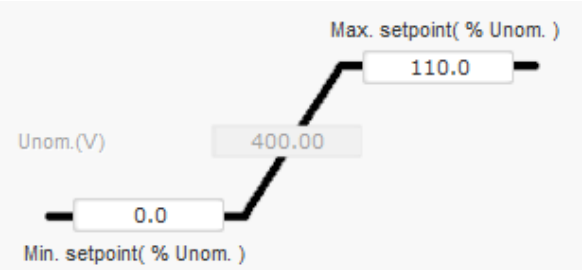
The set point is configured by either:

- An **internal set point** fixed reference.
- An **analogue input** set with a range.
- An **internal potentiometer**, which is the default configuration.

If a value is configured, it can be changed with the CAN bus.

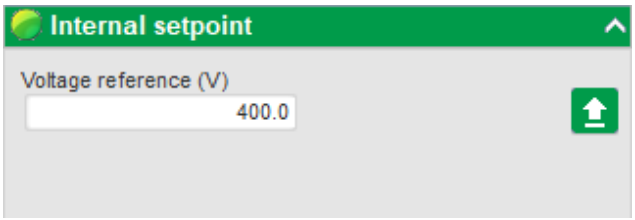
The limits of the set point are the absolute limitations of the setting and are used for all the methods for set point configuration (internal set point, analogue input, or internal potentiometer).

In this example, the minimum voltage set point 0 % of 400 V, and the maximum voltage set point is 110 % of 400 V.



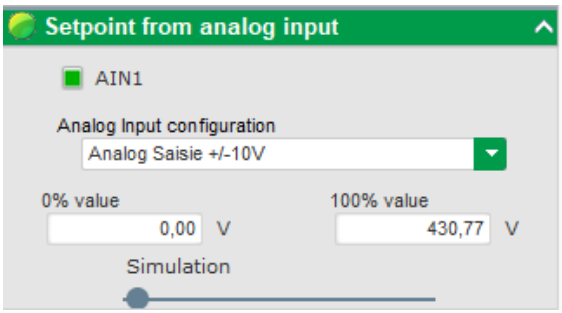
For **Internal set point** reference:

Configure the reference set point value.



For **Analogue input** set point:

Select AIN1 to enable the analogue input.



Select the analogue input configuration:

- 4 to 20 mA
- 0 to 10 V
- +/-10 V
- +/-5 V

Configure the voltage reference for 0 % and 100 % values.

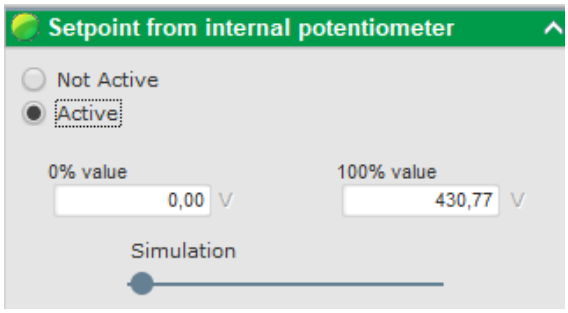
Use **Simulation** to change the values on the voltage and under-speed curves shown to the right.

NOTE You can interchange the voltage terminals if needed. For example, the minimum voltage for 100 % of the analogue input, and the maximum voltage for 0 % of the analogue input.

For **internal potentiometer** set point:

Configure the voltage reference for 0 % and 100 % values.

Use **Simulation** to change the values on the voltage and under-speed curves shown to the right.



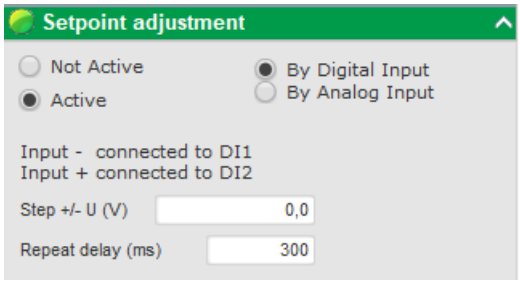
Set point adjustment

The **Set point adjustment** is only available to configure when used with the **Internal set point** or **Internal potentiometer** reference. This option is not available when using an analogue input for the set point.

Set point adjustment with digital input
Adjust the set point with a Step +/- U (V) value to either increase or decrease the set point.

Digital inputs are used to trigger the increase or decrease.

A **Repeat delay** in milliseconds (ms), gives a time delay between the next increase or decrease.



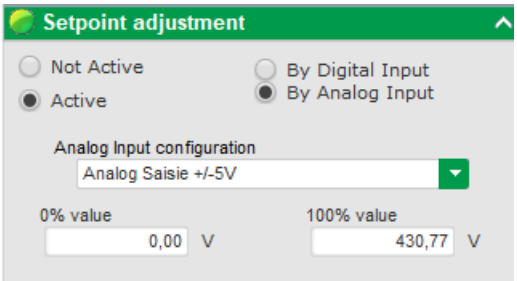
To use the set point adjustment, select **Active** and configure the values:

- **Step +/- U (V)**: Value used for either increase (**Input +**) or decrease (**Input -**).
- **Input -**: The digital input for the decrease trigger.
- **Input +**: The digital input for the increase trigger.
- **Repeat delay**: The repeat delay in milliseconds (ms) between steps.

NOTE The **Input +** and **Input -** digital inputs are the same for all regulation modes, but only have an effect on affect the regulation modes in which they were enabled.

Set point adjustment with analogue input
Select the analogue input configuration:

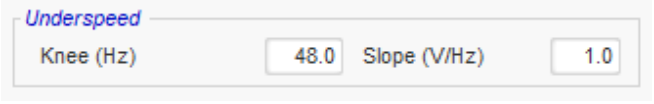
- 4 to 20 mA
- 0 to 10 V
- +/-10 V
- +/-5 V



Configure the voltage reference for 0 % and 100 % values.

For under-frequency there are two under-speed settings.

These values are used to set the voltage drop as a function of the alternator speed.



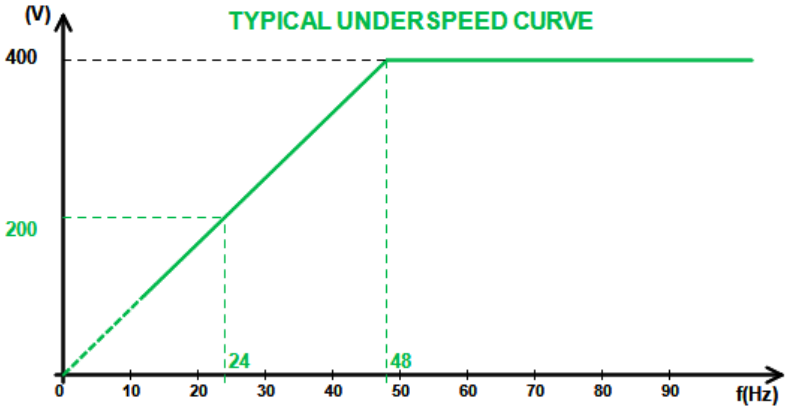
Knee (Hz)

- The typical values are:
  - 48 Hz for an alternator with 50 Hz rated frequency.
  - 57 Hz for an alternator with 60 Hz rated frequency.

Slope (V/Hz)

- Configurable from 0.5 to 5 V/Hz
- The higher the slope value, the greater the voltage drop will be if the motor speed decreases.

The curve drawing for **Typical underspeed curve** is changed as a function of the knee and slope values.



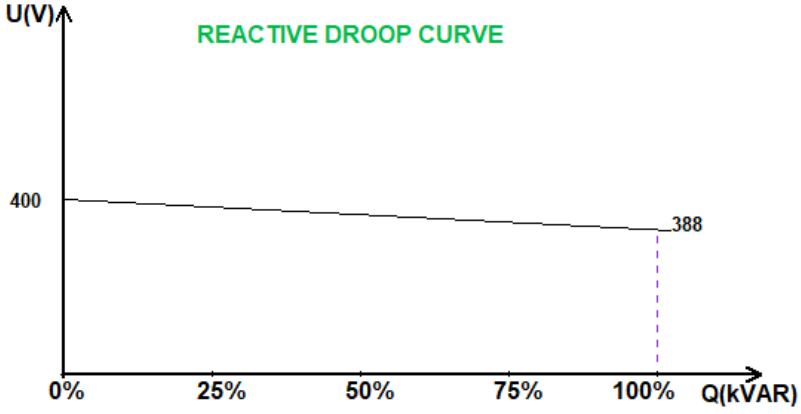
Reactive droop compensation
This function is usually used with alternators operating in parallel with one another.

Select to enable this function.

Configure the voltage drop percentage between -20 % and +20 %. The default value is 3 %.

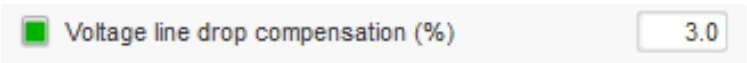
NOTE A negative value is equal to an increase in voltage.

The curve drawing for **Reactive droop curve** is changed as a function of the reactive droop compensation value:



NOTE If reactive droop compensation is enabled, it is no longer possible to have line droop compensation.

Line droop compensation



Select to enable this function.

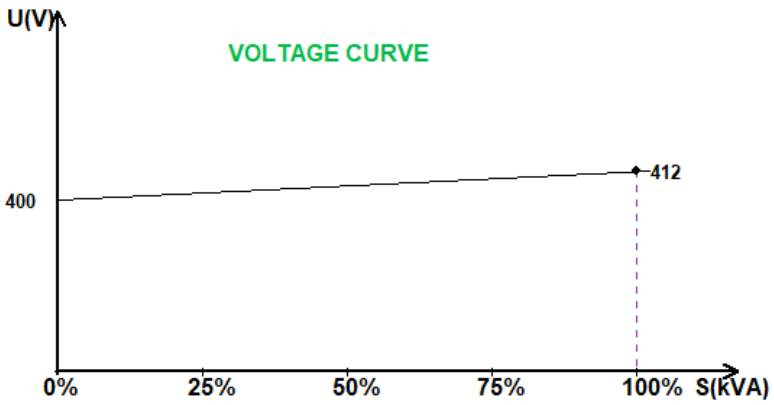
Configure the voltage reference change percentage between -20 % and +20 %. The default value is 3 %.

Depending on the kVA delivered to the machine, this function is usually used to:

- Increase the voltage set point in the case of long distribution lines.

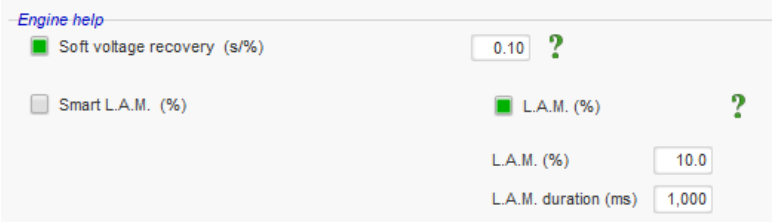
- Decrease the voltage set point (with a percentage down to -20 %) to balance the loads for machines connected to a rectifier (DC bus).

The curve for **Voltage curve** is changed as a function of the line droop compensation value:



LAM: Load Acceptance Module.

This function decreases the voltage set point during load impact, which improves the generator response.



When the measured generator frequency is less than the under-speed knee specified in the configuration (for example 48 Hz or 57 Hz), the voltage set point is decreased to a specified value (in the example above, 10 % under the rated voltage).

If the frequency continues to decrease, the voltage is regulated as specified by the U/f law.

The **Soft voltage recovery** helps the speed recovery of the generator. It is configured in seconds per percent of the rated voltage (s/%).

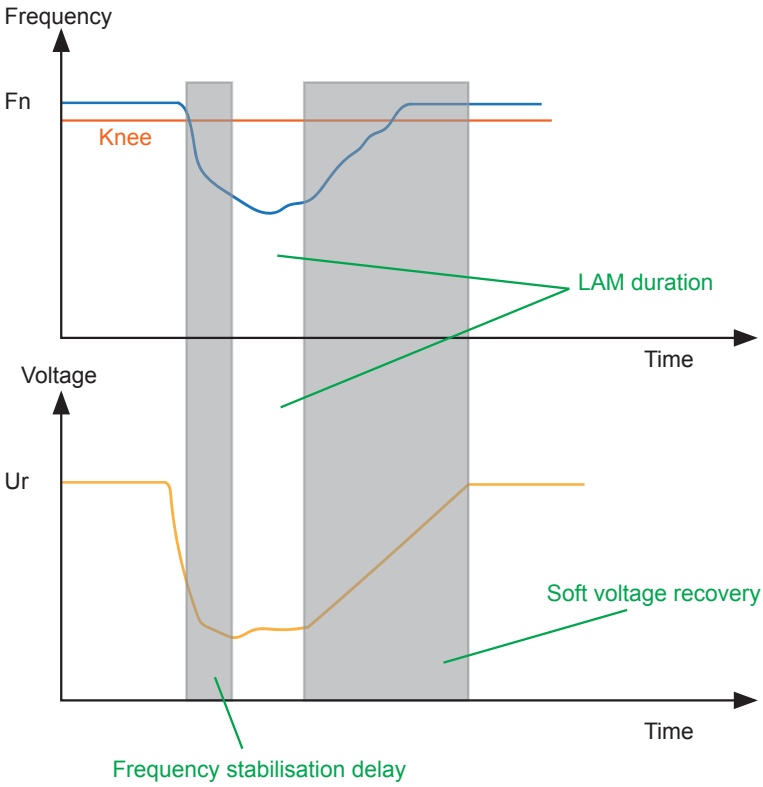
Example

If the frequency decreases by 10 % then the progressive rise time will be 1 second.

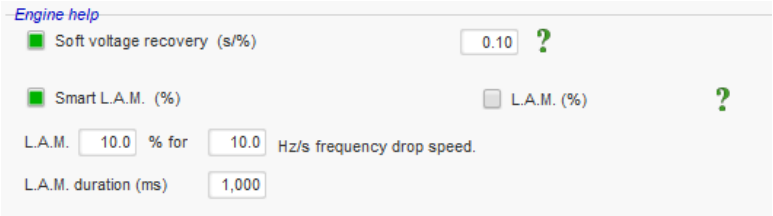
1 s = 0.10 s/% * 10

NOTE If the slope of the progressive rise is more than the U/f law, then the U/f law is used to increase the voltage.

The frequency stabilisation delay is equal to the waiting time before the voltage set point is increased gradually (as specified by the increase of the frequency).



Smart LAM: Self-adaptive Load Acceptance Module. This function decreases the voltage set point during load impact, which improves the generator response. But it has an adaptive level, which means that the percentage of voltage drop is automatically adapted to the level of the load impact.



The controller measures the operating frequency and calculates its derivative permanently. From this derivative value, an attenuation coefficient (K) of the voltage is calculated as specified by the parameters configured by the user.

Example

For a frequency variation of 10 Hz/s, the applied voltage drop will be 10 % of the nominal voltage.

For each load impact, the voltage attenuation is determined by the formula:

$\Delta U = K \times Ur$

Where Ur is the rated voltage of the alternator.

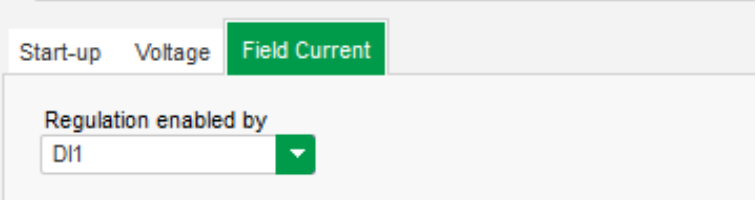
The frequency stabilisation delay is equal to the waiting time before the voltage set point is increased gradually (according to the increase of the frequency).

NOTE During the motor starting, all the other limitations, faults, and protections must be inactivate.

5.5.4 Field current (manual mode)

This regulation mode is used to control the value of the field current directly.

It is usually used during commissioning or as fallback mode if a measurement is incorrect on the AVR (alternator voltage measurement or alternator current measurement).



Select the activation type from the drop-down list to enable the field current regulation:

- Controlled by a digital input (**DI1** or **DI2**)
- **Always enabled**

for a direct field current regulation without external order, you need to select Always enabled.

NOTE If **None** is selected, field current regulation is never enabled.

The reference point is configured by either:

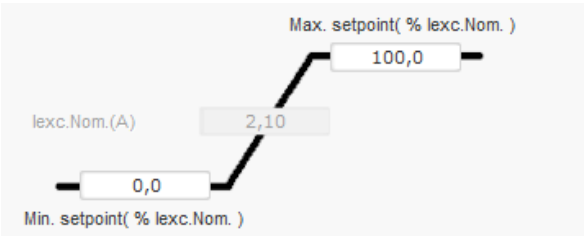
- An **Internal set point** fixed reference.
- An **Analogue input** set with a range.

It takes priority over other active regulation modes.

If a value is configured this value can be changed with the CAN bus.

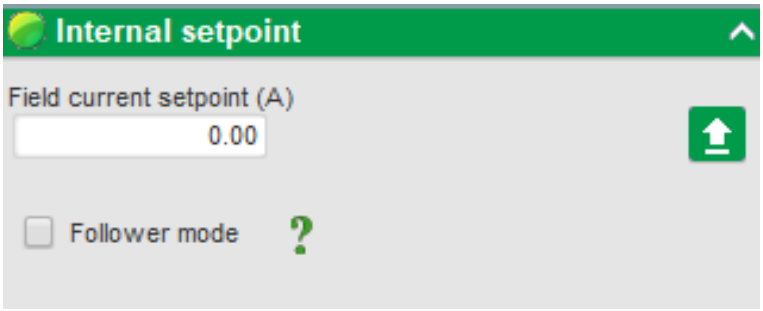
The limits of the set point are the absolute limitations of the setting. They are used for all the set point configuration methods (internal set point or an analogue input).

In this example, the minimum current set point 0 % of 2.10 A, and the maximum voltage set point is 100 % of 2.10 A.



For **Internal set point** :

Configure the field current set point value.



You can enable **Follower mode** (tracking function), when you change from a regulation mode to manual mode. In this mode, the field current measurement is used as a reference, and prevents visible jumps in the operating point of the machine.

NOTE You can only use the **Follower mode** if the **Internal set point** is fixed.

You can change the **Internal set point** by configuring the **Set point adjustment**.

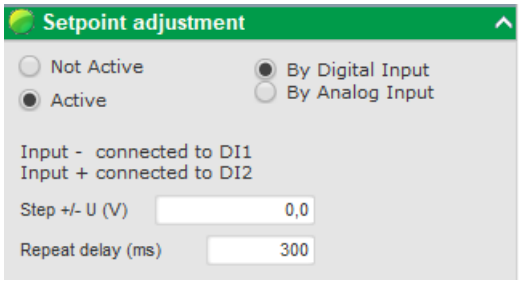
Set point adjustment

The **Set point adjustment** is only available for the **Internal set point** reference. This option is not available when using an analogue input for the set point.

Set point adjustment with digital input
Adjust the set point with a Step +/- U (V) value to either increase or decrease the set point.

Digital inputs are used to trigger the increase or decrease.

A **Repeat delay**, in milliseconds (ms), gives a delay between the next increase or decrease.



To use the set point adjustment, select **Active** and configure the values:

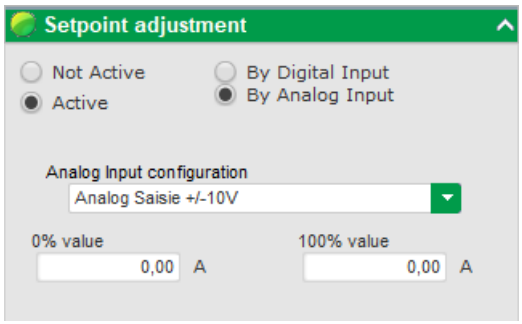
- **Step +/- U (V)**: Value used for either increase (**Input +**) or decrease (**Input -**).
- **Input -**: The digital input for the decrease trigger.
- **Input +**: The digital input for the increase trigger.
- **Repeat delay**: The repeat delay in milliseconds (ms) between steps.

NOTE The **Input +** and **Input -** digital inputs are the same for all regulation modes, but only have an effect on the regulation modes in which they were enabled.

Set point adjustment with analogue input
Select the analogue input configuration:

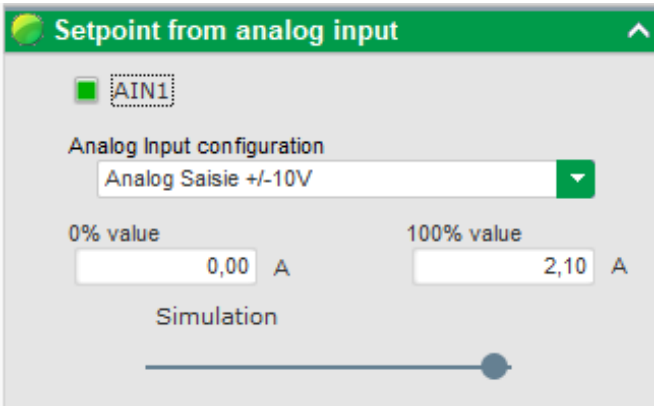
- 4 to 20 mA
- 0 to 10 V
- +/-10 V
- +/-5 V

Configure the voltage reference for 0 % and 100 % values.



For **Analogue input set point** reference:

Select the analogue input AIN1.



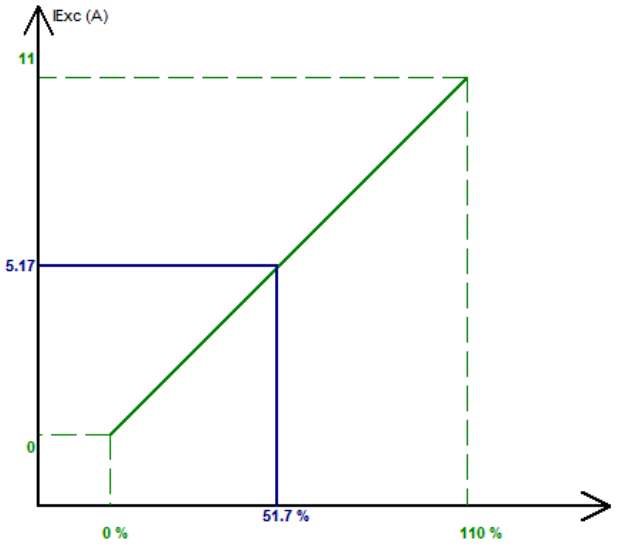
Select the analogue input configuration:

- 4 to 20 mA
- 0 to 10 V
- +/-10 V
- +/-5 V

Configure the current reference for 0 % and 100 % values.

NOTE You can interchange the current terminals if needed. For example, the minimum field current for 100 % of the analogue input, and the maximum field current for 0 % of the analogue input.

Use **Simulation** to change the values of the field current reference (blue line) in the graph on the right.



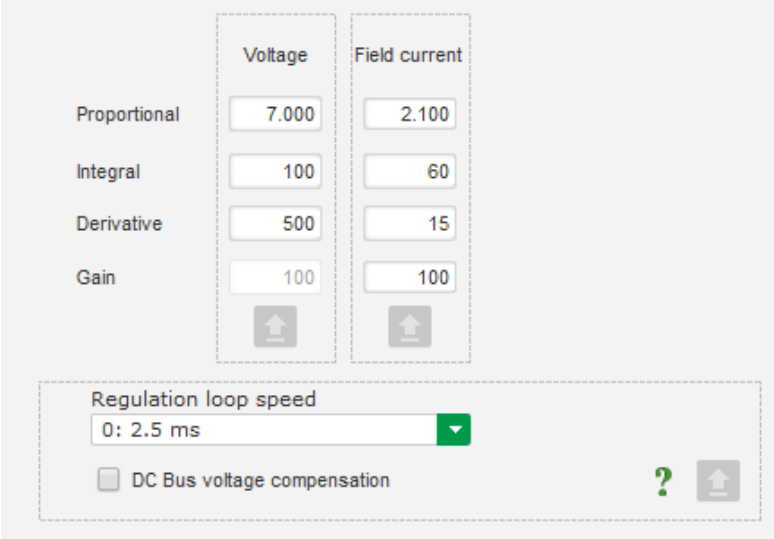
5.6 PID settings

Configure the PID gains.

You must use the PID settings in the DVC 350 after you have configured the nominal settings.

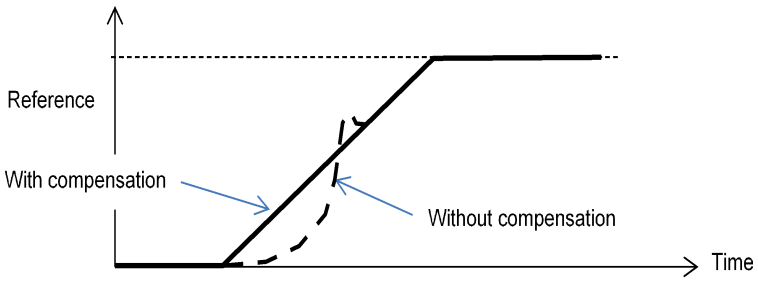
The PID settings shown are not final settings, but you can use it as a starting point for the DVC 350 voltage regulation. Further tuning is necessary for the type of alternator used.

Refer to the response time of the generator to modify the **Regulation loop speed** between 2.5 ms and 20 ms in 2.5 ms steps. If you change this value, you will need to adjust the PID gains.



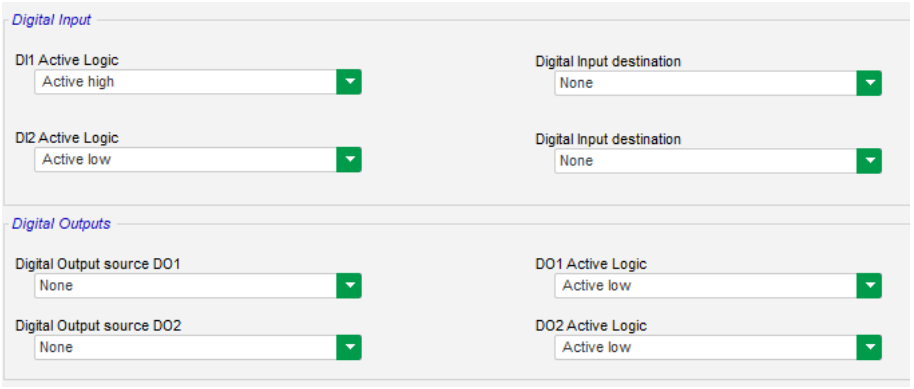
If a shunt or AREP type field is used, the power supply voltage depends directly on the voltage at the alternator terminals.

This can fluctuate with the load and can therefore have an effect on the PID's behaviour. Select **DC Bus voltage compensation (VBus)** to compensate these fluctuations.



5.7 Inputs/outputs

Digital inputs (**DI**) or digital outputs (**DO**):



Digital input (DI)

Active setting:

- **Active low**: Closed if the condition is obeyed.
- **Active high**: Open if the condition is obeyed

Destination setting:

- The input is used to activate or deactivate the selected digital input destination.

Digital output (DO)

Active setting:

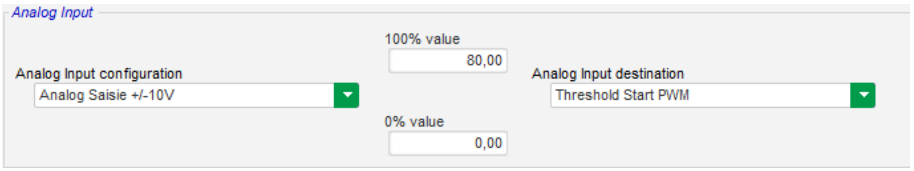
- **Active low**: Closed if the condition is obeyed.
- **Active high**: Open if the condition is obeyed.

Source setting:

- The output depends on the state of the selected digital output source.

Analogue input configuration

Analogue inputs:
To configure the **Analog input** select a configuration, a destination and the 0 % and 100 % values.



Select the input type:

- 4 to 20 mA
- 0 to 10 V
- +/-10V
- +/-5V

Destination setting:

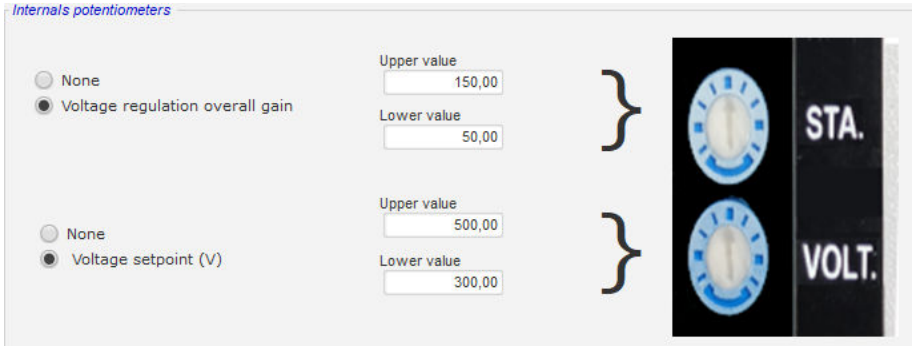
- The input is used to activate or deactivate the selected analogue input destination.

Configure the 0 % and 100 % values.

Internal potentiometers

The DVC 350 has 2 potentiometers:

- **VOLT potentiometer**: is for the voltage setting. The potentiometer can adjust the alternator output voltage in a predefined range, for example 380 V - 420 V.
- **STA potentiometer**: is used for either the PID global gain (stability) or the reactive droop compensation.



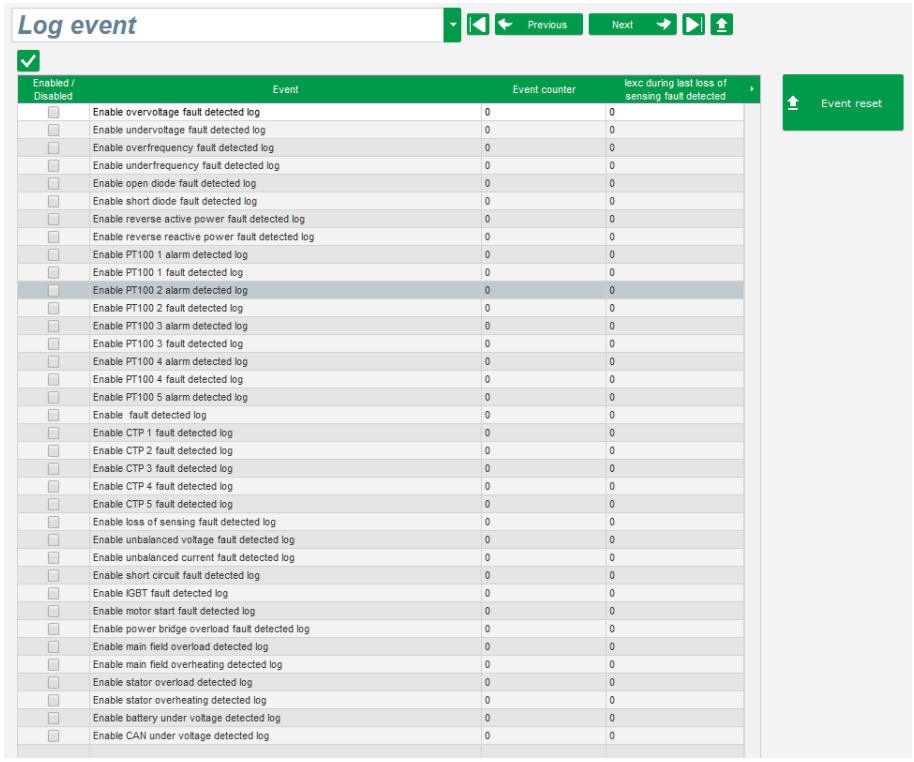
To use the STA potentiometer select **Voltage regulation overall gain** and configure the minimum and maximum value.

To use the VOLT potentiometer select **Voltage setpoint (V)** and configure the minimum and maximum value.

5.8 Log event

Select **Enable** to count the amount of events that are detected.

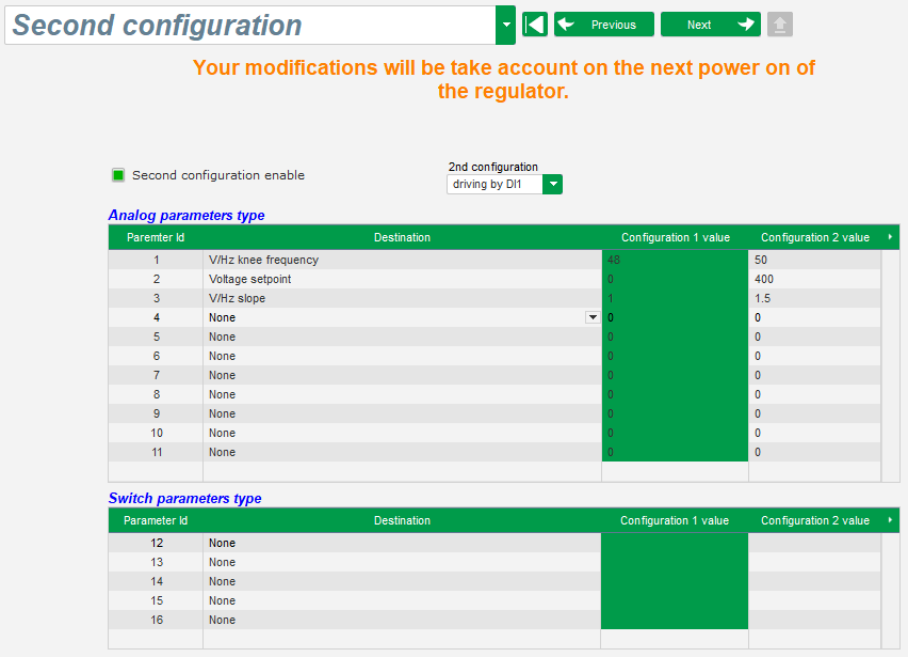
For an enabled event, the excitation current is recorded.



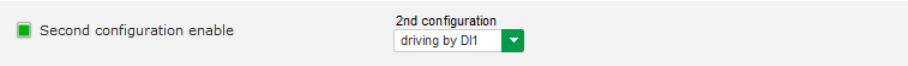
Enabled / Disabled	Event	Event counter	Iexc during last loss of sensing fault detected
	Enable overvoltage fault detected log	0	0
	Enable undervoltage fault detected log	0	0
	Enable overfrequency fault detected log	0	0
	Enable underfrequency fault detected log	0	0
	Enable open diode fault detected log	0	0
	Enable short diode fault detected log	0	0
	Enable reverse active power fault detected log	0	0
	Enable reverse reactive power fault detected log	0	0
	Enable PT100 1 alarm detected log	0	0
	Enable PT100 1 fault detected log	0	0
	Enable PT100 2 alarm detected log	0	0
	Enable PT100 2 fault detected log	0	0
	Enable PT100 3 alarm detected log	0	0
	Enable PT100 3 fault detected log	0	0
	Enable PT100 4 alarm detected log	0	0
	Enable PT100 4 fault detected log	0	0
	Enable PT100 5 alarm detected log	0	0
	Enable fault detected log	0	0
	Enable CTP 1 fault detected log	0	0
	Enable CTP 2 fault detected log	0	0
	Enable CTP 3 fault detected log	0	0
	Enable CTP 4 fault detected log	0	0
	Enable CTP 5 fault detected log	0	0
	Enable loss of sensing fault detected log	0	0
	Enable unbalanced voltage fault detected log	0	0
	Enable unbalanced current fault detected log	0	0
	Enable short circuit fault detected log	0	0
	Enable IGBT fault detected log	0	0
	Enable motor start fault detected log	0	0
	Enable power bridge overload fault detected log	0	0
	Enable main field overload detected log	0	0
	Enable main field overheating detected log	0	0
	Enable stator overload detected log	0	0
	Enable stator overheating detected log	0	0
	Enable battery under voltage detected log	0	0
	Enable CAN under voltage detected log	0	0

5.9 Second Configuration

This function is usually known as the **50/60Hz switch function**, but it has more features and is easier to adapt.



To activate this feature, select **Second configuration enable**.



Select the digital input to activate the second configuration. *

NOTE * The DVC 350 regulation will change to the second configuration when the digital input is activated. When the second configuration is deactivated the regulation goes back to the base configuration.

The change is only taken into account at the start of regulation. Any activation or deactivation when the regulator is in operation is ignored.

Select the parameters, which are activated when you change to the second configuration.

In the example above, new parameters for the second configuration is defined:

- **Knee frequency** at 50 Hz.
- **Voltage set point** at 400 V.
- **V/Hz slope** set to 1.5.

5.10 Analogue AVR

The DVC 350 also works as a simple analogue AVR, but you can only adjust the voltage and stability settings.

Voltage setting

The VOLT potentiometer is used for the voltage adjustment. You can set the voltage from 300 V to 530 V.

Stability setting

The STA potentiometer is used for the stability setting. A counter-clockwise rotation of the arrow on the potentiometer button is the same as a low dynamics performance. A clockwise rotation is the same as a high dynamics performance.

6. Configure the DVC 350 with AGC

6.1 About the DVC 350 with the AGC

6.1.1 Introduction

CAN bus

The AGC controller uses CAN bus to communicate with the DVC 350, additional DEIF controllers, and other equipment.

Always use twisted pairs, shielded cables (120 Ω impedance) of good quality for the CAN bus communication, such as Belden 3105A or Unitronic Bus CAN.

Parameter settings

Many settings for the DVC 350 can be directly configured from the AGC. Some other settings can only be configured by using the **DEIF EasyReg Advanced** utility software.

Parameters controlled by the AGC are greyed out in the DEIF EasyReg Advanced utility software. These parameters must be configured with the AGC utility software.

The first time you set up a DVC 350, the **DEIF EasyReg Advanced** software must be used.

More information
See **Get started with DEIF EasyReg Advanced** in this document for information on downloading and installing the utility software.

NOTICE
GENSET start The genset should not be started before this manual states that it is allowed to start. This is to make sure that the protections and settings have been correctly configured.

6.1.2 Factory settings

AGC controllers are delivered from the factory with certain factory settings. These are based on typical values and are not necessarily the correct settings for matching the engine/generator set in question. Precautions must be taken to check the settings before running the engine/generator set.

6.1.3 Communication options

The AGC can use several CAN bus ports to communicate with a number of other components. A system application could also include additional CIO modules.

The CAN bus communication is based on a J1939 protocol. Many Engine Control Units (ECUs) also communicate with the J1939 protocol, which means that the AGC can communicate to the ECU and DVC 350 on the same CAN bus port.

NOTE Only for AGC-4: If the AGC-4 is used in an application with a DVC 350 and a CANopen based ECU, the communication must be split into two different CAN bus ports on the unit. This can be done with the H12 dual CAN bus. The AGC-4 supports the CANopen engine interfaces: MTU-MDEC and MTU-ADEC.

The following examples can be helpful:

Description of application	AGC-4 settings	AGC 150 settings
Analogue GOV DVC 350	• 2781 (Regulator output GOV): Analogue • 2783 (Regulator output AVR): EIC • 7565 (Digital AVR Interface): DEIF DVC 350 • 7843 (CAN bus port C protocol): External DEIF modules	• 2781 (Regulator output GOV): Analogue • 2782 (Regulator output AVR): EIC • 7565 (Digital AVR Interface): DEIF DVC 350 • 7842 (CAN bus port A protocol): H5 EIC
J1939-based ECU DVC 350	• 2781 (Regulator output GOV): EIC • 2783 (Regulator output AVR): EIC • 7561 (Engine Interface): Relevant J1939 protocol • 7565 (Digital AVR Interface): DEIF DVC 350 • 7843 (CAN bus port C protocol): EIC (Option H5.2)*	• 2781 (Regulator output GOV): EIC • 2782 (Regulator output AVR): EIC • 7561 (Engine Interface): Relevant J1939 protocol • 7565 (Digital AVR Interface): DEIF DVC 350 • 7842 (CAN bus port A protocol): H5 EIC
J1939-based ECU DVC 350 DEIF CIO modules	• 2781 (Regulator output GOV): EIC • 2783 (Regulator output AVR): EIC • 7561 (Engine Interface): Relevant J1939 protocol • 7565 (Digital AVR Interface): DEIF DVC 350 • 7843 (CAN bus port C protocol): EIC • 7891 (CIO Enable): ON (Option H5.2)*	• 2781 (Regulator output GOV): EIC • 2782 (Regulator output AVR): EIC • 7561 (Engine Interface): Relevant J1939 protocol • 7565 (Digital AVR Interface): DEIF DVC 350 • 7842 (CAN bus port A protocol): H5 EIC • 7891 (CIO Enable): ON
Analogue GOV DVC 350 DEIF CIO modules	• 2781 (Regulator output GOV): Analogue • 2783 (Regulator output AVR): EIC • 7565 (Digital AVR Interface): DEIF DVC 350 • 7843 (CAN bus port C protocol): External DEIF modules • 7891 (CIO Enable): ON (Option H5.2)*	• 2781 (Regulator output GOV): Analogue • 2782 (Regulator output AVR): EIC • 7565 (Digital AVR Interface): DEIF DVC 350 • 7842 (CAN bus port A protocol): H5 EIC • 7891 (CIO Enable): ON
CANopen-based ECU DVC 350 (DVC 350 mounted on CAN port D)	• 2781 (Regulator output GOV): EIC • 2783 (Regulator output AVR): EIC • 7561 (Engine Interface): Relevant CAN Open protocol • 7565 (Digital AVR Interface): DEIF DVC 350 • 7843 (CAN bus port C protocol): EIC • 7844 (CAN bus port D protocol): External DEIF modules (Option H12.2)*	-
CANopen-based ECU DVC 350 DEIF CIO modules (DVC 350 mounted on CAN port D)	• 2781 (Regulator output GOV): EIC • 2783 (Regulator output AVR): EIC • 7561 (Engine Interface): Relevant CANOpen protocol • 7565 (Digital AVR Interface): DEIF DVC 350 • 7843 (CAN bus port C protocol): EIC	-

Description of application	AGC-4 settings	AGC 150 settings
	• 7844 (CAN bus port D protocol): External DEIF modules • 7891 (CIO Enable): ON (Option H12.2)*	

NOTE * The above examples use either option H5 or H12 mounted in slot number 2 (H5.2 or H12.2). The different setups will also work if H5 or H12 are mounted in slot number 8 instead (H5.8 or H12.8). If using slot number 8, then the parameters for the CAN port setup must be changed for the application.

NOTICE

Initial set up

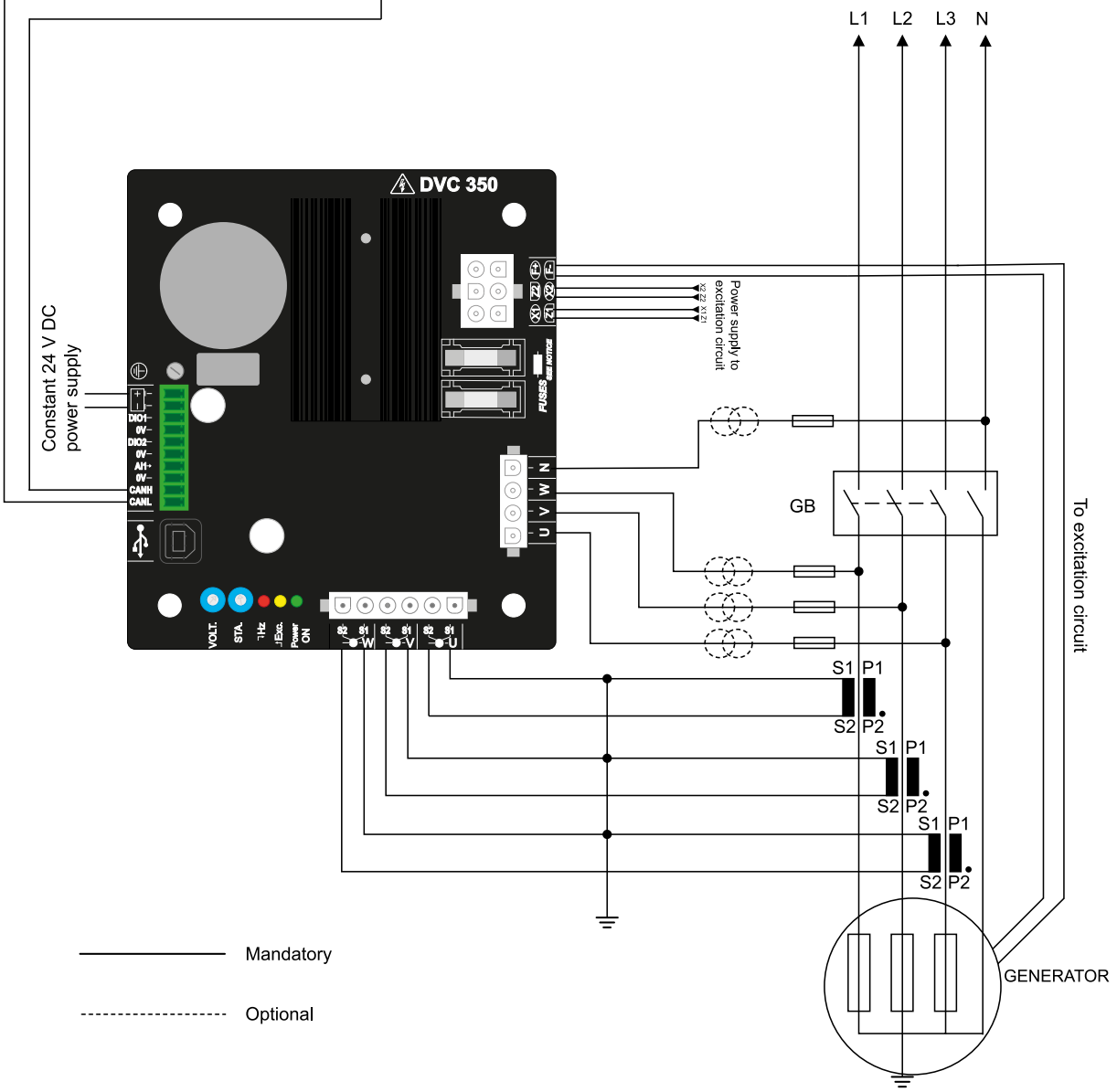
During the initial setup of the DVC 350 with the DEIF EasyReg Advanced software, it is recommended to not have the CAN bus connected to the DVC 350.

6.2 Wiring the AGC to the DVC 350

The AGC uses CAN bus communication to the DVC 350 with the engine communication port via J1939.

Recommended wiring to AGC-4

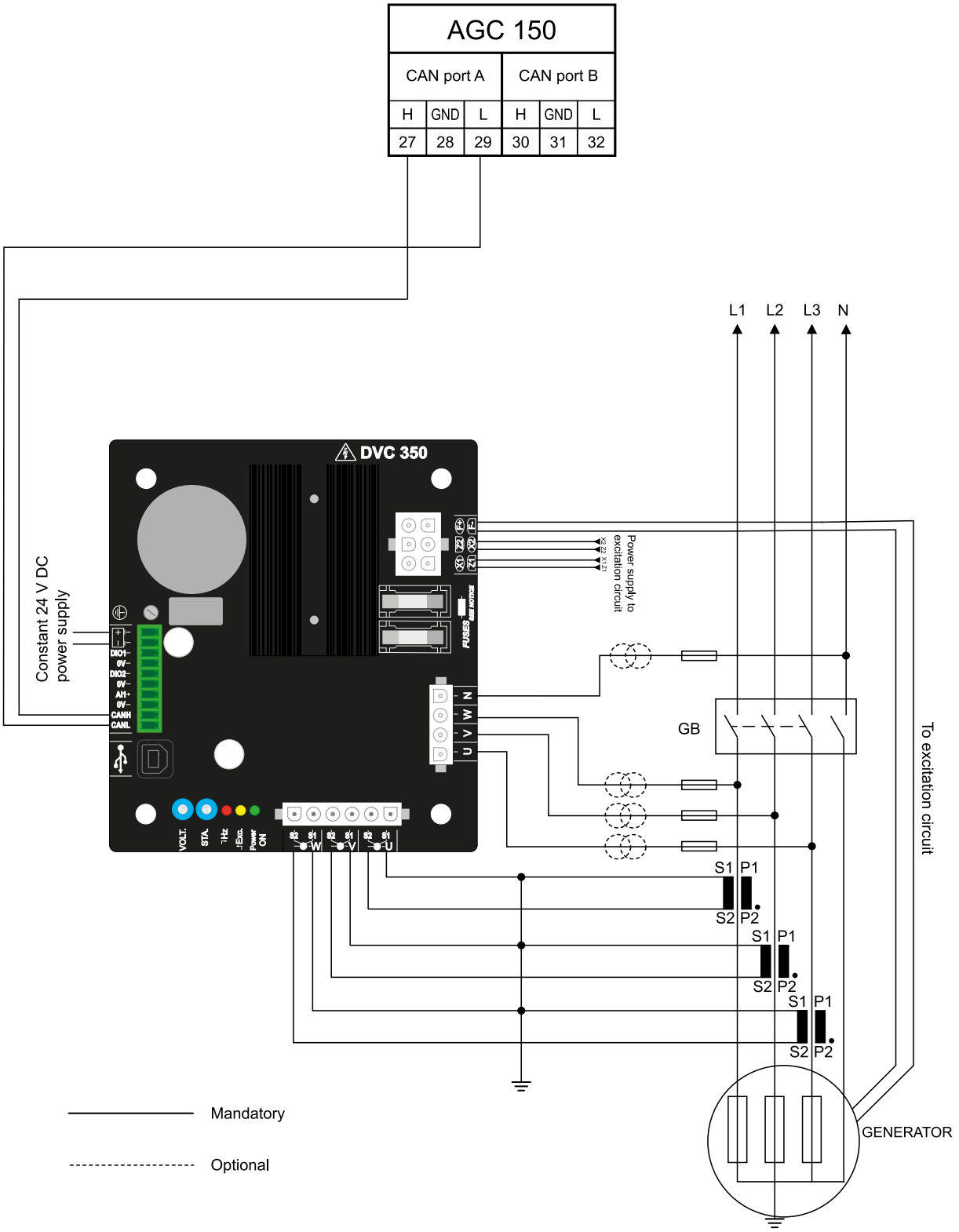
AGC-4												
CAN port C			CAN port D			CAN port E			CAN port F			
H	Sh.	L	H	Sh.	L	L	Sh.	H	L	Sh.	H	
29	30	31	32	33	34	128	129	130	131	132	133	



NOTE If the DVC 350 is mounted at the end of the measuring line, you can couple the CT inputs on the DVC serially with the CT input on the AGC-4. In this case, only one set of current transformers are needed. This is because the S2 terminals are shorted internally.

NOTE CAN bus cable recommendation: Belden 3105A or equivalent, 22 AWG (0.6 mm ⌀, 0.33 mm2) twisted pair, shielded, impedance 120 Ω,<40 mΩ/m, min. 95 % shield coverage.

Recommended wiring to AGC 150

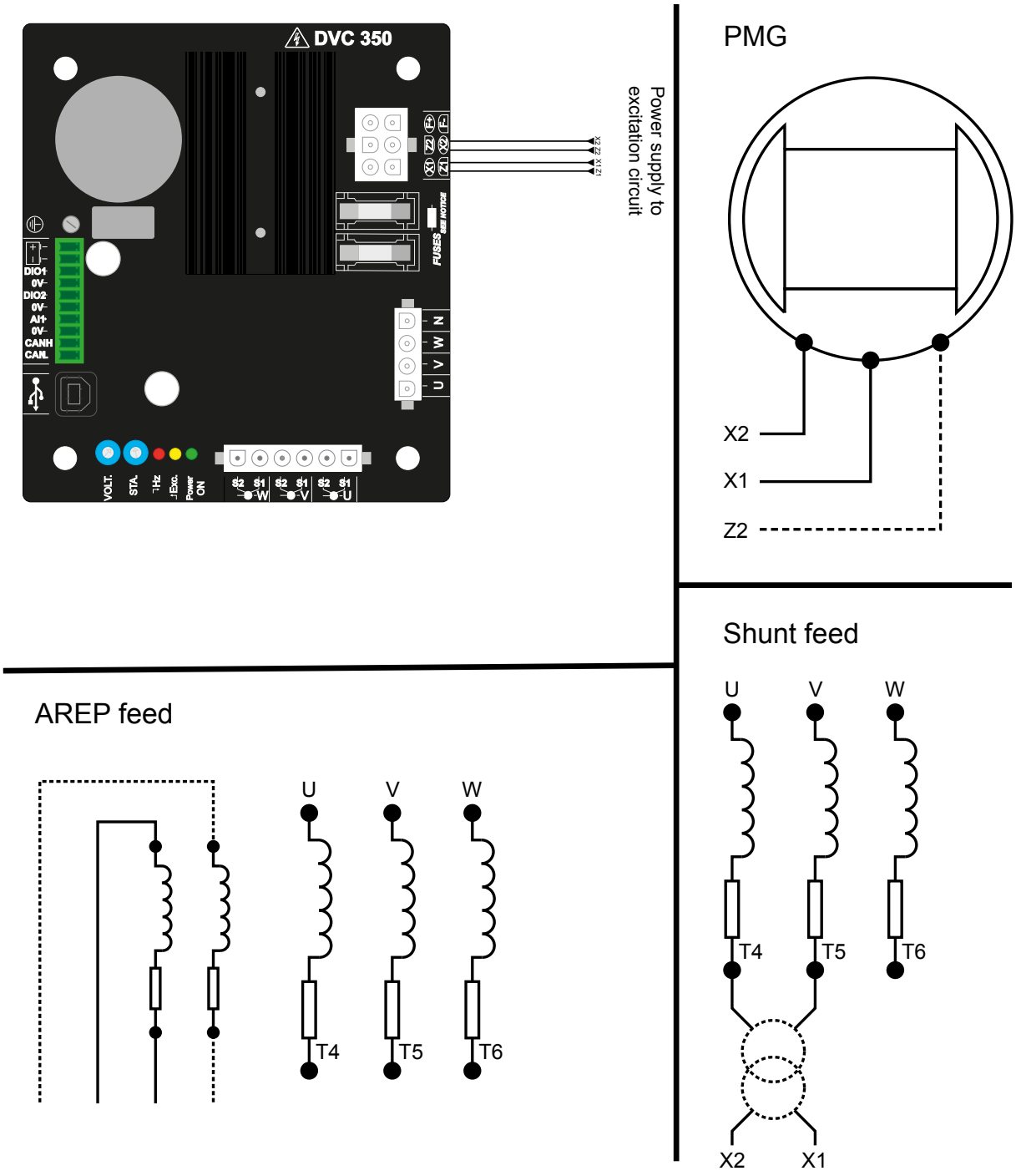


NOTE CAN bus cable recommendation: Belden 3105A or equivalent, 22 AWG (0.6 mm ⌀, 0.33 mm2) twisted pair, shielded, impedance 120 Ω,<40 mΩ/m, min. 95 % shield coverage.

Power supply wiring

Mandatory

Optional



6.3 Configure the DVC 350

6.3.1 Connect and launch DEIF EasyReg Advanced

The DVC 350 is configured by using the **DEIF EasyReg Advanced** utility software.

More information
See **Get started with DEIF EasyReg Advanced** for more information about downloading, installing, connecting, and launching the utility software.

1. Connect the USB cable from your PC to the DVC 350.

2. Launch **DEIF EasyReg Advanced** from your PC.
   - The DVC 350 indicates connection on the USB cable with a blue LED USB.
   - The DVC 350 connection status is also shown in the bottom left of the **DEIF EasyReg Advanced** utility software.
3. Select **Expert** mode Expert.
4. Select **New customized configuration** to create a new configuration.
   - You can also reload a previously saved configuration by using **Open a file**.
5. The **Generator description** settings are now displayed.

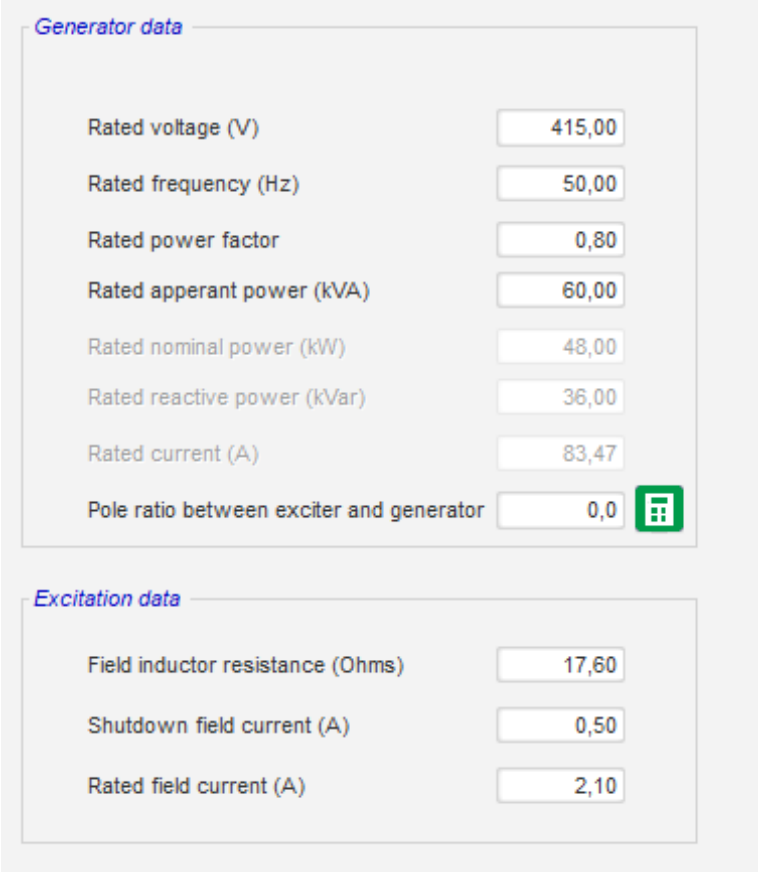
6.3.2 Generator description

Generator data

Describe the alternator electrical properties: voltage (in Volts), frequency (in Hz), power factor and apparent power (in kVA).

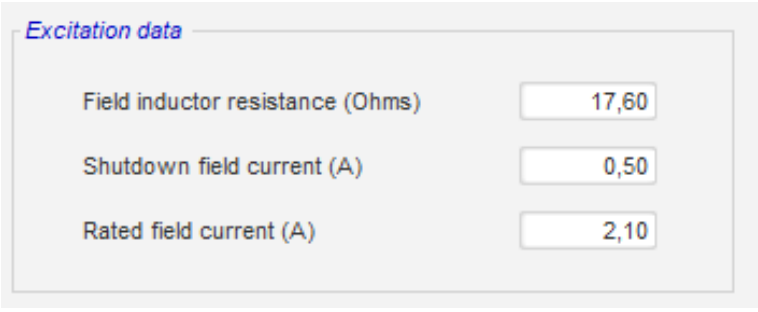
Fields: nominal power, reactive power and rated current are calculated automatically.

Pole ratio for diode fault (exciter poles number divided by generator poles number).



Excitation data

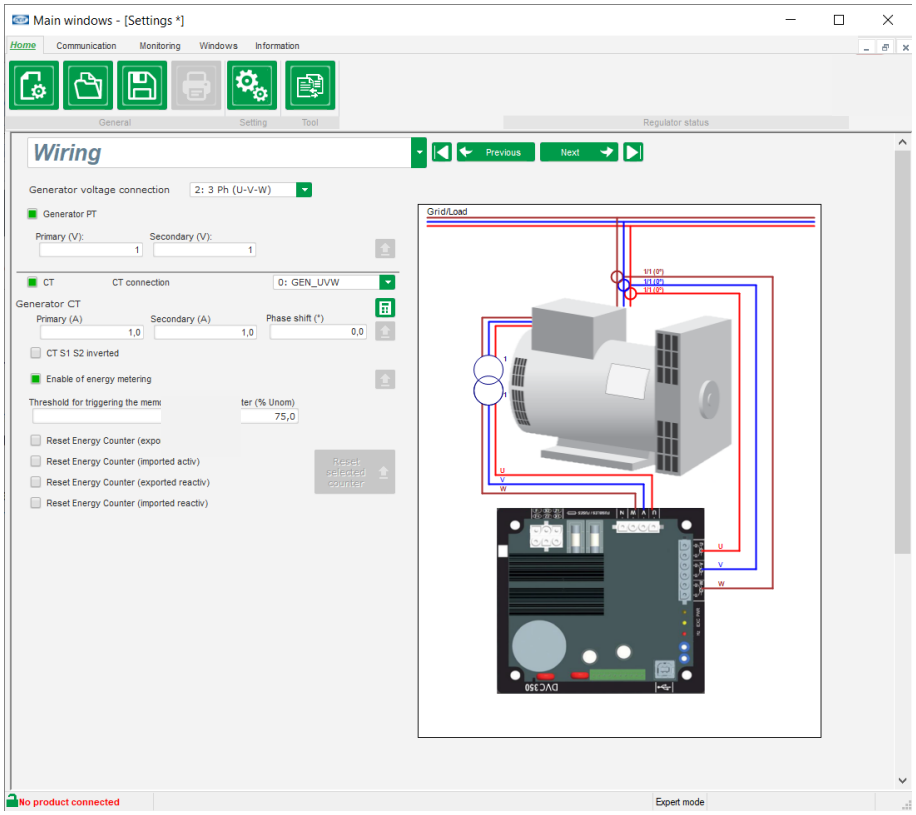
Describe the field excitation properties: field inductor resistance (in Ω), shutdown field current (in Amps), and rated field current (in Amps).



6.3.3 Wiring

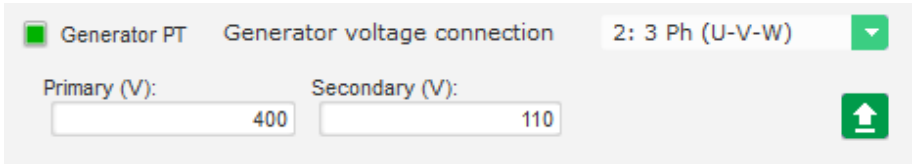
Configure the wiring connections between the DVC 350 and the alternator.

The wiring preview changes when the settings change.



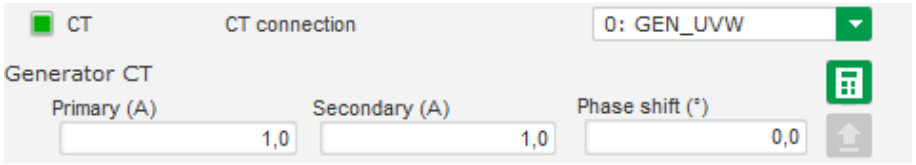
Alternator voltage measurement PTs

- Give the primary and secondary winding voltages (in Volts).
- Give the type of measurement: phase-neutral, phase-phase, 3 phases or 3 phases and neutral using the drop-down menu.



Alternator current measurement CTs

- Give the primary and secondary winding currents (in Amps).
- Give the CT configuration using the drop-down menu.



NOTE The phase shift value should be set during tests and commissioning. It is used to compensate for the phase difference caused by the CTs and VTs.

When the CT only measures part of the generator total current, use the advanced CT configuration mode to complete the configuration.

6.3.4 Start up and tuning in the DVC 350

To protect against over-voltage and over-current, make a shutdown alarm in the AGC before tuning in the regulators.

NOTE The CAN bus communication between the AGC and the DVC 350 should not be connected yet. It will be stated later in this document when this should be connected.

Before the first start of the genset with the DVC 350, make sure that the PWM for start-on threshold is set to 0 % and the **Activation threshold** set point is high, for example 90 % of nominal voltage. It is also a good idea to remove the excitation circuit supply (X1-X2-Z1-Z2) terminal connector.

Additionally, the **Soft-start** ramp should be set slow, for example 10 seconds, to ensure that a slow PID regulation is able to follow the ramp.

When the alarms, start-on threshold, and soft-start settings have been made, the genset is ready for the first start.

NOTE When the genset is started for the first time, it is presumed that all other equipment is tested, verified and tuned as desired. This manual is only relevant for when the DVC 350 is ready for the first start.

At the first start, only remanence voltage will be present, since the PWM is set to 0 %. This remanence voltage can be used to verify that the DVC 350 is able to measure alternator voltage correctly. This measurement should be compared to the genset controller's measured voltage and/or a multimeter reading.

The genset can then be stopped, and the PWM settings can be raised to, for example, 2 % (small steps), and the **Activation threshold** can be set to, for example, 15 % of nominal voltage. The user must verify that voltage is not shooting upwards, and the PWM can be raised until the alternator reaches **Activation threshold** voltage.

When the DVC 350 reaches this **Activation threshold**, the **Soft-start** ramp will now be used, up to the voltage set point.

When the voltage has reached the set point for the alternator, a transient test can be performed from the **Oscilloscope** window.

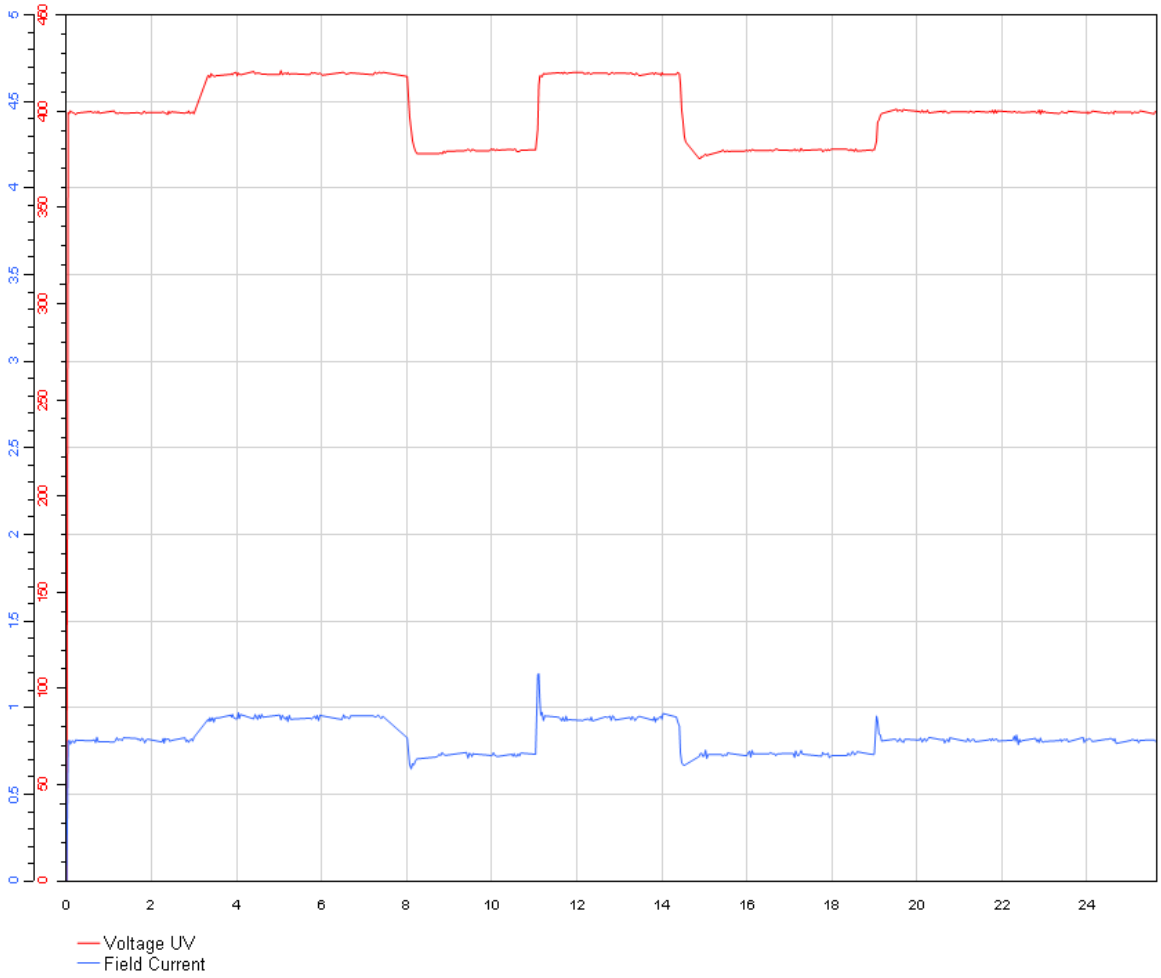
More information
See **Transient test** in **DEIF EasyReg Advanced, Oscilloscope** for more information about configuring a transient test.

For the first transient test, the voltage steps should only deviate about 2 % from the voltage set point.

With the result of the transient test, the regulation of the DVC 350 can now be verified, to see the regulation response.

It is now possible with the transient test to tune the DVC 350 regulation. When the sufficient response is acquired, the deviations for the transient test can be raised to +/- 5 % of the voltage set point.

Shown below is a transient test, which is considered reasonably tuned.



When the regulation has been tuned sufficiently, the **Soft-start** ramp can be tuned down until the user finds the start-up ramp fast enough.

The PWM percentage can be raised, until the first part of the ramp is fast enough for the user. The DVC 350's regulation is not active during start-on threshold. The PWM is a constant percentage of voltage that is led directly through the excitation circuit.

When the regulators and functions have been tuned in, the CAN bus cable between the AGC and the DVC 350 can be connected.

It is recommended to go to parameter 7805 and set this to ON. Then the AGC will be in control of the DVC 350, which makes it possible, for example, to switch regulation modes.

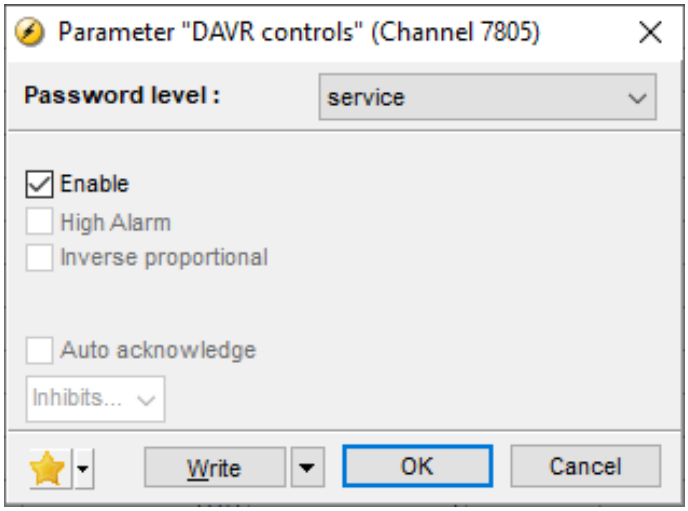
More information
When the CAN bus cable is connected between the AGC and the DVC 350, see **Overview of shared parameters** and configure the settings for **Soft-start** ramp, **Start-on threshold**, **PWM** and other settings made during commissioning of the DVC 350. Make sure that the gain factor in DEIF EasyReg Advanced and the gain factor parameter 7801 are the same.

6.3.5 Configure AGC to DVC 350 communication

For the AGC to communicate with a DVC 350, configure these parameters with the *DEIF Utility software 3*.

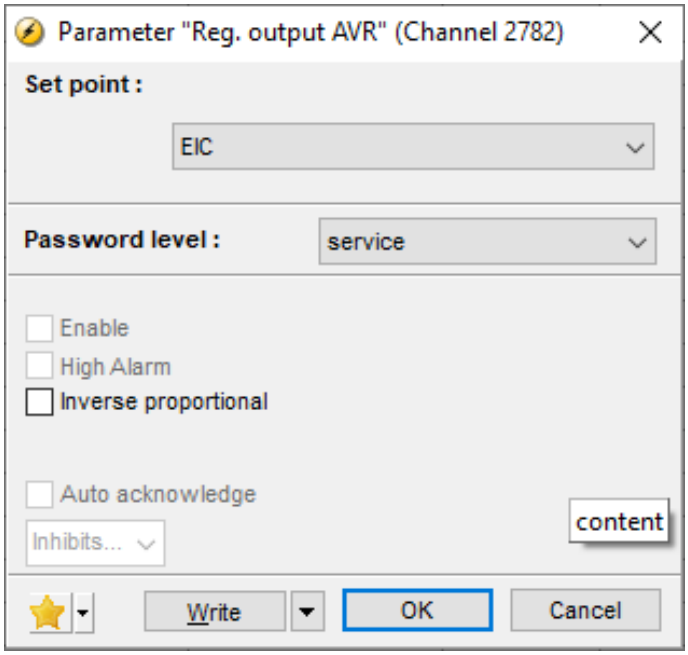
DAVR controls (7805)

The DAVR control is enabled by default.



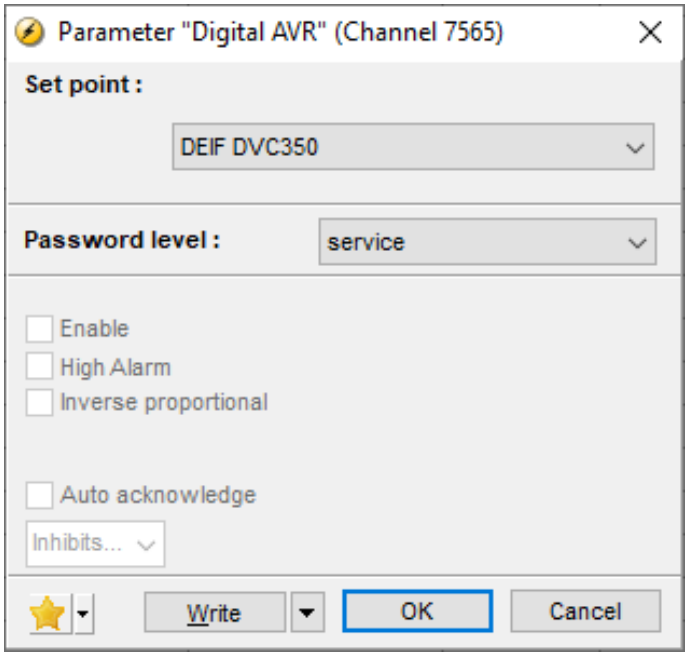
Reg. output AVR (2783)

Select the regulation output AVR to be EIC on parameter 2783 (AGC-4) or 2782 (AGC 150):



Digital AVR (7565)

Select **DEIF DVC 350** for the digital AVR type on parameter 7565:

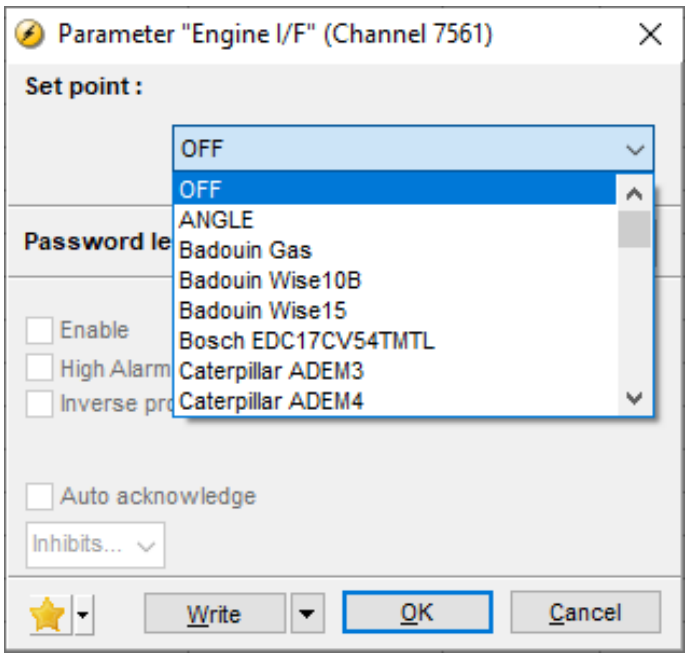


Engine I/F (7561)

The engine interface must be configured on parameter 7561:

- If you are using other external DEIF modules for CAN bus, set this to OFF.
- If you are not using external DEIF modules, select the relevant protocol.

See **Communication options** for examples of how to set up the communication options.



This parameter must be configured even though relay or analogue regulation is used for governor control.

NOTE When performing initial setup of the DVC 350 with the DEIF EasyReg Advanced software, it is recommended not to have the CAN bus connected to the DVC 350.

6.3.6 Voltage transformer settings

The DVC 350 has the possibility to use voltage transformers (VT or PT) for alternator as well as busbar measurements.

The VT ratio is configured in the general settings in the AGC (parameters 6041-6042 and 6051-6052). The DVC 350 provides the opportunity to have different VTs than those used in the AGC (meaning that the range of the DVC 350 VTs is different from the range of the AGC VTs). If this is the case, parameter 7745 must be enabled, and then the parameters 7741 to 7744 are used and must be configured for DVC 350 VT ratio.

Parameter 7746 can be used to configure the phase selection. The default is 0, which uses the AGC-4 AC settings. This can be changed to 1 for 2-phase (W-U), 2 for 2-phase (V-W), or 3 for 3-phase (U-V-W). This setting overrides the DVC 350 setting.

NOTE When the communication between the AGC and the DVC 350 is running, multiple settings are sent to the DVC 350. This is, for example, knee set point, soft-start timers, VT settings.

More information
See **Overview of shared parameters** for a list of these settings.

Parameter	Item	Range	Default	Note
7741	DVC 350 VT's primary setting (side that is in contact with generator voltage).	400 to 32000 V	400 V	Only in genset.
7742	DVC 350 VT's secondary setting (side that is in contact with the DVC 350 voltage input).	50 to 600 V	400 V	Only in genset.
7743	DVC 350 busbar VT's primary setting (side that is in contact with busbar voltage).	400 to 32000 V	400 V	Only in genset.

Parameter	Item	Range	Default	Note
7744	DVC 350 busbar VT's secondary setting (side that is in contact with the DVC 350 voltage input).	50 to 600 V	400 V	Only in genset.
7745	Activation of VT settings in the DVC 350 (when set to ON, the settings above will be sent).	OFF ON	OFF	Only in genset.
7746	DAVR AC config	0: Use AGC-4 AC setting 1: 2-phase (W-U) 2: 2-phase (V-W) 3: 3- phase (U-V-W)	0	Only in genset

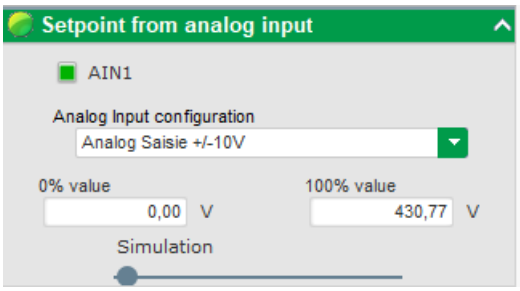
6.3.7 Analogue bias connection from AGC

It is possible to connect the DVC 350 to the AGC or any other controller, and to have the voltage regulation made using analogue lines.

Control in this way to the DVC 350, means that digital features will not be available. Only voltage regulation will be effective when using the analogue lines.

To use analogue lines, the DVC 350 must be configured for an analogue input.

Configure this under **Regulation mode** and voltage analogue set point.



It is also possible to configure analogue regulation from the AGC by switching parameter 2783 (AGC-4) / 2782 (AGC 150) to analogue instead of EIC. Remember to set the transducer output also at parameter 5991. At parameter 7796, the input type on the DVC 350 is set, and it will expect it to have an analogue. To enable sending of all these commands, parameter 7805 must be enabled. By this, it is possible to send all commands via CAN bus and to control the DVC 350 via analogue bias using parameter 7796.

6.4 Generator start up

6.4.1 Start mode

Use *Normal start* as the start mode with DVC 350.

6.4.2 Normal start

Excitation is activated at start-up. Normal start is obtained when close before excitation is disabled at parameter 2254. During a normal start, both the start-on threshold and soft-start function are used.

There two ways to control the excitation ramp for a normal start:

1. With the start-on threshold and soft-start ramp.

2. Where the start-up ramp is controlled by the U/f slope.

1. Control the excitation ramp with the start-on threshold and soft-start ramp.
In this method the excitation ramp is controlled during start-up.

2. Control the excitation ramp with the U/f slope.
In this method the start-up ramp is controlled by the U/f slope.

The DVC 350 will regulate towards this on start-up, as the RPMs are ramping up during a start sequence.

Not using the soft-start functionality is only recommended on engines that slowly ramp up the RPM, since the U/f law ramp-up can give an overshoot.

For this method, configure:

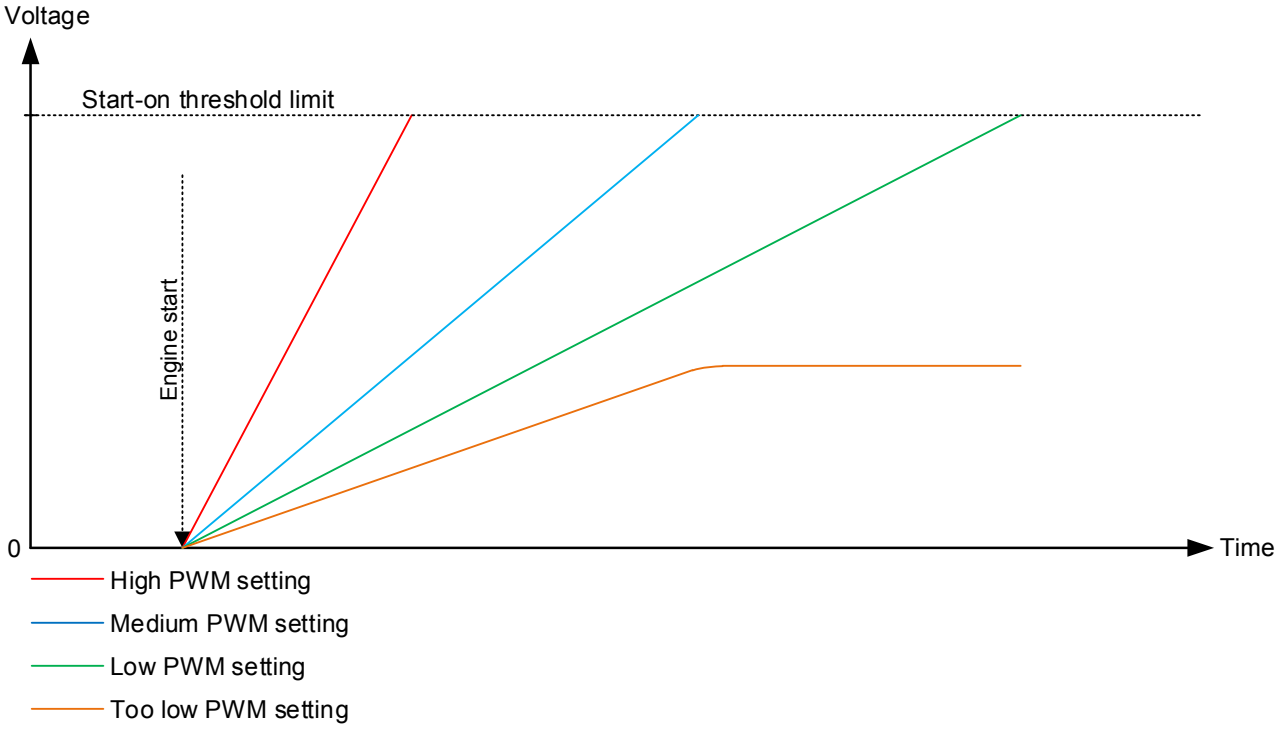
- Start-on threshold to 100 % (7751).
- Upper limit for the start-on threshold to 0 % (7752).
- Soft-start ramp to 0.1 s (7753).

6.4.3 Start-on threshold

The first part of the excitation ramp is called the start-on threshold. The parameters for start-on threshold are located at parameters 7751 and 7752:

Parameter	Item	Range	Default	Note
7751	PWM signal for start-on threshold ramp percentage of nominal voltage	0.00 to 100.00 %	10.00 %	Only in genset
7752	Start-on threshold set point percentage of nominal voltage	0.0 to 100.0 %	35.0 %	Only in genset

Here it is possible to set the upper limit and a PWM output. The upper limit determines when the soft-start function takes over. As a default, this value is set to 35 %, which means 140 V AC for a 400 V alternator. This means that the start-on threshold is the excitation ramp from 0 V AC to default 140 V AC. The PWM output decides how steep the slope for the excitation is. When setting the PWM higher, the excitation slope will be steeper/more aggressive. In the graph below, only the PWM is changed:



When the upper limit for the start-on threshold is changed, the start point for the soft-start is also changed. The upper limit for start-on threshold is always the start point for soft-start.

6.4.4 Soft-start

When the upper limit of the start-on threshold function has been reached, the soft-start function will be initiated. The soft-start is used from the point of the upper limit of start-on threshold until the nominal voltage has been reached.

In the soft-start function only a timer is available. The parameter is located at 7753:

Parameter	Item	Range	Default	Note
7753	Soft-start ramp timer/ angle	0.1 to 120.0 s	2.0 s	Only in genset

The timer defines how long time it should take for the soft-start to increase the voltage from 0 to nominal voltage.

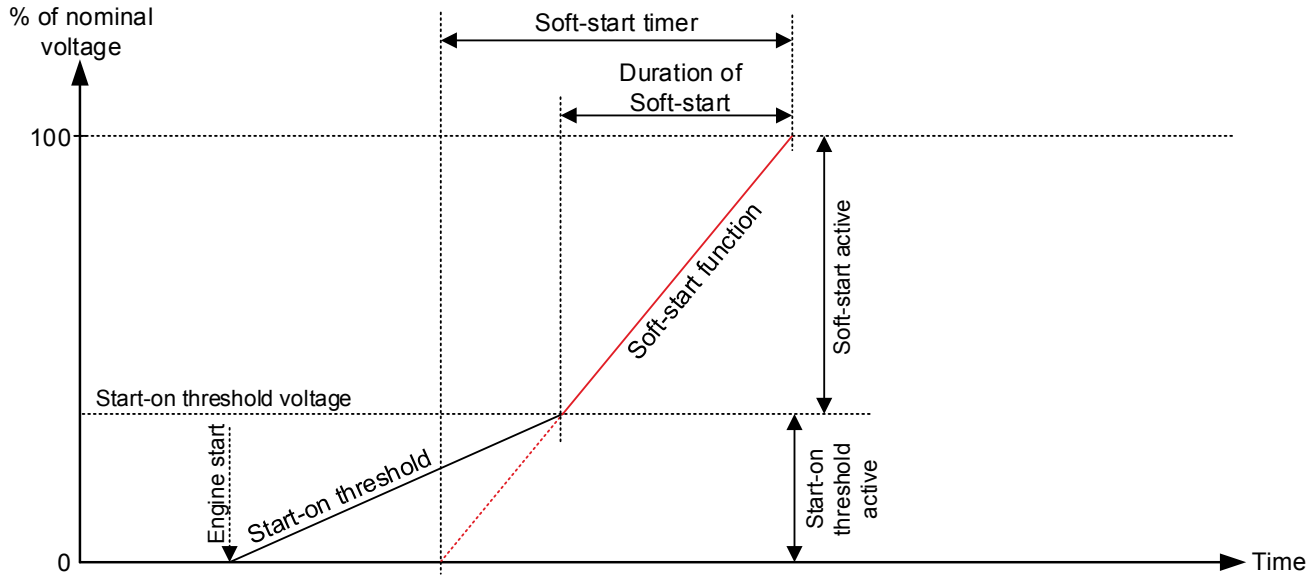
Example

If the timer is set to 5 seconds, with the start-on threshold set to 120 V AC and the nominal voltage is 400 V AC, the soft-start will be active for 3.5 seconds.

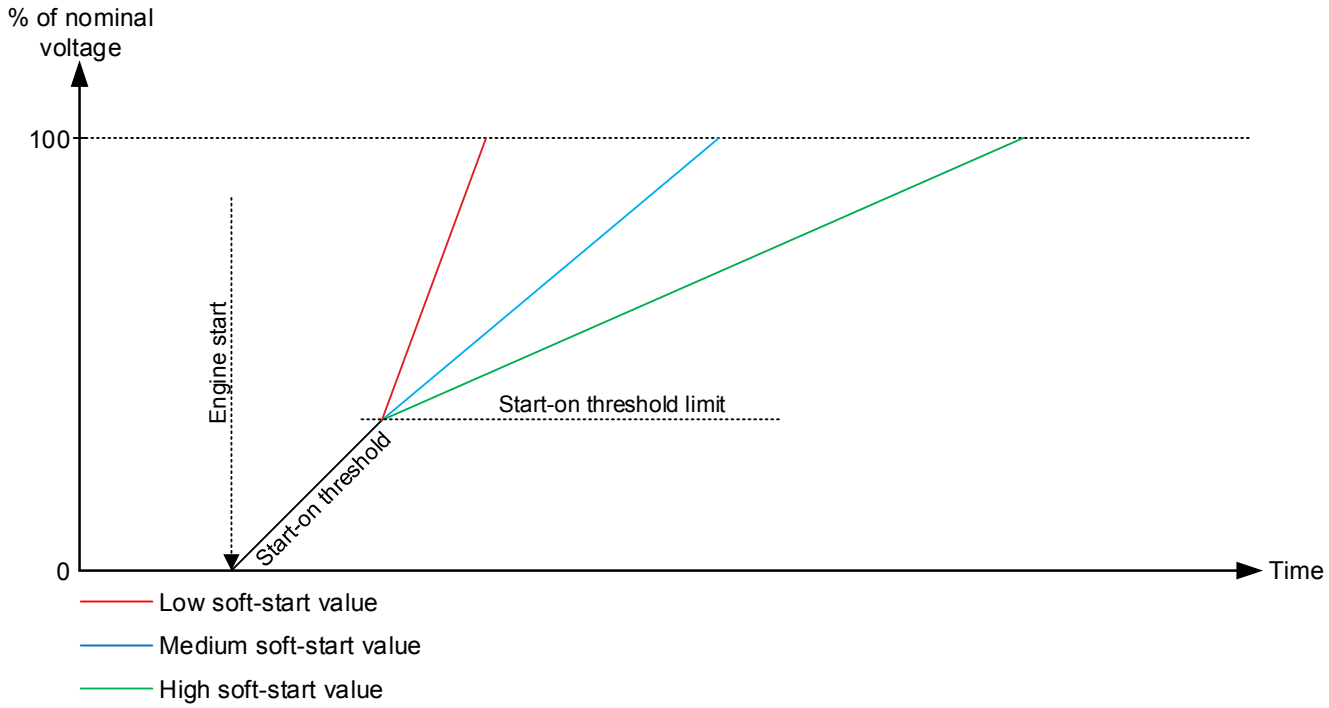
The calculation is:

$$\text{Duration of Soft-start} = \frac{\text{(Nominal voltage) - (Start-on theshold voltage)}}{\text{Nominal voltage}} \times \text{timer for Soft-start}$$

The graph below shows how the different things are placed:



The graph below shows three different settings in the soft-start. The first one has a low timer, the second a medium and the last a high timer. If the DVC 350 has been configured with start-on threshold, the soft-start should not be considered as a timer, but instead as an angle.



Since the soft-start timer represents how much time it should take to ramp up the voltage from 0 V to nominal, the full timer will not be used if the start-on threshold function is also used.

Example

If the wanted duration of the soft-start is known, the timer to set in the parameter can be calculated:

$$\text{Timer for Soft-start} = \frac{\text{Nominal voltage}}{\text{(Nominal voltage) - (Start-on theshold voltage)}} \times \text{Duration of Soft-start}$$

NOTE If the soft-start ramp is set to 0.1 seconds, the soft-start function is disabled. The DVC 350 will then use the U/f slope when ramping up the excitation.

6.5 Operation modes

6.5.1 U/f variable slope (knee function)

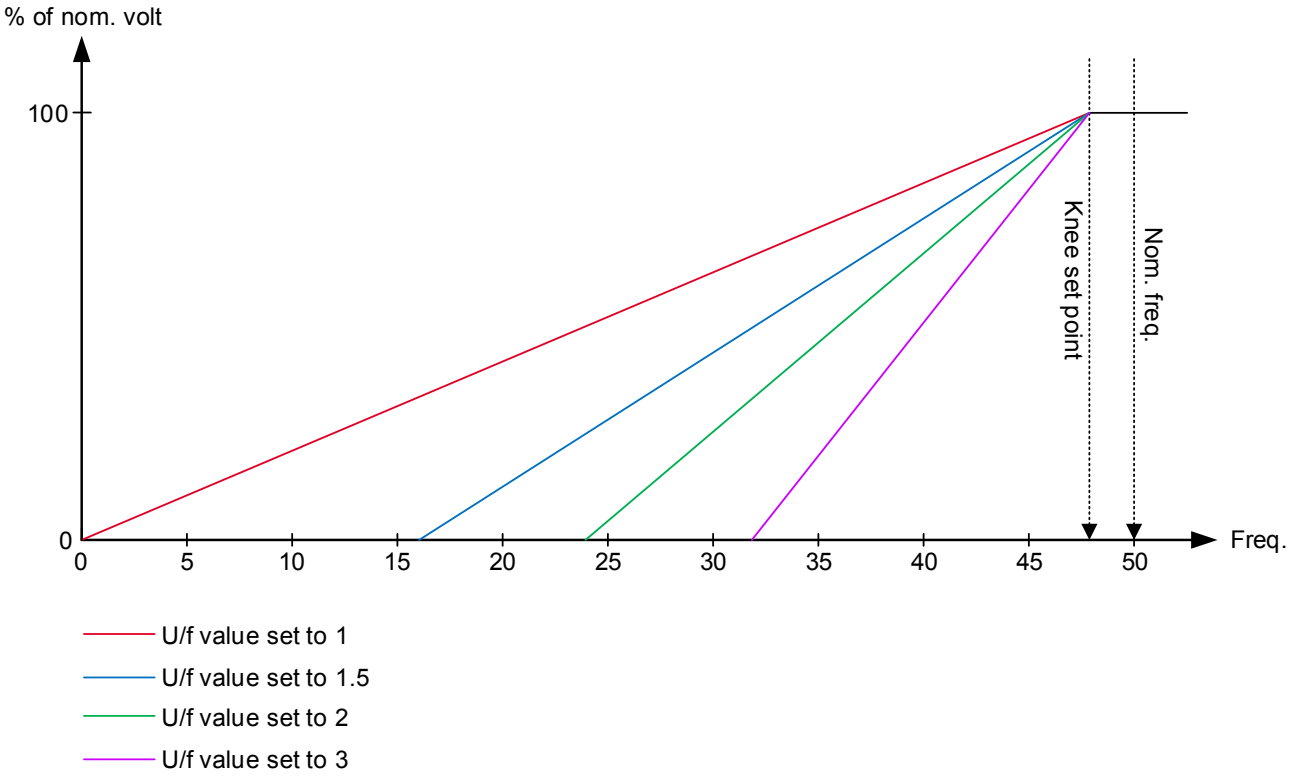
NOTE This function is automatically disabled by the AGC controller when operating parallel to mains.

The U/f variable slope (U/f law) determines the voltage reference/set point used by the DVC 350, depending on the frequency.

The U/f law is used to ensure that the genset does not reach its cutout limit. Some gensets are restricted to cut out when reaching 40 Hz, for example. This limit can be reached at heavy loads. If the dive in frequency is below the genset's cutout limit, the genset will be forced to stop. The U/f law allows the voltage to droop and by this reduce the torque on the engine, so the frequency can be kept above the cutout limit. This function will not work with load that determines constant power, such as frequency converters and UPS installations. But it will work with, for example, electrical motors and electrical heaters where the voltage can be reduced.

The U/f law determines how much the DVC 350 should droop the voltage compared to the frequency drop at big loads. It is possible to configure at which frequency the knee set point should be, and this is set in parameter 7771. Below the knee set point, the DVC 350 will let the voltage droop. The slope of how much the voltage should droop compared to the frequency can be set in parameter 7772.

The changes on the U/f law are shown in the graph below. The knee point is held constant in all of them. The graph shows how much the DVC 350 will regulate down in nominal voltage:



The knee set point determines when the U/f law becomes active. When the frequency goes below the knee set point, the U/f law defines a temporary voltage set point for the DVC 350.

The U/f setting can also be calculated:

$$U/f = \frac{100 - \left(\frac{\text{Minimal voltage}}{\text{Nominal voltage}} \times 100\right)}{\text{Knee set point - Cutout limit}}$$

Example

A genset has the nominal voltage of 400 V AC, the knee set point is set to 48 Hz.

The genset will cut out at 40 Hz, and the breaker will open at 350 V AC.

$$U/f = \frac{100 - \left(\frac{350}{400} \times 100\right)}{48 - 40} = 1.56$$

So the U/f slope can now be set to either 1.5 or 1.6.

The U/f law (knee function) is set up in the parameters shown below:

Parameter	Item	Range	Default	Note
7771	Knee set point	70.0 to 100.0 %	96.0 %	Only in genset
7772	U/f variable slope	0.5 to 5.0	1.0	Only in genset

The voltage regulator of the AGC is inhibited in case the frequency drops below knee set point.

Voltage reference is limited by U/f law at any time.

6.5.2 Load acceptance module (LAM)

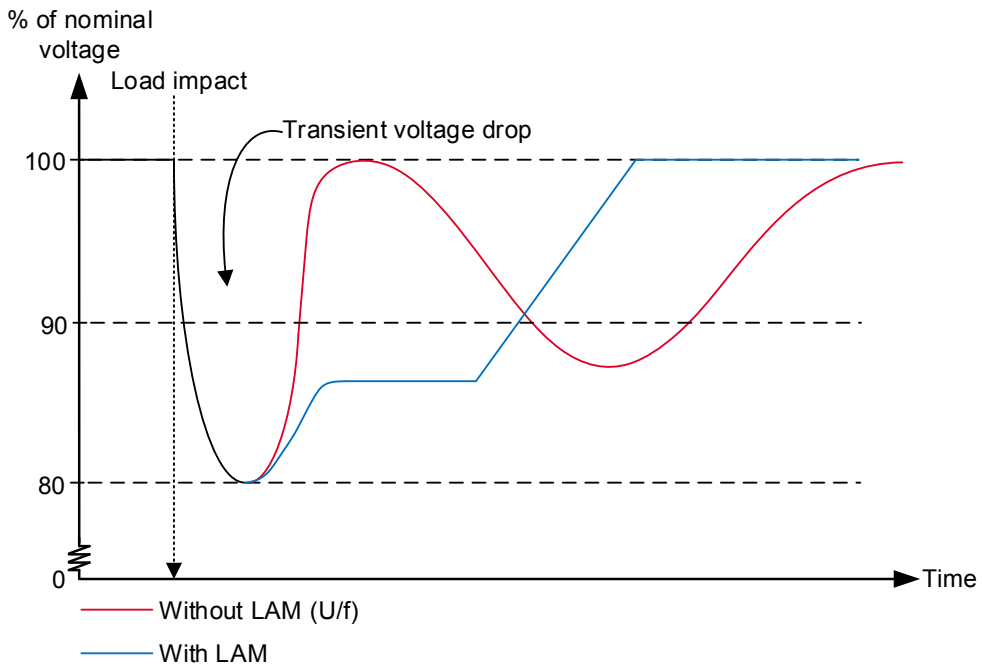
NOTE This function is automatically disabled by the AGC controller when operating parallel to mains.

The DVC 350 supports LAM, which is a functionality to optimise transient performance of frequency when high load steps are applied.

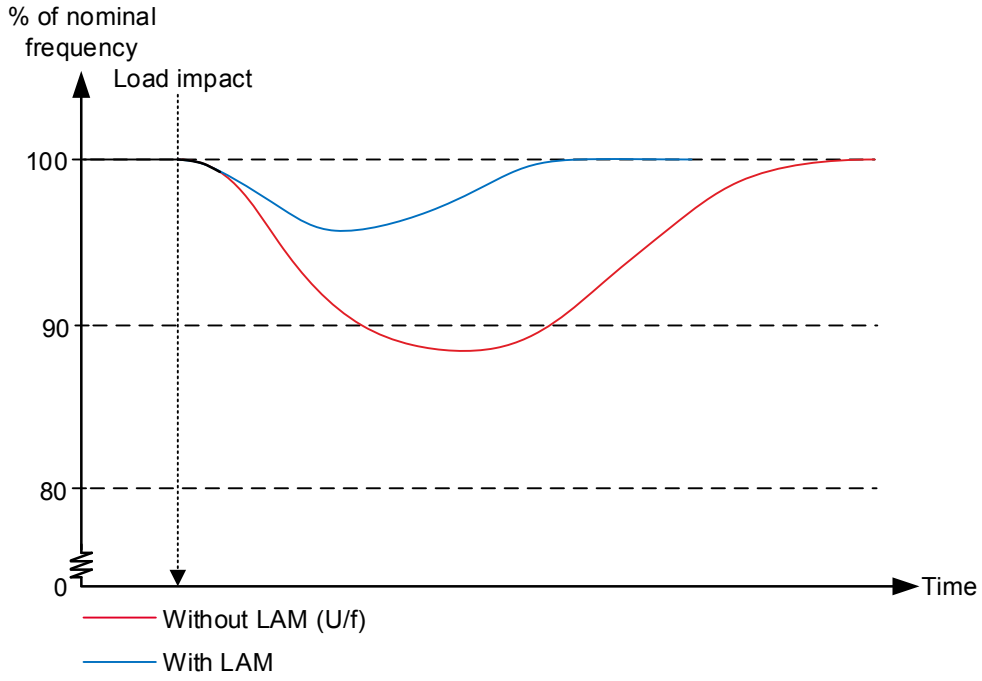
The LAM function is only used together with the Soft voltage recovery (SVR), see parameter 7774.

This is achieved by dropping the voltage reference momentarily when the frequency drops below the knee point. In this way, the torque demand on the engine is reduced momentarily. Afterwards, the voltage is raised slowly (according to the soft voltage recovery setting) towards the voltage reference defined by the U/f law. The LAM function can be used to gain more stability in the regulation when a big load impact has been experienced. The percentage set in the LAM function defines how many percent the voltage is allowed to drop, as soon as the knee point is reached.

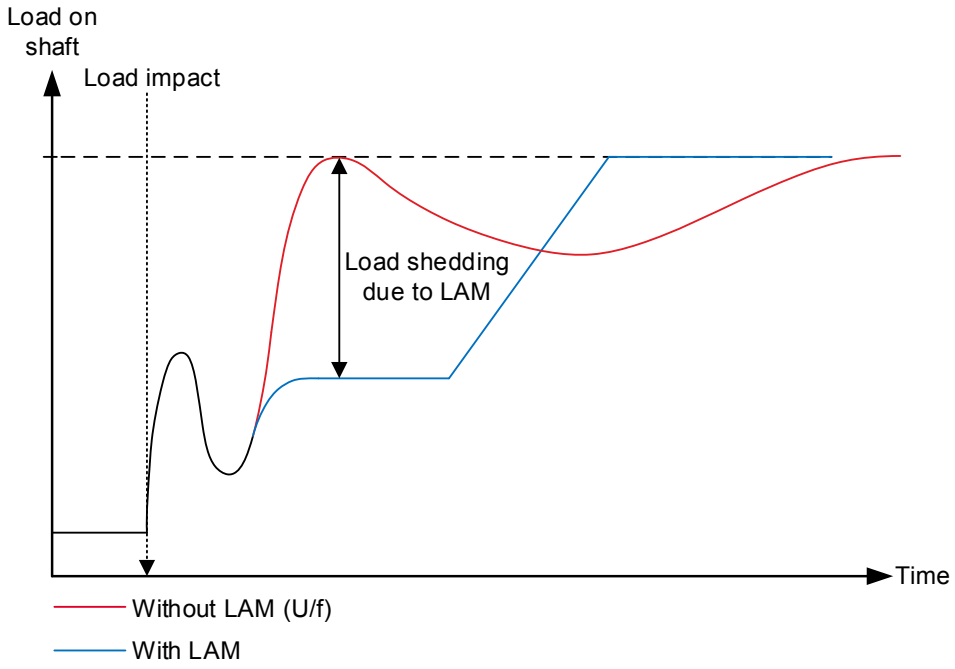
A comparison of U/f and LAM system performance is shown below:



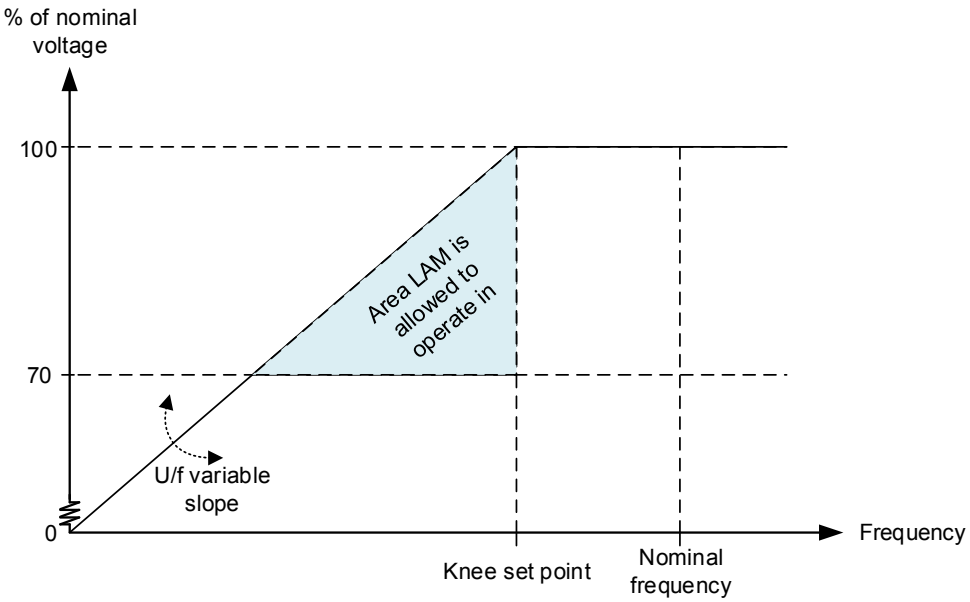
In the graph above, a comparison is made with and without the LAM function. Without the LAM function, the voltage may get unstable at load impacts. Here it is only the U/f law from the knee set point function that determines the voltage set point. With the LAM function, it is allowed to drop the voltage for a short time. The LAM function will start to ramp up the voltage when the frequency is starting to ramp up again. The slope of the ramp-up of the voltage is controlled by the soft voltage recovery function, which will be described later.



The graph above shows that with the LAM function, the frequency will rise and stabilise faster after a big load impact. This is because the LAM function will drop the voltage and by this lower the torque on the engine.



The graph above shows a comparison of the load on the shaft of the engine, with the LAM function enabled and disabled. When the LAM function drops the voltage, the torque on the shaft is lightened, which makes it possible for the engine to rise faster in RPM after a load impact. This also gives the possibility to steadily reach nominal values faster after the load impact, since the LAM function will increase system stability.



The graph above is very similar to the U/f law graph. The difference is that a triangle is marked here. When the LAM function is enabled, the genset is allowed to be inside the marked area. When having the U/f law, the DVC 350 will never cross the U/f law line in the graph, but will always seek to be near it. When the genset is above the knee set point, the DVC 350 will regulate up to the nominal voltage instead. But as long as it is in the marked area (triangle), the DVC 350 will have the U/f law to determine the voltage set point.

The LAM set point in the DVC 350 is set in percentage of how much it should drop the voltage compared to nominal. So if a set point of 10 % is made, the voltage will drop to 90 % of nominal when the LAM function is active. In the AGC, the LAM function is set on how much it should drop to when LAM is active. So, if the LAM function in the AGC is set to 90 %, the DVC 350 will drop the voltage to 90 % of the nominal voltage when LAM is active.

Parameter	Item	Range	Default	Note
7774	Activation of LAM function	OFF SVR + LAM	OFF	Only in genset. Set to **SVR + LAM** to enable.
7775	LAM set point	70 to 100 %	90 %	Only in genset. Defines the voltage level to which the voltage is dropped when the knee set point is reached.
7776	LAM duration	0.0 to 10000.0 ms	1000.0 ms	Only in genset.

NOTE Settings at parameters 7774, 7775 and 7776 are treated as shared set points among the AGC DG units in power management applications.

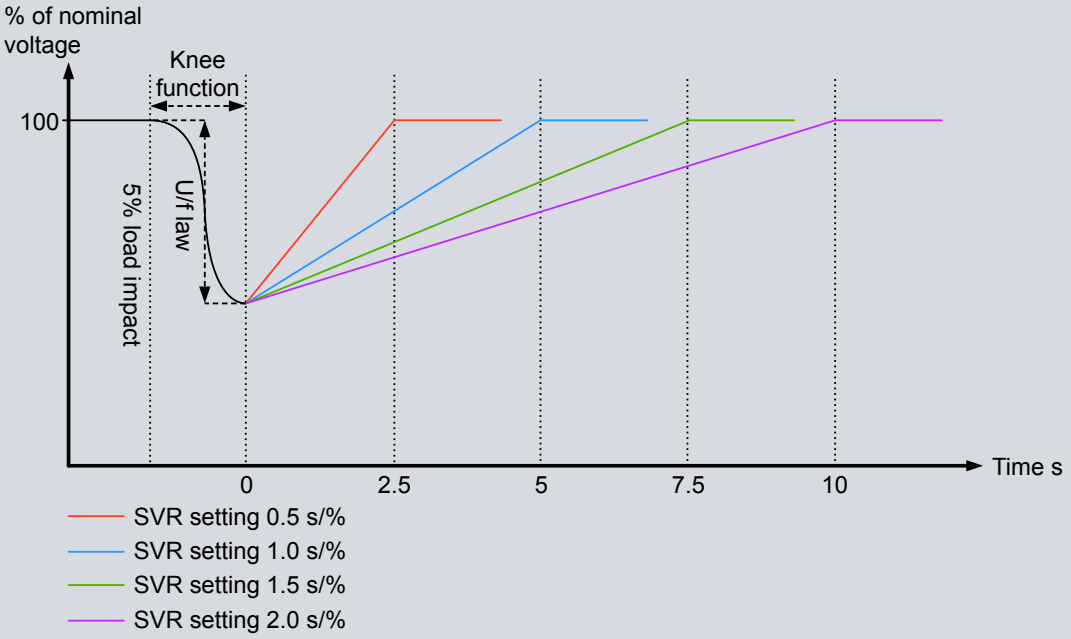
6.5.3 Soft voltage recovery (SVR)

NOTE This function is automatically disabled by the AGC controller when operating parallel to mains.

Soft voltage recovery (SVR) helps the genset return to its rated speed after experiencing a voltage drop due to a load impact. This is done by gradually increasing the voltage towards the voltage defined by the U/f law. The SVR is activated when the frequency drops below the knee point and an increase in frequency is detected. The setting for the SVR function defines the slope for the voltage recovery after a load impact. The SVR setting in parameter 7773 defines how many seconds the voltage should take to recover to nominal voltage from a percentage drop of voltage due to load impact.

Example

Different SVR settings are shown at 5 % voltage drop due to a load impact:



The dotted line at time point 0 represents where the frequency is starting to recover again. When the frequency starts to recover, the SVR function will be activated. When the genset is exposed to a 5 % voltage drop due to a load impact and the SVR setting is 1.0 s/%, the voltage will be recovered in 5 seconds. But the U/f law can still not be passed, which can make the SVR longer than for example 5 seconds. This can happen if the engine is not fast to recover in RPM from a load impact.

The voltage regulator of the AGC is inhibited in case the SVR functionality is active. Regulation is activated again when the SVR timer runs out.

Parameter	Item	Range	Default	Note
7773	Soft voltage recovery timer	0.0 to 10.0 s/%	0.2 s/%	Only in genset
7774	Activation of soft voltage recovery function	OFF SVR + LAM	OFF	Only in genset

NOTE Parameter 7774 is treated as a shared set point among the AGC DG units in power management applications.

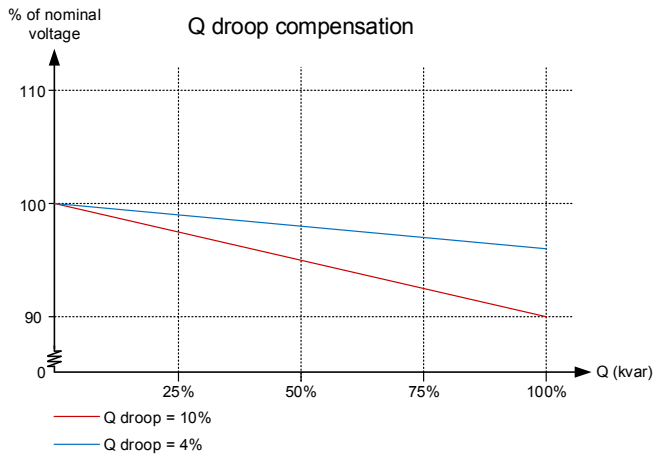
6.5.4 Droop compensation

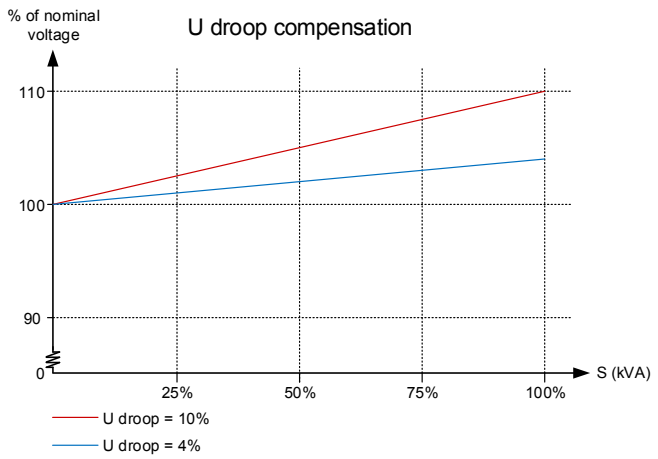
NOTE This function is automatically disabled by the AGC controller when operating parallel to mains.

Two types of droop compensation are supported by the DVC 350:

- Reactive droop.
- Voltage line droop.

They can be controlled with the AGC.





The droop compensation decides how much the voltage is allowed to droop if the regulation is turned off in the AGC. The regulation can be turned off by setting the AGC to MANUAL. The regulation can also be off if the CAN bus cables should break. With the droop, it is possible to give the DVC 350 a set point for the voltage if an error in the CAN bus lines should occur. This makes it possible for the genset to share the reactive load when no interfacing is available.

It is recommended that the U droop compensation is not turned on when interfacing the DVC 350 with an AGC. These functions will try to work in opposite directions, which may cause instability.

All settings for droop are found in menu 7780 - Droop compensation.

Parameter	Item	Range	Default	Note
7781	Q droop compensation set point	0.0 to 10.0 %	2.0 %	Only in genset
7782	U droop compensation set point	0.0 to 10.0 %	2.0 %	Only in genset
7783	Activate droop compensation type	Q droop compensation OFF	Q droop compensation	Only in genset

NOTE All settings at menu 7780 are treated as common set points among the AGC DG units in power management applications.

NOTE Only one of the droop functions can be active.

6.6 Protections

6.6.1 Introduction

The DVC 350 provides many configurable protection functions. These must be configured with the DEIF EasyReg Advanced software.

More information
See **Protections** in the chapter **About the DVC 350** for more information about all of the available protections.

The AGC can be configured to display and log alarms created from the DVC 350.

The alarms logged can then be viewed:

- On an AGC display by using the jump menu 9090.
- In the event log for the AGC.

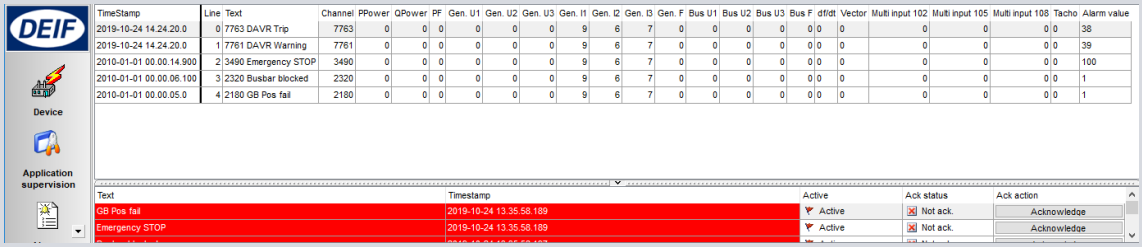
6.6.2 Alarm logging from DVC 350 to AGC

Two additional parameters need to be enabled, that will activate when alarms are created by the DVC 350.

Parameter	Description
7761 DAVR Warning	Activates if a protection is activated by the DVC 350 where *Action after fault*: • 0 : No action
7763 DAVR Trip	Activates if a protection is activated by the DVC 350 where *Action after fault* is either: • 1 : Stop regulation • 2 : Shutdown current • 3 : Field current before fault

The log entry for either parameter includes a fault value, which provides information on which fault was created.

Example AGC-4 event log



In this example, the **DAVR Trip** and **DAVR Warning** have these values:

108	Tacho	Alarm value
0	0	38
0	0	39

- DAVR Trip - value 38
- DAVR Warning - value 39

DAVR Trip shows that **AIN1 Wirebreak fault** was detected.
DAVR Warning shows that **AIN2 Wirebreak fault** was detected.

List of AGC alarm values from DVC 350

Alarm value	Description
1	Over-voltage
2	Under-voltage
3	Over-frequency
4	Under-frequency
5	Open diode
6	Shorted diode
7	Reverse active power
8	Reverse reactive power
9	Pt100 1 alarm
10	Pt100 1 fault

Alarm value	Description
11	Pt100 2 alarm
12	Pt100 2 fault
13	Pt100 3 alarm
14	Pt100 3 fault
15	Pt100 4 alarm
16	Pt100 4 fault
17	Pt100 5 alarm
18	Pt100 5 fault
19	PTC 1 fault
20	PTC 2 fault
21	PTC 3 fault
22	PTC 4 fault
23	PTC 5 fault
24	Loss of AC voltage sensing
25	Unbalanced voltage
26	Unbalanced current
27	Short circuit
28	Excitation chain fault
29	Motor start
30	Power bridge overload
31	Battery supply low
32	CAN supply low
33	Pt100 1 open/short
34	Pt100 2 open/short
35	Pt100 3 open/short
36	Pt100 4 open/short
37	Pt100 5 open/short
38	AIN1 wirebreak fault
39	AIN2 wirebreak fault
40	AIN3 wirebreak fault
41	AIN4 wirebreak fault
42	AOUT1 overload/wirebreak
43	AOUT2 overload/wirebreak
44	AOUT3 overload/wirebreak
45	AOUT4 overload/wirebreak
46	DOUT overload fault

6.7 Regulation of DVC 350

6.7.1 PID settings

Configure the PID settings for the AGC under menu 7800.

Parameter	Description	Comment
7801	PID Gain	This is a gain for the PID regulator in the DVC 350
7803	Wr All settings	This parameter sends all settings to the DVC 350. • This is a pulse command. • By default the parameter returns to OFF state after use.

The PID regulators can only be changed with DEIF EasyReg Advanced software.

More information
See **PID settings** in **Configure the DVC 350** for more information about PID configuration.

When the AGC has the control (parameter 7805 is enabled) only the voltage regulators are used. The gain for voltage regulator is set from the AGC at parameter 7801.

More information
See **DAVR control** in **Bias and control** for more information about the AGC control settings.

With parameter 7803, the AGC writes the settings as the settings are made. The user can apply this parameter to ensure that all the settings regarding the DVC 350 in the AGC are written once more.

The ranges and defaults for the parameters are shown below:

Parameter	Item	Range	Default	Note
7801	PID gain in DVC 350	1 to 200	20	Only in genset.
7803	Write all settings to DVC 350	OFF ON	OFF	Only in genset. When set to ON, it will automatically reset to OFF.

6.7.2 Bias and control

Bias range

Parameter 7804, the AGC can control how wide the bias range should allow the AGC to control the voltage in the DVC 350.

By default, it is set to +/- 10 %, which means that the AGC is allowed to regulate the voltage on a 400 V genset from 360 V to 440 V. The bias range should be wide enough to ensure that the gensets can load-share the reactive power in both capacitive and inductive situations. By making the bias range wider, the resolution for load sharing between the AGCs will be harder, since a small step gives a bigger response. By experience, the +/- 10 % bias range covers most applications.

The bias range is for CAN bus based bias signal or for analogue bias and CAN bus based bias signal.

Bias for analogue regulation

Parameter 7796 can be set with the type of input the DVC 350 should expect to receive if parameter 2783 (AGC-4) / 2782 (AGC 150) is set to analogue.

To ensure that the DVC 350 is regulated from the AGC, parameter 5990 must be set to the correct transducer output that must give the bias to the DVC 350.

DAVR control
Parameter 7805 controls whether the AGC should send commands and information in the CAN bus. This could, for example, be controlling the DVC 350 in switching regulation mode, and sets the knee set point and other settings/commands to the DVC 350.

It does not matter if **DAVR control** is set to ON or OFF as regards the bias signal. The AGC is still able to regulate on the CAN bus based bias to the DVC 350. Parameter 2783 (AGC-4) / 2782 (AGC 150) must then still be set to **EIC**, and the engine interface 7561 must be set to a J1939-based protocol.

If the AGC has the control and the communication is up and running, it can be seen in the DEIF EasyReg Advanced software.

Settings controlled by the AGC are shown greyed out, so these settings can only be changed from the AGC.

More information
See **Common DVC 350 settings** in this chapter for more information about the common settings for DVC 350.

The table below shows the parameters that are described above:

Parameter	Item	Range	Default	Note
7804	DVC 350 bias range for CAN bus-based regulation	0.1 to 30.0 %	10.0 %	Only in genset.
7805	Allow the AGC to control DVC 350	OFF ON	ON	Only in genset.
7796	DVC 350 analogue bias input type	±10 V ±5 V Potmeter	0 to 10 V DC	Only in genset.

6.8 AGC-4 and DVC 350 cooperation

6.8.1 Nominal settings

When the CAN bus communication is established and the parameter 7805 for **DAVR control** is enabled, the AGC controls the nominal settings in the DVC 350.

For rental customers, this can be helpful in cases where the gensets are exposed to different scenarios where different nominal settings can be required. By shifting the nominal settings in the DVC 350, it makes sure that the bias range is still the same even though the nominal voltage is either higher or lower.

The nominal settings that are sent automatically from the AGC are active nominal voltage and frequency. So if the nominal setting is shifted between the four possible nominal settings, the active nominal settings will be sent automatically to the DVC 350.

6.8.2 Auto-view

If the CAN bus communication between the AGC and the DVC 350 is established, the AGC is able to display some values that it receives via the CAN bus. These values will be added to the 20 views that are already present in the AGC, so the total number of views will be expanded. It will still only be possible to configure the first 20 views.

The extra lines will be displayed if parameter 7564 is enabled and the CAN bus is active. Parameter 7564 will automatically switch to OFF again.

NOTE If the DVC 350 is mounted on a genset that also has an ECU, and the ECU also gives information via the CAN bus, then the ECU data might not be required to start the genset before toggling the auto-view to ON, because some ECUs only give information when the engine is running.

The parameter for auto-view:

Parameter	Item	Range	Default	Note
7564	Auto-view - enable	OFF ON	OFF	Only in genset. Note that it automatically switches to OFF again.

6.8.3 Communication error

When the settings regarding communication to the DVC 350 have been set, the AGC has an alarm for checking the communication lines. If the communication between the AGC and the DVC 350 suddenly stops, the AGC creates the alarm **DAVR Comm. Err**.

The alarm is configured on parameter 7830, where it is also possible to set a fail class to activate if the **DAVR Comm. Err** alarm occurs.

The parameters used for the communication alarm error:

Parameter	Item	Range	Default	Note
7831	Digital AVR communication error - delay	0.0 to 100.0 s	0.0 s	Only in genset.
7832	Digital AVR communication error - output A	Not used Option-dependent	Not used	Only in genset.
7833	Digital AVR communication error - output B	Not used Option-dependent	Not used	Only in genset.
7834	Digital AVR communication error - enable	OFF ON	OFF	Only in genset.
7835	Digital AVR communication error - fail class	Block Trip GB Warning Trip+stop Shutdown Trip MB Safety stop	Warning	Only in genset.

6.8.4 DVC 350 alarms on AGC

The DVC 350 can give two different levels of alarms:

- **DAVR Warning**
- **DAVR Trip**

This is enabled in menu 7760, in which it is also possible to set a fail class.

Parameter	Item	Range	Default	Note
7761	DAVR Warning	Block Trip GB Warning Trip+stop Shutdown Trip MB Safety stop	Warning	Only in genset.
7763	DAVR Trip	Block Trip GB Warning Trip+stop Shutdown Trip MB Safety stop	Warning	Only in genset.

6.8.5 DAVR info menu (jump 9090)

AGC-4

Jump menu 9090 shows information about DAVR software version and any active alarms in the DAVR.

Parameter 9093 acknowledges any current active alarms and clears any alarms if they are no longer active.

Parameter	Item	Note
9091	DAVR SW version	Display of DAVR software version
9092	DAVR alarms	Display of all active alarms
9093	DAVR trip alarms	Display of active trip alarms (select to acknowledge alarms from the DAVR)

AGC 150

The Jump function in AGC 150 is only available via the Shortcut button on the controller.

Enable the Jump function under **Settings >Basic settings > Controller settings > Display > Display control** in parameter 9157.

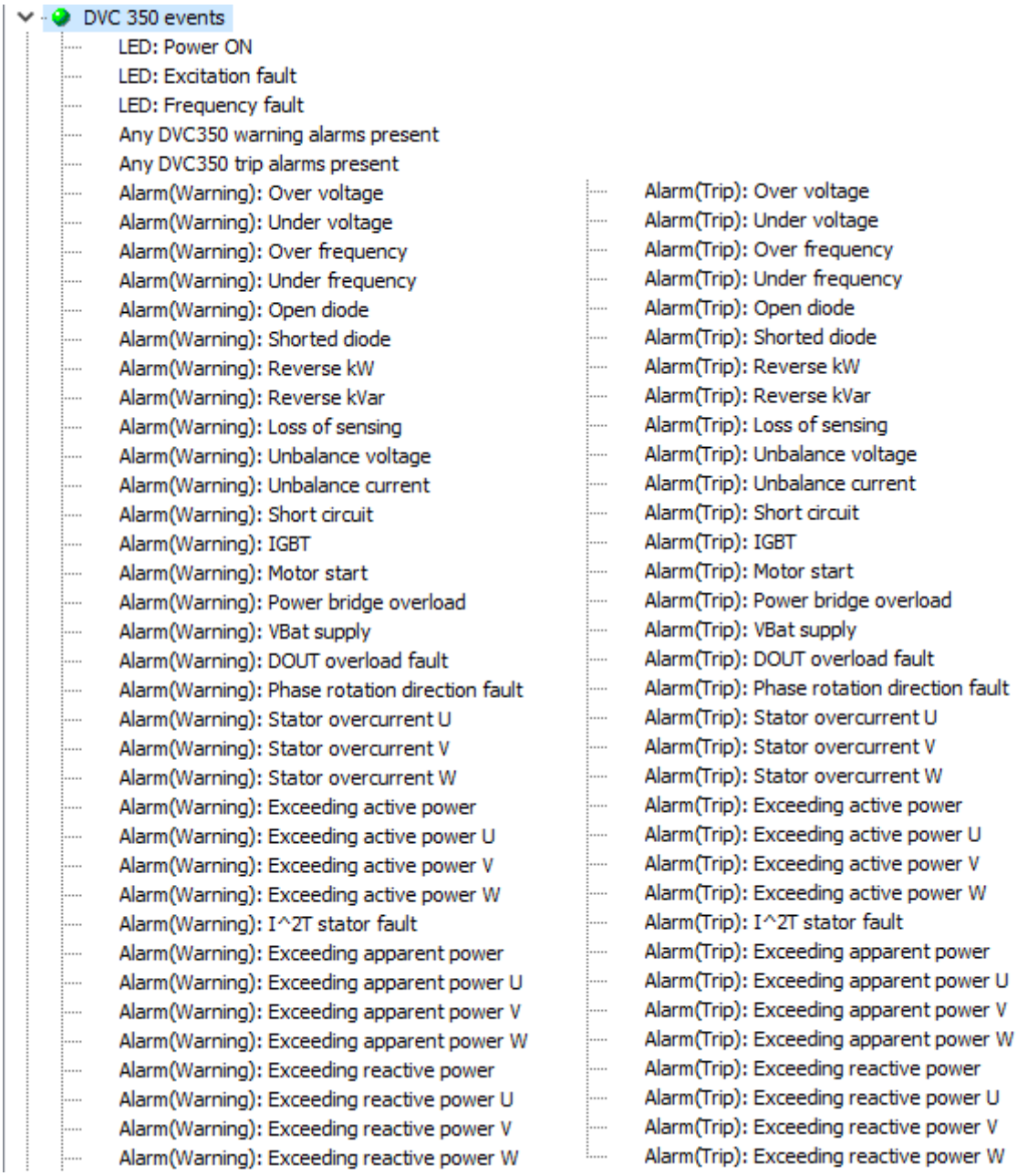
More information
See **General product information, Menu numbers and the Jump function, Jump function** in the **AGC 150 Designer's handbook** for more information about the Jump menu.

6.9 M-Logic events and outputs for DVC 350

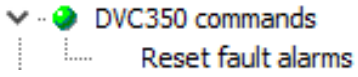
M-Logic has many DVC 350 related events. It also has an output function.

Events

These are grouped under **DVC 350 events**:



Outputs



6.10 Modbus communication

This chapter is additional information for option H2/N (Modbus RS-485 RTU).

If option H2/N is installed, the data can be transmitted to a PLC, a computer, the alarm-and-monitoring system or a Scada system.

More information
Please refer to the technical documentation for **Option H2 and H9 Modbus communication** and **Option N Modbus TCP IP** available on the DEIF homepage : https://www.deif.com/products/agc-4#documentation

The data readable by the Modbus communication are converted into the chosen unit in menu 10970.

Modbus table

Function code 4			
Address	**Bit**	**Content**	**Note**
916		AVR generator AC Voltage [V]	
917		AVR generator frequency [Hz] 1/10	
918		AVR generator AC current [A]	
919		AVR field excitation current [A] 1/10	
920		*Not used*	
921		AVR generator reactive power	
922		AVR generator Power Factor [ ] 1/100	
923		AVR generator Power Factor lagging	00= lagging 01= leading
924		*Not used*	
925		Total Power	
926		*Not used*	
927		AVR generator apparent power	
928		AVR Pt100 1 temperature [deg C/F]	
929		AVR Pt100 2 temperature [deg C/F]	
930		AVR Pt100 3 temperature [deg C/F]	
1056	0	AVR comm. error	
	1	AVR Warning	
	2	AVR Trip	
	3-15	*Not used*	
1365	0	USB LED	
	1	POWER LED	Function code 4
	2	U = U	
	3	PF kVAR	
	4	I Exc.	
	5	Diode fault	
	6	Exc. fault	
	7	Voltage fault	
	8	Frequency fault	
	9-15	*Not used*	

Function code 4			
Address	**Bit**	**Content**	**Note**
1366	0	Over voltage	
	1	Under voltage	
	2	Over frequency	
	3	Under frequency	
	4	Open diode	
	5	Shorted diode	
	6	Reverse P	
	7	Reverse Q	
	8	Pt100 1 alarm	
	9	Pt100 1 fault	
	10	Pt100 2 alarm	
	11	Pt100 2 fault	
	12	Pt100 3 alarm	
	13	Pt100 3 fault	
	14	Pt100 4 alarm	
	15	Pt100 4 fault	
1367	0	Pt100 5 alarm	
	1	Pt100 4 fault	
	2	PTC 1 fault	
	3	PTC 2 fault	
	4	PTC 3 fault	
	5	PTC 4 fault	
	6	PTC 5 fault	
	7	Sensing lost	
	8	Unbalanced U	
	9	Unbalanced I	
	10	Short circuit	
	11	Excitat. chain	
	12	Motor start	
	13	Pwr bridge	
	14	Batt supply lo	
	15	CAN supply low	

Function code 4			
Address	**Bit**	**Content**	**Note**
1368	0	Pt100 1 op/sho	
	1	Pt100 2 op/sho	
	2	Pt100 3 op/sho	
	3	Pt100 4 op/sho	
	4	Pt100 5 op/sho	
	5	AIN1 wirebreak	
	6	AIN2 wirebreak	
	7	AIN3 wirebreak	
	8	AIN4 wirebreak	
	9	AOUT1 ol/wb	
	10	AOUT2 ol/wb	
	11	AOUT3 ol/wb	
	12	AOUT4 ol/wb	
	13	DOUT overload	
	14-15	*Not used*	

7. Troubleshooting

7.1 Preventive maintenance instructions

During a downtime period for the alternator, it is recommended to:

- Check the wires are tight in the connectors.
  - Torque setting between 0.6 Nm and 0.8 Nm.
- Blow dry air through to get rid of any dust that may have settled on or around the DVC 350.
- Check there is free circulation of air around the aluminum heat sink at the front of the device.
- Check the running time counter.
  - If this exceeds 40,000 hours, consider changing the AVR.

7.2 Troubleshooting

Issues can occur on the AVR which may lead to its replacement.

The main faults are listed below:

Fault	Cause(s)	Solution	Restart action(s)
Voltage sensing fault.	Alternator sensing VT broken.	Replace defective VT.	1. Stop the alternator. 2. Replace defective VT. 3. Restart the alternator.
	Internal measurement broken.	Replace the AVR.	**More information** See **Replace a defective DVC 350** for how to replace.
Excitation fault.	• Defective component. • Opening of the field excitation circuit which caused a voltage surge on the transistor.	Replace the AVR.	**More information** See **Replace a defective DVC 350** for how to replace.
24 V DC auxiliary supply fault.	External supply fault.	Replace the 24 V DC power supply.	1. Stop the alternator. 2. Replace the defective power supply. 3. Restart the alternator.
	Voltage converter fault.	Replace the AVR.	**More information** See **Replace a defective DVC 350** for how to replace.
The AVR is not responding (display does not operate, no communication).	Microcontroller fault.	Replace the AVR.	**More information** See **Replace a defective DVC 350** for how to replace.

Fault	Cause(s)	Solution	Restart action(s)
The regulation mode controlled by an input is not active.	Defective input.	Change the control of the regulation mode to another input	1. Stop the alternator. 2. Configure new settings. 3. Restart the alternator.
		Replace the AVR.	**More information** See **Replace a defective DVC 350** for how to replace.
	The wiring is defective	Check that the input has been enabled by shunting the 0 V and the local input and checking the input state on the HMI.	Restart the alternator.
The field excitation does not start.	Defective starting input	Change the control of starting to another input	1. Stop the alternator. 2. Configure new settings. 3. Restart the alternator.
	The AVR power is not on.	Check the VBus voltage on the HMI.	Restart the alternator.
	The 24 V DC power supply is defective	Check that the AVR is on by looking at the HMI LEDs. **Power ON**	Restart the alternator.
Regulation of the power factor is unstable.	The active power is too low to have a correct power factor measurement.	Use kVAr mode for low load regulation (less than 10 % of rated load)	1. Stop the alternator. 2. Configure new settings. 3. Restart the alternator.
	The stator current measurement is incorrect.	Check the CT wiring on the current measurement input and the CT.	Restart the alternator.
		Replace the AVR if the wiring is correct.	**More information** See **Replace a defective DVC 350** for how to replace.

7.3 Replace a defective DVC 350

DANGER!

Hazardous live currents and voltages

Risk of electrical shock and/or damage

While the AVR is in operation, do not unplug any connectors or make any wiring modifications. This may lead to electric shock and/or destruction of the AVR and/or damage to the alternator.

NOTICE

Configuration changes during operation

Possible damage to equipment

Modifications to the main alternator settings, such as: machine data, voltage and current measurement transformer wiring, upper or lower reference limits, or starting control, must be made when the alternator stopped.

NOTICE

Operating range

Possible damage to equipment

The operating ranges must always be adhered to. Changing the settings to inappropriate voltages or currents may cause partial or total destruction of the AVR and/or alternator.

NOTICE

Power input protection

Possible damage to equipment

The power input must be protected by a circuit-breaker or fuses in order to avoid irreparable damage to the AVR in the event of short-circuit or voltage surge.

NOTICE

Installation/Replacement

The installation/replacement must only be carried out by authorised personnel who understand the risks involved in working with electrical equipment.

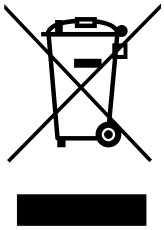
To replace a defective DVC 350 AVR:

1. Stop the alternator (if not already done).
2. Switch off and electrically isolate the auxiliary supply and power supply.
3. Make sure that a voltage cannot be detected.
4. Carefully remove all the AVR connectors, and note their positions.
5. Remove the AVR mounting brackets so it can be removed from the installed location.
6. Upload your your configuration project to the new DVC 350 AVR using DEIF EasyReg Advanced.
7. Disconnect the DVC 350 USB cable.
8. Mount the new DVC 350 to replace the defective AVR.
9. Reconnect all the connectors on the new AVR.
10. Switch on the auxiliary supply and check that the AVR is energized.
11. Switch on the alternator drive system.
12. Switch on the power supply without exciting the machine.
13. Before exciting the alternator, check the alternator voltage measurement and power supply voltage (VBus).
14. Switch on the alternator excitation.
15. Check all the AVR measurements and regulation modes, and controlled outputs.

8. End-of-life

8.1 Disposal of waste electrical and electronic equipment

WEEE symbol



All products that are marked with the crossed-out wheeled bin (the WEEE symbol) are electrical and electronic equipment (EEE). EEE contains materials, components and substances that can be dangerous and harmful to people's health and to the environment. Waste electrical and electronic equipment (WEEE) must therefore be disposed of properly. In Europe, the disposal of WEEE is governed by the WEEE directive issued by the European Parliament. DEIF complies with this directive.

You must not dispose of WEEE as unsorted municipal waste. Instead, WEEE must be collected separately, to minimise the load on the environment, and to improve the opportunities to recycle, reuse and/or recover the WEEE. In Europe, local governments are responsible for facilities to receive WEEE. If you need more information on how to dispose of DEIF WEEE, please contact DEIF.