DEIF

-power in control

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MULTI-LINE 2
APPLICATION NOTES
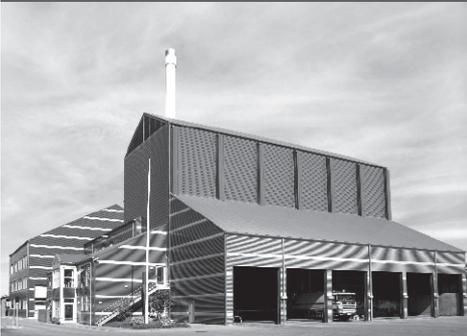
The DEIF Emulation Tool
- Function overview
- Requirements
- Configuration

1. Introduction

2. Emulation function overview

3. Requirements for the DEIF emulation tool

4. Using the emulation tool

5. Configure emulation

1. Introduction

1.1 Purpose of this document

1.1.1 Why read this document?

This user guide provides detailed information on using and setting up the DEIF emulation tool for a controller system.

⚠️ **Please read this document before working with the DEIF controller and the associated genset. Failure to do so could result in injury or damage to the equipment.**

1.1.2 Intended users

This user guide is mostly for people responsible for:

- Design and installation of a controller system, in most cases this would be a panel designer or builder.
- Testing and commissioning the system.
- Training new operators.

1.2 Warnings, legal information and safety

1.2.1 Warnings and notes

Throughout this document, a number of warnings and notes with helpful user information will be presented. To ensure that these are noticed, they will be highlighted as follows in order to separate them from the general text.

⚠️ **Warnings indicate a potentially dangerous situation, which could result in death, personal injury or damaged equipment, if certain guidelines are not followed.**

ⓘ **Notes provide additional information, hints and tips which help you with the task or procedure.**

1.2.2 Safety issues

Installing and operating the controller involves working with dangerous currents and voltages. The installation must only be performed by authorised personnel who have been trained to work with live electrical equipment.

⚠️ **Note that when working with the controller there are hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to serious injury or death.**

1.2.3 Legal information and disclaimer

DEIF takes no responsibility for installation or operation of the generator set. If there is any doubt about how to install or operate the engine or generator controlled by the DEIF controller, the company responsible for the installation or the operation of the genset must be contacted.

⚠️ **The DEIF controller must not be tampered with by unauthorised personnel. If the controller is opened, the warranty becomes void.**

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.

1.2.4 ESD caution

Sufficient care must be taken to protect the terminals against static discharges before and during the installation. Once the controller is installed and connected, these precautions are no longer necessary.

1.2.5 Factory settings

The controller is delivered from the factory with default factory settings. These are based on average values and are not necessarily the correct settings for the engine/generator set. You must check the settings before running the engine/generator set.

2. Emulation function overview

2.1 Emulation functions and features

2.1.1 Why use the DEIF emulation tool?

The emulation tool enables you to imitate the power system and the environment that the controller is (or will be) connected to. You only need to have the controller(s) for the specific application. You do not need to connect to gensets and switchgear for emulation.

You can use the emulation tool to test power management, test plant logic, and get approvals. The emulation tool can also be used to minimise site time, and optimise training. The emulation tool allows you to operate the system as if the controllers were connected to a real mains connection, real gensets, and real breakers. You can prepare your parameter file and test it, and also test sequences and alarms.

During the emulation process, the software in the controller runs, and responds to the emulation stimuli, exactly as if the controller was installed in a power system and measuring the specified values at its inputs. The emulation is dynamic, with the response based on the regulator characteristics configured in the controllers. In addition, during emulation, the controller can activate outputs as if it were running in a power system. The emulation is therefore more extensive than a software simulation of the system.

2.1.2 Uses for the DEIF emulation tool

The following table displays some of the uses for the emulation tool.

Usage	Details
Test power management	Test switchboard sequences, the power management system response to load changes, genset auto start, genset auto stop, M-Logic functions, and so on.
Factory Acceptance Test (FAT)	When the switchboard is complete, use the emulation tool to test the effect of switchboard buttons and switches when the mains, gensets and/or bus tie breakers are present.
To train operators	To demonstrate the control system to operators. The function enables the operators to safely practise operating the system before the system is commissioned. For example you can demonstrate how the controller system responds to load changes: ● How loads shift when the bus tie breakers are opened and closed. ● How the controller mode effects the controller's response.

2.2 Scope

2.2.1 Scope of the DEIF emulation tool

The following table provides an overview of the values that can be specified, changed and tested during emulation.

Emulation stimuli	Details
Load	Specify the active and reactive loads connected to the busbar.
Fuel	Set the fuel optimisation parameters.
DG	Emulate the effect of a genset start failure.
Breakers	Emulate the effects of a breaker trip, a breaker where open or close is blocked, and the breaker feedback inputs.
Digital inputs	Activate controller digital inputs.
Measurements	Specify controller analogue inputs (typically measurements).
Mains	Emulate the effect of the frequency and voltage at the mains controller.

In addition to the emulation stimuli above, you can operate the system using the display push-buttons during emulation. Do this by selecting the controller mode, start and stop gensets, and close and open breakers. You can also use the display to modify parameters during emulation.

2.2.2 Limitations of the emulation tool

The dynamic characteristics of the system loads, the mains grid and the gensets are not defined for the emulation, and therefore cannot be included. The emulation responses and performance will therefore be faster and more stable than experienced in reality. In particular, synchronisation may be a lot faster for emulation than in reality. Load sharing may also be faster and more equal.

2.2.3 Compatible DEIF controllers

This document applies to the following DEIF controllers:

- AGC 100, from software version 4.01.1
- AGC 200, from software version 4.21.0
- AGC-4, from software version 4.00.0

The utility software (USW) is version 3.36.0 and later.

(i) **The screenshots displayed in this document are from the AGC-4.**

3. Requirements for the DEIF emulation tool

3.1 Hardware

3.1.1 Controllers

The controllers must meet the following requirements:

1. You must have all the controllers for the system that you want to emulate. For example, the system might consist of a mains controller, three bus tie breaker controllers and 10 DG controllers. You will therefore need 14 AGC-4 controllers to emulate this system.
2. All the controllers must include software option I1.
   - If any controller does not include option I1, you can buy the option from DEIF, then click ![icon] (Upgrade options) in the utility software to install it.
   - If option I1 is missing from one or more controllers, the controllers' display units will show the message "Application hazard" when you try to start emulation.
3. The controller type (for example, DG, BTB, mains) must be set correctly in each controller.
4. Each controller must have a unique ID number (parameter 7531 in menu 7530).

3.1.2 Wiring

The following table lists the wiring that is required for emulation. Additional wiring may also be present.

Wiring	Details
Power supply	Each controller must be connected to a power supply. AGC-4: connect the power supply to terminal 1 (12/24 V DC) and terminal 2 (0 V DC).
CAN bus	Each controller's CAN bus terminals must be connected to the other controllers' CAN bus terminals. AGC-4: connect the A1, A2 and A3 CAN bus terminals. See the Installation instructions for more details, including connection of the shield and end resistors.

3.1.3 Connection to PC

At least one controller must be connected to a PC with the utility software (USW) by either an Ethernet cable or a USB connection.

See ML-2 application notes Getting started USW 3.x for more details. Note that an Ethernet connection is a lot faster than a USB connection.

- One connection to a PC is enough to run emulation. However, if you want to change the settings in another controller, you have to move the connection to the other controller. This does not affect the emulation, since the emulation runs on the controllers, not from the PC.
- If you are using Ethernet connections, it can be useful to connect several controllers to the PC by using a switch. This not only saves having to move the Ethernet connection to change the settings in another controller, but the USW automatically connects to another controller in the network if you click that controller's connection icon (![icon]) in the Application supervision tab. There are no special requirements for the switch. However, each controller in the network must have an IP configuration. For AGC-4, configure the IP address in menu 7900, the Gateway in menu 7910, and the Netmask in menu 7920.
- If you are using a USB connection, you can only have one connection to the PC.

3.1.4 Displays (optional)

Displays can give you an immediate overview of the system during the emulation. Displays also allow you to easily test the effect of the display push-buttons. However, it is possible to run emulation without a display connected to each controller, and the displays are therefore optional.

If the controller is connected to an HMI or SCADA system, the HMI/SCADA system will show the emulated values when emulation is running.

3.2 Software

3.2.1 Utility software

In order to use the emulation tool you must install the utility software (USW) on a PC and set up and configure an Ethernet or USB connection between the PC and a controller; see the ML-2 application notes Getting started USW 3.x.

The USW includes help (press F1, or select **Help** > **Help**):

- For information on configuring the application, see the **Help** files under **Features** > **Application configuration**.
- For general information on emulation, see the **Help** files under **Features** > **Application supervision** > **Emulation**.

3.2.2 Initial configuration

As a minimum, you must complete the initial configuration of the nominal values for each controller. However, for a complete emulation, the controller must be completely configured, as it would be when installed in the system. For example, this includes setting up regulation, assigning functions to the inputs, and programming the M-Logic functions.

ⓘ **A correct configuration may prevent a genset start during emulation. For example, a HIGH emergency stop input is normally required for a genset start. You can use the emulation stimuli (described later in this document) to set the emergency stop input to HIGH. Alternatively, you can connect to a voltage source to provide a physical HIGH on the digital input.**

4. Using the emulation tool

4.1 Set up the emulation tool

4.1.1 Configure and activate the tool

⚠ **Disconnect the AC voltage and current measurement connections before activating the emulation tool. Failure to do this could result in injury or damage to the equipment.**

The emulation process starts when you write the activated emulation tool (see below for details) to a controller. If live voltage is detected by the controller, the controller activates the "Live voltage detected" alarm.

For the emulation tool to work, it must be activated and configured in an application. Perform the following to configure and activate the application:

1. Click 🔗 ▾ (Start communication with the device (F5)) to connect to a controller. If you cannot connect to the controller, see the ML-2 application notes Getting started USW 3.x for information on how to set up an Ethernet or USB connection. Note that you must configure the connection in the USW.
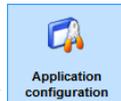
2. When you are connected, click 📷 . This is the last tab in the left tab menu.
3. Click 🗎 (New plant configuration) to create the plant configuration. You can configure up to four plant configurations.
4. The **Plant options** menu is displayed. The following describes the **Plant options** fields indicated below, see the USW help for information on the other options:
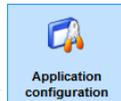
1. **Product type** drop-down menu:
   - **The PC is connected to a controller:** When the controller is connected, the controller type is displayed and is shown greyed out.
   - **The PC is not connected to a controller (offline):** Select from the drop-down menu a list of compatible controllers.
2. **Plant type** drop-down menu:
   - **Single DG:** Restricts the plant to a one stand-alone genset controller.
   - **Standard:** Design a plant up to the full capacity of the AGC-4 product, that is, up to 16 genset controllers, eight bus tie breaker controllers and 16 mains controllers. This is the most common option for power management. This option is used in the emulation example in this application note.
   - **Genset group plant:** Advanced option, not covered in this guide. The plant design allows more than one group of gensets.
   - **Genset group:** Advanced option, not covered in this guide. The plant design allows one group of up to 16 gensets.
3. **Applicable emulation** options:
   - **Off:** Emulation is not active.
   - **Breaker and engine cmd. active:** Emulation is active, and the relays and analogue outputs (to control the genset, breakers, and so on) are active during the emulation.
     - **Warning:** If the controller is installed in a plant, carefully evaluate whether you should select this option. For example, do not create a hazardous situation by allowing the controller to close a breaker on a live busbar while the controller is running an emulation.
     - This option can be helpful for checking switchboard wiring. For emulation in an office, it can also be helpful to hear the relay clicks as the controllers respond to the emulation stimuli.
   - **Breaker and engine cmd. inactive:** Emulation is not active, and the relays and analogue outputs (for example to control the genset, breakers).

(i) **Emulation is activated when an application with option Breaker and engine cmd. active or Breaker and engine cmd. inactive is written to a controller. However, if the other controllers do not have the same application, the controllers activate an "Application hazard" alarm. The "Application hazard" alarm is deactivated when the application is broadcast to all the controllers.**

The utility software (USW) help also includes a description of how to configure an application. Press **F1**, then see **Features** > **Application configuration**.

4.1.2 Design the plant

The next step is to design the plant you want to emulate.

After you select the **Plant options** and click **OK**, the **Area control** window appears in the top left corner of the **Application configuration** canvas, as shown below. The Area control window defines one vertical section of the plant single line diagram. Use this window to add and define plant components. Use the < or > button at the top of the window to move to the adjacent section.
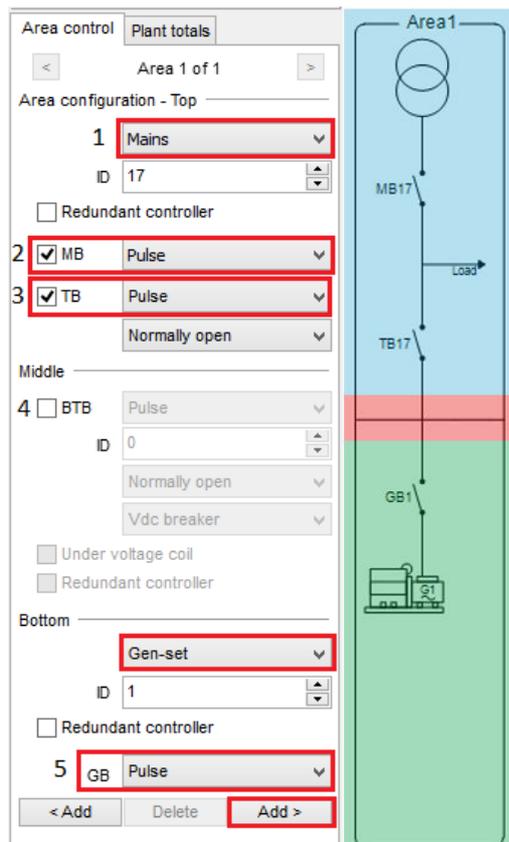

The single-line diagram of the plant is shown on the Application configuration canvas, to the right of the **Area control** window. The single-line diagram has three horizontal sections:

1. **Top** (blue section).
2. **Middle** (red section).
3. **Bottom** (green section).

For the **Top** and **Bottom** zones, you can select the options **None**, **Mains** or **Genset**.

- If you select **Mains**, (1) a transformer is shown (in the **Top** zone in the diagram). You must define whether there is a mains breaker (**MB** selection box (2)) and/or a tie breaker (**TB** selection box (3)). For each breaker, you can select how it is controlled by using the drop-down menus.
- The **Middle** zone allows you to place a bus tie breaker (**BTB** selection box) on the busbar (4).
- If you select **Genset,** a generator is displayed (in the **Bottom** zone in the example shown here). You can select how the genset breaker (**GB**) is controlled (5).
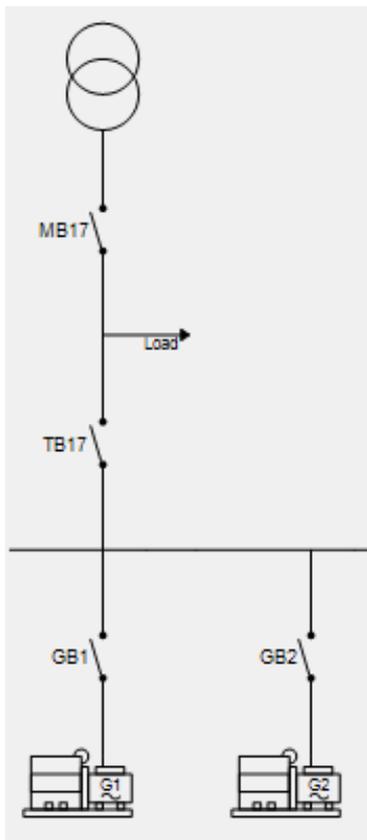
When the area is configured, you can click **< Add** or **Add >.** The USW will add a section to the single-line diagram.

Use **< Add** or **Add >** to design a plant with more than one genset or mains.

Note: The **ID** selected for a component must be the same as the controller ID (parameter 7531) in the corresponding controller.
For the example, there are two genset controllers and one mains controller, as shown here.

4.1.3 Write the application plant configuration
After completing the plant single-line diagram, the next step is to transfer this information to the controllers.

1. Click ![icon] (Write plant configuration to the device) to write the application plant configuration to the controller that you are connected to.

2. The **Write** window displays. You can see and select which application to send to the controller. You can also select which application to activate in the controller. If only one application has been designed, then applications 2 to 4 will be greyed out.
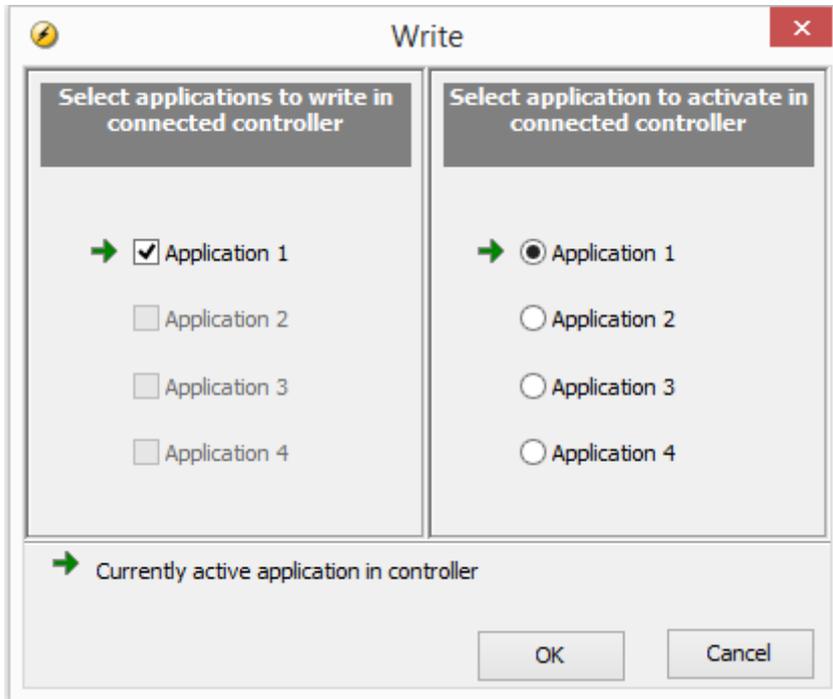
3. After you click **OK**, the utility software writes the application to the controller. This is very fast for an Ethernet connection. For a USB connection, you will see the writing progress box. The controllers communicate with each other over the CAN bus connections. After the application is written, the controllers will discover that their applications are not identical, and activate the "Application hazard" alarm.

4. Click (Broadcast plant application). The controller that the PC is connected to broadcasts the application to the other controllers over the CAN bus connection. The display unit information texts show that the application is being broadcast and received. After the application is broadcast to all controllers, the controllers will deactivate the "Application hazard" alarm.

The emulation is now active in all controllers. The voltage, frequency, current, and all the genset surroundings are emulated, and can be seen on the display, just as if the physical measurement wires were connected.

5. Configure emulation

5.1 Application supervision

5.1.1 Using application supervision

Click ![Application supervision icon] at the top of the left tab menu to see the plant single-line diagram, live plant information, and controller information.

The single-line diagram colours show the running status of the gensets. The breaker symbols change when a breaker opens or closes.

Click ![icon] (Show/hide plant supervision legend) to see/hide the colour legend box. The box includes the following legends:

● Busbar status.
● Genset auto start, running, blackout and Hz-V status.
● Controller connection and redundancy.
● Miscellaneous icons (Alarm, No info, Hz/V measurement point and Current direction).

5.1.2 Customising application supervision

You can click ![icon] (Edit the colour schemes) to create a new set of colours for the plant single-line diagram. When a new colour scheme is selected, the **Color legend** box also shows the new colours.

You can click ![ID icon] (Identifiers) to edit the names of plant components. The **Identifiers** window opens. Click the **Labels** tab. Enter a new name, then click **Write** to the device.

ⓘ **You must be logged in as master to change plant component names.**
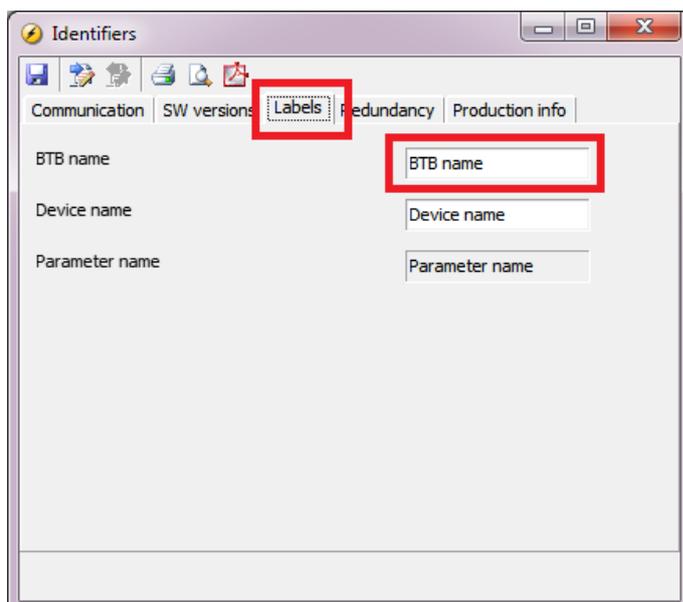
5.2 Emulation stimuli tool

5.2.1 Using the emulation stimuli

The emulation stimuli tool allows you to change the environment which is being emulated.

Click f_x (Emulation stimuli) to open the **Plant emulation** window. The **Plant emulation** window includes several tabs. Each of them contain values (or data) that can be modified.

You can only change the values (or data) for the controller that the utility software (USW) is connected to. If you need to change the values for another controller, you must disconnect and then connect to that controller.

For a value with a slider, you can use the sliding cursor to modify the value. Alternatively, you can click the number to open the **New value** window. You can type in the new value and click OK.

After you change a value, click **Write to xxx** to write it to the controller (where xxx is the controller name). The emulation responds to the new value as soon as it is written to the controller.

5.2.2 Plant emulation: Load

The **Load** tab displays the **Active load** and **Reactive load**. These values can be modified.

The load is regarded as connected to the busbar, next to the associated genset or mains connection. If the breaker to the genset or mains connection is open, the load is still present on the busbar, and is shared equally over the busbar between the connected power sources.
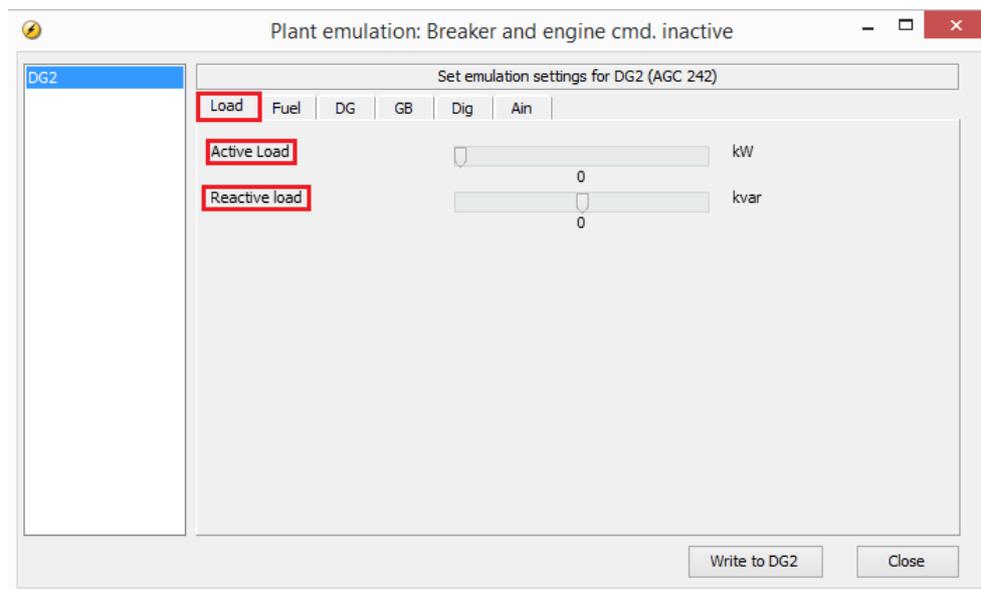
For example, if a 500 kW active load is assigned to DG1 in the example (which consists of three controllers: mains, DG1 and DG2), the load is supplied as follows:

- MB, GB1 and GB2 open: the load is not supplied (that is, 0 kW).
- MB closed, GB1 and GB2 open: the mains supplies the 500 kW load.
- MB open, GB1 closed and GB2 open: DG1 supplies the 500 kW load.
- MB open, GB1 open and GB2 closed: DG2 supplies the 500 kW load.
- MB open, GB1 and GB2 closed: DG1 and DG2 supply 250 kW each.

5.2.3 Plant emulation: Fuel
The **Fuel** tab allows you to adjust the fuel parameters, as the following shows.
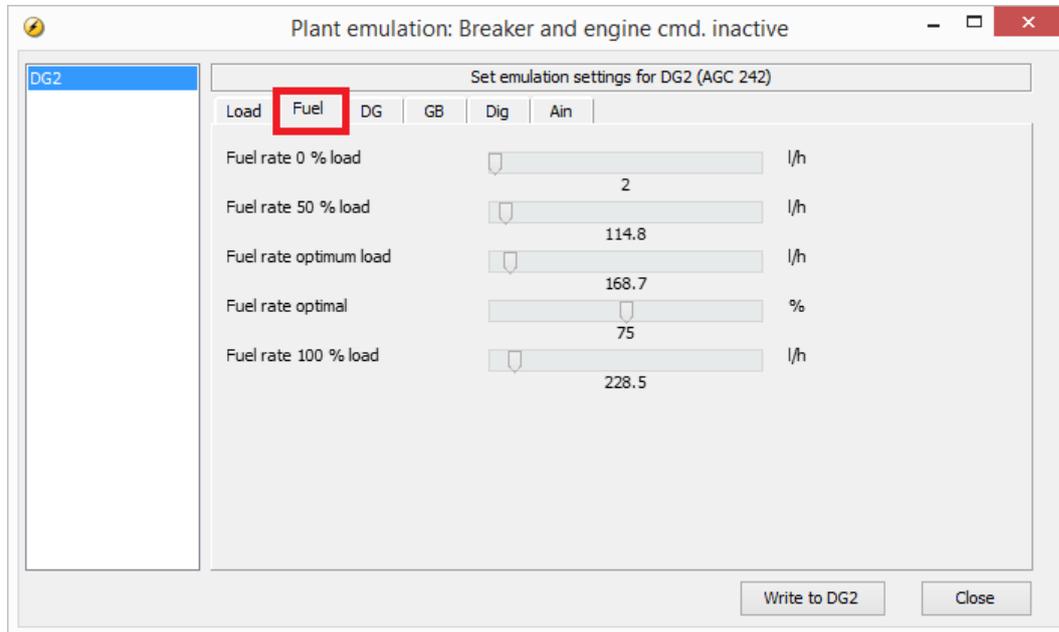
5.2.4 Plant emulation: Diesel genset
The **DG** tab allows you to test the effect of a DG start failure.
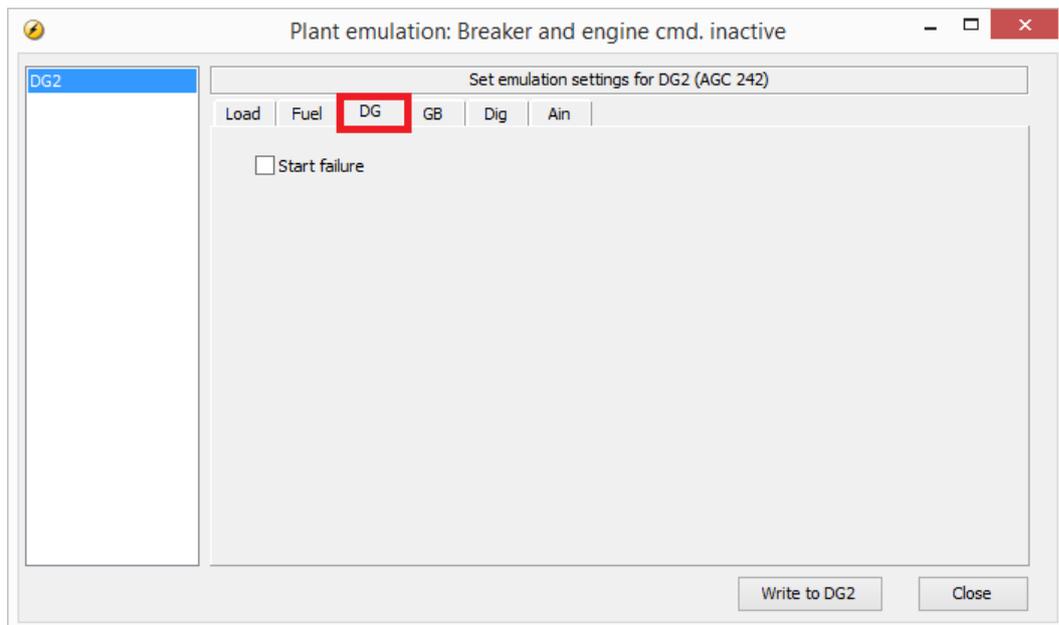
5.2.5 Plant emulation: Generator breaker, tie breaker or mains breaker

For a genset, the **GB** tab (shown below) allows you to test generator breaker failure scenarios.
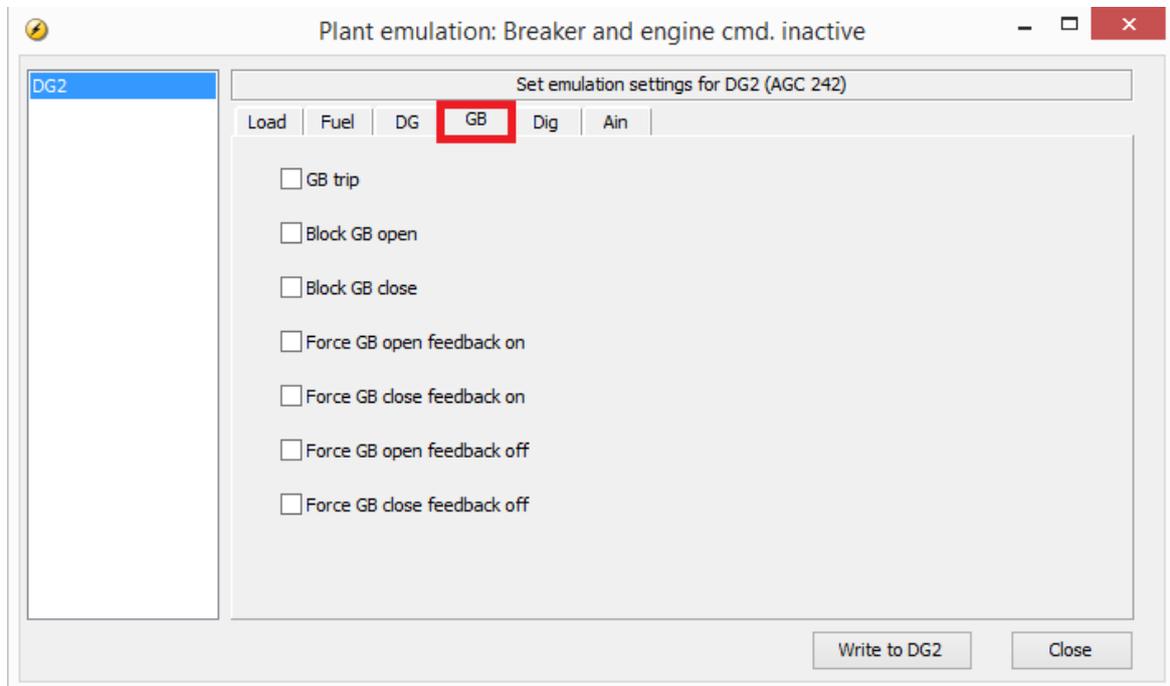
For a mains connection, the **MB** tab allows you to test mains breaker failure scenarios.
For a mains connection or bus tie breaker, the **TB** tab allows you to test tie breaker failure scenarios.

5.2.6 Plant emulation: Digital inputs

The **Dig** tab allows you to emulate the effect of a high signal on a digital input.

In this tab, when you select a digital input and then write to the controller, the controller responds as if the input is high. This triggers the action connected to the input.

In this example, the box for **Input 80** is selected. **Input 80** is assigned the function **SEMI-AUTO MODE**. When **Write to DG2** is clicked, the controller treats **input 80** as high. As a result, the controller mode is changed to semi-auto mode. The controller remains in this mode as long as the box is selected.
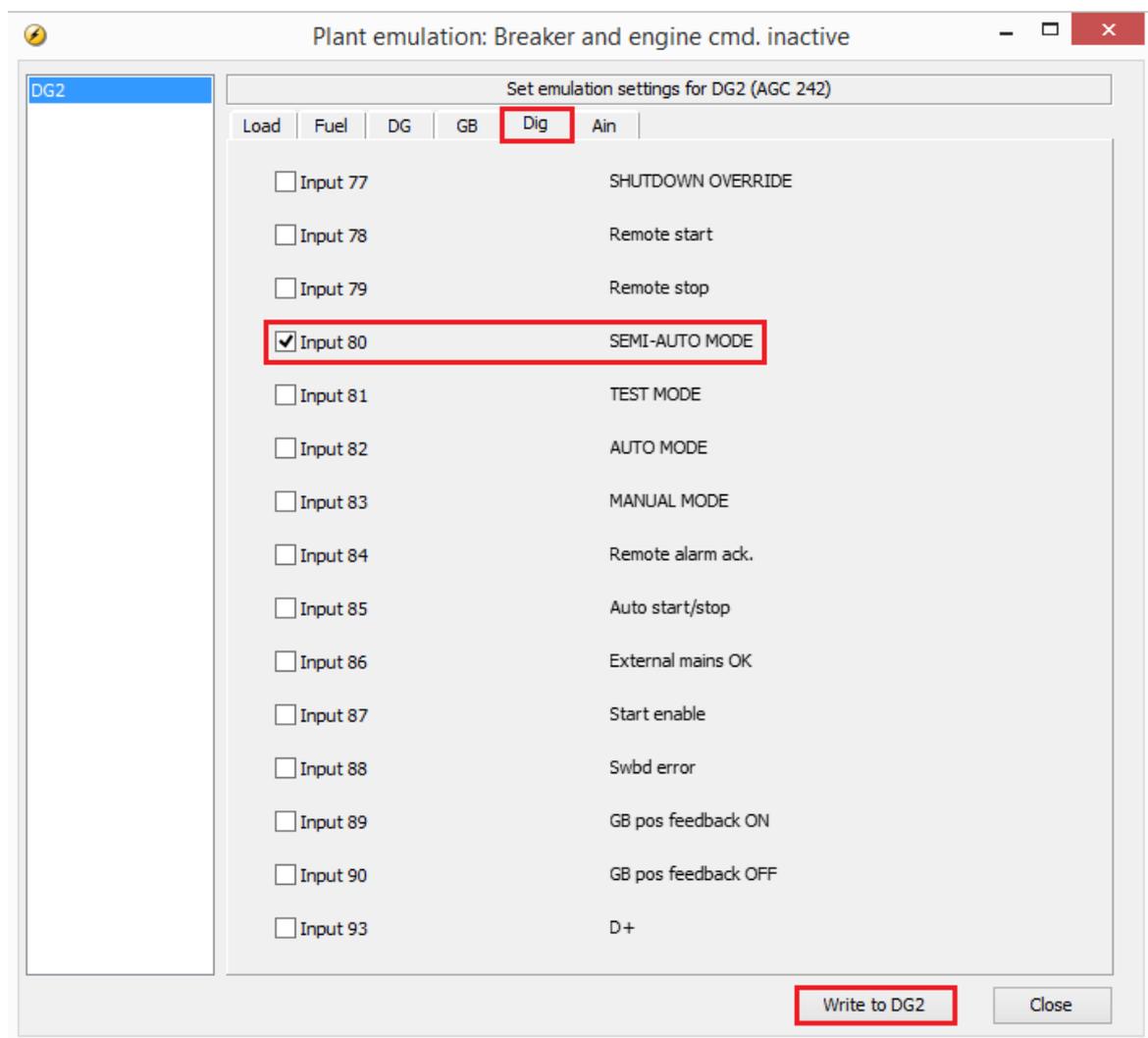
5.2.7 Plant emulation: Analogue inputs

The **Ain** tab allows you to emulate the effect of specified analogue inputs.

Emulating analogue inputs is useful for testing the controller reaction to, for example, low lube oil, or high temperature.

You can specify the percentage for each analogue input. Remember to select **Emulate multi inputs**. After you click **Write to XXX**, the controller responds as if the multi-input has the specified value.

> **(i)** **For a 4 to 20 mA input, where 4 mA is 0 % and 20 mA is 100 %, the slider reaction does not appear linear, because the slider scaling is based on the 0 to 24 mA hardware.**
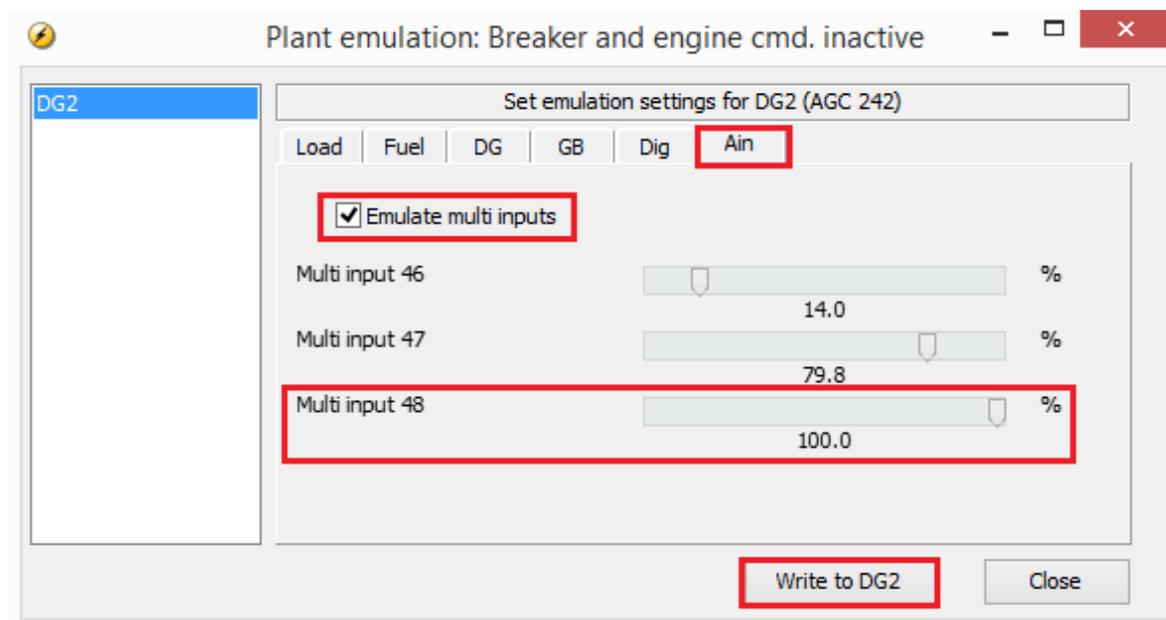
5.2.8 Plant emulation: Mains

Use the **Mains** tab to specify the **Mains voltage** and **Mains frequency** in order to test the effect of mains failure.