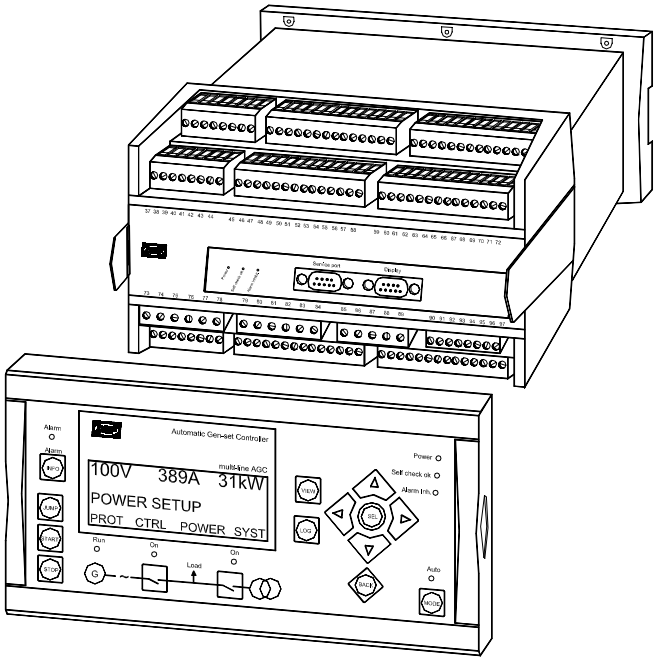
DEIF A/S

Application Notes

Combination plant

4189340425A
AGC SW version 2.1X.X
GPU SW version 2.32.X



- *Multiple generator set power management*
- *4 mains incomers*
- *Parallel with mains (grid)*
- *Load sharing, multiple gen-sets*
- *Utilising DEIF product range*

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1. About this document

General purpose

This document includes application notes for DEIF's Automatic Gen-set Controller, the AGC, combined with GPU protection units and FAS synchronisers. It is just one example of different applications suitable for the units.

For functional descriptions, the procedure for parameter setup, complete standard parameter lists etc., please see the Designer's Reference Handbooks.

The general purpose of the Application Notes is to offer the designer information about suitable applications for DEIF products.

Please make sure to read the relevant documentation before working with the DEIF units and the gen-sets to be controlled. Failure to do this could result in damage to the equipment or human injury.

Intended users

The Application Notes is mainly intended for the person responsible for designing generator control systems. In most cases, this would be a panel builder designer. Naturally, other users might also find useful information in this document.

Contents/overall structure

The Application Notes is divided into chapters, and in order to make the structure of the document simple and easy to use, each chapter will begin from the top of a new page.

2. Warnings and legal information

Legal information and responsibility

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

The units are not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Electrostatic discharge awareness

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

Safety issues

Installing the unit implies work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in working with live electrical equipment.

Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.

Definitions

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

Notes

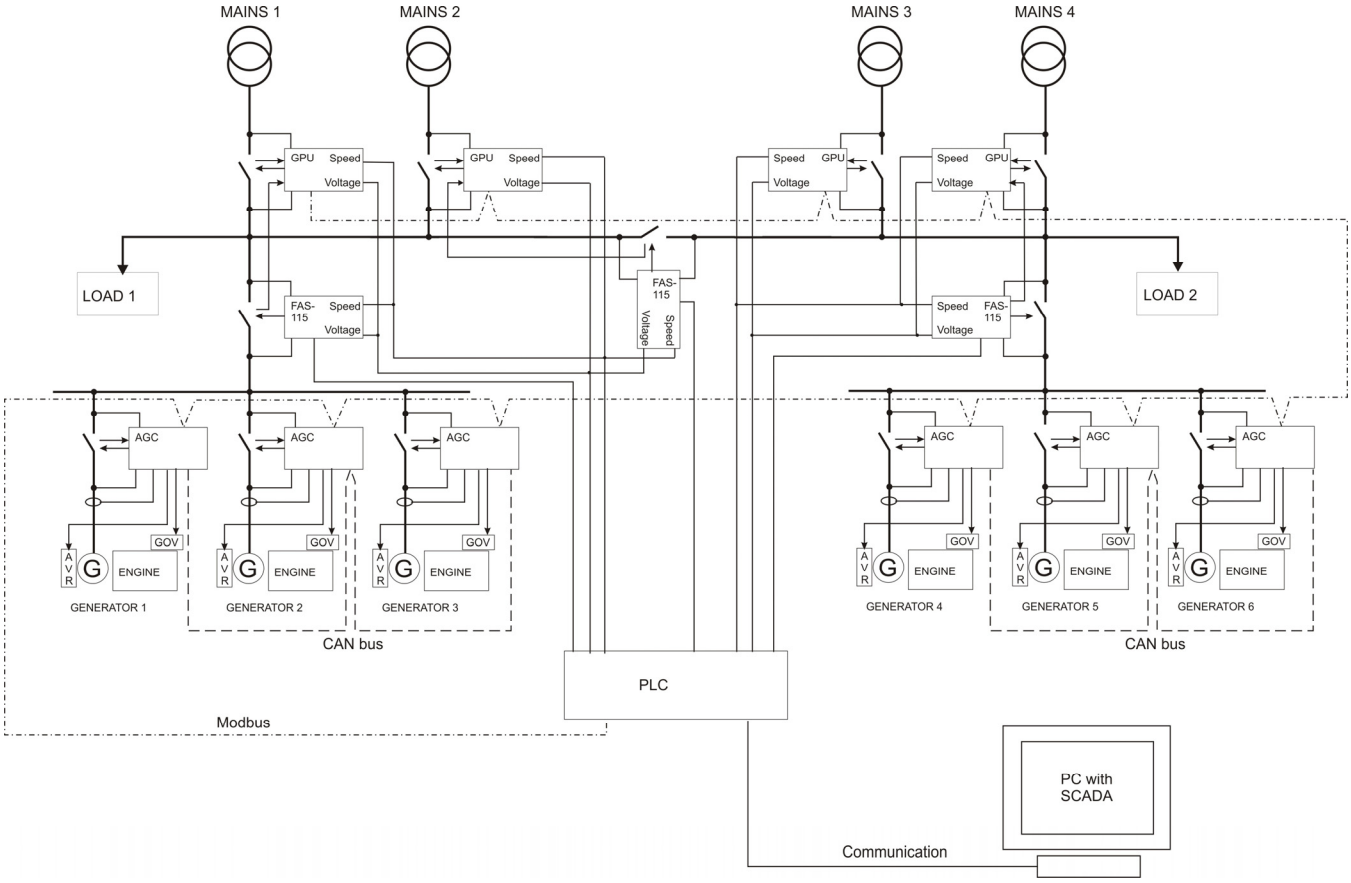
The notes provide general information which will be helpful for the reader to bear in mind.

Warnings

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

3. Plant overview

System single-line diagram



System components

The system is based on the use of standard DEIF components:

- AGC, Automatic Gen-set Controller as main generator control and protection unit.
- GPU, Generator Protection Unit, in this case used as mains synchroniser and protection unit, incl. vector surge (vector jump) and/or df/dt (ROCOF) protection.
- FAS-115DG Fully Automatic Synchroniser with voltage matching used for tie breaker synchronisation.

Also used is a PLC (not DEIF supply), which is used as the plant gateway for signals between GPU, FAS and AGC units. The gateway is a mix between hardwired analogue and binary signals as well as Modbus RTU communication (the PLC acts as plant master and gateway to the SCADA system).

4. System descriptions

- Control and monitoring of 4 mains incomers
- Control and monitoring of up to 32 diesel generators
- Control and monitoring of 3 tie breakers

System running modes

The plant can run as:

- Single plant parallel with mains grid
- Single plant isolated island
- Split in 2 plants, with selection of each side to run
    - Parallel with mains
    - Isolated island, supplying its own consumers
- Single plant with one side supplying all consumers in case the other plant is out of service

For single plant isolated island:

Since the 2 sets of AGC power management systems work independently, the PLC will control the plant by:

- Setting one of the 2 plants in normal power management (free selection between the 2 plants)
    - Frequency control
    - Load dependent start/stop
    - var sharing
- Setting the other in fixed power/fixed var mode
    - The PLC calculates and transmits the set points for power and reactive power to this power management system, which acts accordingly. The commands make the 2 plants supply equal power and reactive power, but only one of the 2 plants carries out frequency control

AGC (Automatic Generator Controller) use

Options used:

- C1 (Generator add-on protection package)
- D1 (Voltage/var/PF control)
- E1 (Analogue controller outputs (if needed) depends on generator and engine)
- G5 (Power management, includes internal CAN bus communication)
- H2 (Modbus communication to PLC)
- H4 (Caterpillar CCM communication if needed)
- H5 (CAN bus based engine interface communication if needed, J1939 or MTU)
- H6 (Cummins communication if needed)

For engine communication:

If the options for engine communication is needed (H4, H5, H6) the Modbus communication must be done using the Service port due to the lack of communications available in the ML-2 platform. This will be solved by making special software.

The AGC units carry out diesel engine and generator control and protection. Moreover the AGC units contain power management for the 2 sides of the plant. The 2 power management systems are independent.

The AGCs contain:

- Engine protection (possibly via option H4 or H5 or H6)
- Power management using CAN bus communication
  - Load dependent start/stop
  - Start priority selection
  - Fixed power to/from mains or load sharing control
  - Power factor or var sharing control
- Generator control
  - Frequency/power control
  - Voltage/var/power factor control
- Generator protection
  - Overcurrent
  - Reverse power
  - …etc.
- Communication to plant PLC via Modbus RTU:
  - Running mode selection commands from PLC
    - Island load sharing
    - Parallel with grid (fixed power)
    - Parallel with other plant (fixed power or load sharing)
  - Set point commands from PLC
    - Frequency
    - Power
    - var
    - Power factor

All AGC options are available according to requirement.

GPU (Generator Protection Unit) use

Options used:

- A (Protection: Voltage, frequency, mains decoupling)
- D2 (Voltage matching during synchronisation)
- G2 (Control output: Synchroniser)
- H2 (Modbus communication to PLC)

The GPU units carry out mains connection control and protection:

- Mains breaker synchronisation with voltage matching
  - Speed UP/DOWN signals
  - Voltage UP/DOWN signals
  - Synchronisation pulse to breaker (close command)
- Mains incomer protection with mains or tie breaker trip
  - Over-/undervoltage
  - Over-/underfrequency
  - df/dt (ROCOF)
  - Vector jump (vector surge)

All GPU options are available according to requirement.

FAS-115DG (Fully Automatic Synchroniser) use

Options used:

- None

The FAS units carry out tie breaker synchronisation:

- Speed UP/DOWN signals
- Synchronisation pulse to breaker (close command)

PLC use

Needed functions:

- Binary 24V DC inputs
- Relay outputs
- Modbus RTU communication
- Communication to SCADA system

The PLC is the master controller of the system, picking up statuses and alarms as well as measured AC and analogue values from generators, engines, tie breakers and mains connections. The combination of this information and the operator's choices enables the PLC to select running mode and send commands to the DEIF units in the system.

Also the PLC is the connection gateway between the 2 AGC generator control systems, setting the running modes of the 2 plants and transmitting set points for power and frequency required for the load sharing. This will of course only take place, if the centre tie breaker is closed. If the centre tie breaker is open, the 2 sides operate fully independently of each other.

The PLC does not contain the power management control, since this is a part of the AGC G5 option. The PLC is the plant running mode controller as well as the gateway to the SCADA system. This is necessary, since the Modbus does not allow for more than one master, and the PLC itself is the master of the system.

5. AGC connections

AC connections

For AC connections, please refer to the Installation Instructions, DEIF document no. 4189340259.

Standard DC connections

Please refer to the AGC Installation Instructions, DEIF document no. 4189340259.

Special DC connections

AGC units have no special DC connections, since all signals to/from the PLC are done via Modbus.

6. GPU connections

AC connections

For AC connections, please refer to the Installation Manual, DEIF document no. 4189340290.

Standard DC connections

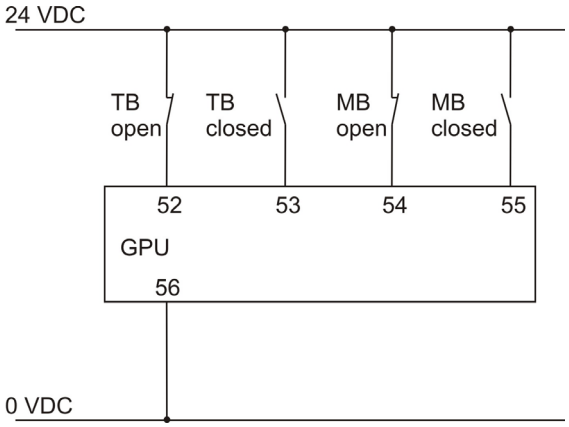
Please refer to the GPU Installation Manual, DEIF document no. 4189340290.

Special DC connections

Monitoring of tie breaker position:

Since the tie breakers are controlled using FAS units, which have no communication facilities, the tie breaker position (ON/OFF) feedbacks must be picked up by the GPUs in order to transmit the signals to the PLC.

The inputs for the purpose can be chosen freely, but in this example the inputs are on terminals 52 (open) and 53 (closed), since these are placed next to the mains breaker feedbacks (terminals 54 and 55). Terminal 56 is common.

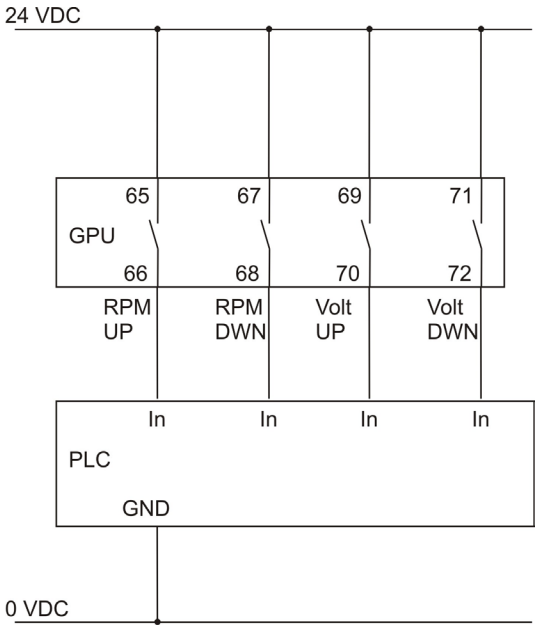


Speed and voltage control signals:

The speed and voltage control signals are relay outputs, transmitted to binary inputs on the PLC.

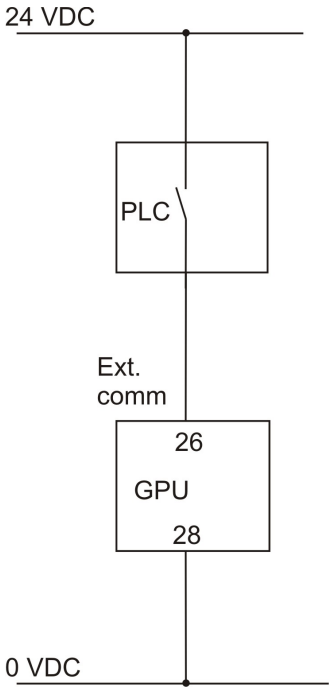
It is assumed that the PLC accepts +24V DC inputs.

The PLC inputs for speed and voltage control can be shared by all GPC and FAS units, if it can be accepted that only one of these is active at a time. If this is not acceptable, separate speed and voltage inputs can be assigned for each GPU/FAS.



Modbus command enable:

To enable the PLC to write commands to the GPU, the "external communication" input must be activated.



All other signals are carried out via the Modbus to/from the PLC.

7. FAS connections

AC connections

Please refer to the FAS Installation Instructions, DEIF document no. 4189340127.

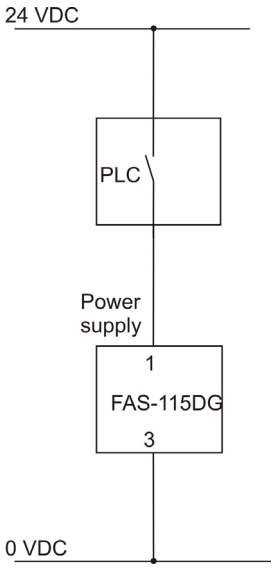
FAS standard DC connections

Please refer to the FAS Installation Instructions, DEIF document no. 4189340127.

FAS special DC connections

Power supply:

The FAS power supply (24V DC) is switched ON and OFF by the PLC in order to control when to synchronise the tie breakers.



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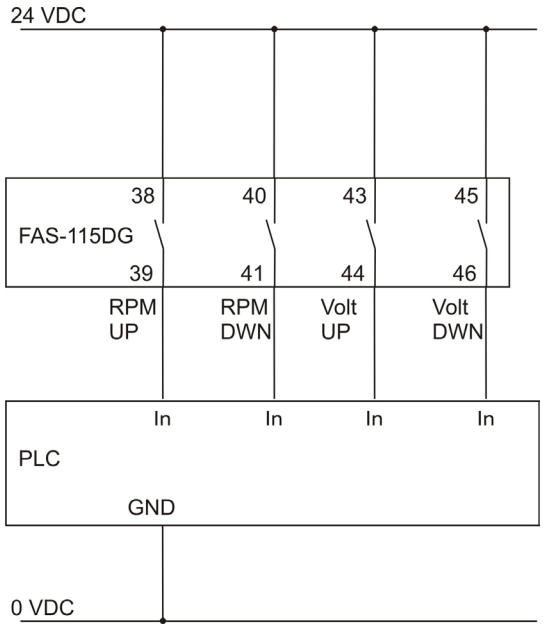

8. PLC connections

AC connections

The PLC does not have or need any AC connections. All AC values are transmitted via Modbus.

DC connections

All DC connections are binary inputs/outputs, as already described in the sections for the AGC, GPU and FAS units.