

ANSI code 25  
Type FAS-115DG

- **Synchronisation of generator to busbar**
- **Circuit breaker time compensation**
- **Voltage matching**
- **LED indication of status**
- **LED for activated control**
- **LED for synchronising signal**
- **35 mm DIN rail or base mounting**

### Application

The FAS-115DG synchroniser is applied for synchronisation of a generator to the busbar and closing of its circuit breaker when the voltage difference, the slip frequency and the phase angles are within the preset limits. The synchroniser can be applied in conjunction with a wide range of prime movers, as its control pulses may be set to fit several types - from slowly reacting diesel engines to swiftly reacting gas turbines.

### Function

The FAS-115DG performs a dynamic synchronisation, ensuring that the slip frequency is always positive to prevent reverse power conditions to occur (see option D). Furthermore the FAS-115DG is provided with relay outputs for controlling the AVR for voltage matching. In order to calculate when to transmit the closing signal to the generator breaker, the synchroniser measures the actual slip frequency and compares this with the circuit breaker closing time (potentiometer marked BREAKER). When the slip frequency and the voltage deviation are within the settings (potentiometers marked FREQ and VOLTAGE), the above calculation is performed, and the synchroniser transmits the closing signal to the breaker "x" degrees before top allowing time for this to close.

In case of harmonic distortion or noise on the voltage inputs the FAS-115DG is equipped with special filters on the AC voltage inputs to avoid unprecise synchronisation pulse to be transmitted. Furthermore a  $df/dt$  (ROCOF) function is implemented, if the filters are unable to make the necessary filtering of the input signals, the  $df/dt$  function will prevent unprecise synchronisation pulse to be transmitted. If the  $df/dt$  function is active, the situation will be indicated by a flashing  $\Delta f$  LED (see option C).

The FAS-115DG is provided with an analogue frequency output and an analogue voltage output, intended for common control of the frequency and the voltage of DEIF load sharing units type LSU-112/113/114DG and LSU-122DG, a function applied for simultaneous synchronisation of all generators of a plant to the busbar.

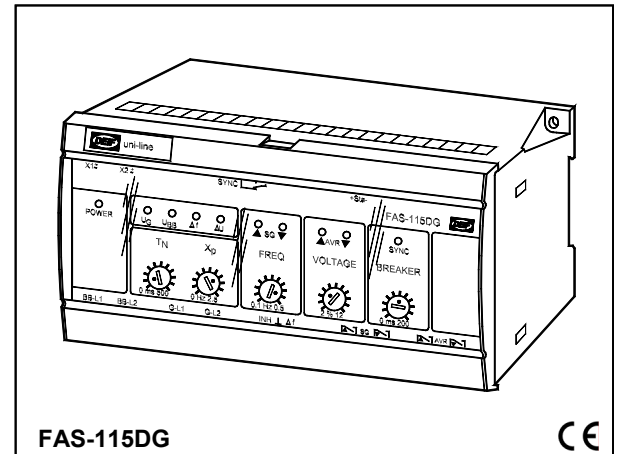
### Regulator output

The unit is provided with 2 contact outputs for speed control and 2 contact outputs for voltage control:

# Synchronisers

uni-line

4921240116E



### Frequency control:

The regulating speed of the servomotors for the prime mover is controlled by the built-in P controller of the FAS-115DG according to its setting for:

$T_N$  (pulse length):

The min. duration of the control pulse.

$X_P$  (proportional band):

The zone within which the pulse/pause ratio changes proportionally to the frequency deviation from  $f_{set}$ .

Dead band 0.05Hz:

The zone within which no control pulses are emitted.

### Voltage control:

Regulation of the servomotor for the AVR is controlled by the built-in on/off regulator of the FAS-115DG.

The phase angle advance is calculated and a synchronising signal transmitted provided that:

1. the voltage difference is within  $\pm 2... \pm 12\%$  of the busbar voltage, and
2. the frequency difference is within  $\pm 90\%$  of the value set on the FREQ potentiometer, and
3. the generator frequency is higher than the busbar frequency (see option D also).

When the above 3 conditions are fulfilled, a synchronising signal is transmitted, the yellow LED SYNC is lit, and the output contact is activated for 400 ms.

### Special function for commissioning

The FAS-115DG is equipped with a function for checking of the phase sequence. When the frequency and the voltage between the busbar and the generator inputs are the same and the phase is inside  $\pm 5^\circ$  for 1 s, the sync. relay is activated. If the generator is stopped and the star point is opened and the generator breaker is closed, the FAS-115DG will transmit a closing signal if the phase sequence is OK.

### Self-monitoring

The FAS-115DG is equipped with a self-monitoring function. The function supervises the built-in micro-controller and hereby verifies if the programme is running correctly. The green LED marked POWER is connected to this function. Constant green light indicates that the supply voltage is accepted and the unit is running correctly. Flashing green light 2-3Hz indicates that the supply voltage is accepted but the unit is running incorrectly. In this situation the status output terminals 17 and 18 are activated (open).

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### Terminals/function

Connection	Connect	
Busbar	L1 to term. 24	L2 to term. 26
Generator	L1 to term. 29	L2 to term. 31

Terminal no.	Description/action
1 and 3 X1/X2	Input for supply voltage
8, 9 and 10	Relay contact for circuit breaker. On time 400 ms
17 and 18 Sta	Status output, activated (closed) when the supply voltage is connected and the unit is working correctly
24 and 26 BB/L1 BB/L2	Input for busbar voltage measurement. This input becomes active when the voltage level exceeds 80% of nominal voltage
29 and 31 G/L1 G/L2	Input for generator voltage measurement. When the voltage level on this input exceeds 60% of nominal voltage, the FAS-115DG is activated and the regulator outputs (SG) become active. Note that with an auxiliary contact on the generator circuit breaker this function can be used for resetting of the FAS-115DG after synchronisation and hereby deactivation of the SG outputs. This function allows the supply voltage to be connected at any time
33 ("ΔU") Option F	This output is intended for common control of the voltage of all the connected reactive power load sharing units type LSU-122DG in a generator island. If terminal 33 is connected to the common voltage line (US) on the LSU-122DGs, the FAS-115DG will regulate the voltage on the generator island so it matches the voltage on the unit the island is about to be connected to
34 and 35 ("INH")	May be connected to a potential-free N/O contact. When this contact is activated, the FAS-115DG will not transmit a closing signal (terminals 9 and 10), but the SYNC LED will be lit when the sync. pulse is transmitted. This function can be used for testing purposes. Note that if the FAS-115DG is equipped with option A or B, this input has a different function
36 ("Δf")	This output is intended for common control of the frequency of all the connected load sharing units type LSU-112/113/114DG in a generator island. If terminal 36 is connected to the common frequency line (FS) on the LSUs, the FAS-115DG will control the frequency on the generator island so it matches the frequency on the unit the island is about to be connected to
35 ("⊥")	Common earth terminal for the above input/output
38 and 39 Relay contacts "SG"	Relay contact for increase of the speed
40 and 41 Relay contacts "SG"	Relay contact for decrease of the speed
43 and 44 Relay contacts "AVR"	Relay contact for increase of the voltage
45 and 46 Relay contacts "AVR"	Relay contact for decrease of the voltage
<b>NOTE:</b> Relay contacts	Relays (SG) should always be connected via external aux. relays when a DC pilot motor is applied. A transient suppressor should always be connected across the relay coil of the external relays

## Options

The FAS-115DG can be configured with the following options:

### Frequency controller, option A

The FAS-115DG is set to act as a frequency controller ensuring a stable generator frequency according to the setting (50Hz or 60Hz). The function is activated when the INH input is closed. Please note that with option A implemented, disabling of the sync. relay output is not possible. If the INH input is open, the FAS-115DG functions as a normal synchroniser. When the input INH is activated, the FAS-115DG will act as a frequency and voltage controller and regulate the generator to the frequency setting (50Hz or 60Hz)  $\pm 0.05\text{Hz}$  and the voltage to nominal  $\pm 2\%$ . No sync. pulse will be transmitted.

### Dead bus, option B

When implemented the dead bus function enables the FAS-115DG to transmit a closing signal to the generator breaker when no busbar voltage is present. When the generator voltage is within 60% of nominal level and the busbar voltage is below 20% of nominal level, the FAS-115DG will start to control the generator frequency and voltage according to the setting (50Hz or 60Hz). When the frequency becomes nominal  $\pm 0.05\text{Hz}$  and the voltage level is nominal  $\pm$  the setting (potentiometer marked VOLTAGE), the sync. pulse is transmitted to the breaker. Please note that after closing of the breaker (voltage on both inputs on the FAS-115DG), the FAS-115DG will start controlling the frequency to the setting on the FREQ potentiometer. If this setting is 0.5Hz, the resulting busbar frequency will be 50.5Hz or 60.5Hz. This can be avoided, if the generator voltage input (terminal 29 or 31) is disconnected from the FAS-115DG after closing of the breaker. To make it possible to open the generator breaker from another system and prevent the FAS-115DG from performing a new dead bus closing of the breaker, the time when the generator breaker must close can be controlled by means of the INH input. If the INH input is activated (closed), the FAS-115DG will not activate the sync. relay even if there is a dead bus situation. When INH is deactivated, the FAS-115DG will transmit the closing signal. Please note that with option B implemented, disabling of the sync. relay is not possible.

### Deactivation of the df/dt protection function, option C

If instability in the speed loop control system occurs resulting in jitter on the voltage signals (fast instability typically occurs, if the governor is responding to engine firings), and it is not possible to adjust this on the governor, or in applications with much noise and harmonic distortion (frequency converters), the df/dt protection function can be activated resulting in NO sync. pulse. If this is the case, and the switchgear is properly protected against wrong synchronisation, the df/dt protection function can be disabled. Please note that when this function is disabled, noise on the busbar and the generator inputs of the FAS-115DG can, at worst, result in a 180° out of phase synchronisation.

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### Options, continued

#### Accept of both undersynchronisation and oversynchronisation of the generator breaker, option D

Option D can be activated in applications where a fast synchronisation has priority and the risk for reverse power is unimportant. With this option activated the FAS-115DG will regulate the generator to perform either an under- or an oversynchronisation, the parameter used for either under- or oversynchronisation is the parameter which first obtains a synchronisation as fast as possible.

#### Extended circuit breaker closing time, option E

In applications with very slow generator circuit breakers with closing time up to 400 ms this option will prolong the setting of the closing time (potentiometer marked BREAKER) to cover the range 200...400 ms.

#### Voltage difference analogue output, option F

This output is standard 0...5...10V corresponding to 80...100...120% of  $U_{nom}$  for control of the LSU-122DG. If option F is selected, the output is changed to -10...0...10V corresponding to 90...100...110% of  $U_{nom}$  for control of the units in the multi-line series, e.g. PPU/GPC.

## Technical specifications

### Accuracy:

Breaker closing: Slip frequency 0.1...0.25Hz:  $\pm 3^\circ$  el.  
Slip frequency 0.25...0.5Hz:  $\pm 5^\circ$  el.

**Meas. voltage:** See supply voltage - AC ranges  
**Load:** 2k $\Omega$ /V

**Frequency range:** 40...45...65...70Hz

**Breaker closing pulse length:** 400 ms  $\pm$ 10 ms

**Inhibit input:** Potential-free contact  
Open: 5V. Closed: 5mA

### Contact outputs:

Sync. pulse output: 1 change-over switch  
Freq. control outp.: 2 make contacts  
Volt. control outp.: 2 make contacts  
Contact ratings:  
AC1: 8A, 250V AC  
DC1: 8A, 24V DC  
AC15: 3A, 250V AC  
DC13: 3A, 24V DC

**Life electrical:** 1 x 10<sup>5</sup> (nominal value)

### Analogue output:

Freq. difference: 1 analogue output:  
-10...0...10V DC ~ -5...0...5Hz  
Volt. difference: 1 analogue output:  
0...5...10V DC ~ 80...100...120% of  $U_n$   
-10...0...10V DC ~ 90...100...110% of  $U_n$   
with option F activated

**Optocoupler outp.:** System status off = Failure  
Max. voltage 30V DC, max. current 5mA

**Temperature:** -25...70°C (operating)

**Temperature drift:** Set-points:  
Max.  $\pm 0.2\%$  of full scale per 10°C

**Galv. separation:** Between inputs and outputs:  
3250V - 50Hz - 1 min.

**Supply volt. ( $U_n$ ):** 57.7-63.5-100-110-127-200-220-230-240-  
380-400-415-440-450-660-690V AC  $\pm 20\%$   
(max. 3.5VA)  
24-48-110-220V DC -25/+30%  
(max. 2W)

**Climate:** HSE, to DIN 40040

**EMC:** To EN 50081-1/2, EN 50082-1/2,  
SS4361503 (PL4) and IEC 255-3

**Connections:** Max. 4 mm<sup>2</sup> (single-stranded)  
Max. 2.5 mm<sup>2</sup> (multi-stranded)

**Materials:** All plastic parts are self-extinguishing to  
UL94 (V1)

**Protection:** Case: IP40. Terminals: IP20, to IEC 529  
and EN 60529

**Type approval:** The uni-line components are approved by  
the major classification societies. For  
current approvals see [www.deif.com](http://www.deif.com) or  
contact DEIF A/S

## Type FAS-115DG

### Settings

Setting of	Range
T <sub>N</sub> Control pulse length	25...500 ms
X <sub>P</sub> Proportional band	±0.25...±2.5Hz
f <sub>set</sub> Slip frequency	0.1...0.5Hz *
ΔU <sub>max</sub> Acceptable volt. diff.	±2...±12% of U <sub>BB</sub>
T <sub>BC</sub> Breaker closure time	20...200 ms (200...400 ms) option E

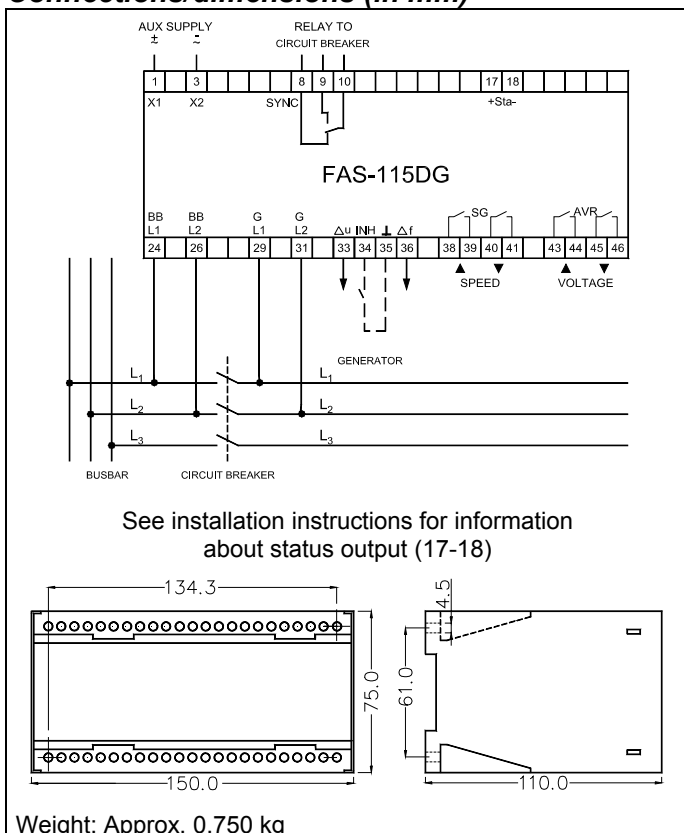
\* Accept of max. df/dt depends on f<sub>set</sub>  
 0.1Hz ~ 2.5Hz/sec.  
 0.5Hz ~ 12.5Hz/sec.

### Indication

LEDs	Light
U <sub>G</sub> Generator voltage	Green, when value is within the acceptable range Switched off, if outside this range
U <sub>BB</sub> Busbar voltage	
Δf Frequency difference	
ΔU Voltage difference	
SYNC Synchronising	Yellow, when relay is activated
SG▲ Increase speed (freq.)	
SG▼ Decrease speed (freq.)	
AVR▲ Increase voltage	
AVR▼ Decrease voltage	

Once the relay has been mounted and adjusted, the transparent front cover may be sealed, preventing unwanted change of the setting.

### Connections/dimensions (in mm)



### Order specifications

Type – Measuring voltage – Supply voltage –  
 (Option – Generator frequency)

Example:

FAS-115DG – 380V AC – 24V DC – Option A – 50Hz

### NOTE:

Option A and option B cannot be chosen at the same time.

Due to our continuous development we reserve the right to supply equipment which may vary from the described.



-power in control-

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