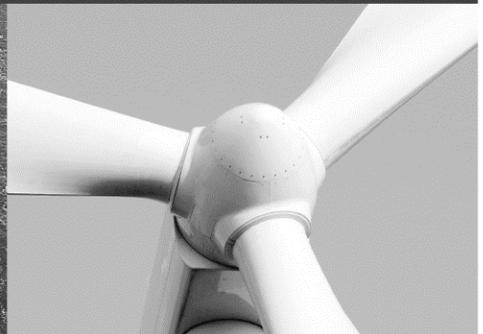




-power in control



## DATA SHEET



### **Synchronisers, FAS-113DG** ANSI code 25

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



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**Application**

The FAS-113DG 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-113DG performs a dynamic synchronisation, ensuring that the slip frequency is always positive to prevent the occurrence of reverse power conditions (see option D). 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-113DG is equipped with special filters on the AC voltage inputs to avoid imprecise synchronisation pulse being 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 imprecise synchronisation pulse from being transmitted. If the  $df/dt$  function is active, the situation will be indicated by a flashing  $\Delta f$  LED (see option C).

The FAS-113DG 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 two contact outputs for speed control:

**Frequency control:**

The regulating speed of the servomotors for the prime mover is controlled by the built-in P controller of the FAS-113DG 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  $f_{set}$ .

Deadband 0.05 Hz:

The zone within which no control pulses are emitted.

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

1. the voltage difference is within  $\pm 2$  to  $\pm 12$  % 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 (also see option D).

When the above three 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-113DG 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 closed, the FAS-113DG will transmit a closing signal if the phase sequence is OK.

**Self-monitoring**

The FAS-113DG is equipped with a self-monitoring function. The function supervises the built-in microcontroller 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 2-3 Hz 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).

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-113DG 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 to reset the FAS-113DG after synchronisation and hereby deactivate 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-113DG 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-113DG 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-113DG 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-113DG 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 con- tacts "SG"	Relay contact for increase of the speed.
40 and 41 Relay con- tacts "SG"	Relay contact for decrease of the speed.
<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-113DG can be configured with the following options:

### Frequency controller, option A

The FAS-113DG is set to act as a frequency controller ensuring a stable generator frequency according to the setting (50 Hz or 60 Hz). The function is activated when the INH input is closed. If the INH input is open, the FAS-113DG functions as a normal synchroniser. When the input INH is activated, the FAS-113DG will act as a frequency controller and regulate the generator to the frequency setting (50 Hz or 60 Hz)  $\pm 0.05$  Hz and no sync. pulse will be transmitted. It is not possible to have option A and option B at the same time.

### Dead bus, option B

When implemented, the dead bus function enables the FAS-113DG 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-113DG will start to control the generator frequency according to the setting (50 Hz or 60 Hz). When the frequency becomes nominal within  $\pm 0.05$  Hz,  $\pm 0.5$  Hz or  $\pm 3$  Hz depending on internal jumper setting,  $\pm 0.5$  Hz is set as default if no specific request is made, and when 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-113DG), the voltage input on terminal 29 or 31 or the supply voltage on terminal 1 or 3 must be disconnected, otherwise the FAS-113DG will run the generator into overspeed. If the INH input is activated (closed), the FAS-113DG will not activate the sync. relay even if there is a dead bus situation. When INH is deactivated, the FAS-113DG will transmit the closing signal. It is not possible to have option A and option B at the same time.

### 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-113DG can, at worst, result in a 180 ° out of phase synchronisation.

### 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-113DG 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 to 400 ms.

### Voltage difference analogue output, option F

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

**Technical specifications**

<p><b>Accuracy:</b> Breaker closing: Slip frequency 0.05 to 0.25 Hz: ±3 ° el. Slip frequency 0.25 to 0.5 Hz: ±5 ° el.</p> <p><b>Meas. voltage:</b> 57.7-63.5-100-110-127-200-220-230-240-380-400-415-440-450-480-660-690 V AC UL/cUL Listed: 57.7 to 450 V AC</p> <p>Load: 2 kΩ/V</p> <p><b>Frequency range:</b> 40 to <u>45 to 65</u> to 70 Hz</p> <p><b>Breaker closing pulse length:</b> 400 ms ±10 ms</p> <p><b>Inhibit input:</b> Potential-free contact Open: 5 V. Closed: 5 mA  UL/cUL Listed: +/-5 V DC (using pot. free ext. contacts)</p> <p><b>Contact outputs:</b> Sync. pulse output: 1 change-over switch Freq. control outp.: 2 make contacts Contact ratings: AC1/DC1: 250V AC/24V DC, 8 A AC15/DC13: 250V AC/24V DC, 3 A  UL/cUL Listed: Resistive load only</p> <p><b>Life electrical:</b> 1 × 10<sup>5</sup> (nominal value)</p> <p><b>Analogue output:</b> Freq. difference: 1 analogue output: -10 to 0 to 10 V DC ~ -5 to 0 to 5 Hz  Volt. difference: 1 analogue output: 0 to 5 to 10 V DC ~ 80 to 100 to 120 % of U<sub>n</sub> -10 to 0 to 10 V DC ~ 90 to 100 to 110 % of U<sub>n</sub> with option F activated  UL/cUL Listed: +/-10 V DC</p> <p><b>Optocoupler outp.:</b> System status off = Failure Max. voltage 30 V DC, max. current 5 mA Voltage drop 1.5 V ~ 2 mA  UL/cUL Listed: 30 V DC, 5 mA</p>	<p><b>Temperature:</b> -25 to 70 °C (-13 to 158 °F) (operating) UL/cUL Listed: Max. surrounding air temp. 60 °C/140 °F</p> <p><b>Temperature drift:</b> Set points: Max. ±0.2 % of full scale per 10 °C/50 °F</p> <p><b>Galv. separation:</b> Between inputs and outputs: 3250 V - 50 Hz - 1 min.</p> <p><b>Supply voltage (U<sub>n</sub>):</b> 57.7-63.5-100-110-127-220-230-240-380-400-415-440-450-480-660-690 V AC ±20 % (max. 3.5 VA)  24-48-110-220 V DC -25/+30 % (max. 2.5 W)  UL/cUL Listed: Only 24 V DC and 110 V AC  DC supply must be from a class 2 power source</p> <p><b>Climate:</b> HSE, to DIN 40040</p> <p><b>EMC:</b> To IEC/EN 61000-6-1/2/3/4</p> <p><b>Connections:</b> Max. 4.0 mm<sup>2</sup> (single-stranded) Max. 2.5 mm<sup>2</sup> (multi-stranded)</p> <p><b>Materials:</b> All plastic parts are self-extinguishing to UL94 (V1)</p> <p><b>Protection:</b> Case: IP40. Terminals: IP20, to IEC 529 and EN 60529</p> <p><b>Type approval:</b> The Uni-line components are approved by the major classification societies. For current approvals see <a href="http://www.deif.com">www.deif.com</a> or contact DEIF A/S.</p> <p><b>UL markings:</b> UL Listed only on request  UL Listing will be lost if the product is re-customised outside DEIF DK's production plant  Wiring: Use 60/75 °C (140/167 °F) copper conductors only  Wire size: AWG 12-16 or equivalent  Installation: To be installed in accordance with the NEC (US) or the CEC (Canada)</p>
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Settings

Setting of	Range
T <sub>N</sub> Control pulse length	25 to 500 ms
X <sub>P</sub> Proportional band @ 50 Hz	±0.25 to ±2.5 Hz
X <sub>P</sub> Proportional band @ 60 Hz	±0.50 to ±2.5 Hz
f <sub>set</sub> Slip frequency	0.05 to 0.5 Hz *
ΔU <sub>max.</sub> Acceptable volt. diff.	±2 to ±12 % of U <sub>BB</sub>
T <sub>BC</sub> Breaker closure time	20 to 200 ms (200 to 400 ms) option E

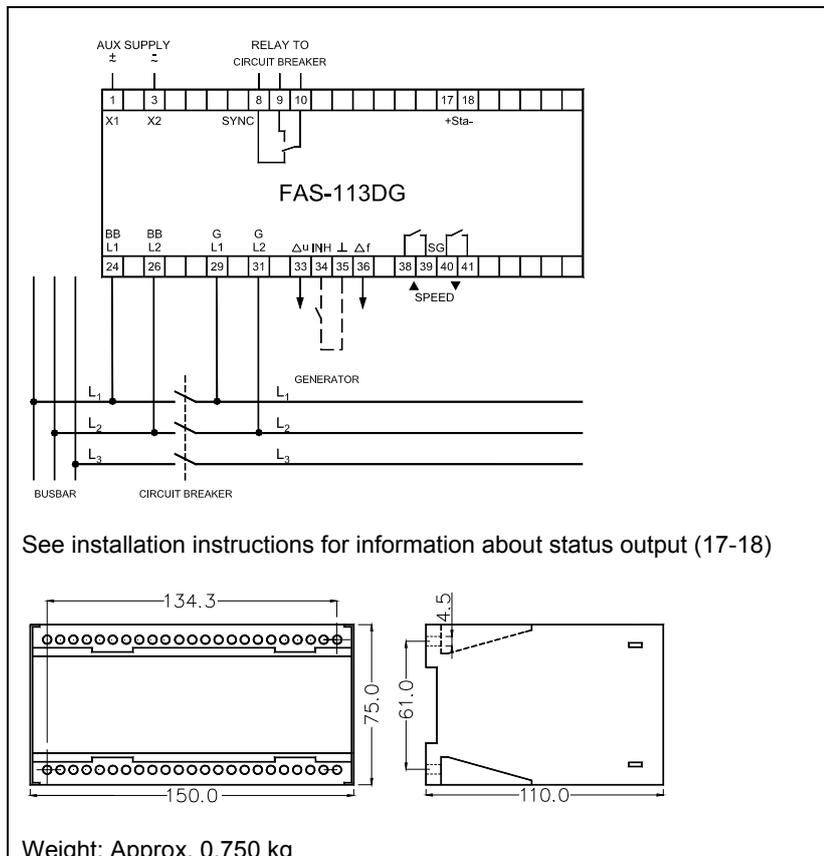
\* Accept of max. df/dt depends on f<sub>set</sub>  
 0.05 Hz ~ 2.5 Hz/sec.  
 0.5 Hz ~ 12.5 Hz/sec.

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 (df/dt check)	
ΔU Voltage difference	
SYNC Synchronising	Yellow, when relay is activated
SG▲ Increase speed (freq.)	
SG▼ Decrease speed (freq.)	

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

Connections/dimensions (in mm)



**Available variants**

Item no.	Variant no.	Variant description
2913010160	01	FAS-113DG - DC supply
2913010160	02	FAS-113DG - AC supply

**Order specifications**

Variants:

Mandatory information						Additional options to the standard variant
Item no.	Type	Variant no.	Measuring voltage	Supply voltage	Generator frequency	Option

Example:

Mandatory information						Additional options to the standard variant
Item no.	Type	Variant no.	Measuring voltage	Supply voltage	Generator frequency	Option
2913010160-01	FAS-113DG	01	380 V AC	24 V DC	50 Hz	Option A

**NOTE:**

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

Regarding option B, please remember to indicate the accuracy for the frequency if this differs from  $\pm 0.5$  Hz. Other settings are  $\pm 0.05$  Hz or  $\pm 3$  Hz.

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



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