DEIF A/S

ANSI code 90

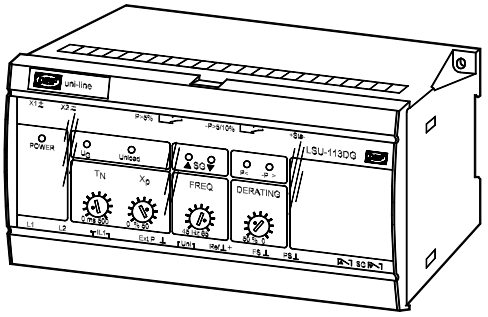
Type LSU-113DG

Load sharing units

uni-line

4921240120H

- ***For control of diesel and gas generators***
- ***Built-in power and frequency transducer***
- ***Reverse power protection/unload and trip***
- ***Constant power or isochronous mode***
- ***LED indication of status/activated control***
- ***35 mm DIN rail or base mounting***



LSU-113DG CE

Application

The LSU-113DG is a control unit for control of the prime mover in a power unit.

The LSU-113DG can control the power unit
- in stand-alone mode, performing frequency control
- parallel with grid, performing power control
- parallel with other power units, performing frequency and power control

The unit is designed for connection to a mechanical speed governor, however in conjunction with the DEIF electronic potentiometer type EPN-110DN or EPQ-96 it can control electronic speed governors as well.

The LSU-113DG has a built-in frequency transducer. If a very stable frequency is wanted, an external frequency transducer common for all the LSU-113DGs in the power plant can be connected. If a number of power units are to be synchronised to the busbar at the same time, the frequency may likewise be controlled externally.

Function

The LSU-113DG is measuring the voltage and the current from which the frequency and the power produced by the power unit are measured. The built-in power transducer is based on an I x cos phi principle.

The following couplings are available:
- 1W(4) – single phase
- 1W3 – 1 element 3 phase, 3 wire, balanced load

If unbalanced load can be expected, an external power transducer with an output of 4…20mA can be connected to the LSU-113DG. In this case the built-in I x cos phi transducer is automatically interrupted.

The power and frequency measured by each LSU-113DG are fed to 2 paralleling lines for comparison with the frequency (FS) and power (PS) of the other connected LSU-113DG.

If L1 or L2 is disconnected from the LSU-113DG at the same time as a power unit in a power plant is disconnected from the power line (busbar), built-in relays in the LSU-113DG ensure that the power output and the frequency output of the associated unit are disconnected from the paralleling lines. Likewise the power and frequency outputs are disconnected if the auxiliary voltage to the LSU-113DG is disconnected.

The LSU-113DG is equipped with an unload input and a "low power" output. When activated the input will control the power unit to zero power, and the output will trip the breaker below P <5% of P_{nom}. At the same time the input is activated, the power output of the LSU-113DG is disconnected from the paralleling line.

The LSU-113DG is provided with a reverse power output. The set-point for this output is:
-P >5% fixed delay 5 s or 10 s
-P >10% fixed delay 5 s or 10 s

The calibration of the LSU-113DG is done so it matches its power unit. This means that load sharing between power units with different size will be performed according to the actual size of the individual power unit in the plant. E.g. a 100kW PU and a 150kW PU running in parallel will share a total load of 125kW into 50kW and 75kW. If the 150kW PU is derated to 100kW by means of the DERATING potentiometer on the front of the LSU-113DG, the load in the above example will then be shared equally between the 2 power units.

Outputs

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

Power and frequency control:
The regulating speed of the servomotors for the prime mover is controlled by the built-in P controller of the LSU-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/power deviation from the required value.

Dead band:
The zone within which no control pulses are emitted:
Power: ±0.5% of P_n (or for derated value)
Frequency: ±0.1Hz

Tripping output:
2 change-over contacts, normally de-energized, for low power and reverse power tripping.

Self-monitoring

The LSU-113DG 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).

Type LSU-113DG

Terminals/function

Connection type	Connect	
1W3 (standard)	L1 to term. 24	L2 to term. 26
1W (betw. phase/neutral)	L1 (P) to term. 24	Neutral to term. 26

Terminal no.	Description/action
1 and 3 X1/X2	Input for supply voltage
8, 9 and 10 ("P <5%")	After unloading (short-circuit of terminals 33 and 34 ("Unl")) an opening signal is transmitted to the generator circuit breaker when the power has dropped to 5% or less of P_n
13, 14 and 15 ("-P >5/10% 5 s/10 s")	Relay output for reverse power protection. The -P > set-point is set by DEIF to either -P >5% (delay: 5 s or 10 s) or -P >10% (delay: 5 s or 10 s)
17 and 18 Sta	Status output, activated (closed) when the supply voltage is connected and the unit is working correctly
28 and 29 IL1	Input for the current measurement. Note that S1 on the external current transformer is connected to terminal 28, and S2 is connected to terminal 29
31 and 32 Ext. P.	Must be short-circuited, if the internal power transducer is used (normal). For applications with unbalanced load it is recommended to use an external power transducer (replacing the built-in one). Connect external power transducer to 31 (+) and 32 (-). The output of the external transducer must be 4…20mA DC. The output of the connected transducer must limit the output to min. 2mA and max. 22mA. DEIF transducer type TAS-331DG is recommended
33 and 34 ("Unl")	May be connected to a potential-free N/O relay contact. When this contact is activated, the power of the generator is regulated to zero (unloading) and the LSU-113DG is disconnected from the PS power line
35 ("Ref.")	Reference input. Must be connected to term. 36 ("⊥"), if not used. This input is used to control the power unit running in power control mode (fixed load to grid). A +0.5V…5V connected to the input with respect to ⊥ will control the PU in the range 10…100% power. The input activates at 0.55V and deactivates at 0.45V. Please notice that when this input is active the LSU-113DG is still connected to the PS and FS lines. In this mode the PS line acts only as an output
37 ("+5V")	Reference output. This voltage output can be used for local power control mode. If terminal 37 is feeding a voltage divider, and the output from the voltage divider is connected to terminal 35, local power control can be performed
36 ("⊥")	Common earth terminal for the above reference input/output
38 (FS) and 39 ("⊥")	Paralleling line for frequency sharing of the connected LSU-113DGs
40 (PS) and 41 ("⊥")	Paralleling line for power sharing of the connected LSU-113DGs. Normally 5V at nominal busbar voltage and cos phi = 1. If cos phi 0.8 is stated on the label, 4V correspond to 100% power
43 and 44 Relay contacts "SG"	Relay contact for increase of the speed
45 and 46 Relay contacts "SG"	Relay contact for decrease of the speed
NOTE: Relay contacts	Relays (SG) should always be connected via external auxiliary relays when a DC pilot motor is applied. A transient suppressor should always be connected across the relay coil of the external relays

NOTE:
All terminals marked "⊥" are internally connected.

For correct function of the LSU-113DG any analogue DC input must not exceed 110% of its nominal value. To ensure correct power measurement it is important that the AC current input does not exceed 110% of its nominal value. To accomplish this it is important to take the value of the max. cos phi into consideration when ordering/configuring the LSU-113DG, e.g. by using the kVA figure of the generator and cos phi = 1.

Application

The schematic drawings on the next page show the different couplings for the LSU-113DG. For further information see the Application notes for uni-line, doc. no. 4189340150.

DEIF A/S

ANSI code 25

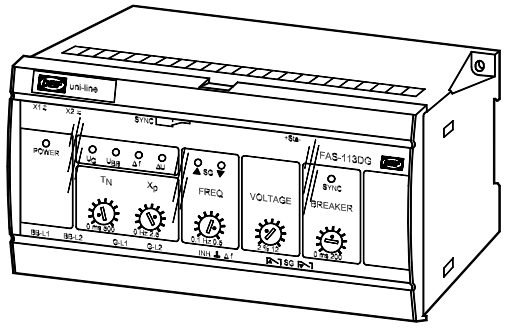
Type FAS-113DG

Synchronisers

uni-line

4921240114G

- ***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***



FAS-113DG CE

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 reverse power conditions to occur (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 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 imprecise synchronisation pulse to be transmitted. If the df/dt function is active, the situation will be indicated by a flashing Δf 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 2 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}.

Dead band 0.05Hz:
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 ±2...±12% of the busbar voltage, and
2. the frequency difference is within ±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-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 ±5° 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-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 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).

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 for resetting of the FAS-113DG after synchronisation and hereby deactivation of the SG outputs. This function allows the supply voltage to be connected at any time
33 ("∆U") 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 ("∆f")	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 contacts "SG"	Relay contact for increase of the speed
40 and 41 Relay contacts "SG"	Relay contact for decrease of the speed
NOTE: 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 (50Hz or 60Hz). 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 (50Hz or 60Hz) ±0.05Hz, and no sync. pulse will be transmitted.

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 (50Hz or 60Hz). When the frequency becomes nominal within ±0.05Hz, ±0.5Hz or ±3Hz depending on internal jumper setting, ±0.5Hz is set as default if no specific request is made, and the voltage level is nominal ± 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.

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.