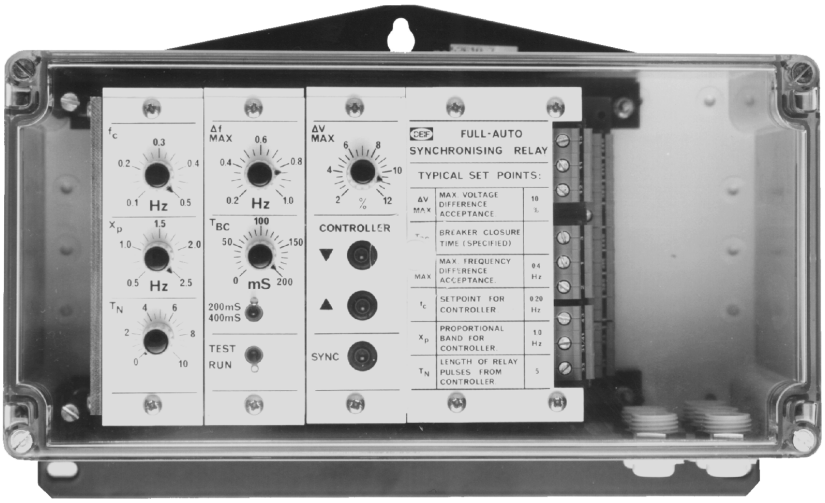
DEIF A/S

Synchronising relays

Types FAS-2N, FAS-3N, HAS-2N

4921250029D



FAS-3N

- *High accuracy (±3° el.) and fast synchronisation*
- *Circuit breaker time compensation*
- *Test switch*
- *Voltage matching (type FAS-3N)*

Available types

Fully automatic relay	Fully automatic relay with voltage matching	Semi-automatic relay
FAS-2N	**FAS-3N**	**HAS-2N**

The synchronising relays types FAS-2N, FAS-3N and HAS-2N are CE marked for residential, commercial and light industry plus industrial environment.

Features

- **Accurate synchronisation** — Synchronisation will be obtained within ±3° el. of phase zero.
- **Fast synchronisation** — High-slip frequency is permissible because of the accurate compensation for the circuit breaker closure time.

  The generator will be continuously controlled to a frequency (f_c) approximately 0.2Hz higher than the busbar frequency by means of differential frequency measuring and a PI controller (FAS only).

  The problem of synchronising when the two frequencies are similar and out of phase for a long time, is thus eliminated (FAS only).
- **Simple adjustment** — All values are set on accurate scales.
- **Easy testing** — LED for synchronising signal.

  LEDs for control signals (FAS only).

  Built-in test switch for isolating the synchronising relay.

  The automatic frequency control can be adjusted and tested. (FAS only).
- **Reliable synchronisation** — Withstands transients according to IEC 255-4 (class 3) and SS4361503 (PL4) (1MHz - 2.5kV and 4...8kV transients).

  Unaffected by irregularities of measured voltages, e.g. bad wire connection, unfastened fuses or the like.

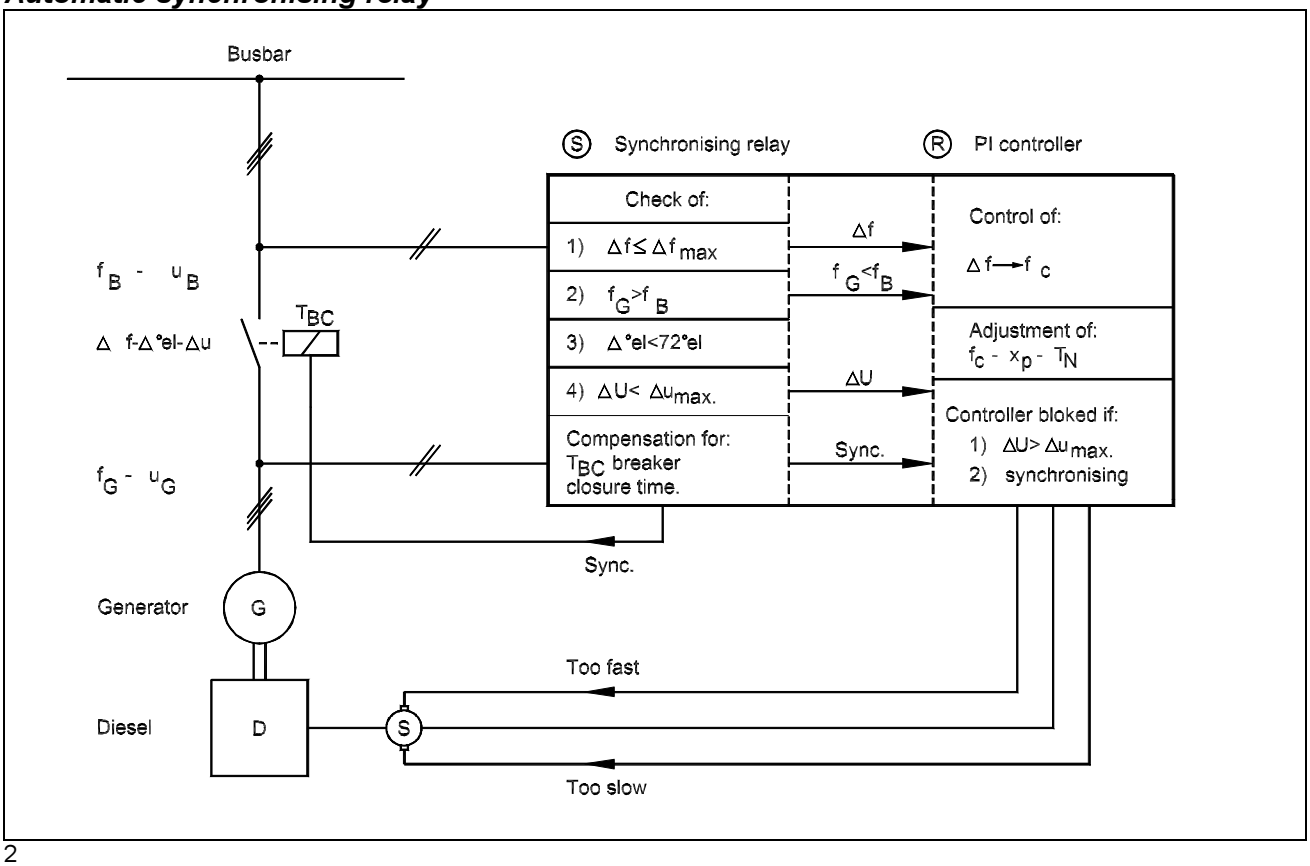
  The synchronising pulse can only be initiated if the phase angle difference is less than 72° before phase zero, preventing damage due to incorrect setting of the synchronising relay
- **Reverse power protection** — Synchronisation will only be obtained if the generator frequency is higher than the busbar frequency.

  The automatic frequency control ceases when the synchronisation signal is initiated to the circuit breaker (FAS only).
- **Construction** — Modular construction

  Suitable for 110-220V AC **or** 380-415-440V AC.

  Suitable for 50 **and** 60Hz.

Automatic synchronising relay



The automatic synchronising relay consists of two parts (see drawing page 2):

(S) Initiates the synchronising signal to the circuit breaker, provided that:

1) The frequency difference is less than the selected maximum value, Δf_{max}.

2) The frequency difference is positive, i.e. the generator frequency is higher than the busbar frequency.

3) The phase difference is less than 72°.

4) The voltage difference is less than the set value $\Delta V_{max.}$

(R) PI control of the generator frequency towards f_c (set point of the controller) so that conditions 1, 2 and 3 will be fulfilled. (Normally item 4 is fulfilled).

Before synchronisation the frequency controlling remains blocked until the voltage difference is less than the selected maximum value, $\Delta V_{max.}$

After synchronisation the PI control function will cease.

If the frequency difference is negative (generator frequency lower than busbar frequency) the servomotor receives a continuous controlling signal until the frequency difference is positive.

If the frequency difference is positive (generator frequency higher than busbar frequency) the servomotor will be controlled by the PI controller.

Within the proportional band (x_p) the pulse ratio will change proportionally to the frequency deviation from f_c (set point of controller).

Additional FAS-3N functions

The fully automatic synchronising relay type FAS-3N with voltage matching is a further development of the FAS-2N.

It is provided with a "window comparator" with the following logical functions:

1) It cancels the synchronising signal from terminals Nos. 21-23, if the voltage difference exceeds the set value, ΔV_{max} ($\pm\Delta V > \pm\Delta V_{max}$).

2) It cancels the frequency controlling signal from terminals Nos. 1-3 and 11-13, if the voltage difference exceeds the set value, ΔV_{max} ($\pm\Delta V > \pm\Delta V_{max}$).

3) It closes the relay contacts connected to term. Nos. 33-31, if the generator voltage is too low, i.e. $-\Delta V > -\Delta V_{max.}$

4) It closes the relay contacts connected to term. Nos. 41-43, if the gen. voltage is too high, i.e. $+\Delta V > +\Delta V_{max.}$

   NOTE: Terminals Nos. 31/41 are coupled together to one common terminal.

5) The voltage matching relays will not be energised, if either the generator voltage or the busbar voltage is less than approx. 70% of the nominal voltage.

   Note: The busbar voltage should be monitored by means of a Busbar Monitor set to ±5...10%.

6) If $\pm\Delta V < \pm\Delta V_{max}$, both relays will be de-energised, and the voltage will not be further matched. (I.e. the generator voltage is within the "window").

   Both sides of the "window" are set on the scale marked "ΔV_{max}". (Typical setting: 2%).

Semi-automatic synchronising relay type HAS-2N

The dimensions and technical specifications of HAS-2N are identical to the synchronising part (S) of the FAS.

However, the PI controller and its associated relays have been omitted and the generator frequency is controlled manually.

Adjustment of set points

ΔV_{max} is typically set to 10% (FAS-3N: 2%).
If ΔV_{max} is reduced, the possibility of reactive power flowing between the generator and the busbar after synchhronisation will be reduced as well, but the risk of not achieving synchronisation is increased. (A high ΔV is not very common, though when using modern AC generators).

(FAS **only**): The automatic frequency regulation remains blocked till $\Delta V < \Delta V_{max.}$

T_{BC} is set to the specified breaker closure time plus the operating time for extra relays, if any.
If T_{BC} is longer than 200 ms, the scale switch must be set to "400 ms". If circuit breakers with various closing times are to be operated by one synchroniser, T_{BC} should be set to the longest breaker time and the differences in time must be compensated by auxiliary electronic timers.

Δf_{max} is typically set to 2 x f_c= 0.4Hz or f_c +0.2Hz.
If the lowest possible slip frequency is requested, the setting should be:

Δf_{max}= 0.2Hz
and
f_c = 0.1Hz (FAS only)

but this will cause an increase in the synchronisation time. When using "small" diesel generators (≤150kW) and a short T_{BC} (≤100 ms) the following settings are suggested for fast synchronisation:

Δf_{max}= 1.0Hz
and
f_c= 0.5Hz (FAS only)

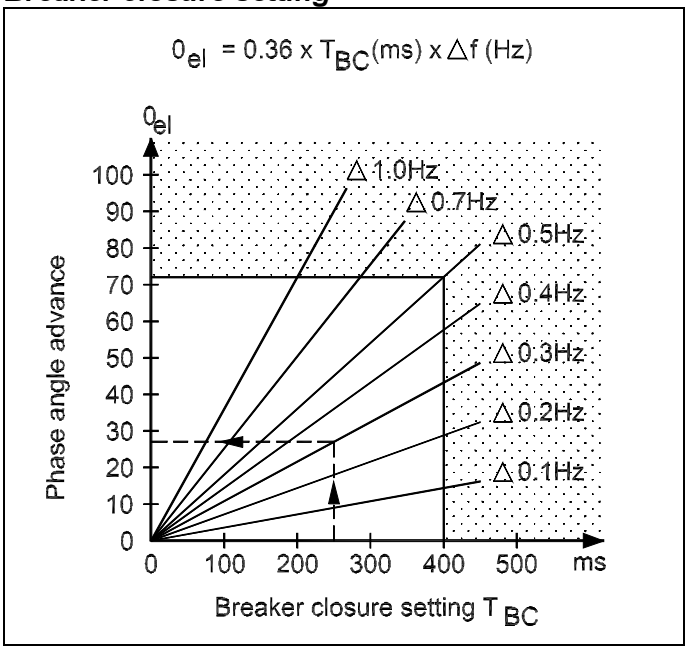
An increase of the set points is recommended during the running-in period on account of inertia of the diesel generator and possible inaccuracies in the closing time of the circuit breaker.

f_c (FAS only) The set point of the PI controller, typically set to 0.15...0.2Hz.
If the busbar frequency varies much, it may be necessary to choose a higher f_c value (see Δf_{max}).

x_p (FAS only) The proportional band of the PI controller, typically set to Δ1Hz.
Servomotors with a fast response require a high x_p setting, whereas "slow" servomotors require a low x_p setting.

T_n (FAS only) The relative pulse length setting of the PI controller (ON + OFF time), typically set to 5.
Increase T_n as much as possible, but in such a way that the generator frequency does not start to oscillate about the f_c.

Breaker closure setting



In the “dotted” region, the breaker closing signal is blocked **irrespective** of the settings for Δf_{max} and T_{BC}.

Example: T_{BC} = 250ms

If Δf_{max} is set to 0.3Hz, the phase angle advance will be 0...27° el., depending on the actual Δf.

Testing procedure

1) Set the function switch to the "TEST"-position whereby:

   1.1. the built-in synchronising relay is inoperative but:

   1.2. the LED marked "SYNCH" will be illuminated for the time T_{BC} before the two systems are in phase (provided that the synchronisation conditions are fulfilled).

2) As an extra precaution the synchronising signal from terminals Nos. 21-23 should be disconnected close to the circuit breaker coil.

3) Check that the phase connections of the two measured voltage inputs are correct. Incorrect connection will cause an erroneous synchronising signal.

4) (FAS only)
   Adjust the frequency controller by means of f_c, x_p and T_n.

5) 5.1. (FAS only)
   Δf_{max} is set to 2 x f_c or f_c plus 0.2Hz.

   5.2. Δf_{max} is set to 0.3...0.4Hz.
   The LED marked "SYNCH" will now be illuminated for the time T_{BC} before the systems are in phase (provided that the synchronisation conditions are fulfilled).

6) (FAS only)
   Check that the servomotor of the diesel engine does not permit a frequency change of more than 0.4Hz/sec. under continuous operation. If this value is exceeded it may not be possible to control the frequency and the generator will oscillate around the busbar frequency.

7) (FAS only)
   Increase the frequency (approximately 3Hz) for a short period by manual operation. If the frequency now starts to oscillate about the f_c, one or more of the following adjustments can be made:

   7.1. increase x_p

   7.2. decrease T_n

   7.3. increase f_c

   If, however, the frequency is being pulsed too slowly towards f_c, the following adjustments can be made:

   7.4. decrease x_p

   7.5. increase T_n.

8) It should now be possible to stop the synchronising signal by:

   8.1. decreasing f_G until $f_G < f_B$, i.e. when a synchroscope is rotating counter-clockwise.

   8.2. increasing f_G until $f_G > \Delta f_{max}$.

   8.3. increasing ΔV until $\Delta V > \Delta V_{max}$.

9) The function switch is set to the "RUN"-position.

10) (See step 2). To finally check the synchronising signal a voltmeter should be substituted for the circuit breaker coil.

11) The generator should be stopped and the leads for the synchronising signal re-connected to the circuit breaker, provided that step 10 is satisfactorily fulfilled.

The system is now adjusted for automatic synchronisation.

Technical specifications

Rated voltages (V_r): 110-220V AC **or** 380-415-440V AC.

Effective range: V_r ±25%.

Overvoltage: 2 x V_r for 10 sec.

Consumption: Max. 2 x 3VA.

Frequency range: 40...70Hz.

Synchronising relay

Breaker closing accuracy: ±3° el.
Voltage differential: 2...12% scaled.
Frequency differential: 0.2...1Hz scaled.
Phase angle advance: Automatic 0...72° el.
Breaker closing time compensation: 0...200 ms, scaled. 0...400 ms, scaling x 2.
Breaker signal duration: Equal to T_{BC}.
Synchronising relay: 1 make contact.
Contact rating: AC: 250V-5A-1250VA. DC: 30V-5A-150W. (resistive load).

Function switch

"TEST"-position	Synchronising relay switched off.	
	Synchronising, - LED "ON"	T_{BC} before phase difference is zero.
	Synchronising, - LED "OFF"	At 10° el. past zero phase difference.
"RUN"-position	Synchronising relay + LED "ON"	T_{BC} before phase difference is zero.
	Synchronising relay + LED "OFF"	1) At 10° el. past zero phase difference, by means of an internal reset circuit if synchronising is **not** achieved. The next time the synchronising conditions are fulfilled a new synchronising signal will be initiated. 2) By means of an external reset circuit if synchronising **is** achieved. (See page 7).

PI controller (FAS **only**)

Set point (f_c): 0.1...0.5Hz, scaled.

Proportional band (x_p): 0.25..2.5Hz, scaled.

Dead band: ±0.05Hz, fixed.

Pulse length (T_n): 0...10 (scaled).

Servomotor speed: Max. change 0.4Hz/sec. at continuous operation.
FAS-3N: Max. 0.5% of V_N, per sec.

Controller relays: 1 changeover switch per relay.

Voltage relays (FAS-3N **only**): 1 make contact per relay.

Controlling (FAS-3N **only**): 3-point.

Hysteresis (FAS-3N **only**): 1.0% of V_N, for each relay.

General technical specifications

Temperature: -10...55°C (nominal), -25...70°C (operating), -40...70°C (storage).

Temperature drift: Phase: 0.1°per 10°C. Frequency: 0.02% per 10°C.
Voltage differential: max. error 0.2% per 10°C.

Galvanic separation: Between circuits and between circuits and earth: 2kV-50Hz for 1 min.

Climate: Class HSE, according to DIN 40040.

EMC: To EN 50081-1/2, EN 50082-1/2, SS4361503 (PL4) and IEC 255-4 (class 3).

Mechanical construction: Case: self-extinguishing polycarbonate.

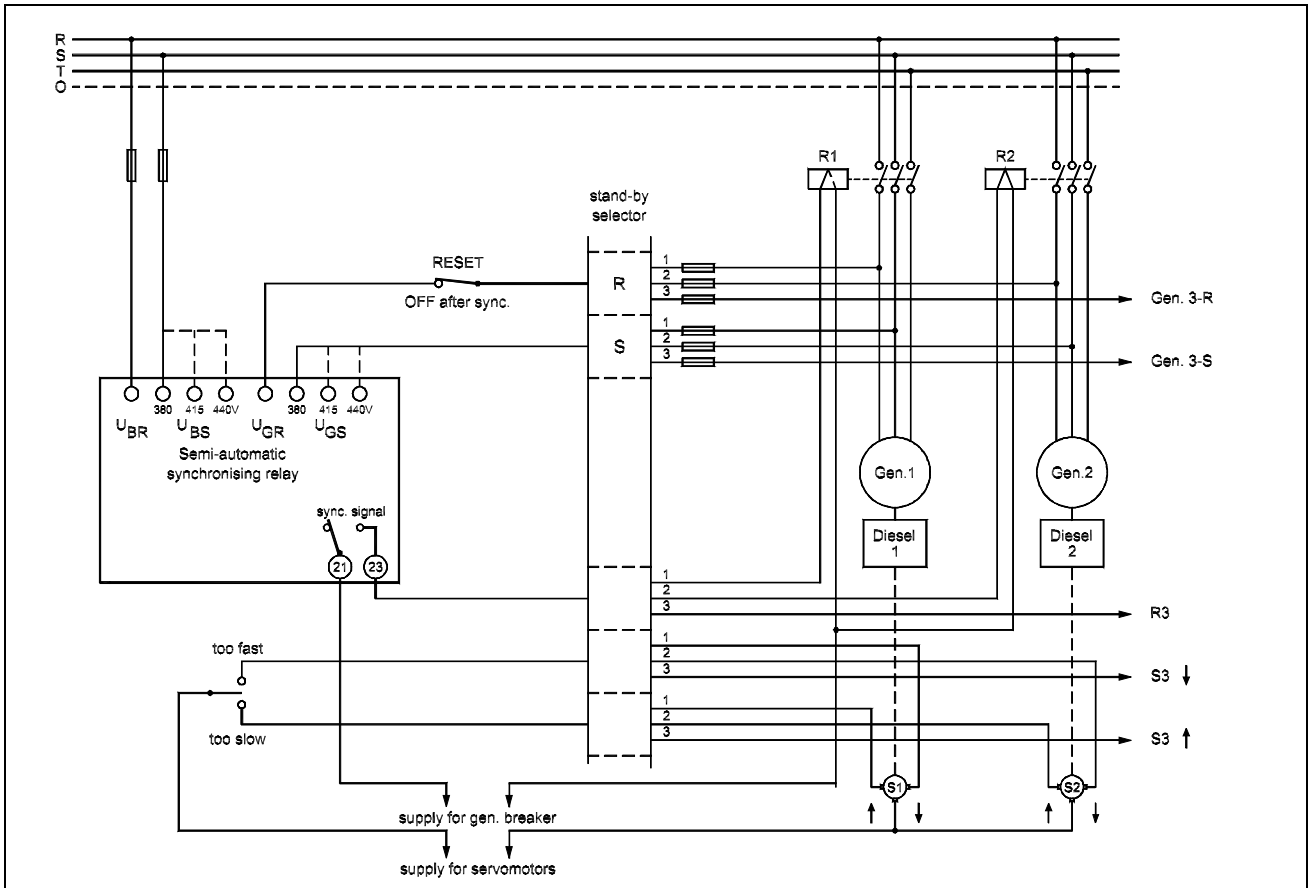
Terminals: Screw terminals: max. 4 mm² single core (self-extinguishing).

Protection: IP53, to EN 60529 and IEC 529.

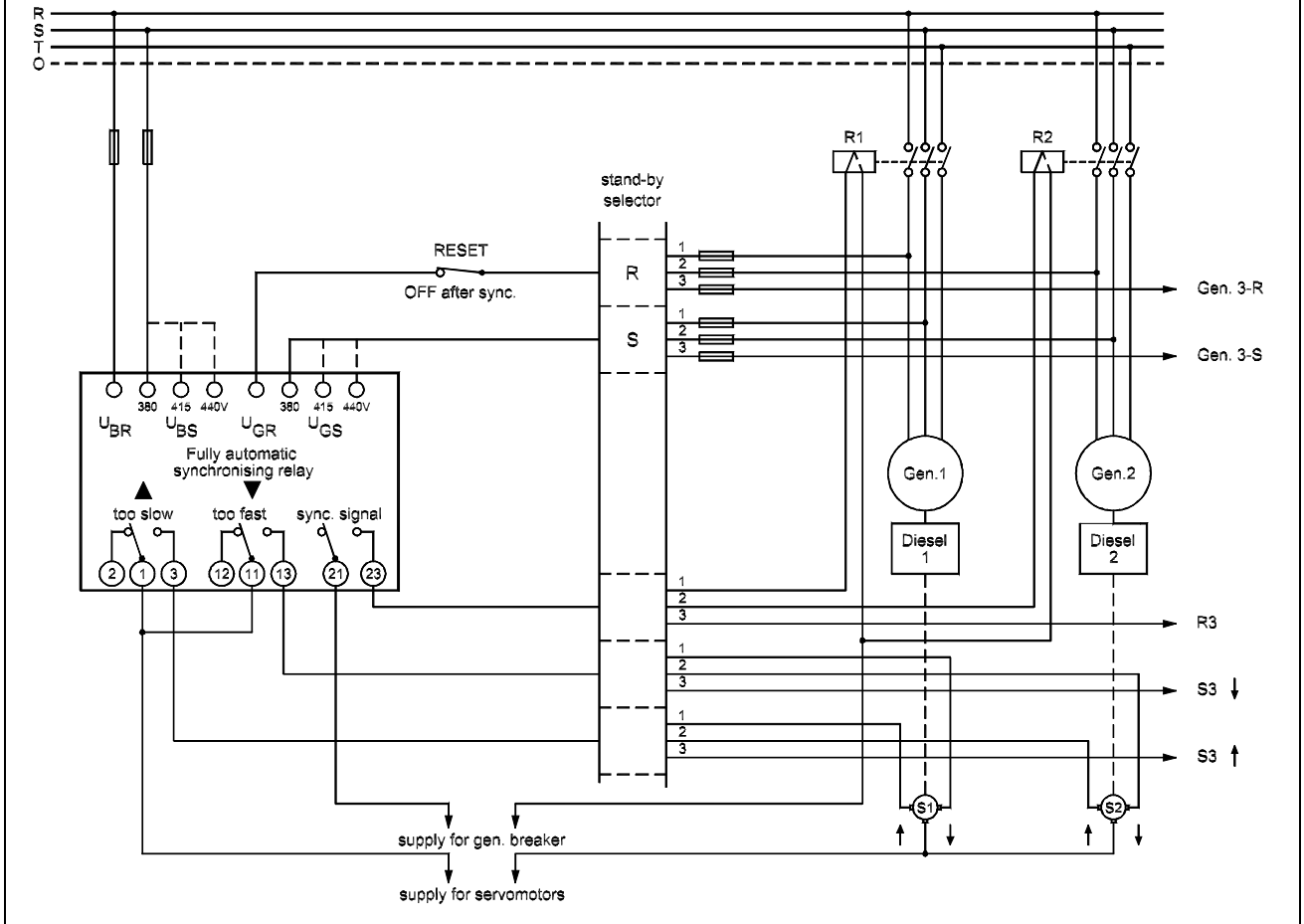
Typical application schemes/connections

All relays are normally de-energised.

Note: It is recommended to switch off the synchroising relay after synchronising by means of the RESET-circuit shown. This is activated by an extra contact on the circuit breaker. The RESET-contact can be connected to any of the 4 measuring leads.

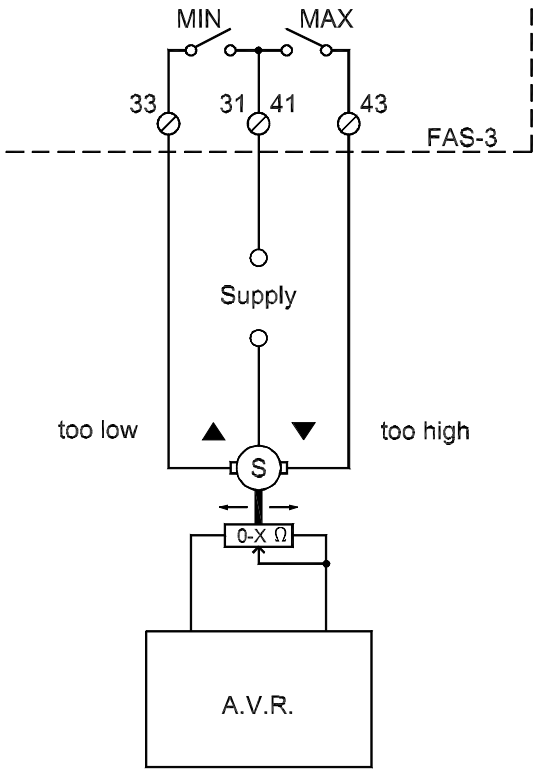


HAS-2N



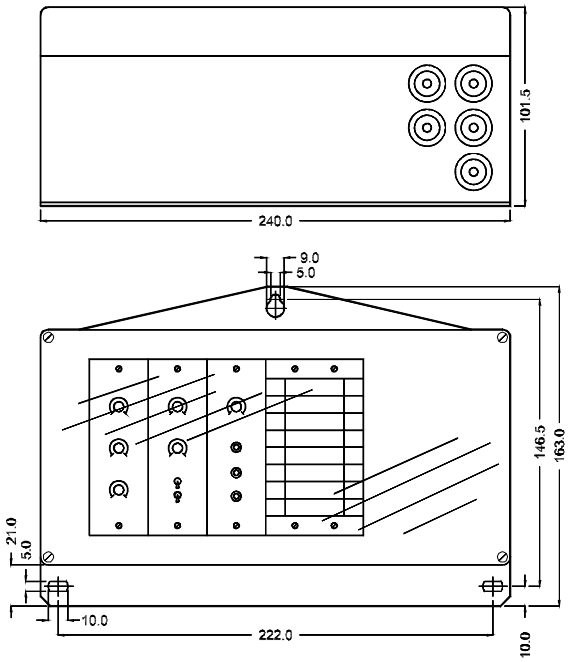
FAS-2N/FAS-3N

Connections FAS-3N



Dimensions

All dimensions in mm



FAS-2N/FAS-3N/HAS-2N Weight: max. 1.9 kg

Order specifications

	Type	**Voltage**
Example	FAS-2N	110-220V AC

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

***DEIF A/S**, Frisenborgvej 33*
DK-7800 Skive, Denmark

Tel.: +45 9614 9614, Fax: +45 9614 9615
E-mail: deif@deif.com, URL: www.deif.com