

System description Synchronizing Equipment	Respons. dept GPEL	Date 04-02-19	Reg. E DB 101
	Prepared T.Cota		YAMAMA CEMENT

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Purpose of the system

The purpose of the synchronising system is to perform synchronising or manual dead bus closing of the generator circuit breaker or other selected circuit breakers.

General description of the system

The synchronising equipment comprises a synchro check relay, a manoeuvre panel for manual synchronisation, synchronising instruments and dedicated software in the turbine control system.

There are two different ways of synchronising, Automatic Synchronising and Manual Synchronising. The synchro check relay is monitoring both manual and automatic synchronisation.

Sequence Synchronising can only be used during start-up of the unit. When the GT unit reaches idle speed and the voltage is inside the pre-set range Automatic synchronising is initiated. Thereby the unit starts to synchronise to the bus bar and when the conditions for synchronism are fulfilled the breaker will automatically be given a close order.

Operator Station Synchronising is re-synchronising or synchronising of selected breaker to the bus bar. The operator orders breaker selection and Automatic Synchronising from the operator station.

Generator Panel Synchronising means manual synchronising (with synchrocheck). The operator has to manually adjust the GT unit frequency and voltage to acceptable values for synchronisation and to press the circuit breaker close push button.

Main components

- Combined Synchro-check Relay and Synchroscope
CBP10

The parameters maximum permitted voltage difference, maximum permitted phase difference and breaker closing time delay for the synchro check function are pre-set on the rear of the combined synchroscope and synchro check relay.

The rotation of the red LED circle indicates the frequency difference. The faster the rotation, the larger the frequency differences. One rotation pr. second equals 1Hz difference.

The position of the lit red LED indicates the phase difference between UGEN and UBUSBAR. The circle represents a degree-scale from 0-360 degree with zero degree at the 12 o'clock position. With 36 LED's the resolution on the reading is 10 degrees.

If the frequency difference between UGEN and UBUSBAR is higher than 3Hz, the rotation of the LED circle stops. If it stops with at lit red LED at it TOO SLOW., the frequency of the UGEN is lower than UBUSBAR. If it stops with at lit red LED at it TOO FAST, the frequency of the UGEN is higher than UBUSBAR. When the phase angle between UGEN and UBUSBAR is within the pre-set window, then the yellow LED OK will be lit. If the voltage difference between UGEN and UBUSBAR is outside the pre-set U range, one of the two red LED's will be lit and the SYNC relay cannot be activated. If the voltage on UGEN is higher than UBUSBAR LED UGEN TOO HIGH will be lit. If the voltage on UGEN is lower than UBUSBAR, LED UGEN TOO LOW will be lit. If both the UGEN TOO LOW and in UGEN TOO HIGH LED's are lit simultaneous, it indicates an overvoltage error at the input.

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LEDs on primary front (normal mode):

LED	Colour	Function
Circle	Red	The lit LED in the circle shows the phase difference between GEN and BUSBAR
SYNC.	Green	All preset sync. parameters are OK and output relay is activated
. OK	Yellow	The phase difference between GEN and BUSBAR is within the preset window
UGEN TOO HIGH	Red	The voltage difference between GEN and BUSBAR is outside the preset range. UGEN is too high.
UGEN TOO LOW	Red	The voltage difference between GEN and BUSBAR is outside the preset range. UGEN is too low.

- Selector Switch Synchronising Mode
CBP10

The switch, used for selecting of synchronising mode, has three positions; Operator Station, Synchronising Blocked and Generator Panel.

Operator Station Position means Automatic synchronising and breaker selection from the operator station control display.

Synchronising Blocked Position means that synchronising and closing order to the breaker is blocked.

Generator Panel Position makes it possible to synchronise from the generator standby panel and close selected breaker with "Breaker ON" push button. When closing breaker to a dead bus, push also "Dead Net release" button.

Warning !

"Dead Net release" push button shall ONLY be used when closing selected breaker to a **dead bus!**

Incorrect use will cause **severe damage!**

Note that the synchro-check relay is not used. It is possible to close a breaker to active net.

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- Selector Switch Circuit Breaker
CBP10

The switch, used for selecting of breaker to synchronise, has three positions; SYNCH GCB10, SYNCH UCB1 and SYNCH UCB2. The position of this switch is only considered when the synchronising mode selector switch is in Generator panel position. In this case one of the three selector signals will result in an output signal to the respective relay, which will connect the relevant reference voltage and enable the synchronising system breaker close order to reach the selected breaker.

- Combiflex Relays
CBP10

Following relays are used in the synchronising system.

Description

- Connection of the reference voltages to the synchronising equipment
- Select generator reference voltage (phase to phase)
- Select bus bar reference voltage upstream GCB
- Select generator reference voltage (phase to neutral)
- GCB open order (Sub 1 and Sub 2)
- Select bus bar reference voltage upstream UCB1
- Select bus bar reference voltage upstream UCB2
- UCB1 Position indication open/close
- UCB2 Position indication open/close
- UCB1 Order open/close
- UCB2 Order open/close

Type of relay

- RXMB 1-873 C
- RXMB 1-803
- RXMB 1-873 C
- RXMB 1-873 C
- RXMB 1-802
- RXMB 1-873 C
- RXMB 1-873 C
- RXMB 1-804
- RXMB 1-804
- RXMB 1-440
- RXMB 1-440

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Function

Start up

If the synchronising should be performed automatically as a part of the start-up sequence the synchronising selector switch must be in Operator station position. The generator circuit breaker should be selected from the operator station.

Continuous operation

The totally automatic synchronising sequence is controlled by the common GT control system AC100 giving orders to different involved pieces of equipment. The control system first checks the following criteria.

1. Is the generator speed above $f_n - 15\%$ and the voltage above $U_n - 20\%$.
2. Does the network voltage exceed $U_n - 20\%$
3. Is the synchronising selector switch in Operator station position?

If so, then the following activities are initiated.

Frequency Adjustment

A signal corresponding to the frequency of the network voltage is together with a small bias frequency (0.08 Hz) connected to the frequency/load control of the turbine governor. Hereby the generator frequency will be adjusted to a value slightly (0.08 Hz) above the network frequency.

Voltage Adjustment

The network voltage is compared with the generator voltage in the Advant Controller (AC100) which adjusts the automatic voltage regulator set value in a way that the two voltages will become equal in amplitude.

Close Order

When the control system detects a voltage difference of less than $\pm 2\%$ it gives a close order to the synchronising relay, that upon satisfying difference between the phase angles of the voltages closes the circuit breaker.

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Operating instruction for Auto Synchronising used during start-up.

Action

Put the Synchronising Mode Selector Switch in Operator station position on the generator panel.

Select Auto Synchronising on the operator station (FG synch/off i Auto).

When the GT is at idle speed and the generator voltage is 100% the unit will start to synchronise to grid.

The automatic synchroniser will adjust the turbine speed and generator voltage to match the bus bar and close the selected breaker when the conditions for synchronising are met.

The position indicators for the selected breaker will change.

When the selected breaker has closed the synchronising equipment is automatically reset.

Immediately after synchronising, the turbine controller will automatically increase the set point of the power output controller to prevent reverse power to the GT unit.

Display

AUTO SYNCH.

Turb. in Operation

OPEN to CLOSED

Unit in Operation

Operating instruction for Sequence Synchronising (Resynchronising or Manually Ordered Automatic Synchronising)

Action

Select which breaker to synchronise from the operator station.

Select sequence synchronising.

Start synchronising. (FG synch/off; manual select on)

The automatic synchroniser will adjust the turbine speed and generator voltage to match the bus bar and close the selected breaker when the conditions for synchronising are met.

The position indicators for the selected breaker will change.

When the selected breaker has closed the synchronising equipment is automatically reset.

Immediately after synchronising, the turbine controller will automatically increase the set point of the power output controller to prevent reverse power to the GT unit.

Display

SYNCH GCB or
SYNCH UCB1 or
SYNCH UCB2

Seq. synch

SYNCH ON

OPEN to CLOSED

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Operating instruction for Generator panel Synchronising (Manual back-up procedure)

If the automatic synchronising should fail it is possible to use Manual Synchronising at generator control panel CHA10.

Action

Select manual synchronising on the generator panel.
Synchronising instruments are connected.
Select which breaker to synchronise.

Panel

SYNCH GCB or
SYNCH UCB1 or
SYNCH UCB2
INCREASE and
DECREASE
FREQUENCY
RAISE and
LOWER
VOLTAGE
CLOSE
SELECTED
BREAKER

Use the push buttons to adjust the turbine speed and generator voltage to match the bus bar so that a slow rotation appears on the synchroscope.
One turn on the synchroscope scale should take approximately 10s.

When the LED's of the synchroscope is indicating synchronised generator (position 12 o'clock or slightly before), push the button for selected breaker.
A synchro-check relay will prevent out-of-synch closing of the selected breaker.

The position indications for the selected breaker will change.
Select Auto or Synchronising blocked on the synchronising mode selector switch to deactivate the synchronising instruments.

OPEN to CLOSED
Operator Station or
Synchronising
Blocked

Operating instruction for Dead Bus Closing (Synchro-check relay by-pass)

To enable closing of a circuit breaker to a dead bus bar the system requires that the operator selects Generator panel Synchronising and simultaneously presses the Dead Net Release push button and the Breaker Close push button for selected breaker on the generator panel.

Warning !

This instruction shall ONLY be used when closing selected breaker **to a dead bus!**
Incorrect use will cause **severe damage!**

Note that the synchro-check relay is not used. It is possible to close a breaker to active net.

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<p>Action</p> <p>Select manual synchronising on the generator panel. Synchronising instruments are connected. Select which breaker to synchronise.</p> <p>Push the Breaker Close button for selected breaker and the Dead Net Release Closing button simultaneously.</p> <p>The position indications for the selected breaker will change. Select Auto or Synchronising blocked on the synchronising mode selector switch to deactivate the synchronising instruments.</p> <p>The breakers can manually be opened from the operator station or the generator panel by using the push buttons "GCB OFF", "UCB1 OFF" or "UCB2 OFF"</p> <p>Turbine stop</p> <p>N/A.</p> <p>Stand still</p> <p>N/A.</p> <p>Disturbances</p> <p>Gas turbine trip</p> <p>N/A.</p> <p>Generator breaker trip</p> <p>N/A.</p> <p>Loss of power supply</p> <p>N/A.</p> <p>Other faults</p> <p>Fault in connecting systems:</p> <ul style="list-style-type: none"> Tripped MCB in the Potential Transformers secondary circuit Tripped MCB in the reference voltage circuits should send an alarm to the control system. Loss of reference voltage will stop automatic synchronising. It can also mislead the operator to close the breaker manually to a <u>not</u> dead bus. 		<p>Panel</p> <p>SYNCH UCB1 or SYNCH GCB1 or SYNCH GCB2</p> <p>CLOSE SELECTED BREAKER OPEN to CLOSED Operator Station or Synchronising Blocked</p>		
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Technical specification

Design criteria and standards

The GT can be synchronised to a grid with the following data for the voltage and frequency deviation from the nominal:

- $f_n - 5\% < f < f_n + 5\%$
- $U_n - 10\% < U < U_n + 10\%$

Dimensioning data

Engineering data

Emergency power supply

N/A.

Installation

All system equipment, except for the GT common control system, is installed in the generator panel.

Materials

The combined Synchro-check Relay and Synchronoscope is a DEIF (Cewe) type CSQ96.p.

Component data

Testing and service

Testing during normal operation

Accessibility during normal operation

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