AUTOMATIC ELECTRIC CONTROL BOARD FOR GENERATING SETS IN PARALLEL AMONG THEMSELVES WITH GENSYS LOGIC AND PLC

GENERAL INFORMATION:

GS PAR automatic control board, subject of this data-sheet, is designed to manage two or more emergency generating sets in a completely automatic way. The automatism can ensure the gen. sets' starting, the parallel and power delivery in a short time at mains voltage failure

OPERATION:

At mains failure moment, the control unit sends starting commands to all the machines pre-set for starting, the first one that reaches the steady running becomes pilot and allows the synchronism and the subsequent parallel of all the others, once all the gen. sets' parallel has been reached the change-over is operated by the control unit (that can be included or excluded from the supply). It is possible to select a plant set-up that sends the MAINS>GEN. SET change-over signal when there is just one gen. set at steady running (to feed priority load that cannot wait for the complete synchronisation), or when there are n gen. sets in parallel or even all the plant has reached the parallel. It is possible either to keep all the gen. sets in parallel aside from the current load (recommended for load variable according to frequency), or to conform the number of gen. sets running according to the load required (regular load without current rushes). Obviously, in the latter case, when n gen. sets stop for overload, they are immediately started again when the load exceeds the programmable load demanding thresholds. It is also possible to replace a loaded running gen. set with another one in stand-by state without varying the power delivery. In any case generators connected to the load divide it among themselves in a balanced way and according to the output of each gen. set, until the voltage returns to the parameters set on the mains undervoltage relay, at this time a programmable mains return delay starts. Whet it is finished, an opposite change-over command will be given (gen. set>mains). Now the gen. sets still in parallel will wait the programmable cooling time, before disconnecting from BUS. While running, the gen. sets are protected by suitable protections, some of them are on even when the engine is stopped. According to the request, the gen. set can be included in a central system of N gen. sets in parallel or in mains parallel or even together with N gen. sets in parallel with one or more private networks, having however the same control system.

The operator depending on the kind of plant and the work requirements can directly perform those and other functions.

CARPENTRY:

Consisting of a cabinet made by bent steel, thickness 20/10mm (frame) and 15/10mm (panelling and doors), electrophoresis painting cycle, rubber seals, colour tone RAL

7035. Outside IP 44, inside IP 20. The structure includes detachable side panels to help the cable connection and lifting eyebolts necessary for the carriage and the positioning.

ELECTRICAL CONTROL BOARD:

The standard control board's manufacture includes several side-by-side modules, in particular one column each gen. set. The upper part contains auxiliary circuits, the parallel and gen. set control card, while at the bottom there is the motorised power switch in a position kept apart from the auxiliaries; whereas the parallel column includes the central control system and, if expected, the output switch. The control board's back part is for power connections that can be from either the bottom or the top on request. The front access is only in gen. sets delivering little power.

OPERATION:

Each gen. set is individually controlled by a microprocessor card type **Gensys** which controls every electric parameters, start and stop controls, protections and alarms. A pre-setting commutator enables the following operations:

1. **MANUAL**
2. **AUTOMATIC**
3. **TEST**

1 - MANUAL OPERATION

Start and stop are operated by push buttons. It is possible to manually operate the closing of the gen. set switch using its 0/I push button. All the alarms are on and operating.

2 - AUTOMATIC OPERATION

In this position the gen. set start and stop take place at "PLC parallel" control (mains failure, central test or remote start control). In this position the gen. set's access in the parallel sequence is possible, all the alarms are operating.

3 - TEST

A simulation of mains failure takes place, the gen. set therefore starts but the mains / gen. set changeover does not take place. However there would be the latter in the case the mains really failed.

The above mentioned functions are meant considering a single unit, independent from the parallel function.

THE CONTROL BOARD HAS THE FOLLOWING MAIN COMPONENT PARTS:

N° 1 microprocessor control card type Gensys fixed on the board front offering several status and alarm signallings such as:

ALARMS: *the readings are showed on an alphanumeric LCD display*

Alarm reading	***Signalling (optic-acoustic)***	***Lock***
Low lube oil pressure	Yes	Yes
High engine temperature	Yes	Yes
Low fuel lever	Yes	No
Overload	Yes	Yes
Starting failure	Yes	Yes
Emergency	Yes	Yes
Overspeed	Yes	Yes
Pre-heating failure	Yes	No
Battery undervoltage	Yes	Yes
Low radiator water level	Yes	No
Gen. set undervoltage	Yes	Yes
Maximum gen. set voltage	Yes	Yes
Minimum gen. set frequency	Yes	Yes
Maximum reactive power	Yes	To set up
Maximum active power	Yes	To set up
Non-specific alarm	Yes	To set up
Non-specific pre-alarm	Yes	To set up
Further programmable I/O	To set up	To set up

(Those are default values but all of them can be set up on request)

INSTRUMENTS: The μP card è can show, by means of an alphanumeric display, some electrical parameters such as:

Signalling reading	***Meaning***
Bus voltage	It displays the parallel bars' datum voltage (V)
Bus frequency	It displays the parallel bars' frequency (Hz)
Gen. set voltage	It displays the gen. set's voltage delivered to the three line phases (V)
Gen. set current	It displays the phase currents delivered by the gen. set (A)
Frequency	It displays the gen. set's frequency (Hz)
work hour meter	It display the running hours
Battery voltage	It displays the voltage value at the starting batteries (V)
Active power	It displays the delivered P active power value (kW)
Reactive power	It displays the delivered Q reactive power value (kVAR)

Power factor	It display the gen. set's cosφ value
Revolution number	It displays the engine's revolution number (RPM)
Engine temperature	It displays the coolant's temperature value (°C)
Lube oil pressure	It dispalys the lube oil's pressure value (bar)
Programmable	Analog values connected with programmable input parameters
Active energy	Active energy delivered (kWh)
Reactive energy	Reactive energy delivered (kVARh)

CONTROLS

Control reading	***Function***
BUZZER push button	Necessary for the acoustic device's reset in case of card alarm
ALARM RESET push button	Necessary to reset the alarm shown on the card when it is all clear
FAILURE push button	Necessary to show the occurring failures
ALARM push button	Necessary to show the occurring alarms
INFO push button	Necessary to enter the personalised menu
LED push button	Necessary to show the card LED working
CONTROL push buttons	Plant pre-setting, starting and stop control, load change-over
SURFING push buttons	Necessary for parameters' display and set-up

THE CONTROL BOARD'S FUNCTIONS ARE:

Gen. set's **automatic starting** when the parallel PLC sends the starting signal, with adjustable delay;

Gen. set's **automatic connection** to BUS when the generator reaches the steady and synchronisation parameters

Diesel engine and alternator's **automatic monitoring** by means of specific protections;

Gen. set's **automatic disconnection** from the load at mains voltage return after an adjustable delay;

Gen. set's stop after an adjustable time for the diesel engine's cooling;

Pre-setting for a new starting;

Control and protection of diesel engine pre-heating device to help the speedy starting and so the prompt power delivery.

- **Control and protection** of automatic battery charger that keeps the batteries charged during the generating set's stand-by.

CHANGEOVER:
Depending on execution or purchaser's requests, the changeover system can be added either in the same carpentry containing the automation, or in separate box or cabinet.

POWER CIRCUIT:
The power circuit of each gen. set mainly consists of a three-pole or quadripole magnetic thermal switch (according to the system), installed in the very control board or separated; it performs the alternator's protection, allows the parallel closing and the gen. set stop in case of starting.

PARALLEL COLUMN:

The management of the parallel system is entrusted to a PLC with customisable proper program and to a control panel able to interact with the parallel control system; as a matter of fact all the functions of synchronisation and load distribution are performed by the Gensys control cards..

INSTRUMENTS:
To sum up all the BUS electrical parameters, a digital multimeter installed on the door of the parallel module provides the following parameters:

- Gen.set line and phase voltage (V)
- Parallel phase currents (A)
- Active power (kW), reactive power (kVAR), apparent power (kVA)
- Parallel frequency (Hz)
- Power factor (cosfi)
- Active energy (kWh), reactive energy (kVARh), apparent energy (kVAh)

The standard configuration is equipped with a central emergency push-button to stop and lock all the running gen.sets.

MANUAL PARALLEL (optional):
The manual parallel function supplements the electric panel with a set of devices that can safely take over the synchronisation of two gen.sets at a time; the purpose of this function is to allow the semi-automatic parallel running of the gen.sets in case of PLC or automatic synchronising and load sharing system failure. The synchronising phase is left to a digital device that can measure phase, differential voltage and differential frequency and compare them with the master gen.set; only if conditions allow it (parameters within the norm and sinusoids in phase), parallel running is possible, in fact the closing push-buttons remain locked until optimal conditions are reached. The following equipment is added to the parallel module to perform manual parallel:

1. Speeder potentiometers for frequency adjustment (it helps synchronisation and allows load sharing).
2. Selectors to enable the gen.set to be synchronised.
3. Digital synchronising device.

4. Key selector to enable MANUAL PARALLEL and disable the automatic function.

TERMINAL BOX CONTACTS:

The electric board is supplied with the following terminal box contacts for the remote transfer of the following signals (max. capacity 5A)

Voltage free NO (Normally Open) contact for genset failure signal

if power changeover is not supplied, n° 1 NO contact + 1 NC contact for network changeover and n° 1 NO contact + 1 NC contact for genset changeover (capacity 10A AC1) are available on the terminal box.

voltage free NO contact for 'parallel on' signal.

Inputs for a voltage free NC contact for the emergency lock of each gen.set and a NC contact to lock the whole system are also available.

OPTIONAL EXTRAS:

The electric panel described in this document can, on request, be supplied with some accessories and functions:

X Automatic fuelling system

X Low oil level alarm

X Differential

X Text and displays in English language (French, Spanish, Dutch, German, etc)

Parallel power output breaker

X REMOTE CONTROL**:** the main states of the connected gen. sets can be remote on PC or HMI panel, as far as a 100-metre-distance, using the MODBUS protocol available on the RS485 port. by means of that port it is possible to connect a modem for remote control of all the machines connected.

I/O Modules: by means of special I/O modules with CAN protocol it is possible to increase the number of analog or digital points at main card's input or output.

CAN BUS MTU: Pre-setting for reading parameters of engine type MDEC.

POWER FACTOR CONTROLLER: managing of direct power factor control. It can interface with the main alternator manufacturers.

ENGINE SPEED GOVERNING: possibility of engine speed regulation directly by means of control card.

MIXED PARALLEL: it is possible to parallel connect other gen. sets with analog load distributors different from Gensys.

MANUAL PARALLEL: it allows the gen. sets' parallel on purpose.

X MAINS PARALLEL: in case of subsequent need of parallel connection to a mains parallel system, it is enough to complete the system with a column containing certified protections and mains managing systems without modifying the already being* plant.

DISJUNCTOR: disconnector placed on the bus to separate 2 gen.sets, if two gen.sets are to be run isolated. This function can supplement manual parallel, as it allows the load operation of both gen.sets even in the event of failure of the synchronising systems.

MARGEN CONTROL PANEL

GS PAR automatic control board features some standard characteristics and functions to help the control of the connected gen.sets:

- **GS PAR electric panel** has been designed to avoid electric power interruptions caused by the opening of the mains contactor; therefore, panel maintenance operations or the replacement of the control card/s **do not impair regular operation.**
- Additional inputs for non-standard gen.set alarms.
- An interface collecting all card signals is available on request
- During the starting phase, the master gen.set becomes the first gen.set ready to supply power: this is to avoid delays in the supply of the main loads.
- The pilot gen. set's managing is automatic.
- In case of PLC failure, it is still possible to deliver with all the machines connected.
- The submitted system can be interfaced with a network MODBUS system otherwise with the internet explorer by means of RS232.
- Maximum possibility of I/O point expansion.
- PLC function with password
- No specific software for basic programming
- Digital regulations of synchronism and distribution system
- Subsequent parallel or mains parallel connection of other gen. sets. There is no need to change the already being system*.
- The power electrical circuits and the auxiliaries are clearly segregated from each other by means of metallic barriers and diaphragms
- Each auxiliary circuit (battery charger, electronic card, voltage relay, etc.) is protect by magnetic thermal switch and/or by fuses in order to obtain selectivity inside the control board and to allow repair and service operations without putting the plant out of order;
- Wiring using conductors not smaller than 1,5 sq.mm, in accordance with CEI 20.20, AC and DC circuits identified by colour, conductors and components are referenced as denoted in the schematic drawings; fitting with crimped, insulated terminations; fireproof, flame retardant PVC trunking; modular type connection terminal box, high heat resistant, body in copper and zinc alloy with rust preventer, age retarder nickel finish.
- Supply disconnection using copper bars with rounded edges, mounted on special supporting brackets to strengthen the mechanical supports to suit possible dynamic currents.
  Connections by galvanised or stainless steel bolts and nuts and suitable anti-loosening washers. Pre-arrangement suitable for the connection cables; protections against direct touches by means of non-flame-propagating, self-extinguishing, transparent PVC panels.
- The panel has been manufactured in accordance with the requirements of CEI 17-13 EN 60439 type “ANS”; in particular, it has been subjected to applied voltage tests and thermal power dissipation calculation; a current limiter to keep short circuit current under 10kA, to be installed at the auxiliary supply input, is required.
- Emergency shutdown device according to UNI EN 418;
- Carrying out of electrical feeding breaking systems in conformity with IEC 64_8/7;
- Basic panel providing a degree of protection of IP44;
- Brust, EMC emission, temperature tests.
- Metal structure, electrophoretic coating , electrical continuity tests, resistance tests;

*With the "already being" words it is meant a control system already using Gensys. Software or hardware changes can be done to conform the system in case of specific and not standard requests.

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