DEIF A/S

Unimatic

PMS System

General Introduction

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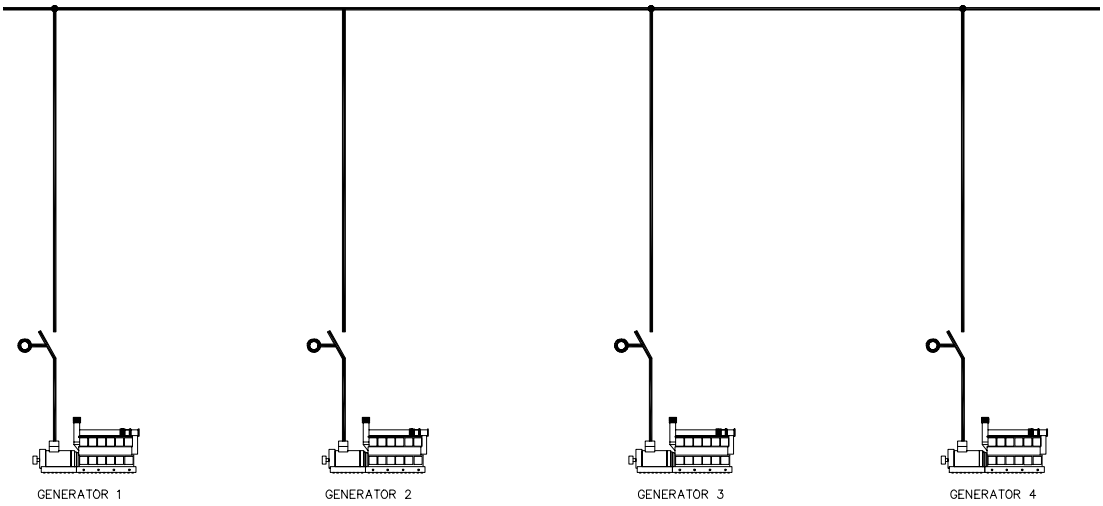

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List of Contents:

The Unimatic PMS system in general

The PMS multi-function system for control and protection of generator plants is able to combine the following functions into *one interactive system*.

- Power Management System (PMS) functions
- Control of generator set(s)
- A number of integrated protective functions
- System logic

The PMS system is able to carry out control of several generator sets within the system.

The PMS system can be delivered in 3 different basic types:

1. Control of 2 to 4 diesel generators connected to one single busbar.

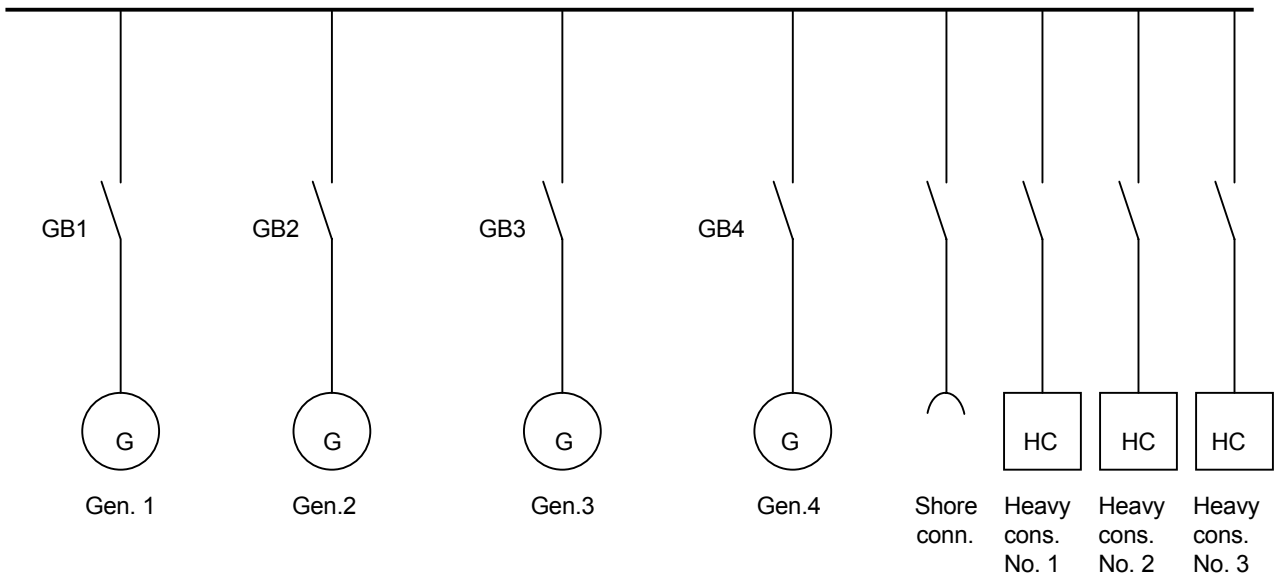
2. Control of 2 to 3 diesel generators and one shaft generator connected to one single busbar.

3. Control of 2 to 3 diesel generators and one shaft generator with diesel generators connected to a single busbar and shaft generator connected to another busbar, with tie breaker synchronizing and possibility to run heavy consumer No. 1 on the shaft generator busbar.

A brief introduction to the functionalism and operation of the PMS multi-function system is given in the following text.

1 2 to 4 generators on a single busbar

1.1 Block diagram

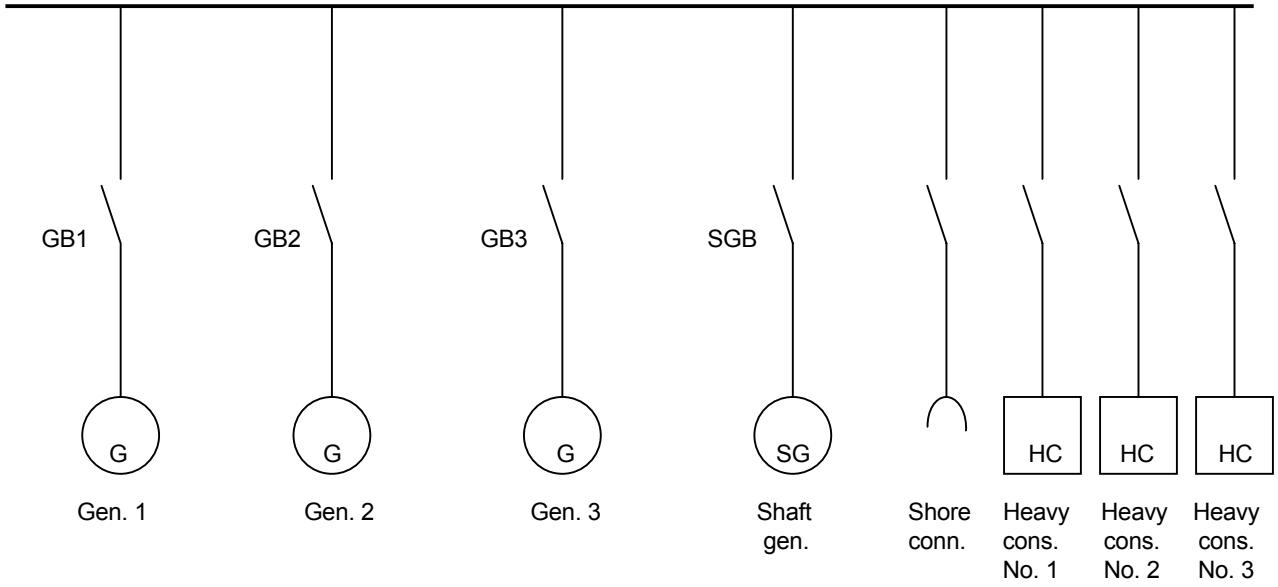


The block diagram shows the fully equipped system, i.e. the system can handle max.:

- 4 diesel generators
- 1 shore connection (supervision, not control)
- 3 heavy consumers, with start of extra generator if necessary

2 2 to 3 generators and one shaft generator on a single busbar

2.1 Block diagram

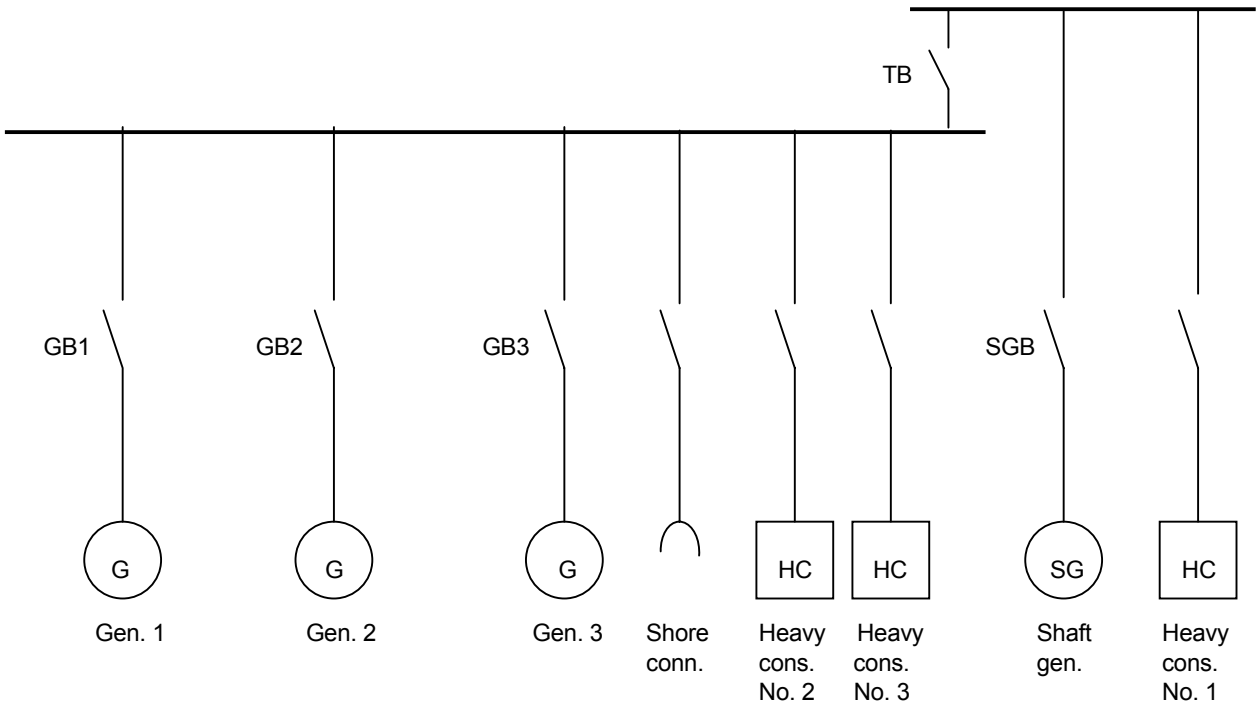


This system is very similar to the first mentioned. The only difference is the shaft generator replacing generator 4. The shaft generator cannot be controlled (frequency and voltage). This means that load-sharing between the shaft generator and the diesel generator(s) is not available.

The system will, however, carry out synchronisation and load transfer between shaft generator and diesel generator(s).

3 2 to 3 generators and one shaft generator on a split busbar

3.1 Block diagram



The equipment needed to control the above system is equal to the equipment needed for the system with the shaft generator connected directly to the busbar. The difference here is that the system controls whether the HAS-111D parallelling relay is to control the shaft generator breaker or the tie breaker.

4 The system components

Basically the PMS system consists of a number of components for control and protection of each generator, a synchronizing unit and a PLC to carry out the system logic.

The configuration of the system is dependent on the system requirements, i.e. different components may or may not be a part of the system.

4.1 Equipment for each diesel geneator

- 1 load sharing unit: LSU 113DG, loadsharing unit
  - reverse power trip function
  - de-load of generator and opening of breaker at 5% load
- 1 power transducer: TAP-210DG/3, 3-phase balanced or unbalanced load
  - Output 0..10 VDC ~ 0..100% Pnom.

- 1 overcurrent relay: RMC-132D, double 3-phase overcurrent relay
  - 1 relay for generator trip
  - 1 relay output for non essential load trip, and/or start signal to next generator at high current condition

The high current condition start of a generator may be applied in systems where the cos φ value is low (e.g. when many refrigerating containers are connected). In this case, the generators may face a high current condition without the generator power exceding the limit.

4.2 Additional equipment for a shaft generator

- 1 HAS-111DG: Parallelling relay (shaft generator synchronizer):
  - voltage check
  - frequency check
  - output to control parallel running diesel generators' frequency in order to synchronize
  - dynamic synchronization
- 1 EPN-110DN: Electronic potentiometer:
  - relay inputs
  - DC voltage output

The EPN-110DN is used to control the diesel generator(s)' power up during de-loading of the shaft generator.

4.3 Additional equipment for a bus tie breaker

The same equipment is used for a bus tie breaker as for the shaft generator, i.e. the components for a system with shaft generator only and a system with both shaft generator and bus tie breaker are the same. No additional equipment is needed for a tie breaker.

4.4 Common equipment for the PMS system:

Provided that the generators are of equal size and characteristics:

- 1 synchronizer: FAS-113DG, dynamic synchronizing of a generator
  - voltage check
  - frequency match

If the generators are of varying size, a synchronizer for each generator is recommended.

- 1 PLC:

  The PLC used is of the make OMRON.

  2 types are used:

  Type 1: CPM1A, DIN-rail mounted

  - 1 CPU unit with 24 binary inputs and 16 binary transistor outputs
  - 1 expansion unit with 12 binary inputs and 8 binary transistor outputs
  - 1 analog module with 2 analog inputs and 1 analog output (if 3 or 4 generators are present, 2 analog modules are used)

  Type 2: CQM1, DIN-rail mounted

  - 1 CPU unit with 16 binary inputs, 4 analog inputs and 2 analog outputs
  - 2 binary input modules with 16 binary inputs each
  - 2 binary transistor output modules with 16 outputs each.

For both types : All binary inputs are 24 VDC
All binary outputs are 24 VDC transistor PNP (output active is +24 VDC)
All analog inputs are 0…10 VDC
All analog outputs are 0…10 VDC or 4…20 mA

The PLC type is dependent on the plant chosen:

Plant	PLC type
2 diesel generators	1
3 diesel generators	1
4 diesel generators	2
2 diesel generators and 1 shaft generator	1
3 diesel generators and 1 shaft generator	1
2 diesel generators, 1 shaft generator and 1 bus tie breaker	1
3 diesel generators, 1 shaft generator and 1 bus tie breaker	2

For technical details, please refer to the relevant data sheets.

4.5 Optional equipment

The following may be added if needed. Note that none of the following functions are part of the standard system, and must be ordered separately.

- overcurrent relays
- over/undervoltage relays
- over/underfrequency relays
- loss of excitation relays
- var sharing units
- synchronisation with voltage control

5 The system functions

The following paragraph is an introduction of the contents of the PMS system solution.

5.1 The PMS functions

The following PMS functions are implemented in the PMS system:

- Plant modes:
  - Automatic
  - Secured (or harbour/manouvering mode)
  - Shaft generator
  - Shaft generator, split busbar
  - Manual

  Not all of the above modes may be available. This depends on the type of plant.

- Load depending start/stop function incl.:
  - transmission of PMS start/stop commands
- Load sharing:
  - symmetrical load sharing
- Conditional connection of 3 heavy consumers
- Trip of non-essential load groups in case of:
  - available power too low (signal from PLC)
  - high current at the generator set

5.2 The generator set functions

The following *Generator set functions* are implemented in the PMS system:

- GB ON sequence; dynamical synchronization of the generator set to the busbar
  - adjustable dynamical synchronization parameters (concerning voltage and frequency)
  - supervision of positive sequential order of phase before synchronization
  - supervision of generator voltage and frequency before synchronization
  - adjustable closing time for the breaker
- Generator set load control
  - load-sharing
- Generator set de-load control
  - de-loading of generator and opening of breaker before stop of diesel
- Generator protection:
  - over-current, I> (two step protection)
  - reverse power, -P> (protection)

5.3 The shaft generator set functions

(Only if a shaft generator is part of the system)

- GB ON sequence; dynamical synchronization of the shaft generator to the busbar
  - adjustable dynamical synchronization parameters (concerning voltage and frequency)
  - supervision of positive sequential order of phase before synchronization
  - supervision of generator voltage and frequency before synchronization
  - adjustable closing time for the breaker
- Short-time parallel
  - transfer of load to/from shaft generator
- Generator set de-load control
  - de-loading of generator and opening of breaker
- Generator protection:
  - over-current, I> (two step protection)
  - reverse power, -P> (protection)

5.4 The tie breaker functions

(Only if a tie breaker is part of the system)

- TB ON sequence; dynamical synchronization of the two busbars
  - adjustable dynamical synchronization parameters (concerning voltage and frequency)
  - supervision of positive sequential order of phase before synchronization
  - supervision of voltage and frequency before synchronization
  - adjustable closing time for the breaker
- Short-time parallel
  - transfer of load to/from shaft generator
- Generator set de-load control
  - de-loading of generator and opening of breaker

6 The System Power and Available Power

The PLC measures the system total power via power measurement on each generator.

For example:

If a system consists of 3 generators, $P_{nom.}$ = 100 kW each:

- If one generator is running, system total power equals 0…100 kW
- If 2 generators are running, system total power equals 0…200 kW
- If 3 generators are running, system total power equals 0…300 kW

From the above it can be seen that generators of varying size may be used.

For calculation of the available power, each generator is equipped with an input for "generator breaker (GB) closed".

The equation for available power is:

- The value of "G1" is 0 for GB1 open and 1 for GB1 closed
- The value of "G2" is 0 for GB2 open and 1 for GB2 closed
- The value of "G3" is 0 for GB3 open and 1 for GB3 closed
- The value of "Gn" is 0 for GBn open and 1 for GBn closed

where n is the maximum numbers of generators in the plant.

If

P_{max} = (($P_{nom.}$(Gen.1)) x G1) + (($P_{nom.}$(Gen.2)) x G2) + ... + (($P_{nom.}$(Gen.n)) x Gn) kW

and

P_{tot} = P_{actual}(Gen.1) + P_{actual}(Gen.2) + P_{actual}(Gen.n) kW

then

P_{avail} = P_{max} - P_{tot} kW

The available power value is used for calculation of:

- Load dependent start and stop of generators
- Blocking of heavy consumers
- Non essential load (NEL) trip

The value of available power is sent to the analog output, which can be used to drive an instrument and/or other limit switches.

Errors and changes excepted.