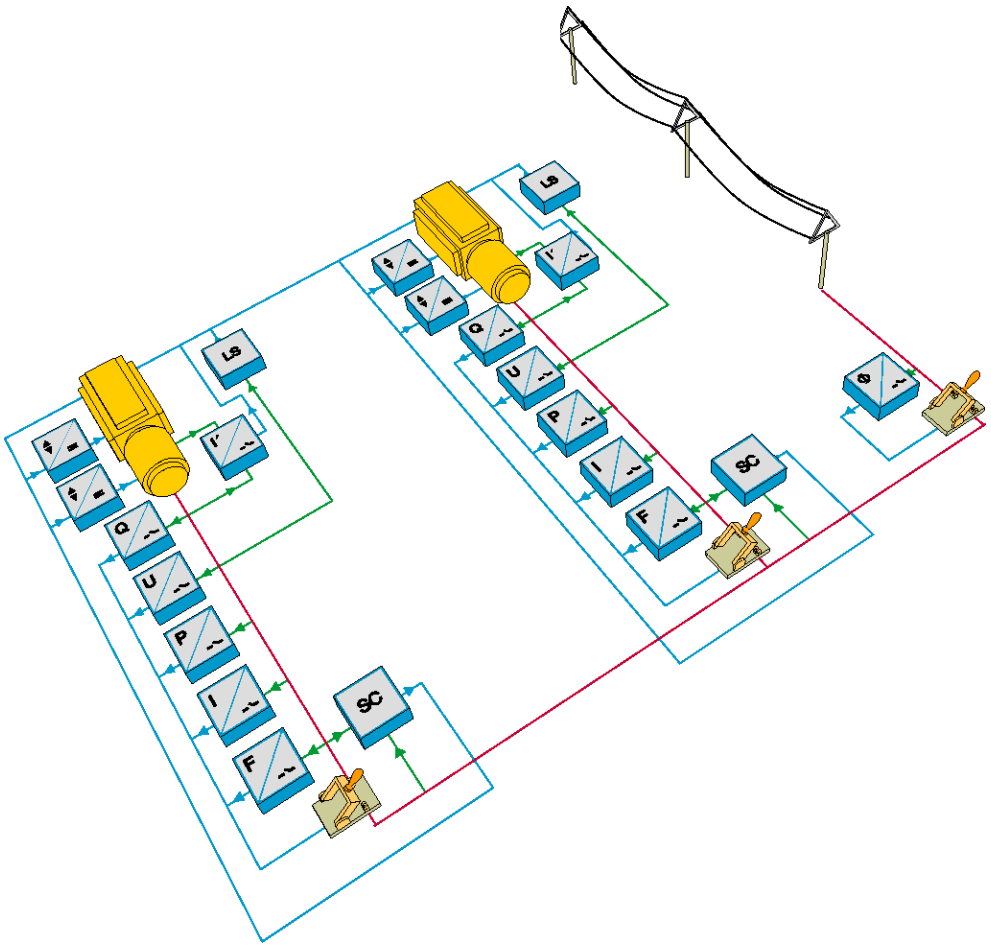
DEIF A/S

Uni-line

4189340150K



Application notes

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1 Warnings and legal information

This paper gives guidelines to installation of the DEIF Uni-line generator control and protection units. It is, however, not a complete installation instruction. Therefore, even if terminal numbers are shown in the drawings, the drawings are to be used as guidance only.

Installing and operating the Uni-line products implies work with dangerous currents and voltages, and therefore it should be done by qualified personal only.

DEIF takes no responsibility for operation or installation of the generator set. If there is any doubt about how to install or operate the system on which the Uni-line products are measuring, the company responsible for installation or operation must be contacted.

2 General description

2.1 Introduction

The DEIF Uni-line units for protection and control of diesel generators and turbine generators can be combined to achieve systems with highly different characteristics.

In the following, a number of applications using the DEIF Uni-line products are shown. The reader should notice that application is a dynamic piece of work; therefore in the future this handbook will be updated from time to time with new applications.

The Uni-line products are divided into two groups. A group of protection relays and a group of control units. This first release of this application handbook will not contain any applications regarding the protection relays, but concentrate on applications based on the control units.

The protection relays in the Uni-line series:

RMV-112D:	Undervoltage/overvoltage protection
RMV-122D:	Overvoltage protection
RMV-132D:	Undervoltage protection
RMV-142D:	Undervoltage/overvoltage protection
RMC-111D:	Short circuit relay
RMC-122D:	Overcurrent and short circuit relay
RMC-131D:	Differential current relay
RMC-132D:	Dual overcurrent relay
RMP-111D:	Overload relay
RMP-112D:	Overload/reverse power relay
RMP-121D:	Reverse power relay
RMQ-111D:	Loss of excitation relay
RMQ-121D:	Overexcitation relay
RMF-112D:	Frequency relay
LMR-111D:	Loss of mains relay

The control units in the Uni-line series:

FAS-113DG: Synchroniser with voltage control
FAS-115DG: Synchroniser with voltage matching
HAS-111DG: Paralleling relay
EPN-110DN: Electronic potentiometer
LSU-112DG: Load sharer unit with built-in power and frequency transducer
LSU-113DG: As LSU-112DG + outputs for low power detection and reverse power protection
LSU-114DG: As LSU-112DG + outputs for automatic start and stop
LSU-122DG: Load sharer unit with built-in reactive power transducer, for VAr sharing.

3 Protection of generators

This information will be included in the next version of this handbook. In the meantime, please use the information in the below data sheets:

		Data sheet
RMF-112D	Frequency protection	4921240098
RMV-112D	Undervoltage/overvoltage protection relay	4921240096
RMV-122D	Overvoltage protection relay with 2 setpoints	4921240096
RMV-132D	Undervoltage protection relay with 2 setpoints	4921240096
RMV-142D	Undervoltage/overvoltage protection relay for single phase	4921240128
RMC-111D	Short circuit protection relay	4921240102
RMC-122D	Overcurrent protection relay	4921240102
RMC-131D	Differential current protection relay	4921240104
RMC-132D	Dual overcurrent relay	4921240102
RMP-111D	Overload protection relay	4921240108
RMP-112D	Overload/reverse power protection relay	4921240110
RMP-121D	Reverse power protection relay	4921240106
RMQ-111D	Loss of excitation protection relay	4921240112
RMQ-121D	Overexcitation relay	4921240112
LMR-111D	Loss of mains protection relay (vector shift)	4921240100
FAS-113DG	Synchroniser	4921240114
FAS-115DG	Synchroniser	4921240116
HAS-111DG	Paralleling relay	4921240144
EPN-110DN	Electronic potentiometer	4921240126
LSU-112DG	Load sharing unit	4921240118
LSU-113DG	Load sharing unit	4921240120
LSU-114DG	Load sharing unit	4921240122
LSU-122DG	VAr load sharing unit	4921240124

4 Applications for island operation

4.1 General information

Control of speed governor
If the prime mover is provided with a mechanical speed governor, this must be equipped with a pilot motor ("PM") for manual/automatic remote control of the prime mover. The 2 relay outputs from the load share unit (LSU-11xDG) may then in conjunction with a supply voltage for the "PM" control the mechanical speed governor.

If the prime mover is provided with an electronic speed governor, an "electronic potentiometer" (EPN-110DN) is applied to manual/automatic remote control of the diesel engine. The 2 relay outputs from the LSU-11xDG can then control the electronic speed governor through the EPN-110DN.

Re EPN-110DN: Ref.: Data sheet no. 4921240126.

Adjustment of speed governors
Mechanical/electronic speed governors must ALWAYS be adjusted to an INTERNAL speed droop, irrespective the control mode is isochronous mode, to ensure stability at manual as well as automatic control! A speed droop of 4% is the rule-of-thumb setting.

Connection of the LSU-11xDG
The generator voltage input (terminals 24 and 26) is connected by means of a normally open auxiliary contact of the generator circuit breaker. This connection will disable the LSU-11xDG's incr. and decr. output relays when the generator breaker is open. The same is also possible by disconnecting the aux. supply to the unit by means of the auxiliary contact of the generator circuit breaker.

Load sharing
All the applications in this handbook are for isochronous mode. The "old" speed droop mode is not possible using the LSU-11xDG.

Isochronous mode
The term "Isochronous" refers to load independent frequency control, i.e. the frequency is kept constant at 50/60Hz at 0...100% load.

Do not be confused, the speed droop setting on the governor is still necessary to make sure the LSU-11xDG is able to do its job - load sharing and frequency control.

Connection of the FAS-11xDG
The generator voltage input (terminals 29 and 31) is connected by means of a normally closed auxiliary contact of the generator circuit breaker. This connection will disable the FAS-11xDG incr. and decr. output relays when the generator breaker is closed. This is also possible by disconnecting the aux. supply to the unit by means of the auxiliary contact of the generator circuit breaker.

Special function for all FAS-units
The FAS-units are activated when the busbar voltage is >80% of Unom. and the generator voltage is >60% of Unom.

Special function for all LSU-units
The LSU-units are activated when the generator voltage is >60% of Unom.

4.2 Normal load sharing

Ref.: Data sheets nos. 4921240114 and 4921240118.

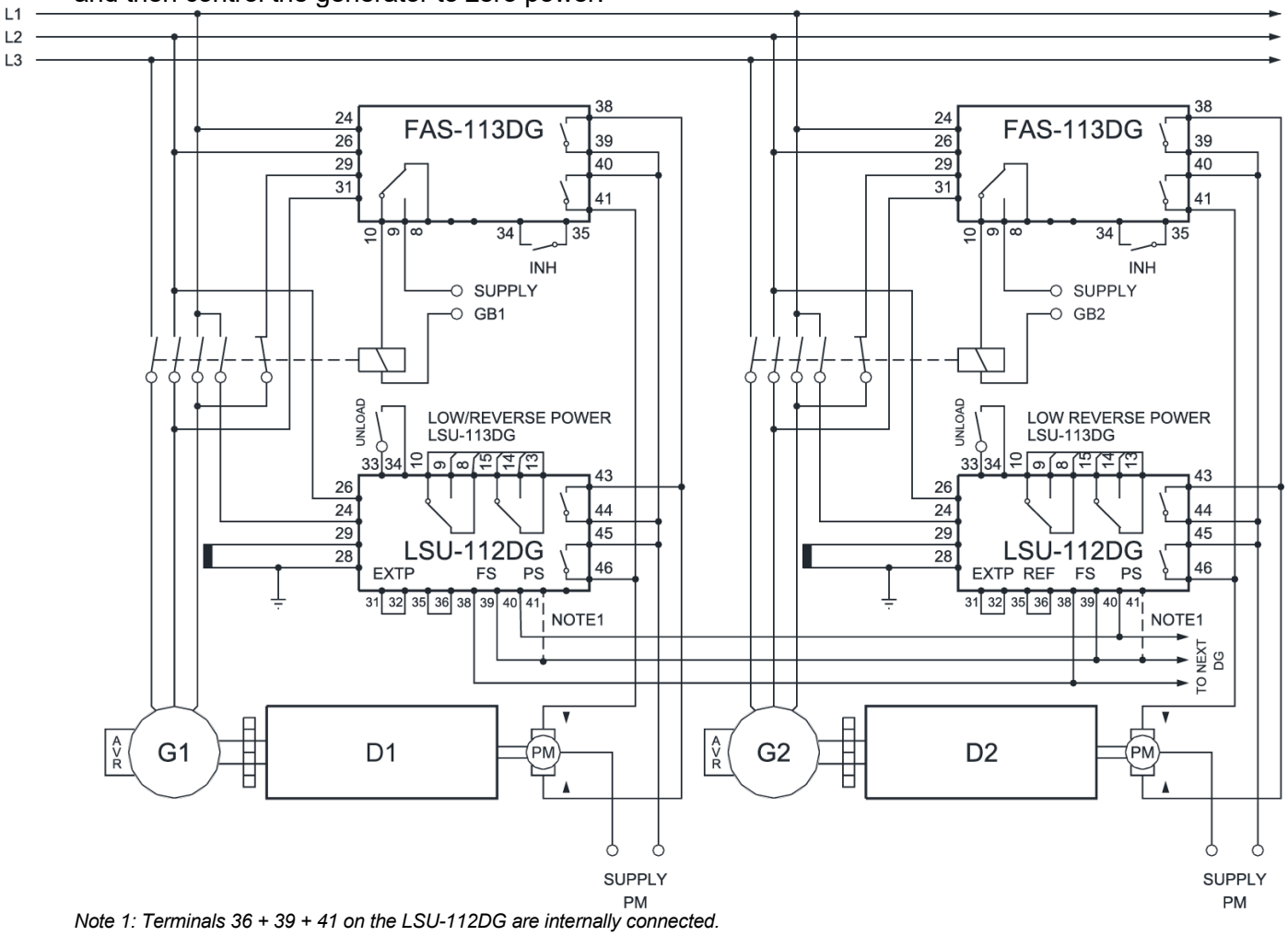
After start of DG1 the FAS-113DG is activated (when the generator voltage exceeds 60% of Unom). The FAS-113DG will control the speed governor towards the set slip frequency (set on potentiometer "FREQ"). When the generator frequency is inside the accept band (±90% of the value set on the FREQ potentiometer) the FAS-113DG will calculate the "correct sync. pulse transmit" according to the breaker closing time and the actual slip frequency.

The contact "INH" is for testing purposes. The "INH" contact will disable the sync. relay pulse, but the LED on the front will indicate the sync. pulse transmits.

After closing of generator circuit breaker, the aux. contact will disable the synchroniser. At the same time the LSU-112DG is activated. The LSU-112DG will connect itself to the common FS line (common frequency control) and the common PS line (common power share line), this is done by internal relay contacts. When only one DG is connected to the busbar, the LSU-112DG will control the frequency according to the setpoint on the LSU-112DG (potentiometer "FREQ").

After DG2 is started and connected to the busbar, the two LSU-112DG's will control the generators to share the load equally in percentages of the active load, according to the size of the generators.

If the showed contact "UNLOAD" is activated, the LSU-112DG will disconnect itself from the PS line, and then control the generator to zero power.



Note 1: Terminals 36 + 39 + 41 on the LSU-112DG are internally connected.

Application for mechanical governors synchronisation and normal load sharing of two or more DGs.

4.3 Master-slave load sharing

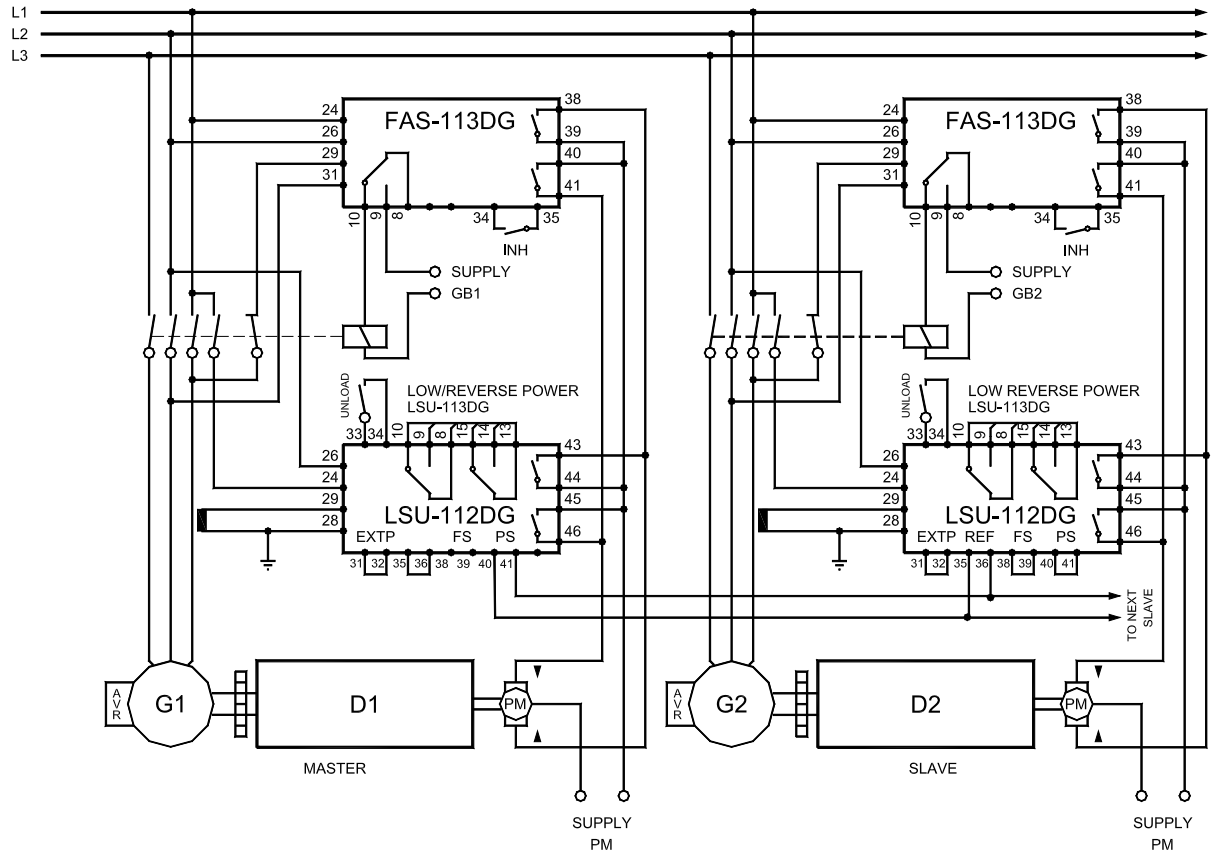
Ref.: Data sheets nos. 4921240114 and 4921240118.

In the first application (normal load sharing) the frequency setting was done on every one of the LSU units in the generator plant. Meaning, if the setting was done differently on every LSU-112DG, the frequency will be the average value of all the settings on the activated LSU units.

To overcome this, a very careful setting was necessary on every LSU-112DG in the generator plant.

Another way to obtain equal frequency control is to connect the LSU-112DG's in the MASTER-SLAVE mode. The below diagramme shows how to connect the LSU units. The FS line is left open for the MASTER unit and the FS line is short circuit on the SLAVE unit. The short circuit across the FS line (terminals 38 and 39) will disable the frequency control in the LSU-112DG. The frequency is set and controlled by the MASTER unit only. The PS line from the MASTER unit is connected to the REF input on the SLAVE unit. This connection will control the SLAVE unit to the same power value as the MASTER (in percentages of the total load and the size of the generators).

The MASTER-SLAVE mode is not a good solution if the generators are connected in a MASTER-STANDBY configuration with standby selector. In this case NORMAL LOAD SHARE mode is recommended.

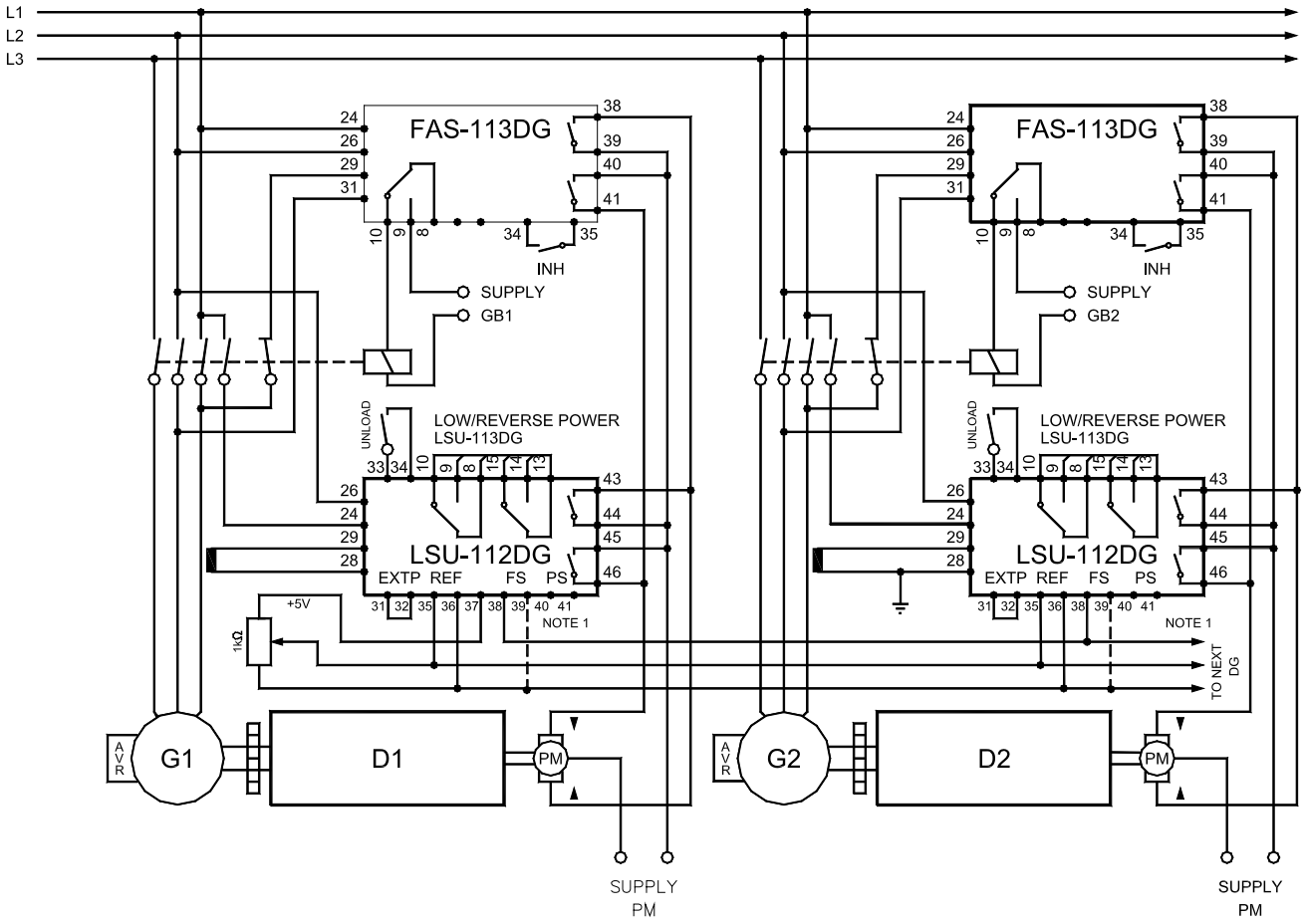


Application for mechanical governors synchronisation and master/slave load sharing of two or more DGs.

4.4 Fixed load to busbar with load sharing - frequency control

Ref.: Data sheets nos. 4921240114 and 4921240118.

This application shows how to connect the LSU units in FIXED LOAD MODE with FREQUENCY CONTROL. This mode can be used for running two or more of the generators in an island in BASE LOAD MODE. By means of the 1kOhm potentiometer, the two generators are controlled to deliver a fixed load to the busbar. The supply for the potentiometer is taken from one of the LSU-112DG. The regulation range is from 10% to 100% of Pnom (voltage measured on the potentiometer wiper 0.5...5V DC). Below 0.5V (10%) the generator is only partly controlled by the LSU-112DG. The common FS line does the frequency control, but the load sharing between the generators will drift. If the situation (input to REF input <0.5V DC) can occur, it is recommended to connect all the LSU-112DG's PS line (terminal 40) together (common power share line). This power share line will force the LSU-112DG's to go into NORMAL LOAD SHARE MODE. In this situation only generators connected to this common power share line must be connected to the busbar.



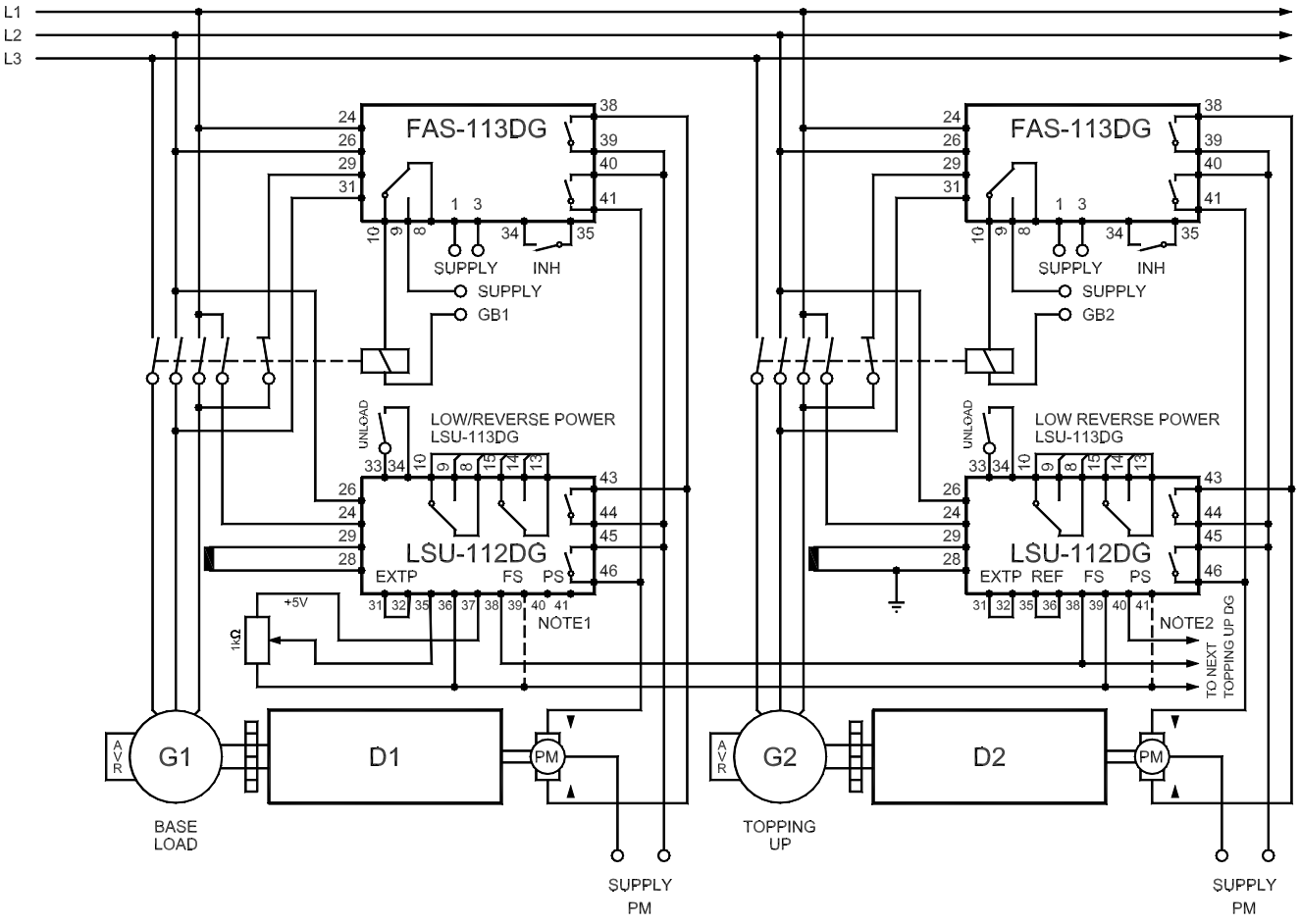
Note 1: Terminals 36 + 39 on the LSU-112DG are internally connected.

Application for mechanical governors synchronisation and fixed load to busbar with load sharing and frequency control.

4.5 Load sharing with base load and topping up

Ref.: Data sheets nos. 4921240114 and 4921240118.

In this application, DG1 is connected in FIXED LOAD MODE and the others (only one shown) are connected in NORMAL LOAD SHARE MODE. The "REF" input (DG1) on the LSU-11xDG is connected to a voltage between 0.5...5V DC. This voltage will control the LSU-11xDG - and the prime mover - to deliver 10...100% of Pnom. This input voltage can be connected as shown in this application or it can come from any external control unit able to deliver a control voltage between 0.5...5V DC. If the voltage drops below 0.5V the prime mover is no longer controlled by the LSU-11xDG. If this situation can occur (voltage drops below 0.5V DC on "REF" input), there are three ways to prevent this uncontrolled situation. If the "PS" line is short-circuit (terminal 40 and 41), the LSU-11xDG will control the prime mover to zero power. If the "PS" line is connected to the other LSU-11xDG in the plant (system), the LSU-11xDG will be forced into NORMAL LOAD SHARE MODE together with the other LSU-11xDG's in the plant. A third method is to close the switch marked "UNLOAD". This will also force the LSU-11xDG to control the prime mover to zero power.



Note 1: Terminals 36 + 39 are internally connected.
Note 2: Terminals 39 + 41 are internally connected.

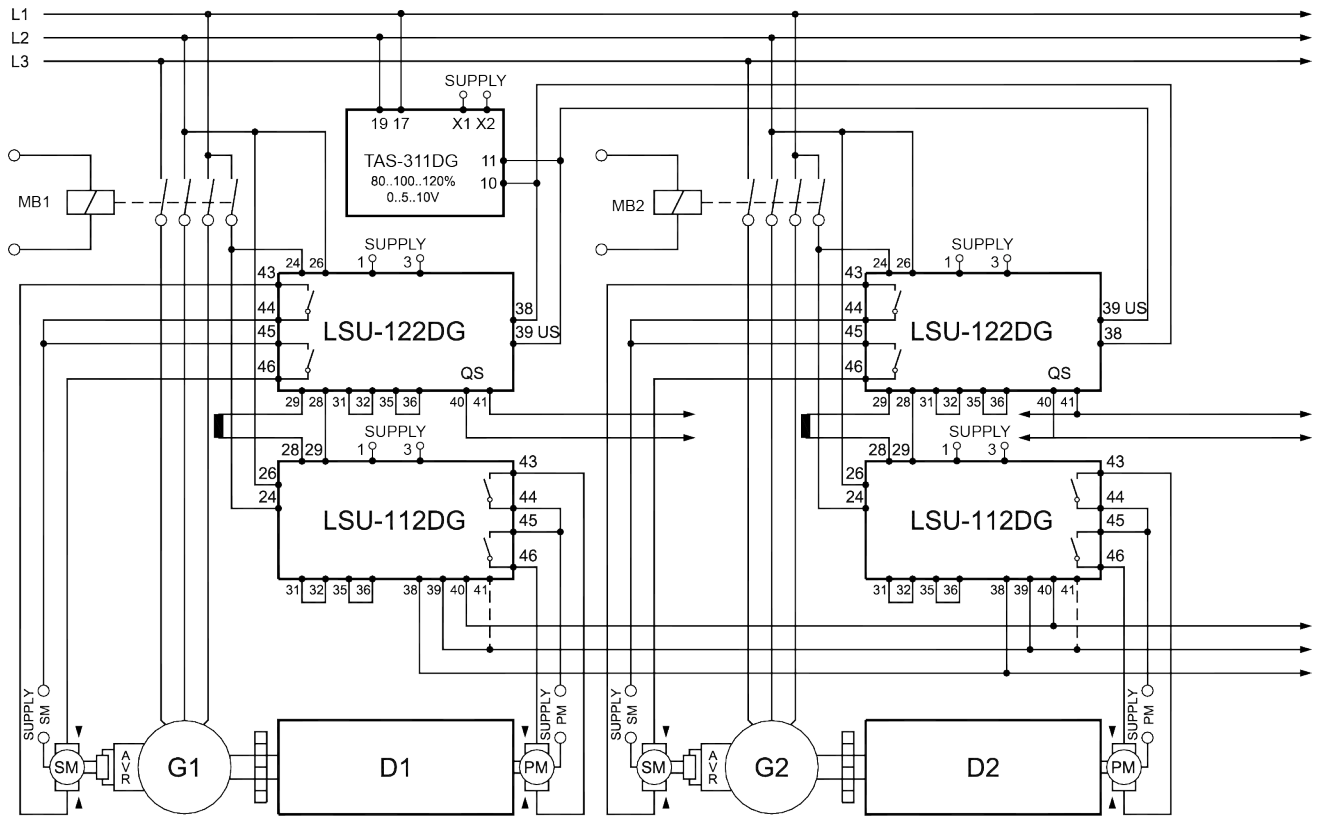
Application for mechanical governors synchronisation and load sharing with base load and topping up.

4.6 Normal active load sharing and normal reactive load sharing

Ref.: Data sheets nos. 4921240118 and 4921240124.

The LSU-112DG's control the prime movers in NORMAL LOAD SHARE MODE. The LSU-122DG likewise controls the AVRs in NORMAL REACTIVE LOAD SHARE MODE.

It is necessary to connect a common voltage transducer to the "US" line on the LSU-122DGs, because these units do not have a built-in voltage transducer. The LSU-112DG for ACTIVE LOAD SHARING, however, has a built-in frequency transducer. Please notice that the TAS-311DG voltage transducer is common for all the LSU-122DGs in the plant (system). The LSU-122DG is provided with a built-in reactive power transducer, implying that the unit in conjunction with the external voltage transducer can carry out an automatic sharing of the reactive load plus control of the system voltage. The relay output contacts from the LSU-122DG is connected to the AVR by means of a motor potentiometer or by means of DEIF electronic potentiometer type EPN-110DN.

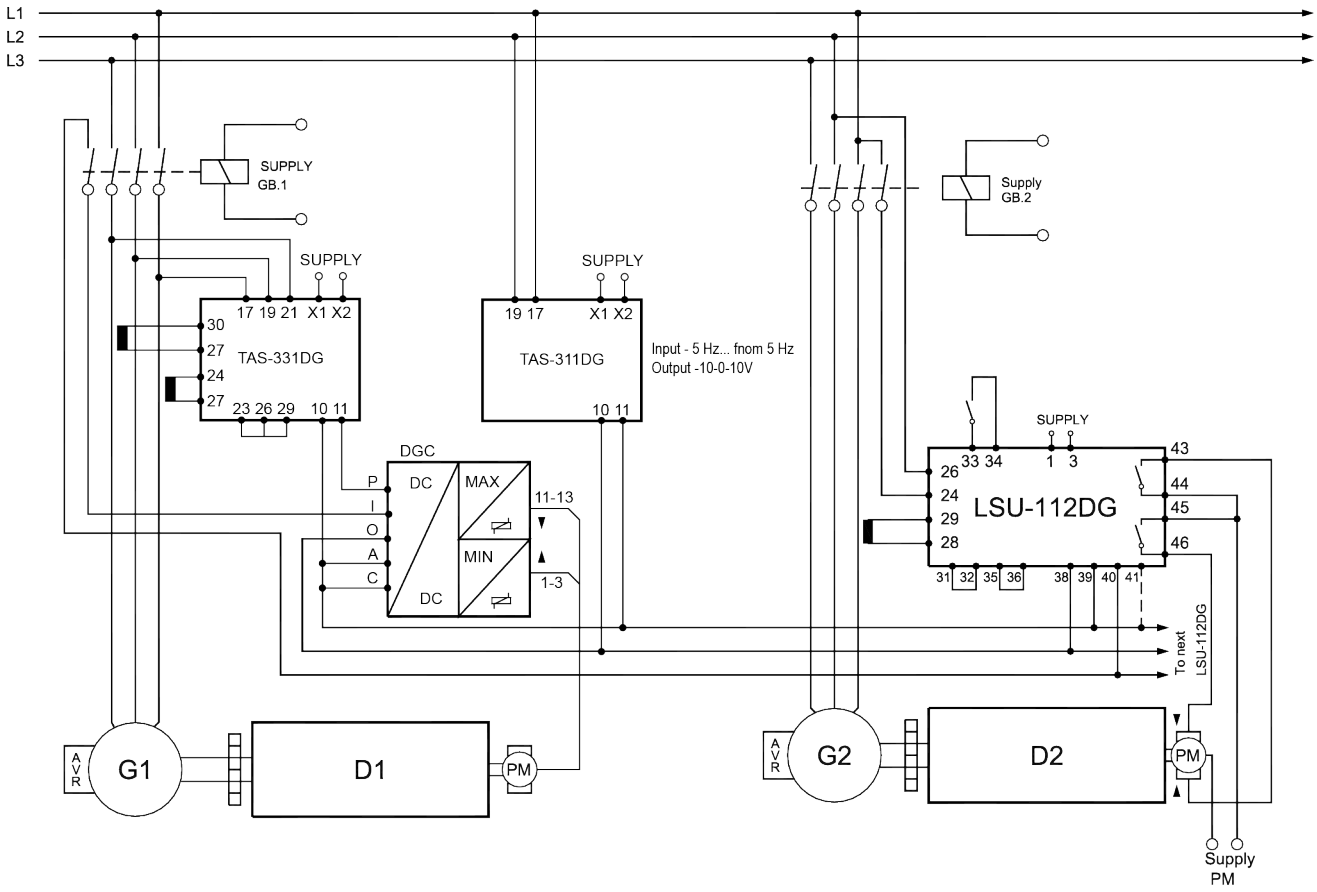


Application for mechanical governors and motor potentiometer controlled AVRs.
Normal active load sharing. Normal reactive load sharing.

4.7 Load sharing between LSU unit and DGC-1 (old model) load sharer

It is possible to have a LSU unit carry out load sharing with a DGC-1 unit. This may be the case if a new generator is to be paralleled with an existing one.

Due to the fact that the internal impedances of the units are dissimilar, a slight unbalance in the load sharing (max. 5%) must be expected. If this is not acceptable, DEIF can make a special adaption of the LSU unit in order to overcome the differences in impedance. Please call DEIF for further details.



Normal load sharing using the DGC-ITF (ITB) together with the LSU-112DG.

5 Application for generators running parallel with mains or shaft generator

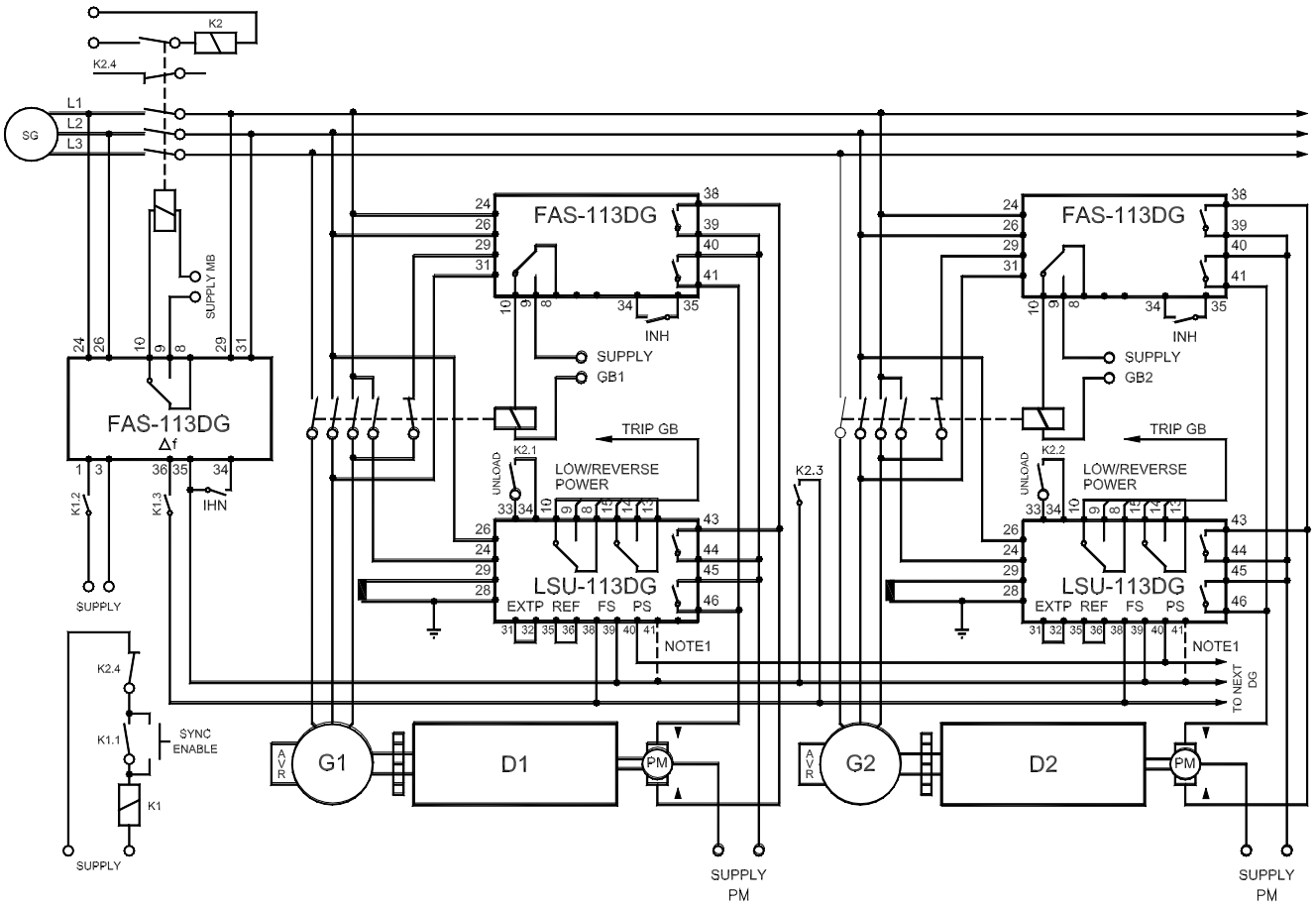
5.1 General information

Seen from a control point of view, a mains network is very similar to a shaft generator. It is a power supply unit running a fixed frequency and voltage, of which we do not have any control. One method is to synchronise the generator island to the mains and then transfer the load and stop the generators. Another method is to control the generators to deliver a fixed power to the mains.

5.2 Synchronisation of a shaft generator using FAS-113DG

Ref.: Data sheets nos. 4921240114 and 4921240120.

In this application the generator island is synchronised to the shaft generator and unloaded. Please notice the contact marked K2.3. When this contact is closed (after synchronisation) the frequency control is cancelled. During synchronisation the analogue frequency output (terminals 35 and 36) from the FAS-113DG controls the frequency on the generator island so that it fits the frequency on the shaft generator. When the relay marked K1 is deactivated and the relay marked K2 is activated, the FAS-113DG is disconnected and the LSU-113DGs start controlling the generators to zero power. When the power from each generator drops below 5% of Pnom, the relay contacts "LOW POWER" (built in the LSU-113DG) will transmit a trip signal to the breakers.



Note 1: Terminals 36 + 39 + 41 on the LSU-113DG are internally connected.

Application for synchronisation of a generator set to shaft generator with unload of generators and tripping of breakers.

5.3 Synchronisation of a generator set to a shaft generator with subsequent transfer of load from shaft generator to the generator set

The shaft generator is running and the breaker (SGB) is closed.

The switch SGB.2 is closed (short circuit of the PS line). This means that the LSU-113DGs will regulate the diesel generators to 0 load. Likewise the switch SGB.1 is closed, so that the frequency control is disabled on G1 and G2.

G1 and G2 are started (not shown) and the two FAS-113DGs will synchronise G1 and G2 according to the frequency and phase of the shaft generator, whereupon they will send out a synchronised signal to their respective breakers (not necessarily at the same time).

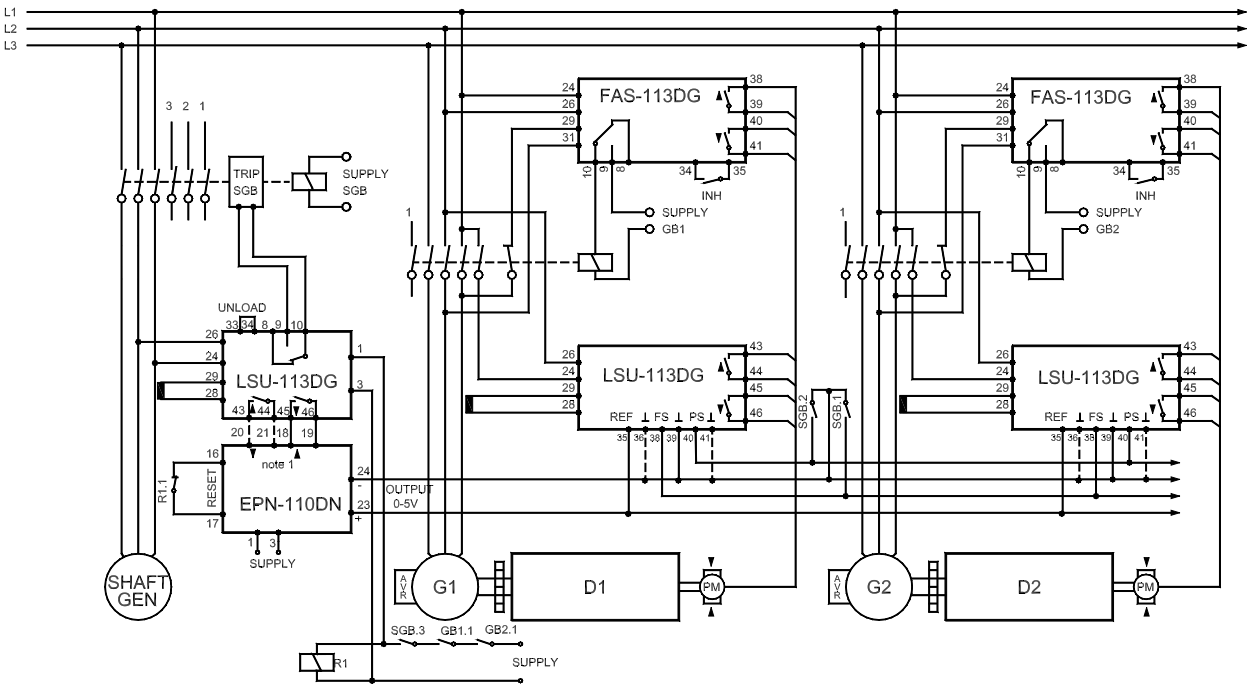
The generator breakers shut down, thus activating the switches GB.1.1 and GB.2.1, whereupon the LSU-113DG (connected to the shaft generator) and the relay R1 are activated. The switch R1.1 opens, thereby cancelling RESET of EPN-110DN.

LSU-113DG will now regulate the shaft generator to 0 load. This is done by transferring the information from LSU-113DG to EPN-110DN whose output will control the REF entries on the LSU-113DGs of the diesel generators, until the LSU-113DG connected to the shaft generator trips SGB at P<5% load.

The load is now transferred from the shaft generator to G1 and G2.

When the SGB is opened, EPN-110DN is reset and the supply to LSU-113DG is disconnected via SGB.3. The switches SGB.1 and SGB.2 are opened, whereupon the frequency regulation and load dispatching of G1 and G2 are taken over by the two LSUs connected to G1 and G2.

The application for return synchronisation and load transfer from the diesel generators to the shaft generator is not shown (see application for synchronisation of a generator set to a shaft generator with subsequent UNLOAD of diesel generators).



Application for synchronisation of a shaft generator to a generator set with load transfer.

5.4 Synchronisation of a bus tie breaker with unload of generators and tripping of breakers

Ref.: Data sheets nos. 4921240144 and 4921240120.

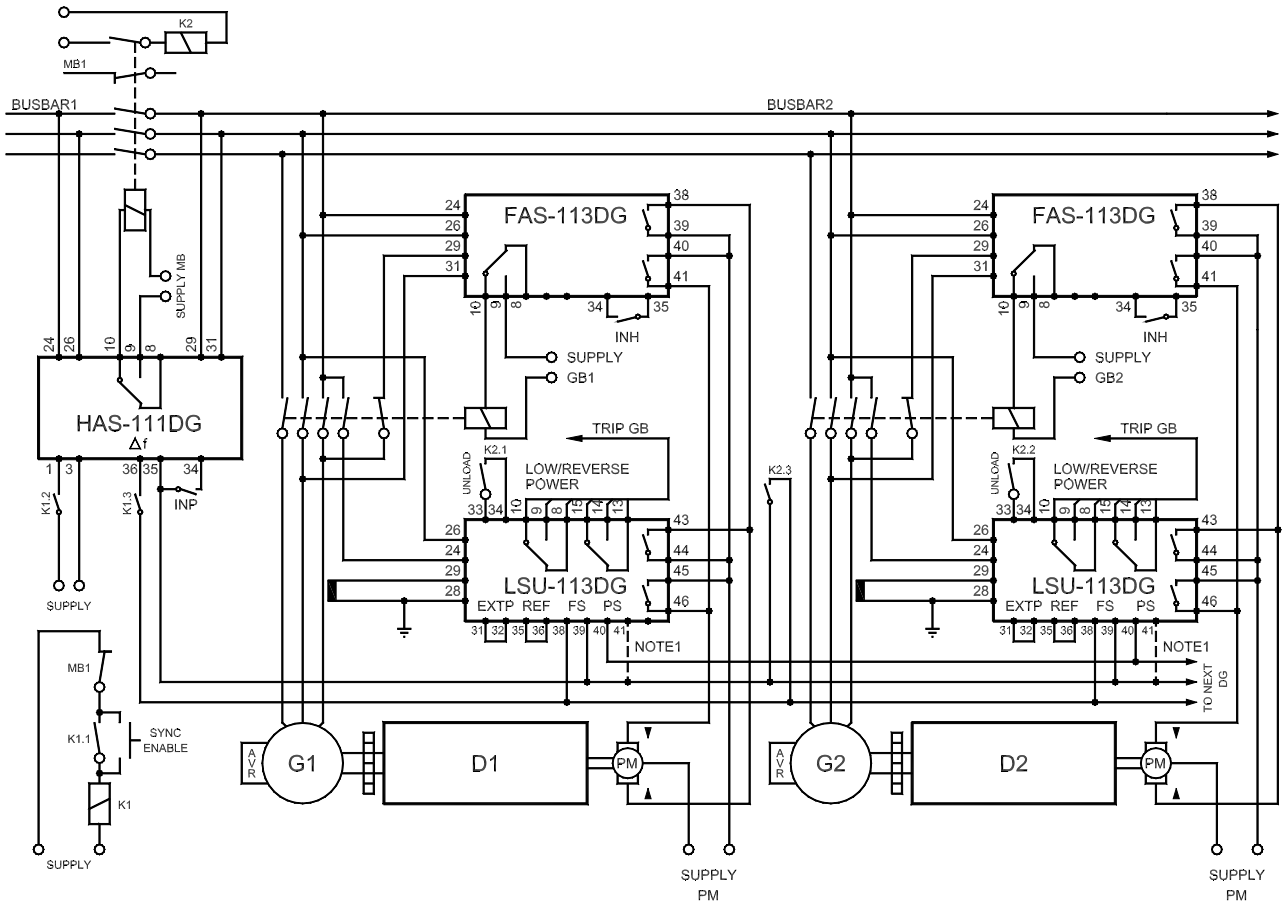
This application is very similar to the one described in paragraph 5.2 (shaft generator). Refer to this for further information.

The HAS-111DG can be selected if the diesel generators are to run slightly faster or slightly slower than the desired frequency during synchronisation. The reason is:

If the major (or all) load is connected to busbar 1 (see drawing) it is preferable to have the diesel generators on busbar 2 run slightly overfrequency compared to busbar 1, in order for them to take some load immediately to prevent reverse power. In this case the contact “INP” on the HAS-111DG must be OPEN.

If the major (or all) load is connected to busbar 2, it is preferable to have the diesel generators on busbar 2 run slightly underfrequency compared to busbar 1 in order for the generator(s) on busbar 1 to take load immediately to prevent reverse power. In this case, the contact “INP” on the HAS-111DG must be CLOSED.

NOTE: If the “unload” is not desired (parallel running of busbar 1 and 2), disable relay K2. In this case a switching to load sharing (busbar 1/2) or base load (D1 + D2) must be carried out. This is not shown in the diagram.



Note 1: Terminals 36 + 39 + 41 on the LSU-113DG are internally connected.
Application for synchronisation of a bus tie breaker with unload of generators and tripping of breakers.

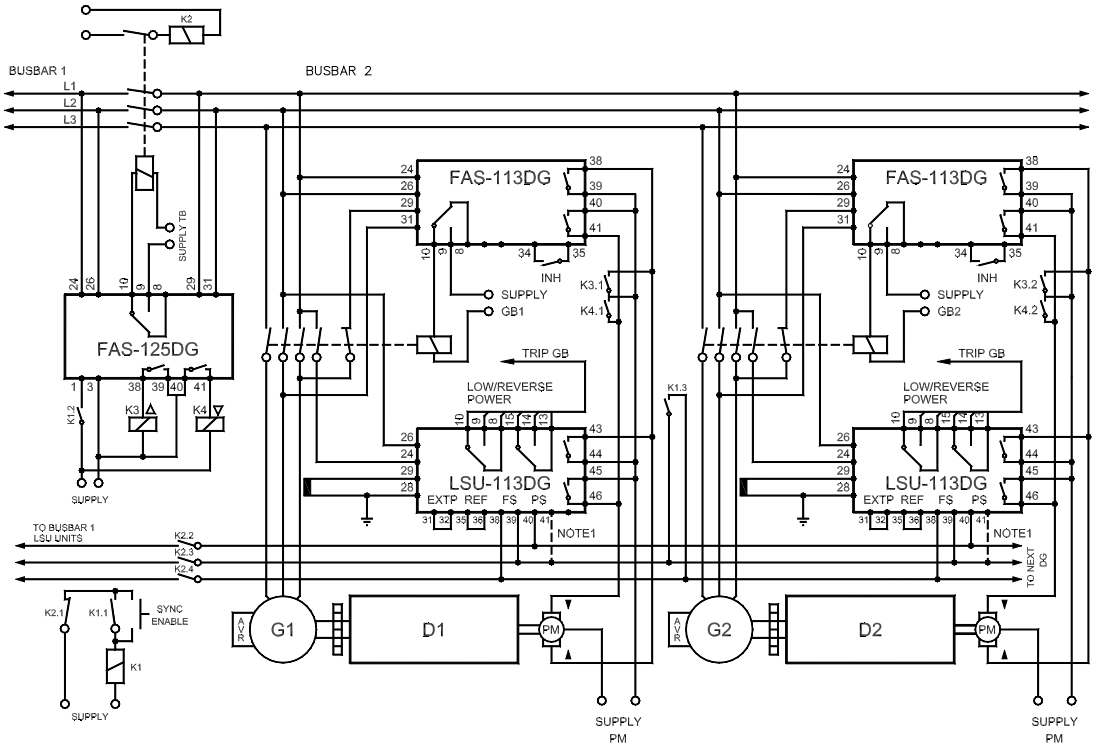
5.5 Synchronisation of a busbar tie breaker and subsequent load sharing

When synchronising bus tie breakers (when generator systems are running in “split busbar”) it is best for the stability of the systems if there is no load transfer across the tie breaker at the closing point.

This means that dynamic synchronisation is to be avoided, as the nature of this is that there is load transfer right after synchronisation.

FAS-125DG (obsolete)

This application was previously made with an FAS-125DG according to below diagramme.



Note 1: Terminals 36 + 39 + 41 on the LSU-113DG are internally connected.

Since the FAS-125DG is obsolete, it is now recommended to use the HAS-111DG for this type of application.

HAS-111DG

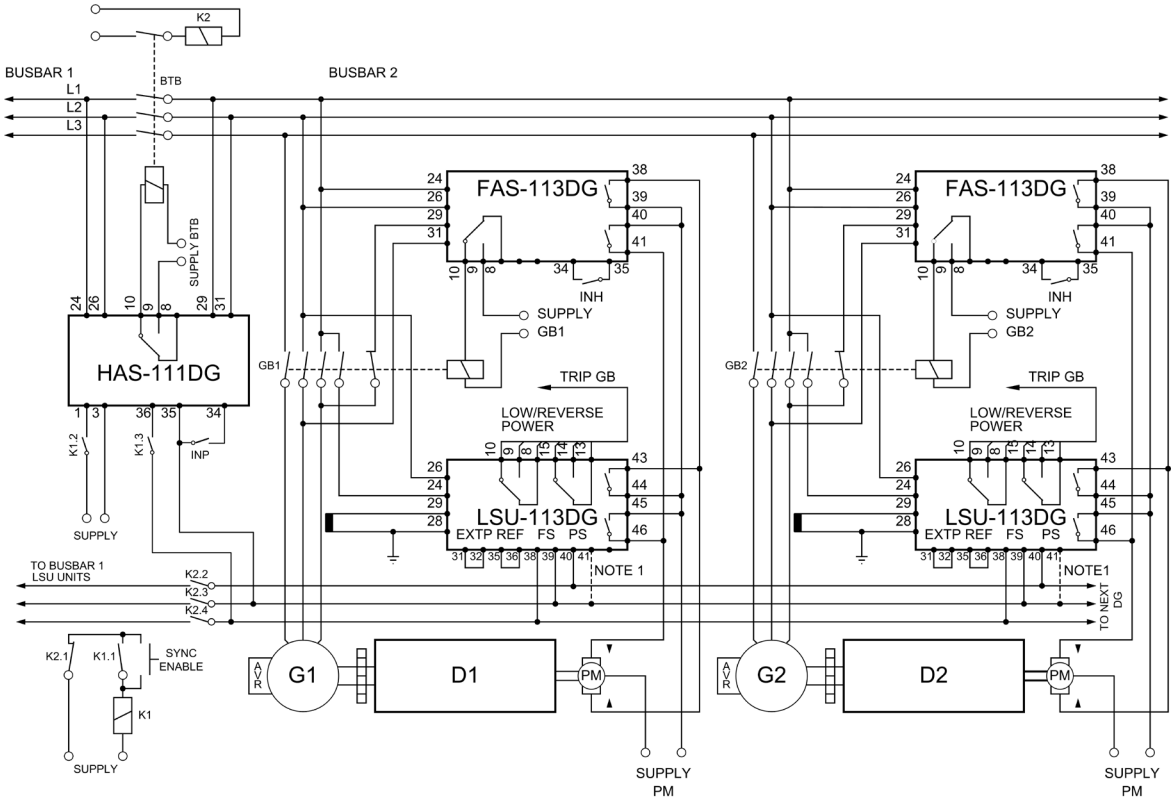
The drawing below shows a system with 2 generators connected to busbar 2. Assuming that generators are also connected to busbar 1, a static synchronisation of the bus tie breaker (BTB) is preferred.
The HAS-111DG is a static synchroniser. This means that the generators of busbar 2 will be synchronised with busbar 1 and kept inside a defined phase angle and slip frequency before closing the breaker.

The relay K1 enables the synchronisation by powering the HAS-111DG and connecting the Δf-output to the FS-line between the LSU units. The LSU frequency control is hereby given an offset equal to the frequency deviation between busbar 1 and 2. Because of this offset, the LSU units will adjust the frequency of busbar 2 up or down until sychronism is obtained and the bus tie breaker (BTB) is closed.

Once the bus tie breaker is closed, relay K1 will deactivate and the HAS-111DG is disabled. Furthermore, relay K2 will connect the load sharing lines to the busbar 1 LSU units. Busbar 1 and 2

are now synchronised and load sharing between all running generators takes place.

During synchronisation, the LSU units are still performing load sharing. This means that the LSU units will carry out active power load sharing and frequency control but with a frequency offset from the HAS-111DG.

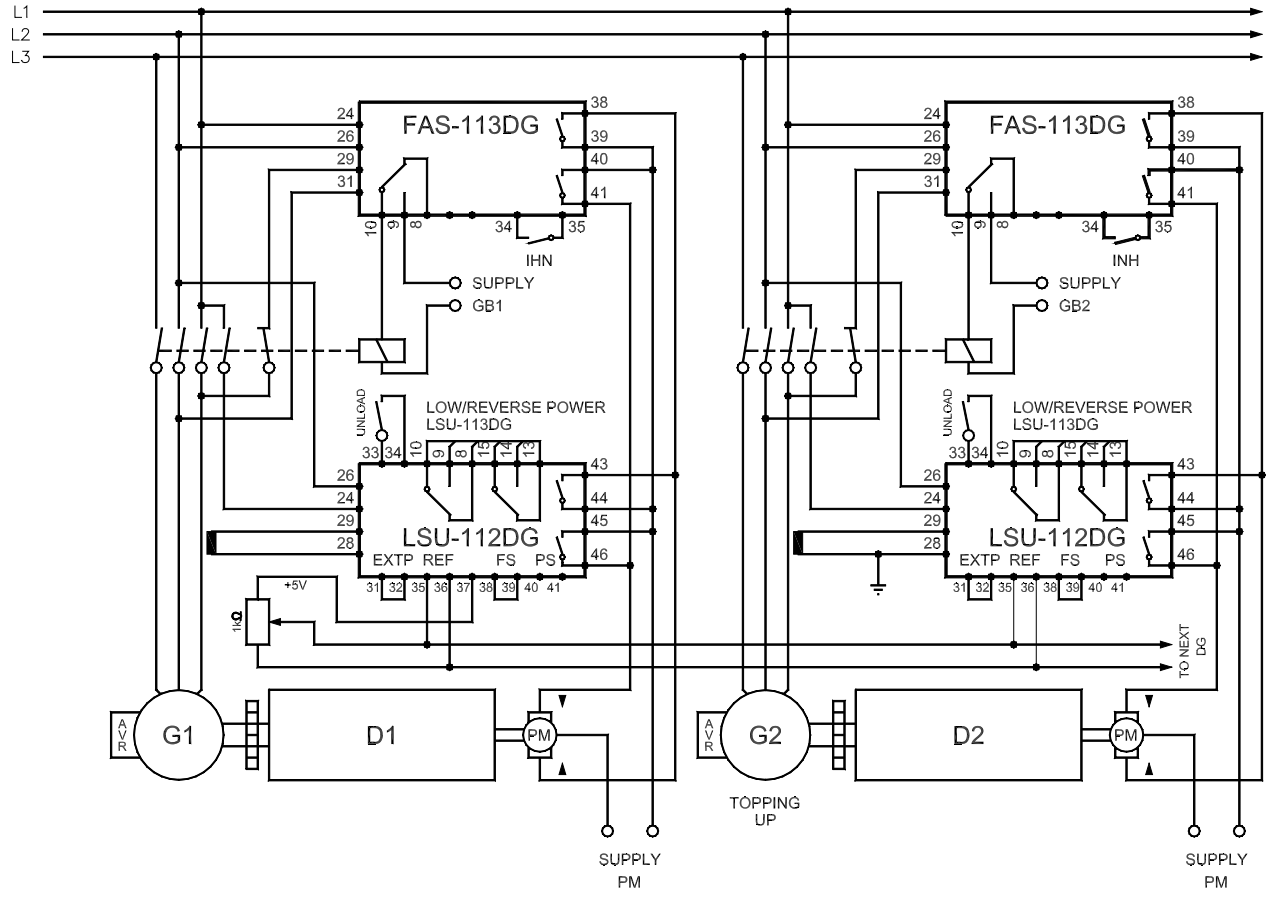


Note 1: Terminals 36 + 39 + 41 on the LSU-113DG are internally connected.

5.6 Fixed load to busbar with load sharing - no frequency control

Ref.: Data sheets nos. 4921240118 and 4921240114.

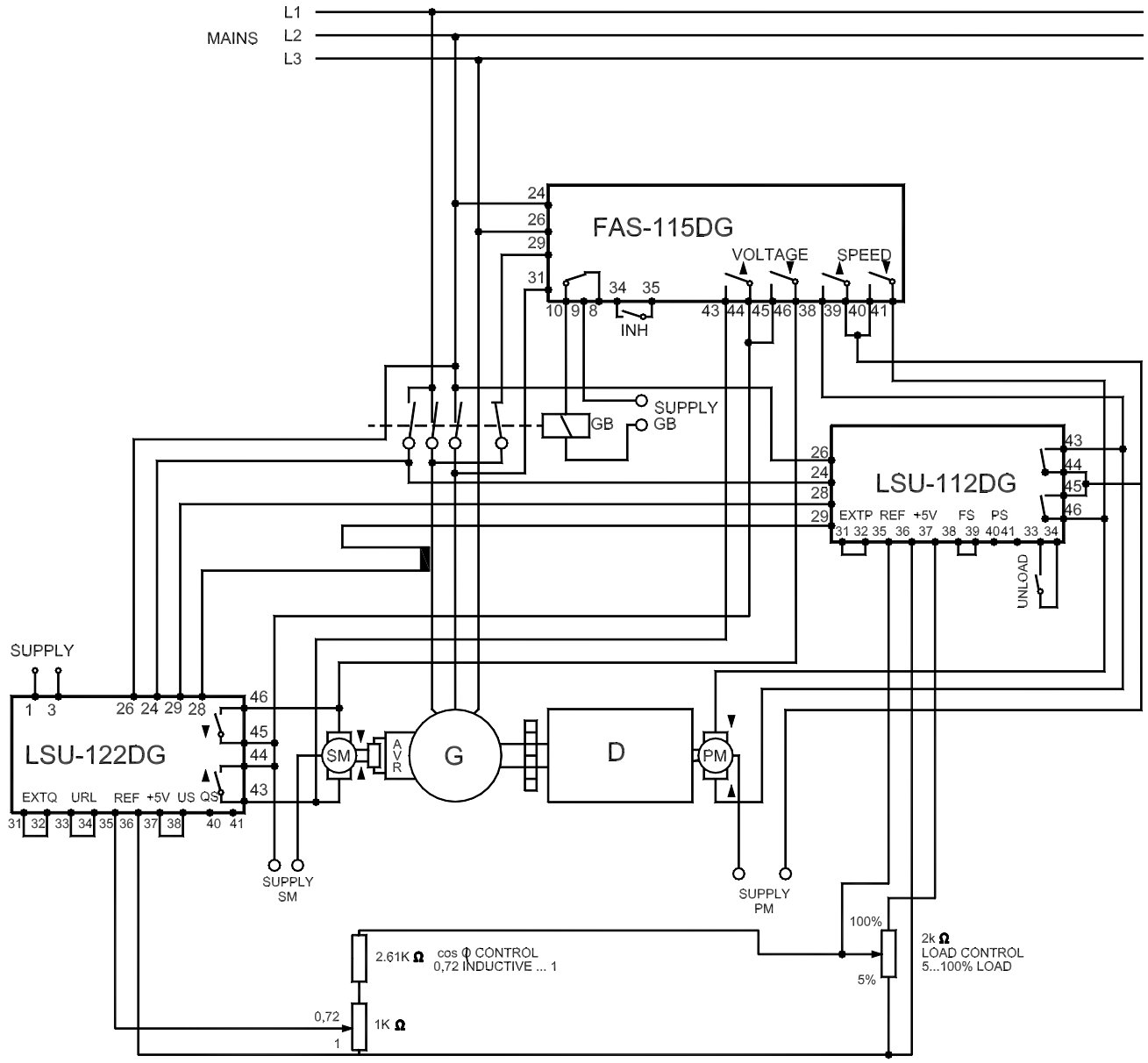
This application shows how to connect the LSU units in FIXED LOAD MODE with NO FREQUENCY CONTROL. This mode is normally used when the generator island is connected to a mains network. By means of the 1kOhm potentiometer the two generators is controlled to deliver a fixed load to the busbar. The supply for the potentiometer is taken from the LSU-112DG. The regulation range is from 10% to 100% of Pnom (voltage measured on the potentiometer wiper 0.5...5V DC). Below 0.5V (10%) the generator is no longer controlled by the LSU-112DG (a built-in protection circuit will prevent the generator to be run into overload). If the situation (input to REF input <0,5V DC) can occur, it is recommended to permanently short-circuit the PS line (terminals 40 and 41) on the LSU-112DG. This short-circuit will force the LSU-112DG to regulate the generator to zero power when the REF input drops below 0.5V DC.



Application for mechanical governors synchronisation and fixed load to busbar with load sharing. No frequency control.

5.7 Fixed load to mains, COSφ adjustable

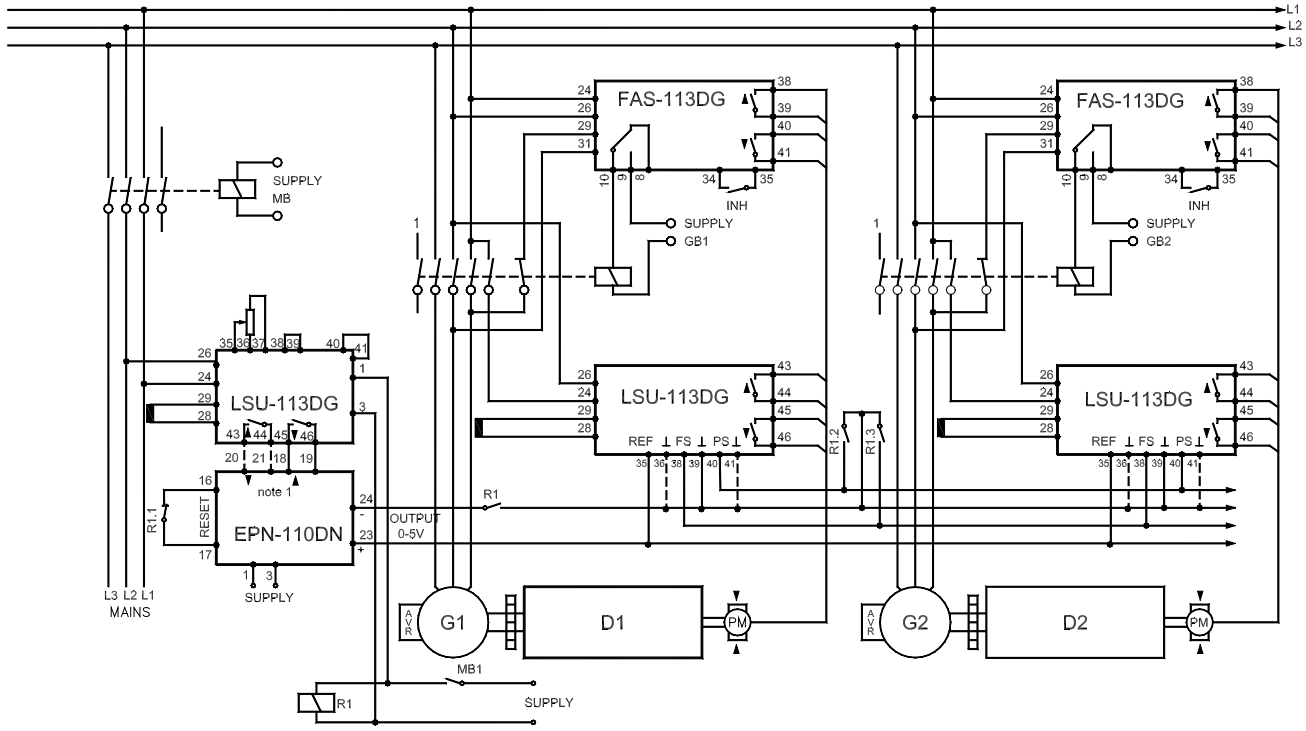
When running a generator parallel with mains, it is usually preferable to keep COSφ close to 1 (Q=0 VAr). An easy way to obtain this is to use the LSU-122DG, set to control the reactive power. The drawing shows a generator intended to run parallel with mains. The synchroniser FAS-115DG will synchronise both voltage and frequency. When the breaker closes, the generator will run parallel with mains producing a fixed power selected with the load control potentiometer, and a fixed COSφ value selected with the COSφ control potentiometer, but without frequency and voltage control (controlled by mains).



5.8 Peak lopping parallel to mains/island operation

Ref.: Data sheets nos. 4921240118 and 4921240114

This application shows how to connect the LSU units in FIXED LOAD MODE with NO FREQUENCY CONTROL. This mode is normally used when the generator island is connected to a mains network. By means of the LSU-112/3 connected at the mains breaker and the EPN-110DN, the mains power transport is controlled. If the mains power consumption rises, the mains LSU will regulate down. As the EPN input ”up” is connected to the LSU output ”down”, this will cause the EPN output signal to rise, whereby the generator(s) will deliver more power. The mains power setpoint is done via the potentiometer connected to the mains LSU. The regulation range is from 10% to 100% of Pnom (voltage measured on the potentiometer wiper 0.5…5V DC). Below 0.5V (10%) the generator(s) are no longer controlled by the LSU (a built-in protection circuit will prevent the generator to be run into overload). If the situation (input to REF input <0.5V DC) can occur, it is recommended to permanently short-circuit the PS line (terminals 40 and 41) on the LSU. This short-circuit will force the LSU to regulate the mains to zero power when the REF input drops below 0.5V DC.



Application for mechanical governors synchronisation and mains peak lopping (no frequency control) island load sharing (with frequency control).

6 Application for synchronisation of generator breakers

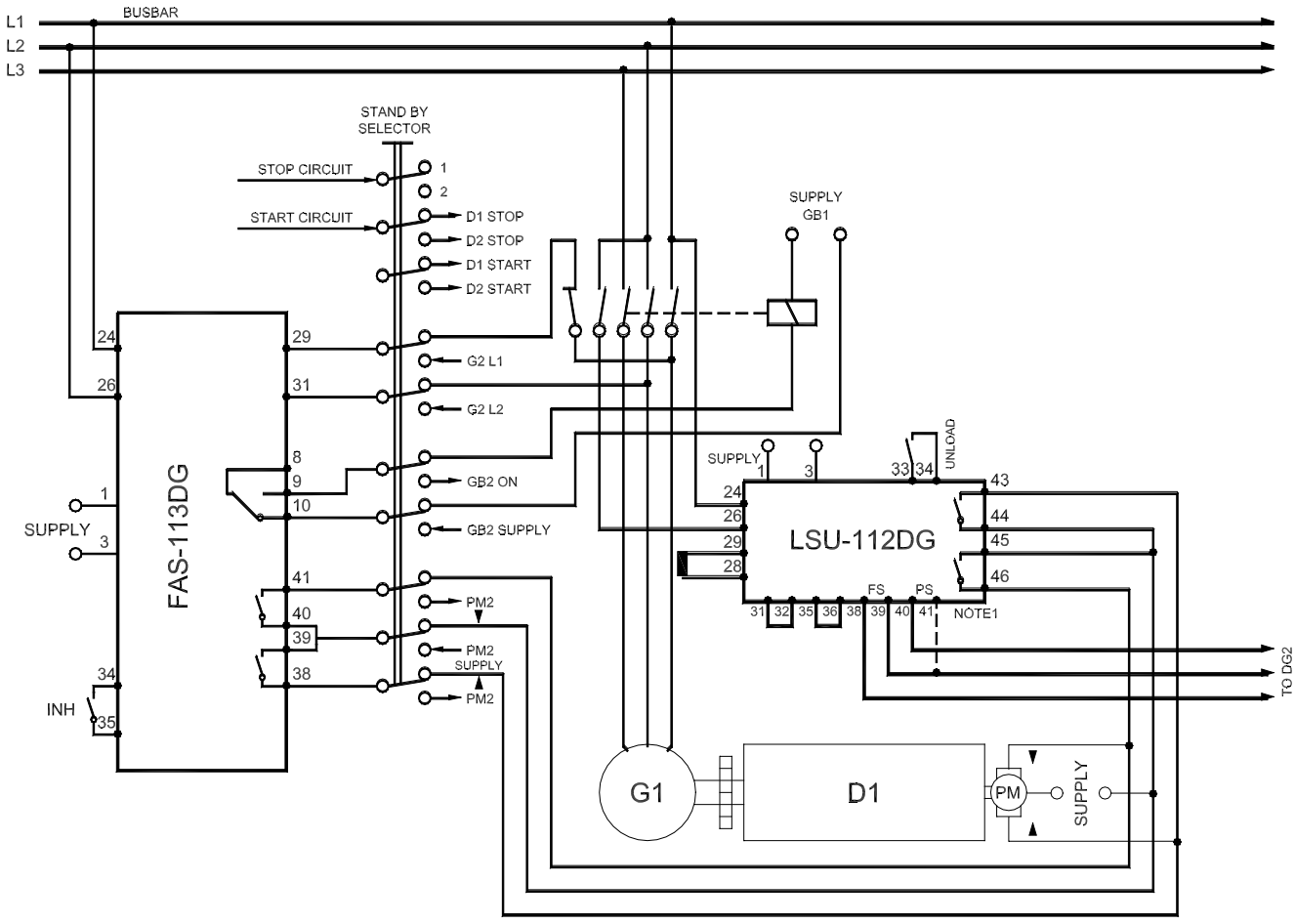
6.1 General information

Considering the price level of the FAS-11xDG, it is appealing to use one unit for every generator in the plant. This method will make the wiring easy and it is possible to use generator circuit breakers with different breaker closing time. However, in some installations the manufacturer wants to use only one unit for the whole plant. This is usually done by connecting the synchroniser to the standby selector.

6.2 Synchronisation of generator breakers using one FAS-113DG

Ref.: Data sheet no. 4921240114.

The following application shows how to connect one synchroniser in a generator plant, by connecting the FAS-113DG together with a stand by selector. The FAS-113DG will control the speed and phase according to the settings on the unit and transmit the closing signal to the breaker according to the breaker closing time - and the actual slip frequency. Please observe! This application does not control the voltage.



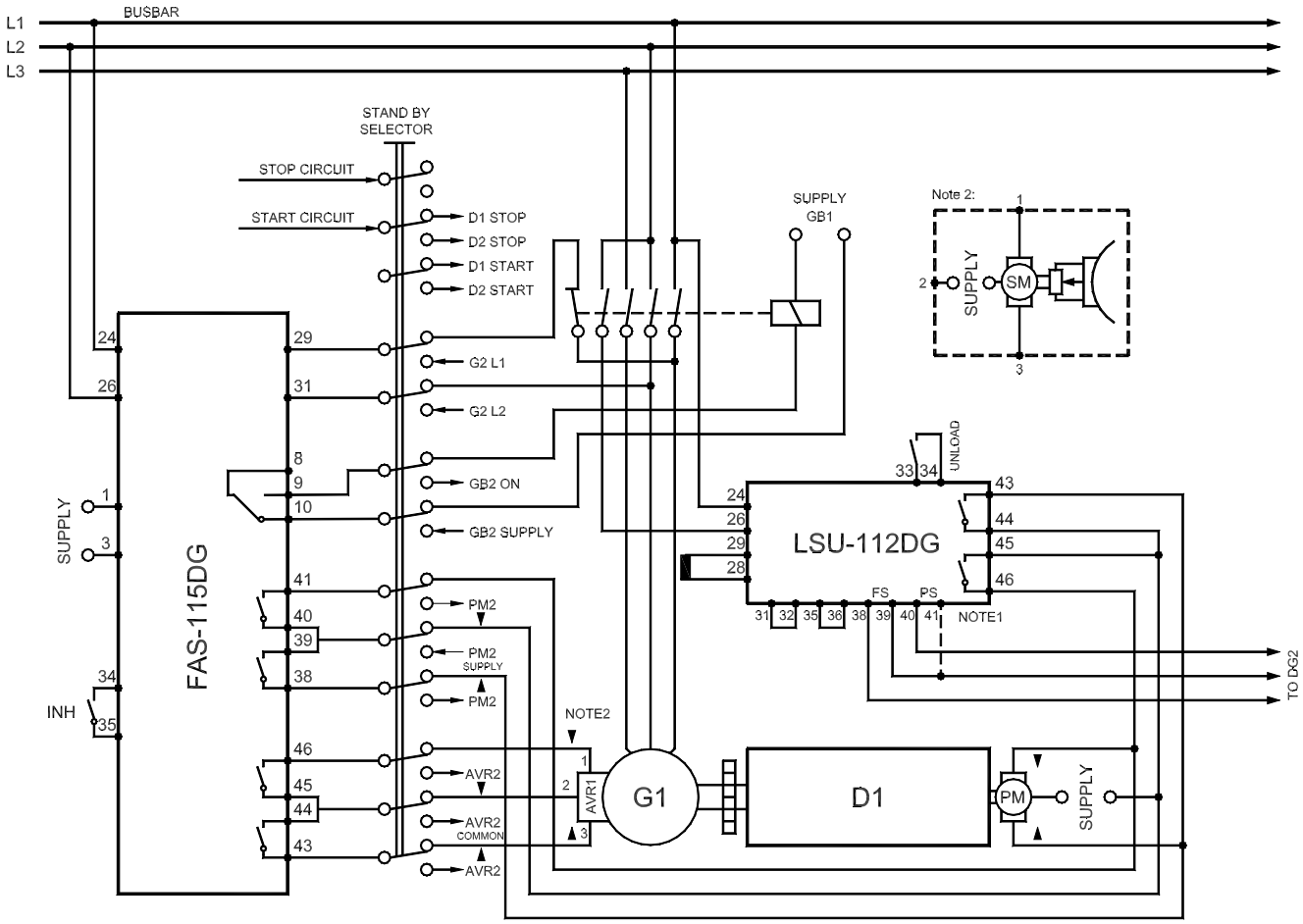
Note 1: Terminals 39 + 41 on the LSU-112DG are internally connected.

Synchronisation of generator circuit breakers using one FAS-113DG (no voltage control).

6.3 Synchronisation of generators breakers using one FAS-115DG

Ref.: Data sheet no. 4921240116.

The following application shows how to connect one synchroniser in a generator plant, by connecting the FAS-115DG together with a stand by selector. The FAS-115DG will control the voltage, speed and phase according to the settings on the unit and transmit the closing signal to the breaker according to the breaker closing time - and the actual slip frequency.



Note 1: Terminals 39 + 41 on the LSU-112DG are internally connected.

Synchronisation of generator circuit breakers using one FAS-115DG with voltage control.

7 Application with start/stop automatic

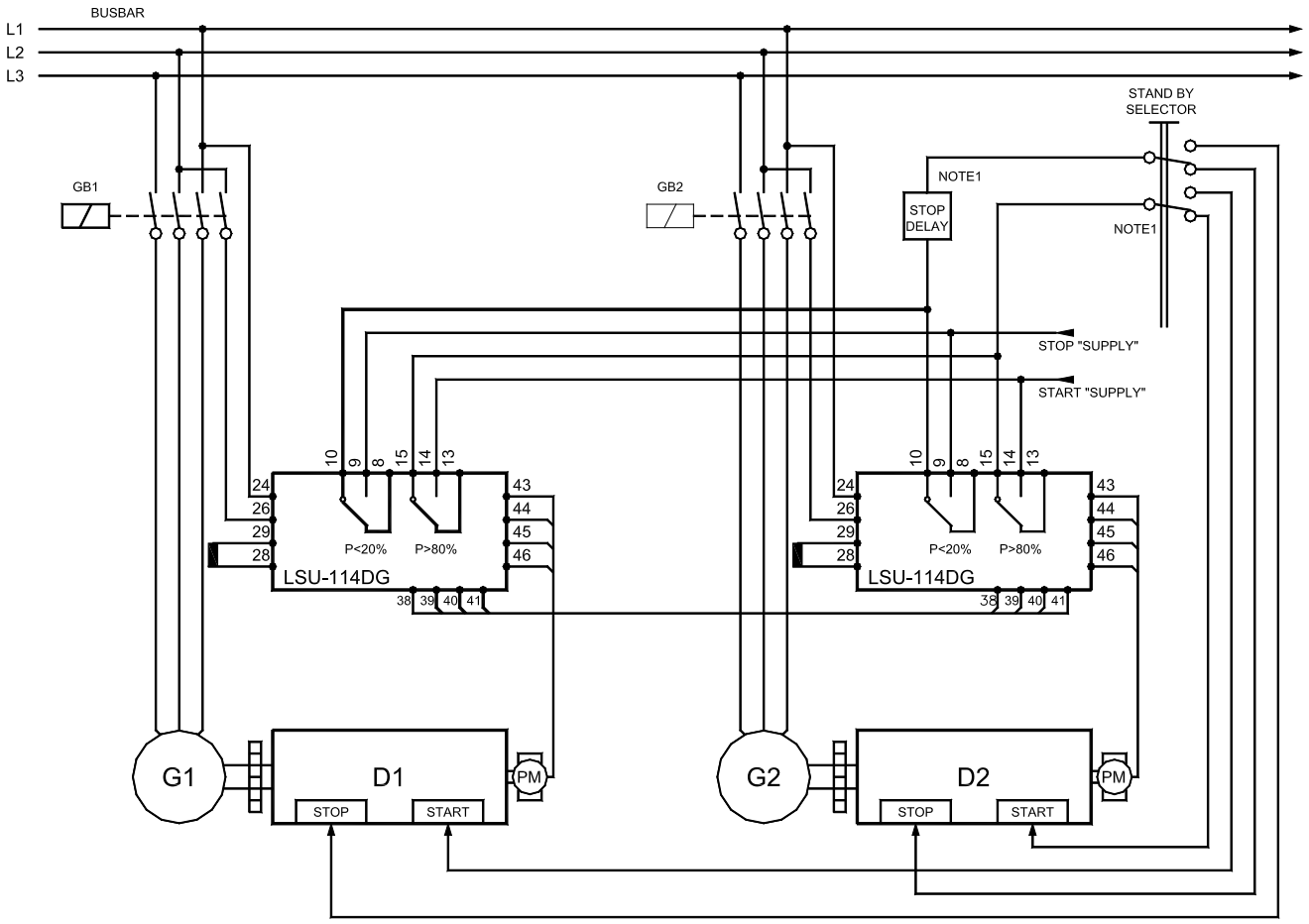
7.1 General information

The Uni-line product programme does not include a load-dependent start stop unit. But the LSU-114DG (load share unit) has two relay outputs - one for transmit of start signal if the load exceeds 80% of Pnom and one for transmit of stop signal if the load drops below 20% of Pnom. Both relay outputs are without any delay. This option can be useful in simple start/stop applications. If a more advanced start/stop function is needed, a PLC with a minimum of one analogue input can be interfaced with the LSU units. This combination can perform load-dependent start/stop and calculation of available power and total power. Likewise, the system can handle blocking of heavy loads and tripping of non-essential load. Application for this combination of Uni-line products and a PLC is under preparation.

7.2 Normal load sharing with auto start/stop of stand by diesel

Ref.: Data sheet no. 4921240122.

The "STOP" and the "START" output from the 2 LSU-114DG in the system is connected in parallel. The stop signal is fed through a "stop delay" timer, and together with the start signal connected to the standby selector. If both generator breakers are closed, both LSU-114DGs will transmit a start signal if the load exceeds 80% of the sum of both generators. Likewise, the stop signal will be transmitted when the load drops below 20% of the sum of both generators. The position of the stand by selector will then decide which generator will be stopped.



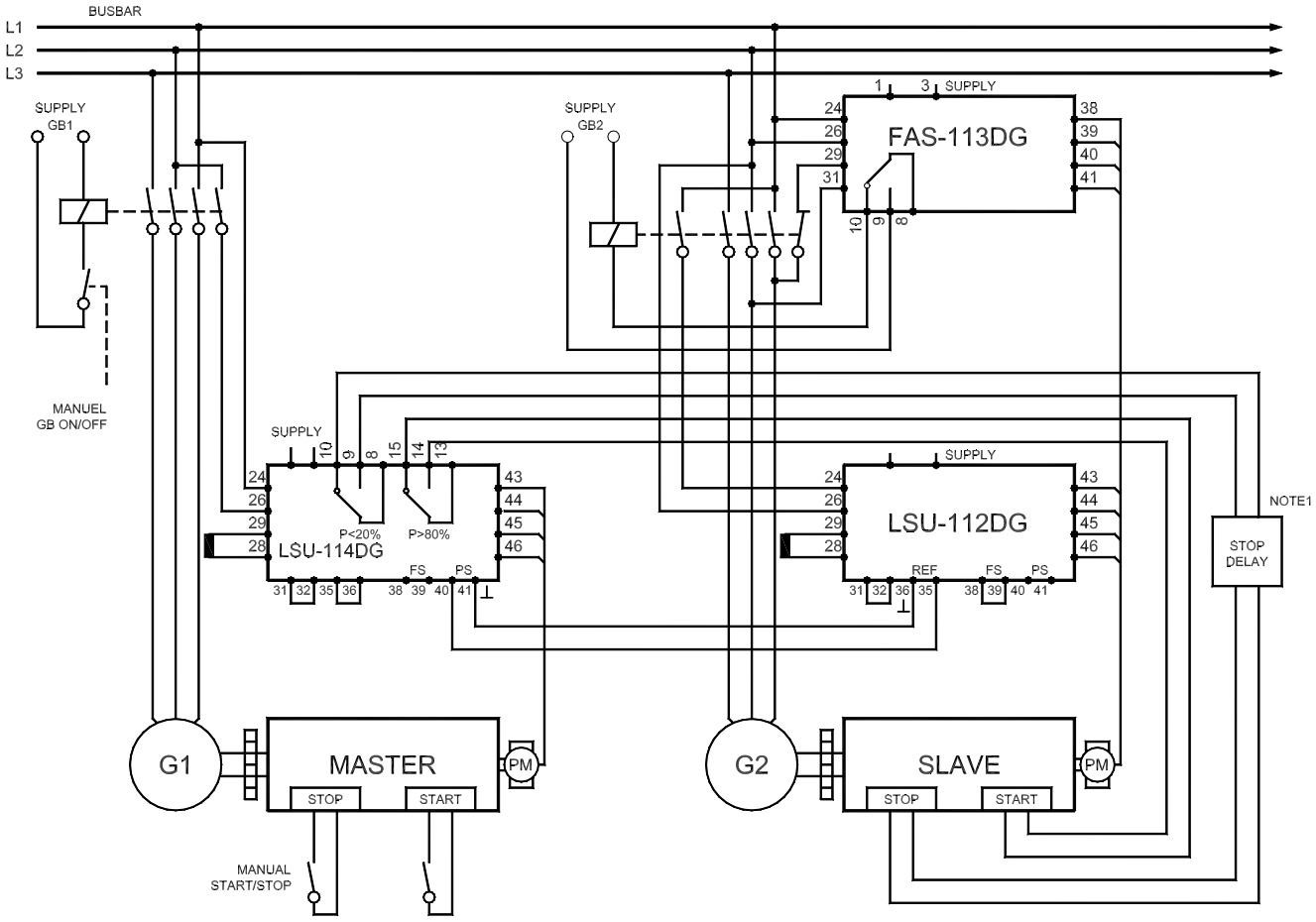
Note 1: The standby selector and the DELAY timer are NOT supplied by DEIF A/S.

Application using LSU-114DG for load sharing and start/stop of standby diesel.

7.3 Master-slave load sharing with auto start/stop of slave unit

Ref.: Data sheets nos. 4921240118 - 4921240122 - 4921240114 - 4921240002 (EC-2).

The MASTER DG is manually started and the generator breaker is manually closed. If the load exceeds 80% of Pnom for the MASTER, the LSU-114DG transmits a start signal to the SLAVE unit (standby generator). After start of standby generator the FAS-113DG will control the synchronisation and close the breaker. After the breaker is closed, the FAS-113DG is deactivated and the LSU-112DG is activated and together with the LSU-114DG controlling the generators into NORMAL LOAD SHARE MODE. If the load drops below 20% of the sum of both generators, the LSU-114DG transmits a stop signal to the slave unit (standby generator). To start, stop, control and supervise the engine, our EC-2 (Engine Controller) is a good choice.



Note 1: The STOP DELAY timer is NOT supplied by DEIF A/S.

Application using LSU-114DG and LSU-112DG together in a MASTER/SLAVE load sharing system with auto start/stop and synchronisation of the slave unit (standby unit).

8 Connection of external transducers

8.1 General information

Ref.: Data sheet no. 4921220002 (Transducers for AC measurement)

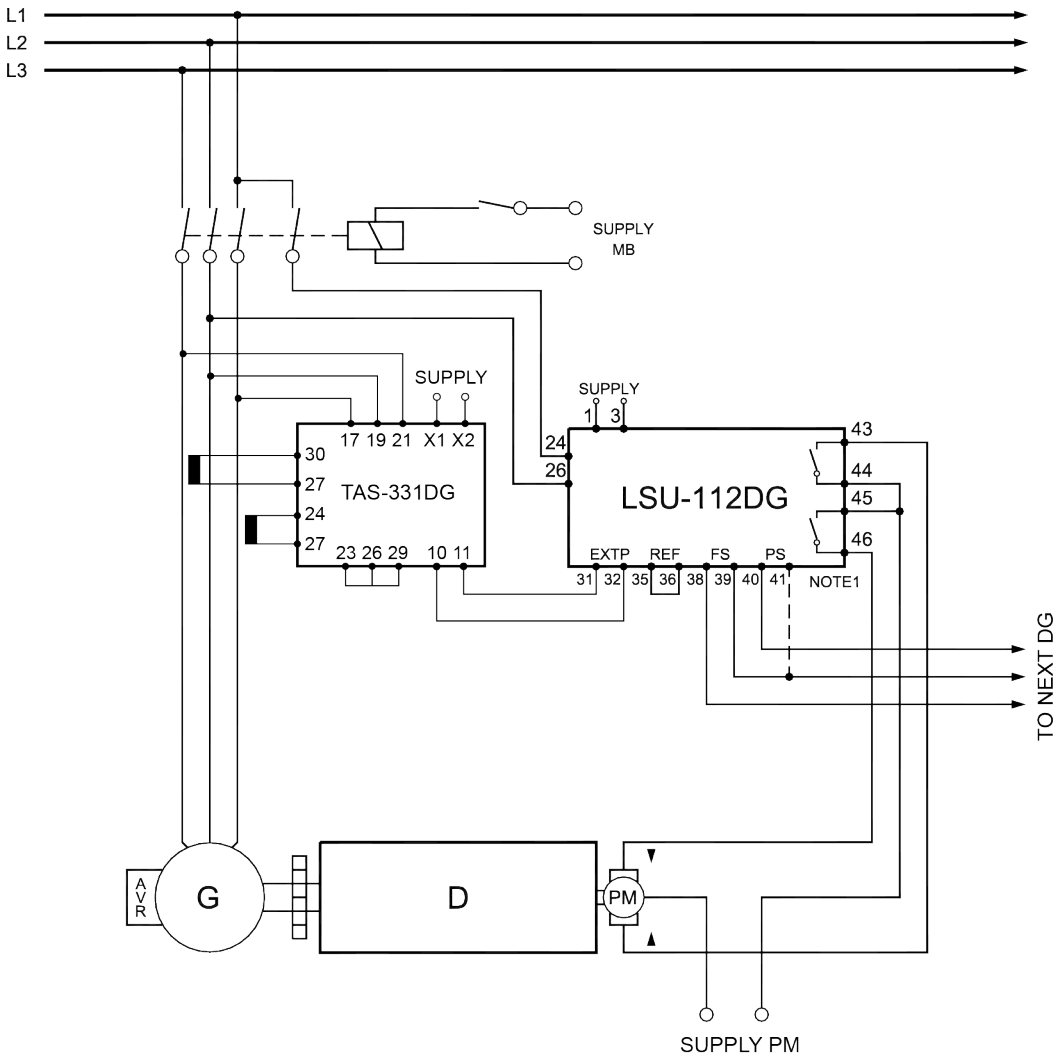
The built-in power transducer in the LSU-11xDG is a so called I x cos phi power transducer measuring the current in one phase. This measuring method is normally sufficient to obtain good load sharing between the generators in the plant. But in special situations like installations with a very high degree of unbalance of the load on the 3 phases especially in installations where START and STOP functions are included the built-in power transducer will not fit. In this kind of installations an external power transducer measuring the power in all 3 phases must be used. The output from this power transducer is then connected to the "Ext. P" input on the LSU-11xDG. The external power transducer will then take control and disable the internal power measurement. Using external power transducer it is still necessary to connect the generator voltage to terminals 24 and 26 on the LSU-11xDG (the generator voltage activates the LSU-11xDG).

The built-in frequency transducer in the LSU-11xDG is very accurate, but in some applications the system frequency depends on the unit or units connected to the busbar. Remember the frequency setting (normal load share mode) is done on every LSU-11xDG in the plant and a difference in this setting will influence on the actual busbar frequency according to the number or numbers of units connected to the busbar. Where two or more LSU-11xDGs are connected the busbar frequency is regulated to an average value of the individual setting on the LSU-11xDGs. In installations where the system frequency must be accurate at all times, a common frequency transducer is connected to the common frequency line "FS" terminals 38 and 39 on all LSU-11xDGs. This external frequency transducer will disconnect the internal frequency measurement.

8.2 External power transducer/LSU

Ref.: Data sheet no. 4921220002 (Transducers for AC measurement)

This application shows connection of an external power transducer to the LSU-11xDG.



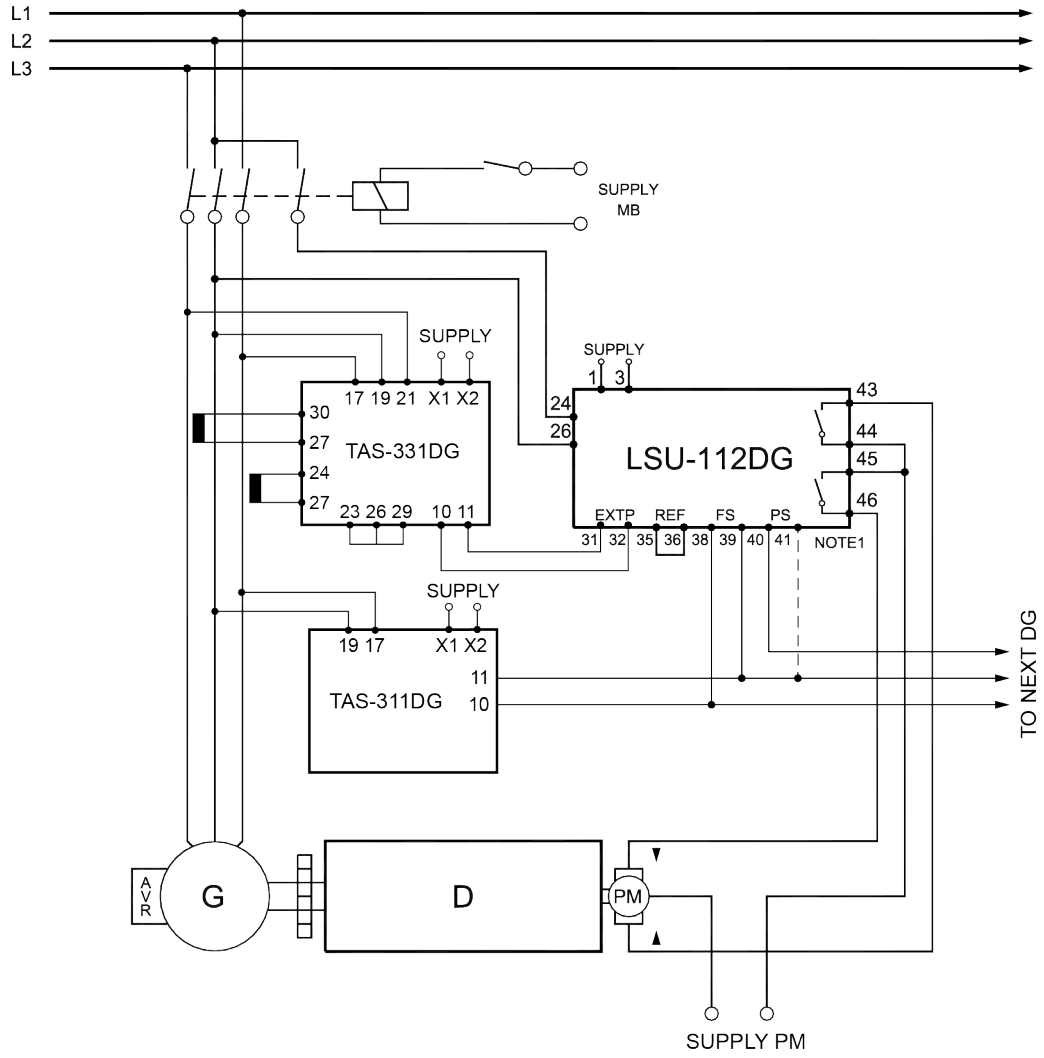
Note 1: Terminals 39 + 41 are internally connected.

Application with LSU-112DG connected to external power transducers.

8.3 External power and frequency transducers/LSU

Ref.: Data sheet no. 4921220002.

This application shows connection of a power transducer and a frequency transducer to the LSU-11xDG.



Note 1: Terminals 39 + 41 are internally connected.

Note 2: Alternative calibration Fn +/- 5Hz, -10…0…10V DC.

Application with LSU-112DG connected to external power and frequency transducers.

9 Applications for earth fault protection

The following applications will cover earth fault protection for generators and load networks in earthed systems. This paragraph does not include any information about insulated networks based on arc suppression or through voltage transformers. Briefly they may be considered to give an insulated neutral and offer the advantage that a system may continue in service after a first earth fault occurs.

9.1 Earth fault protection using single relays

Figure 9.1/a illustrates the use of a core-balance transformer. The three-phase conductors are passed through the ring core of the transformer, which carries a detector winding. Under balanced conditions, the currents in the three phases vectorially sum to zero. The detector winding is then connected to the input of the RMC-142D.

Figures 9.1/b-c illustrate alternative methods of earth fault protection by applying individual current transformers in 3-wire and 4-wire circuits. Current balance under normal conditions is between the secondary currents in the current transformers. In figure 9.1/a, it is the fluxes in the ring core of the current transformer which are balanced.

In case of short circuits between the phases mutually, unwanted differential currents may occur due to the unequal saturation of the current transformers. This will not happen using the method shown in figure 9.1/a as the balance is based on the fluxes.

Figure 9.1/d illustrates how a single relay may be used for earth fault protection. The relay is operated from a c.t. inserted in the neutral earth connection of the generator.

The methods to be used in the installations mentioned are, solid earthing or low resistance earthing employing either an earthing resistor or a reactor (coil). The method using the low resistance earthing will limit the earth fault current and then protect the system against malfunction by preventing saturation in the used current transformers.

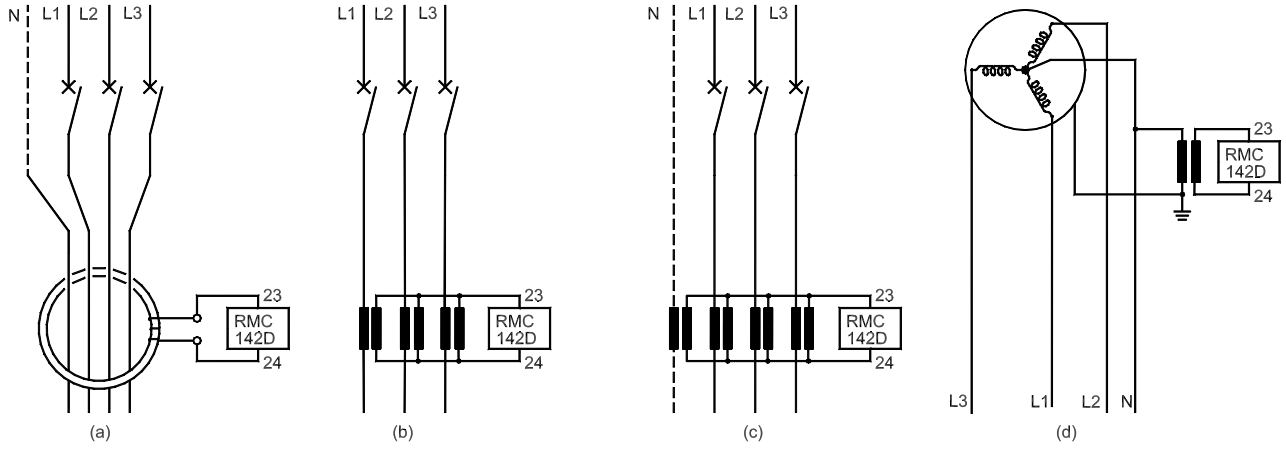


Figure 9.1/a-b-c-d.

9.2 Generator earth fault protection

When earth fault protection is applied to a generator circuit it should be of the type known as restricted earth fault protection. This kind of protection will give full discrimination between earth faults in the generator windings and earth faults in the load network. The alternative configuration known as unrestricted protection implies that no such discrimination is given. Any earth faults occurring well outside the immediate circuit, to which the protection is applied, may cause unnecessary opening of the generator circuit breakers.

Figure 9.2/a shows the simplest arrangement and covers all zones from the generator windings to the final circuits in the load network.

Figure 9.2/b shows an arrangement that covers earth faults in the load network only.

Figure 9.2/c-d indicates the different arrangement necessary for restricted earth fault protection (generator windings). The location of the neutral earthing point in relation to the protection C.T. in the neutral conductor determines whether 4 or 5 C.T.s are employed.

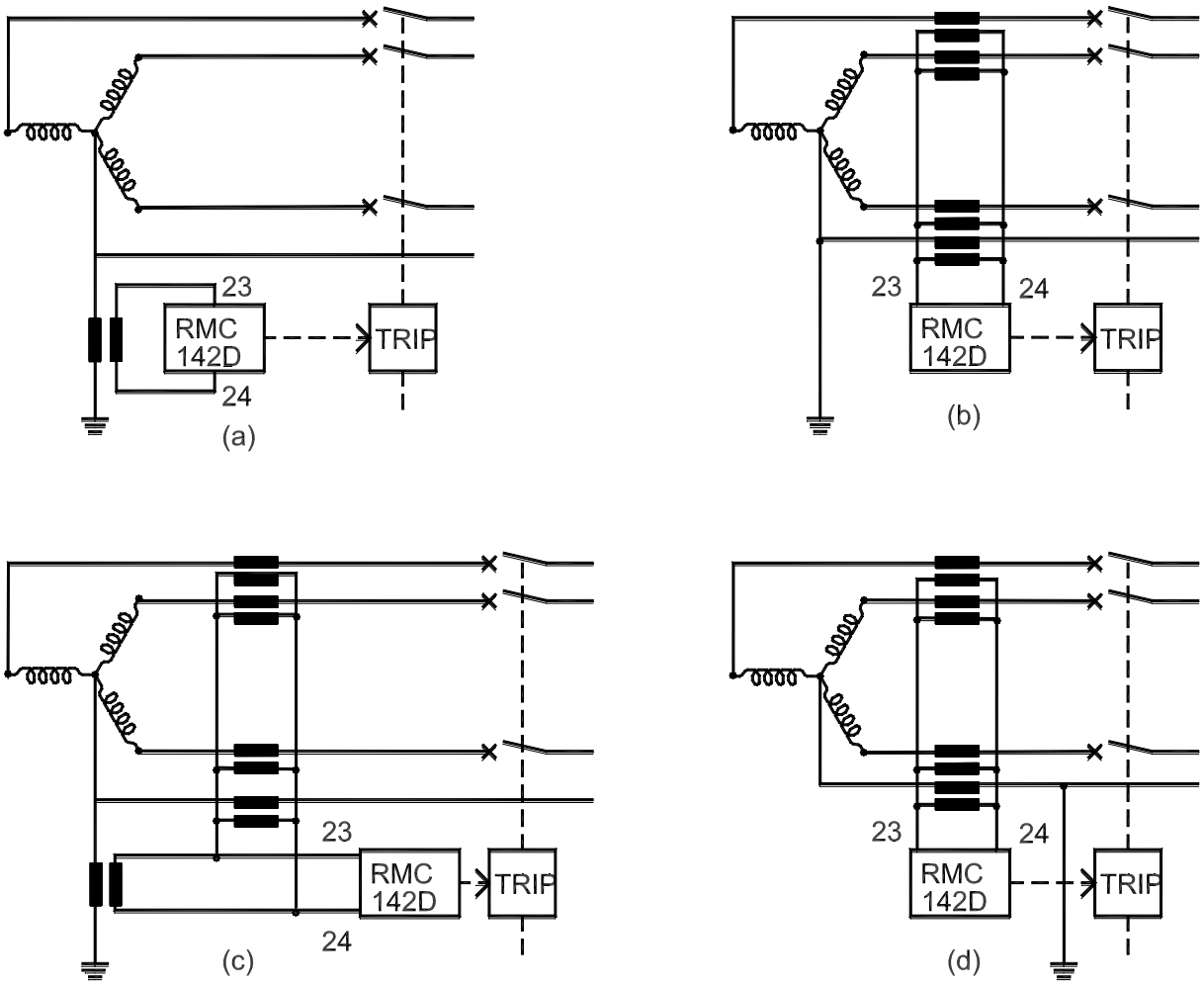


Figure 9.2/a-b-c-d.

9.3 Protection of a single base-load generator installation

Figure 9.3 shows the arrangement for protection in all zones for a single base-load generator installation. Relay 1 covers the faults in the generator and relay 2 covers the faults in the load network. The trip signal from relay 1 should be used to shut down the prime mover and trip the generator breaker. Furthermore action should also be taken to suppress the excitation circuit. For faults in the load (relay 2) it is only necessary to trip the circuit breaker.

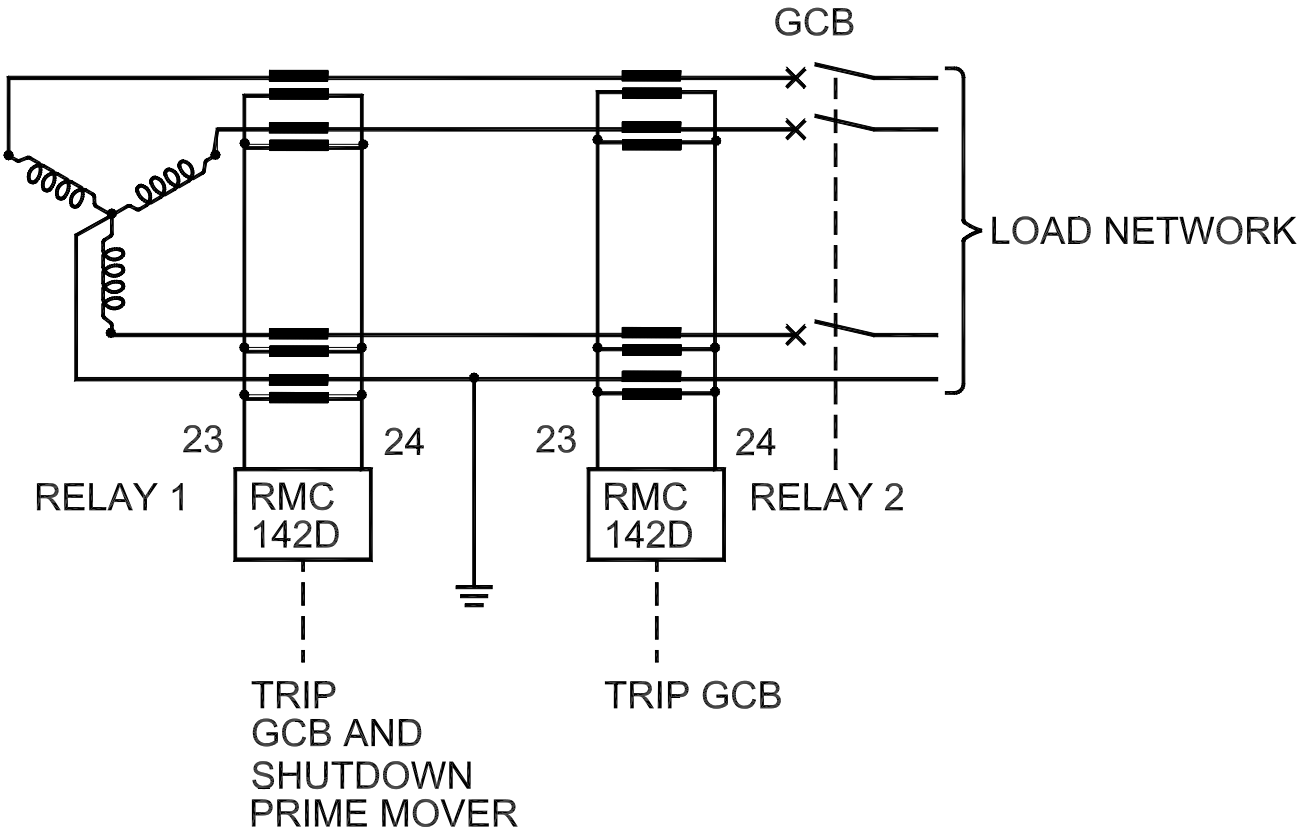


Figure 9.3

9.4 Protection of parallel or non-parallel running generators

Figure 9.4 shows the arrangement of restricted earth fault protection using 3-pole generator breakers. Relay 1 and relay 2 give restrictive earth fault protection for generator winding. Relay 3 protects the load network zone. A signal from this relay should be arranged to trip the circuit breaker.

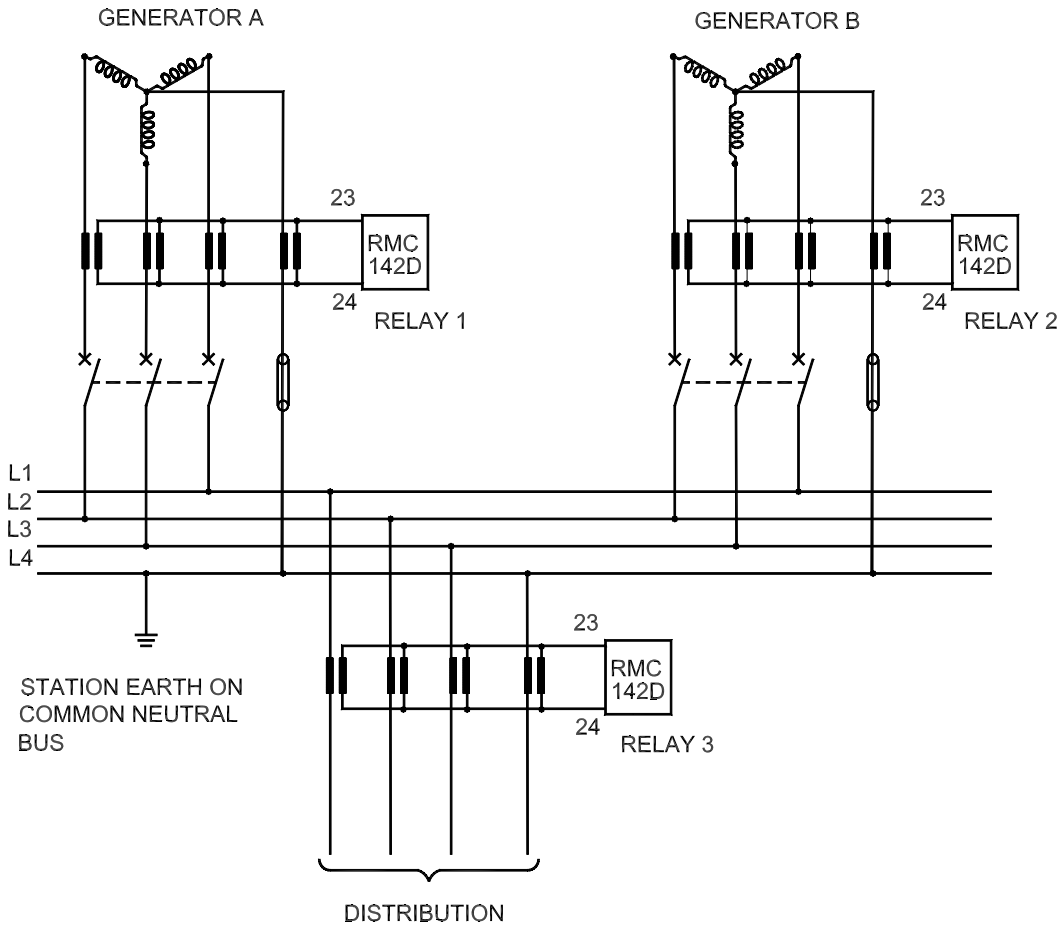


Figure 9.4

Note: Arrangement of the earth fault protection depends on the actual installation and the Electricity Supply Company's regulations. Much will depend upon the method of earthing applied to the installation.

10 Interface to electronic speed governor/AVRs

Ref.: Data sheet no. 4921240126.

DEIF A/S reserves the right to change any of the above.