WOODWARD

SPM-D2-11
Synchronizing Unit

Manual
From Release 7.10-0

Manual 37618A

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before in-stalling, operating, or servicing this equipment. Practice all plant and safety instructions and precau-tions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemper-ature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or oth-er type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the link-age(s), or the controlled device(s) fail.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electri-cal, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" with-in the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent dam-age to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

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Important definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment.

NOTE

Provides other helpful information that does not fall under the warning or caution categories.

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Our Customer Service is available for technical information. Please see last page for the contact data.

Warranty terms

Please enquire about the terms of warranty from your nearest Woodward representative.
For our contact search webpage please go to: http://www.woodward.com/Directory.aspx

Intended Use

The SPMD device must be used exclusively for synchronization of two electrical systems. By opening the device you will loose any warranty.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (1) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (2) invalidate product certifications or listings.

Before starting any operation and after any modification of the parameterization make a documentary proof that your programming and parameterization meets the requirements of your synchronization concept.

Typical applications for this product family/device line are for instance:

*   Synchronizing a mains parallel Generator to the mains

Any usage beyond these applications the devices are not designed for. This applies also to the use as a partly completed machinery. The manufacturer cannot be held liable for any resulting damage, the user alone bears the risk for this. As to the appropriate use of the device: The technical data and tolerances specified by Woodward have to be met.

Revision History

Rev.	Date	Editor	Change
A	2016-01-27	GG	Changed product name "SPM-**D**-xxx" to SPM-**D2**-xxx"
NEW	2015-12-09	GG	Release

Contents

Illustrations and Tables

Illustrations

Tables

Chapter 2.
General Information

The SPM-D2-11 is a synchronizing unit with integrated control functions for generator power levels and load sharing. Through the application of appropriate logic to the discrete inputs the following functions can be realized:

- Synchronization
- Synch-check
- Black start
- Load/var control
- Load/var sharing

The SPM-D2 starts as a standard unit that may have additional functions added with each package. The model of the SPM-D2 is designated as follows:

SPM-D2-11	4	5	B/	xx

Packages according to the Package list.
   These packages can be found in the manual. Each headline points out if the described function is standard or part of a package.

Mounting
   [B].. Flush-mounting

CT's, current transformers, secondary
   [1] = ../1 A
   [5] = ../5 A

Voltage transformers/PT's, secondary
   [1] = 100 Vac
   [4] = 400 Vac

Type

Examples:
- SPM-D2-1145B/LSXR (LSXR package with 400 Vac PT measuring inputs and ../5 A CT measuring inputs)
- SPM-D2-1111B/LSXR (LSXR package with 100 Vac PT measuring inputs and ../1 A CT measuring inputs)

Intended Use The control must only be operated for the uses described in this manual. The prerequisite for a proper and safe operation of the product is correct transportation, storage and installation, as well as careful operation and maintenance.

NOTE

This manual has been developed for a control fitted with all available options. Inputs/outputs, functions, configuration screens and other details described, which do not exist on your control, may be ignored.

The present manual has been prepared to enable the installation and commissioning of the control. Due to the large variety of parameter settings, it is not possible to cover every combination. The manual is therefore only a guide. In case of incorrect entries or a total loss of functions, the default settings can be taken from the list of parameters located in the rear of this manual.

Chapter 3.
Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1.   Before performing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2.   Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3.   Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4.   **Opening the control cover may void the unit warranty.**
     Do not remove the Printed Circuit Board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

     •   Ensure that the device is completely de-energized (all connectors must be disconnected).

     •   Do not touch any part of the PCB except the edges.

     •   Do not touch the electrical conductors, connectors, or components with conductive devices with your hands.

     •   When replacing a PCB, keep the new PCB in the protective antistatic bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the protective antistatic bag.

⚠ **CAUTION**
To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Chapter 4.
Installation

⚠ **WARNING**

A circuit breaker must be located near to the control and in a position easily accessible to the operator. This must also bear a sign identifying it as an isolating switch for the control.

ⓘ **NOTE**

Inductive devices connected to the system (such as operating current coils, undervoltage tripping units, or auxiliary/power contacts) must be connected to a suitable interference suppressor.

⚠ **WARNING**

All technical data and ratings indicated in this chapter are not definite! Only the values indicated in Appendix B: Technical Data on page 71 are valid!

The following chart may be used to convert square millimeters [mm²] to AWG and vice versa:

AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²
30	0.05	21	0.38	14	2.5	4	25	3/0	95	600MCM	300
28	0.08	20	0.5	12	4	2	35	4/0	120	750MCM	400
26	0.14	18	0.75	10	6	1	50	300MCM	150	1000MCM	500
24	0.25	17	1.0	8	10	1/0	55	350MCM	185		
22	0.34	16	1.5	6	16	2/0	70	500MCM	240		

Table 4-1: Conversion chart - wire size

Wiring Diagram

SPM-D2-11/LSXR
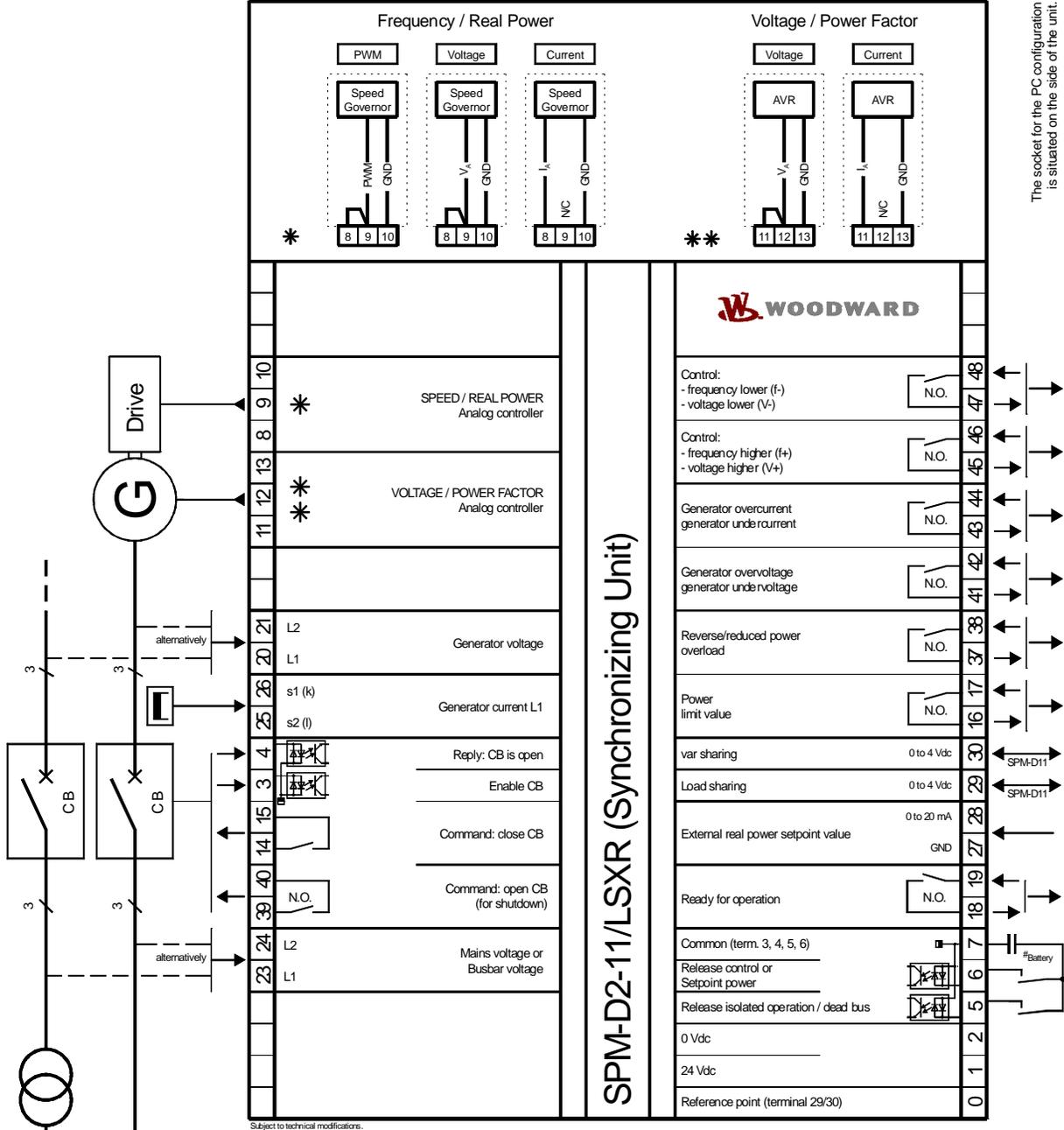
Figure 4-1: Wiring diagram SPM-D2-11/LSXR

Reference Point

Figure 4-2: Reference point

Terminal	Description	A_{max}
0	Reference point: Neutral point of the three-phase system or neutral terminal of the voltage transformer (Measuring reference point); → with three-conductor (delta) systems, do not connect	Sold.lug

Power Supply

⚠️ **WARNING**

There are two different versions of this unit with different voltage input ratings. Look at the DATA PLATE of the unit to determine the correct voltage input ratings. An incorrect power supply may destroy the unit. The voltage input ratings are:

- **V_{aux} = 24 Vdc**
- **V_{aux} = 12/24 Vdc**
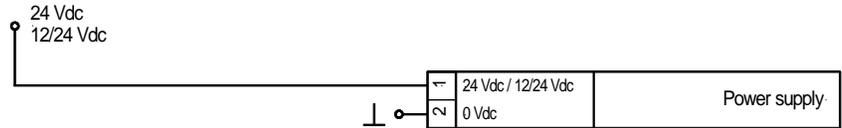
Figure 4-3: Power supply

Terminal	Description	A_{max}
1	+24 Vdc *or* +12/24Vdc	2.5 mm²
2	0 Vdc	2.5 mm²

Measuring Inputs

NOTE

The unit always assumes a clockwise three-phase system (right-handed rotary field). If the unit is used with a counter-clockwise field (left-handed rotary field), the power factor measurement will not be correct. This may be compensated by adapting the angle adjustment (refer to Current Transformer section on page 44).

Voltage

NOTE

The SPM-D2-11 can only operate (monitor) one synchronization point (one power circuit breaker), due to the 1-power-circuit-breaker configuration. The measured voltage at terminals 23/24 is the voltage reference point for the synchronization at terminals 20/21. The synchronization reference voltage can be the mains or busbar voltage.

NOTE

There are generally three variations for connection of the measuring circuit voltage:

① **Direct connection to a low voltage system**
② **Connection to medium voltage via two-phase isolated transformer (e. g. in the case of a delta connection)**
③ **Connection to medium voltage via single- phase isolated transformer (e. g. Y-connection).**

The SPM-D2-11 may be connected to L1/L2 or L1/N. Regardless of what connection is used, the generator and mains/busbar must always be connected identically. Correct measured values can be achieved for three-phase and single-phase systems if the SPM-D2-11 is configured accordingly (refer to Current Transformer section on page 44).

Generator
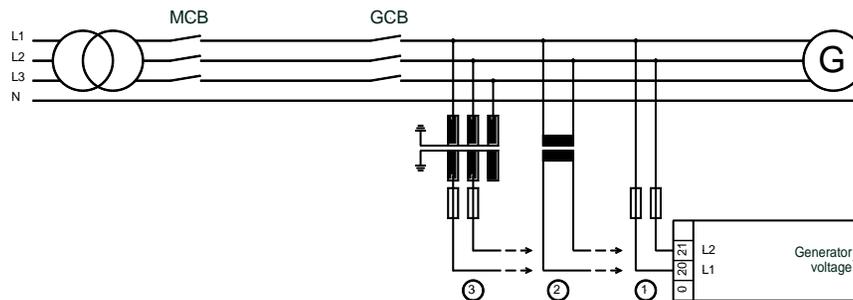
Figure 4-4: Measuring inputs - Generator

Note: Connection corresponding to the mains configuration (see wiring diagram)

Terminal	Measurement	Description	A_max
Connection of the measuring circuit voltage corresponding to the variant ①, ② or ③			
20	direct or Transformer ../100 V	Generator voltage L1	2.5 mm²
21		Generator voltage L2	2.5 mm²
0		Reference point: N-terminal of the low voltage system or star point of the voltage transducer (measuring reference point); → do not connect in delta connection installations	Solder.lug

Mains/Busbar
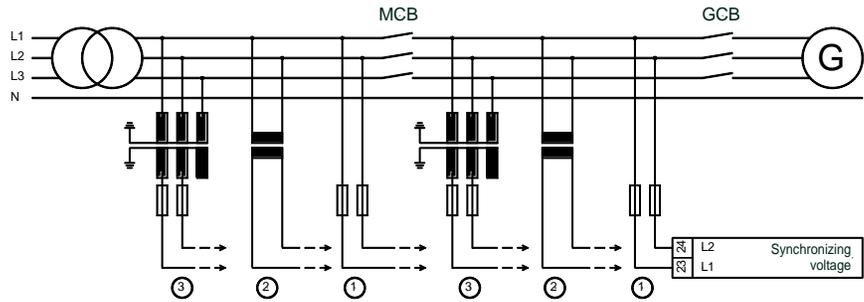
Figure 4-5: Measuring inputs - Synchronization voltage

Note: Connection corresponding to the Bus configuration (see wiring diagram).

Terminal	Measurement	Description	A_{max}
Connection of the measuring circuit voltage corresponding to variant ①, ② or ③			
23	direct	Synchronization ref. voltage L1	2.5 mm²
24	or ../100 V	Synchronization ref. voltage L2	2.5 mm²

Current

⚠ **WARNING**

Before disconnecting the secondary terminals of the current transformer or the connections of the current transformer at the unit, ensure that the transformer is short-circuited.

ℹ **NOTE**

Current transducers are generally to be grounded on one side of the secondary.
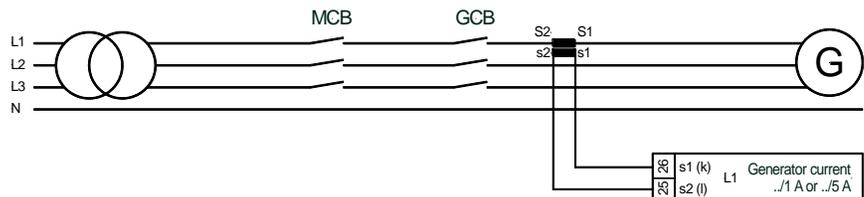
Figure 4-6: Measuring inputs - Current

Terminal	Measurement	Description	A_{max}
25	Transformer ../1 A o. ../5 A	Generator current L1, transformer terminal s2 (l)	2.5 mm²
26		Generator current L1, transformer terminal s1 (k)	2.5 mm²

ℹ **NOTE**

If the generator load is always symmetrically, the current may also be measured in L2 or L3. This must be considered when configuring the SPM-D2-11 (refer to Current Transformer section on page 44). If there is a possibility that the load may be asymmetrical, the current must be measured in L1.

Discrete Inputs

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⚠ **WARNING**

There are two versions of this unit with different discrete inputs. The discrete inputs have different maximum voltage ratings. Look at the DATA PLATE of the unit to determine the correct voltage input ratings. Applying incorrect voltages to the discrete inputs may destroy the hardware. The voltage input ratings are:

- $V_{Cont, dig. input}$ = **+/-18 to 250 Vac/dc**

- $V_{Cont, dig. input}$ = **12/24 Vdc**
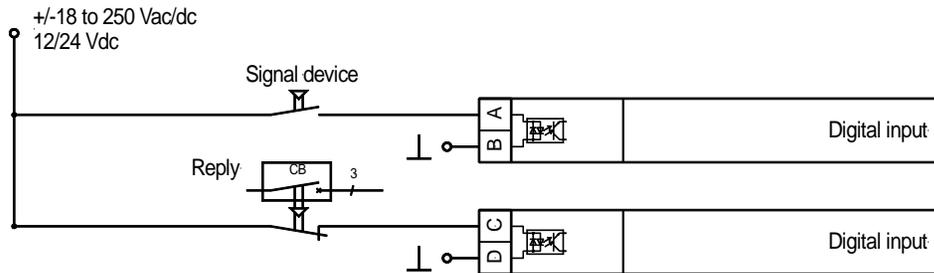
Figure 4-7: Digital inputs

Terminal	Associated zero-terminal	Description (to DIN 40 719 part 3, 5.8.3)	A_{max}
NO (make) contact			
A	*B*		
3		Enable CB	2.5 mm²
5	7	Enable isolated operation / dead bus start	2.5 mm²
6		Enable control or release power set point value 2 *	2.5 mm²
NC (break) contact			
C	*D*		
4	7	Reply: CB is open	2.5 mm²

* refer to parameter Parameter "Terminal 6" on page 45

Analog Inputs

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⚠️ **WARNING**

The analog inputs of the SPM-D2 are not isolated. When using an isolation monitor, we recommend to use two-pole, isolated transmitters.

The analog inputs for active transmitters (0 to 20 mA, 0 to 10V) should only be operated with two-pole, isolated transmitters.
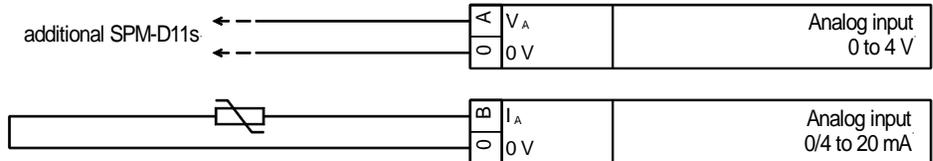
Figure 4-8: Analog inputs

Terminal	Associated zero-terminal	Description (to. DIN 40 719 part 3, 5.8.3)	A_{max}
0 to 4 Vdc			
A			
29	0	Real power load sharing	2.5 mm²
30		Reactive power load sharing	2.5 mm²
0/4 to 20 mA			
B			
28	27	Real power set point value	2.5 mm²

All controls that are load sharing must be interconnected via terminal 29 (terminals 30 must also be interconnected for var sharing). If an SPM-D2-11 is switched off, the load/var sharing line must be disconnected to prevent the disabled SPM-D2-11 from influencing the other controls.
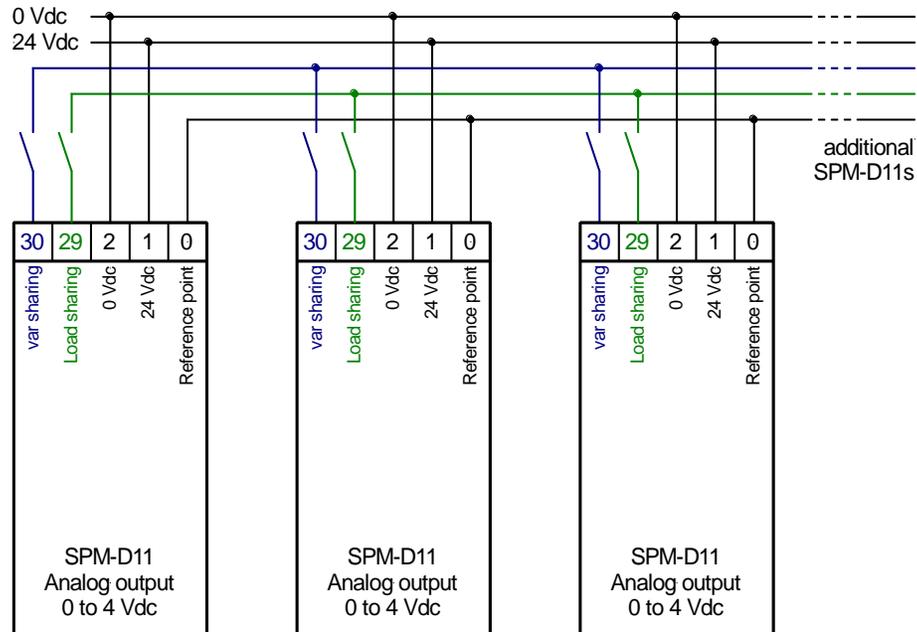
Figure 4-9: Load sharing

Relay Outputs

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max. 250 V AC

external device ← | A | Relay output
⊥ ← | B |
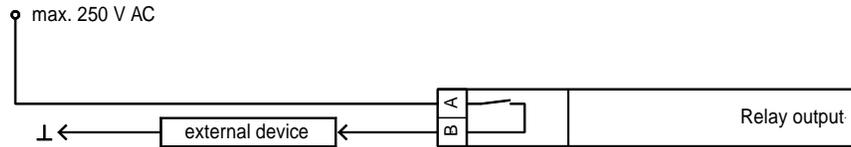
Figure 4-10: Relay outputs - control outputs I (CB control)

Root	Switched	Description	A_{max}
A	**B**		
14	15	Synchronizing pulse, Command: close CB	2.5 mm²
39	40	Command: open CB for shutdown	2.5 mm²

NOTE

The relay "open CB for shutdown" is used to automatically open the CB after the power has been reduced (see also Control Outputs on page 29). This relay is not controlled by monitoring functions.

max. 250 V AC

external device ← | A | Relay output
⊥ ← | B |
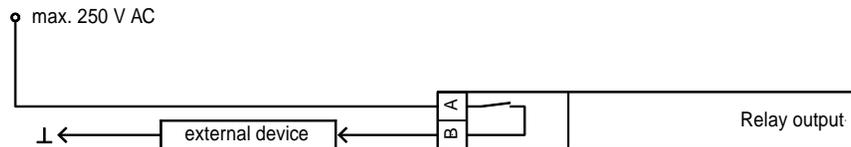
Figure 4-11: Relay outputs - control outputs II (acknowledgements)

Monitoring relay   N.C. functionality

Root	Switched	Description	A_{max}
A	**B**	**Note:** The relays are de-energized and open in case of an fault.	
37	38	Reverse/reduced load, overload	2.5 mm²
41	42	Generator over/under voltage	2.5 mm²
43	44	Generator over/under frequency	2.5 mm²

Signal relay   N.O. functionality

Root	Switched	Description	A_{max}
A	**B**	**Note:** The relay is energized and closed when the function is fulfilled.	
18	19	Ready for operation	2.5 mm²

N.C. functionality

Root	Switched	Description	A_{max}
A	**B**	**Note:** The relay will be de-energized and opens when the power limit is exceeded.	
16	17	Power limit	2.5 mm²

Controller Outputs

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SPM-D2-11/LSXR

The SPM-D2-11/LSXR controller outputs can be configured for the following signals and may require the use of an external jumper between terminals.

Versions

NOTE

Only one controller output may be configured as three-step controller.

- **Three-step controller** via relay manager
  - Control of n/f: Parameter "**f control type**" = THREESTEP
       n+/f+ = Relay connected to terminals 45/46
       n-/f- = Relay connected to terminals 47/48
  - Control of V: parameter "**V control type**" = THREESTEP
       V+ = Relay connected to terminals 45/46
       V- = Relay connected to terminals 47/48

- **Analog controller output**
  - Control of n/f: Parameter "**f control type**" = ANALOG
       Current output (mA) = no external bridge/jumper necessary
       Voltage output (V) = external bridge/jumper between 8/9
       Connect the Controller to terminals 9/10
  - Control of V: Parameter "**V control type**" = ANALOG
       Current output (mA) = no external bridge/jumper necessary
       Voltage output (V) = external bridge/jumper between 11/12
       Connect the controller to terminals 12/13

- **PWM controller output**
  - Control of n/f: Parameter "**f control type**" = PWM
       PWM output = external bridge/jumper between 8/9
       Connect the controller to terminals 9/10

Connection of the controllers

Setting: 'THREESTEP' (three-position controller)

max. 250 Vac

| | A | | | |
| | B | | | Relay output |

The relay has to be decoupled.
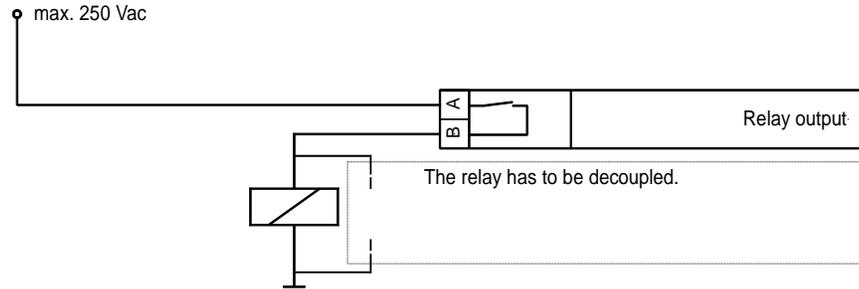
Figure 4-12: Controller - SPM-D2-11/LSXR - three-position controller

Terminal		Description	A_{max}
45	raise	Speed / Frequency controller	2.5 mm²
46		or	2.5 mm²
47	lower	Voltage controller	2.5 mm²
48			2.5 mm²

Setting: 'ANALOG' and 'PWM' (Analog Controller) - Frequency/real power controller
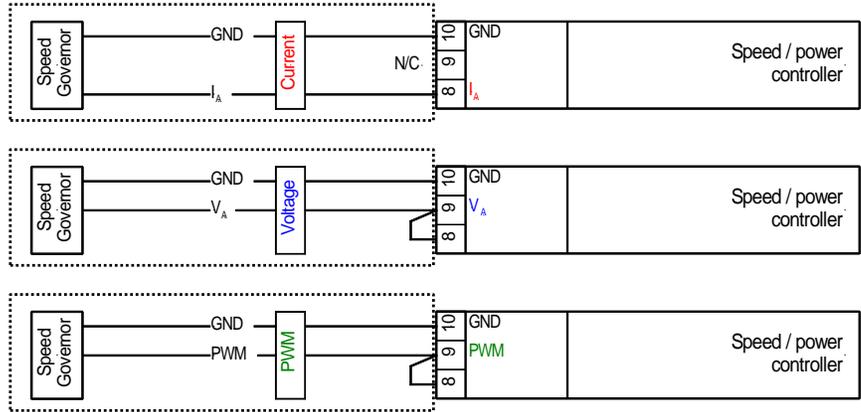
Figure 4-13: Controller - SPM-D2-11/LSXR - Analog controller output - Speed/frequency/real power

Type	Terminal		Description	A_{max}
I Current	8	I_A		2.5 mm²
	9			2.5 mm²
	10	GND		2.5 mm²
V Voltage	8		Speed controller / Frequency controller / Real power controller	2.5 mm²
	9	V_A		2.5 mm²
	10	GND		2.5 mm²
PWM	8			2.5 mm²
	9	PWM		2.5 mm²
	10	GND		2.5 mm²

Setting: 'ANALOG' (Analog Controller) -Voltage / power factor controller
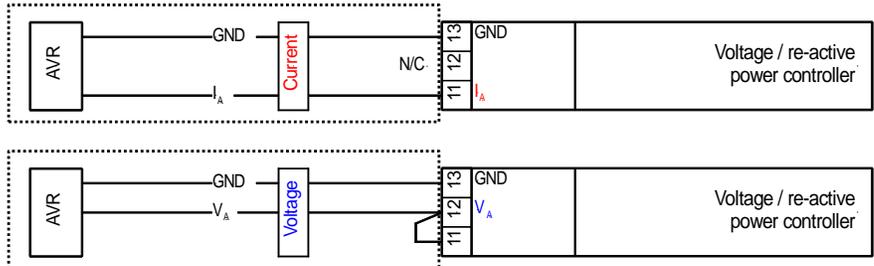
Figure 4-14: Controller - SPM-D2-11/LSXR - Analog controller output - Voltage/power factor

Type	Terminal		Description	A_{max}
I Current	11	I_A		2.5 mm²
	12			2.5 mm²
	13	GND	Voltage controller	2.5 mm²
V Voltage	11		Power factor cosphi controller	2.5 mm²
	12	V_A		2.5 mm²
	13	GND		2.5 mm²

Chapter 5.
Description of Functions

Functional Description

Table for Terminal 6 = "Enable Control"

With this setting, the control can be used as an SPM-A.

The status of the discrete inputs "Reply: CB is open" and "Enable CB" is displayed via the LEDs "Gen CB - ON" and "Gen CB free" on the pressure-sensitive front membrane. Additional to the input signals the conditions Table 5-3: Operating conditions - must be observed.

Input signal				Operating condition	Cond.	Relay "Command: close CB"	Operating mode SPM-A
LED "Gen-CB ON"	**LED** "Gen CB free"	**Discr. input term. 5**: "Enable Isolated operation/ dead start"	**Discrete input term. 6** "Enable controller"				
0	0	x	0	OFF or automatic idle running	- C1	OFF OFF	OFF
0	0	x	1	No load operation or synchronization	C A	OFF OFF	CHECK
0	1	0	0	OFF	A	Slip or phase matching	PERMISSIVE
0	1	0	1	No load operation or synchronization	C A	OFF Slip or phase matching	RUN
0	1	1	0	OFF	A	Synchro-Check	-
0	1	1	1	No load operation or synchronization or dead bus start	C A B	- Slip or phase matching dead bus start	RUN (extended)
1	x	x	0	OFF	-	OFF	-
1	0	0	1	Mains parallel operation or shut down	- E	OFF OFF	-
1	1	0	1	Mains parallel operation	-	OFF	-
1	1	1	1	Load/var sharing or Isolated operation	F D	OFF OFF	-
1	0	1	1	Load/var sharing or isolated operation or shut down	F D E	OFF OFF OFF	-

 0: "OFF" / 1: "ON" / x: Signal of no significance (0 or 1)

Table 5-1: Operating conditions - Terminal 6 = "Enable control"

Table for Terminal 6 = "Enable Power Set point Value 2"

The status of the digital inputs "Reply: CB is open" and "Enable CB" is displayed via the LEDs "GCB closed" and "Release GCB" on the pressure-sensitive front membrane. Additional to the input signals the conditions listed in Table 5-3: Operating conditions - must be observed.

Input signal			Operating condition	Cond.	Relay "Command: close CB"
LED "Gen-CB ON"	**LED** "Gen CB free"	**Discr. input term. 5**: "Enable Isolated operation/ dead start"			
0	0	x	OFF or idle operation	- C1	OFF OFF
0	1	0	No load operation or synchronization	C A	OFF Slip or phase matching
0	1	1	No load operation or synchronization or dead bus start	C A B	OFF Slip or phase matching Black start
1	0	0	Mains parallel operation or shut down	- E	OFF OFF
1	1	0	Mains parallel operation	-	OFF
1	1	1	Load/var sharing or isolated operation	F D	OFF OFF
1	0	1	Load/var sharing or isolated operation or shut down	F D E	OFF OFF OFF

 0: "OFF" / 1: "ON" / x: Signal of no significance (0 or 1)

Table 5-2: Operating conditions - Terminal 6 = "OFF"

Additional Conditions

The function of the control is also dependent, apart from the digital input signals, on the state of the available measured voltages. The particular function must also be enabled in configuration mode:

Condition		

A	Synchronization Generator circuit breaker	- Generator and synchronization voltage must comply with the following:
		    50 % < V < 125 % of the rated voltage V_N
		    80 % < f < 110 % of the rated frequency f_N
		    (after time monitoring expires, the synchronization will be aborted)
		 -Parameter "Synchronization=ON"

B	Dead bus Generator circuit breaker	- Parameter "Dead bus GCB ON" - Synchronization voltage must be less then 5% of the rated voltage - Generator voltage and frequency must be within the configured limits of the dead bus start

C1	Automatic idle running	- Parameter "Automatic idle running ON"
		 - The frequency controller complies with the following conditions:
		    Generator voltage > 50 % of the rated voltage V_N
		 - The voltage controller complies with the following conditions:
		    Generator frequency > 90 % of the rated frequency f_N

C	No-load operation	- for f control:
		    Generator voltage > 50 % of rated voltage V_N
		 - for V control:
		    Generator frequency > 90 % of rated frequency f_N

D	Isolated operation	- Generator voltage > 50 % of rated voltage V_N - For voltage controller: Parameter "Voltage controller in no-load operation ON" - For frequency controller: Parameter "Frequency controller in isolated operation ON".
E	Shut down	- Parameter "Shut down ON"

F	Load/var sharing control	- for load sharing:
		    Parameter "Load sharing ON"
		 - for var sharing:
		    Parameter "var sharing ON"

Table 5-3: Operating conditions - status of measuring inputs and configuration

Control Inputs

========================

Release CB
Terminal 3

- Terminal 6 = "Release control"
  A signal into this discrete input enables operation of the power circuit breaker. For tests during commissioning, ensuring that no voltage is applied to this input will prevent the power circuit breaker from operating, even if the control functions are enabled.
- Terminal 6 = "Set point power"
  A signal into this discrete input enables the operation of the breaker and the control functions.

Reply:
CB is open
Terminal 4

The status of the CB must be transmitted to the unit through this input. The input must be energized if the CB is open. The status of this input is checked for its plausibility and is signaled with the LED "Gen CB - ON".

Enable: Isolated operation/dead bus start
Terminal 5

Energizing this input when the breaker is open enables a dead bus start. Energizing this input when the breaker is closed enables the frequency and voltage controllers for isolated operation or load sharing control.

Enable control
Enable Pset 2
Terminal 6

- Terminal 6 = "Release control"
  The frequency and voltage controllers are enabled by energizing this input. For tests during commissioning, ensuring that no voltage is applied to this input will prevent the power circuit breaker from operating, even if the control functions are enabled.
- Terminal 6 = "Set point power"
  The second set point value or the set point value via analog input is enabled.

⚠️ **CAUTION**

If several generators feed one busbar, it has to be ensured with external interlocking that only one of the generators is released for dead bus start at a time. If several generators are released for dead bus start at the same time, it may happen that the generator circuit breakers close at the same time, which might cause serious damage to the generators!

Isolation of the Power Supply from the Discrete Inputs

============================

NOTE

Please observe the notes about the maximum voltage ratings in the section Discrete Inputs on page 14!

By means of appropriate external wiring, the common reference point of the discrete inputs (terminal 7) can be galvanically separated from the supply voltage (0 V, terminal 2) . This is necessary, for instance, if the discrete inputs are not to be controlled with +24 Vdc and a galvanic separation of the control voltage (e. g. 220 Vdc, 220 Vac) from the supply voltage needs to be ensured.

Wiring should be made as follows:

- Reference points connected with 0 V
    Jumper between terminal 7 and terminal 2 (0 V)
- Reference point of the discrete inputs potential-free:
    Terminal 2:   0 V (supply voltage)
    Terminal 7:   0 V or N (control voltage)

Operating Conditions

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No Load Control

The generator voltage and generator frequency are adjusted to the configured set point values. The generator circuit breaker is open.

Synchronization

Synchronization with slip

The generator voltage will be corrected to the amplitude and frequency of the synchronization voltage. The close command for the power circuit breaker will be issued, taking into account the inherent switching delay. The synchronization is carried out under the following conditions (see also tables in chapter "Function" at page 20):

- The control is in the automatic mode (LED "Automatic" lights up)
- The synchronization is switched on
- The voltages and frequencies are within the specified range
- The input "Enable CB" is energized (if terminal 6 = OFF)
- The input "Enable CB" is energized to enable the close command and the input "Release control" is energized, to enable the control functions (if terminal 6 = Release control)
- The input "Reply: CB is open" is energized
- The synchronization time monitoring is not switched on or has not tripped

Phase Matching Synchronization

The voltage controller will correct the generator voltage to the amplitude of the synchronization voltage. The frequency controller operates in two possible stages:

- Frequency correction: - As long as the difference of the frequency between generator and busbar/mains does not fall below the configured value "df start", the generator frequency is corrected to that of the busbar/mains.
- Phase angle correction: - If the frequency difference between generator and busbar/mains is less than the value "df start", the frequency controller adjusts the phase angle of the generator to that of the busbar/mains, in order to drive the phase difference to zero. The control of the phase angle is stopped only when the frequency difference between the generator and the busbar/mains becomes greater then the value "df start" plus a fixed programmed hysteresis of 0.8 Hz.

The close command for the power circuit breaker is issued under the following conditions:

- The configured limits for voltage and frequency are met
- The phase angle between the systems is less then the maximal permissible angle for at least the configured time
- The input "Enable CB" is energized (if terminal 6 = OFF)
- The input "Enable CB" is energized, to enable the close command and the input "Release control" is energized, to enable the controls (if terminal 6 = Release control)
- The input "Reply CB is open" is energized

The close command is issued without consideration of the inherent switching delay. In the phase-angle-zero-control mode, the analog input should be selected for the frequency controller.

Synch-Check

In this condition, the unit can be used as a check-synchronizer. No control is carried out. The relay "Command: CB close" remains energized, as long as the following conditions are met:

- The configured limit for the voltage difference is met
  (screen "synchronization dV_{max})
- The configured limits for the frequency difference are met
  (screen "synchronization df_{max} and df_{min}")
- The configured limit for the phase angle is met
  (screen "slip synchroniz. $phase_{max}$")
- The input "Reply: CB is open" is energized
- The parameter "Terminal 6" is configured to "Release control"
- The terminal 6 is not energized (the control is disabled)
- The input "Enable isolated operation / dead bus start" is energized
- The input "Enable CB" is energized

The synchronization time monitoring is disabled.

Isolated Operation

The generator voltage and frequency are controlled according to the configurable set point values. The generator breaker is closed. To activate the voltage controller, the parameter "volt. controller in isol. oper." must be set to "ON". To activate the frequency controller, the parameter "freq. controller in isol. oper." must be set to "ON". Additionally, the discrete input "Enable isolated operation / dead bus start" must be energized to enable isolated operation.

Closing the CB Without Synchronization (Dead Bus Start)

A close command for the power circuit breaker will be output without synchronization if the following conditions are met:

- The control is in the automatic mode (LED "Automatic" lights up)
- The parameter "**Gen. circ.break. Dead bus op.**" has been set to "**ON**"
- The bus bar is not energized ($V_{SS} < 5$ % V_N)
- The generator voltage and frequency are within the configured limits
- The input "Enable isolated operation / dead bus start" is energized
- The input "Enable CB" is energized
- The input "Reply: CB is open" is energized

⚠️ **CAUTION**

If several participants in a power pool are enabled to perform a dead bus start, an external interlock must ensure that it is not possible for two or more units to perform a dead bus start.

Shutdown

If the parameter "Download and open GCB" has been configured as "ON", the controller can be configured to perform a shutdown function in the following manner:
- Terminal 3 "Enable CB" is de-energized, initiating the shutdown
- The power will be reduced according to the setting configured in "Power controller ramp" (refer to section Power Set point Value on page 55)
- When the real power falls below 10 % of the generator rated power, the relay "Command: open CB" will open

Mains Parallel Operation

In mains parallel operation both circuit breakers are closed and the real power and the power factor cos phi are controlled to the configured set point values, provided that the controllers are configured to enabled. If the parameter "terminal 6 = Release control" is set, terminal 6 must also be energized, so that the controllers operate.

Selection of the power set point value

- If the generator is connected in parallel with the mains via the CB, initially a partial load is assumed.
- When the partial load pre-run is completed (or deactivated) the following table is valid for the selection of the power set point mode:

Parameter "Terminal 6"	Condition "Terminal 6"	Parameter "Power set point external"	active set point value
Release control	1	ON	External: via 0 to 20 mA
		OFF	Internal: Power controller Pset2
Set point power	1	ON	External: via 0 to 20 mA
		OFF	Internal: Power controller Pset2
	0	x	Internal: Power controller Pset1

0: "OFF" / 1: "ON" / x: Signal of no significance (0 or 1)

Table 5-4: Power set point modes

- If an external signal has been selected for the parameter "Power set point external", the correct signal type must be selected on the following configuration screen.
- The power set point upper limit must be configured as the value "Power controller P max"
- The power set point lower limit must be configured as the value "Power controller P min"
- The power set point has a configurable ramp rate. This slope can be configured in the parameter "Power controller Ramp".

Load Sharing

The SPM-D2-11 is designed so that when several generators are operating in parallel (isolated operation) on a common mains bus, the real power of the isolated system (in reference to the relevant rated load) is shared equally among the generators.

Isolated/mains parallel operation. Each controller participating in load sharing influences the genset to which it is assigned in such a manner that the preset rated frequency (main control variable) remains constant. All units are interlinked via an analog signal against which any deviation in real power (generator power) can be determined for each genset. This control variable (secondary variable) is taken into consideration in controlling the frequency. The weighting, with which the secondary and the main control variable (= "reference variable") are processed, can be set via a weighting factor (parameters "Act. load share Factor"). In settled state, the isolated system has the set rated frequency, whereby the total real power (in reference to the relevant rated power) is subdivided equally amongst those gensets involved.

Note – The frequency regulators of the generators must be suitably configured for parallel operation (i.e. droop operation mode)

Note – Other SPM-D2-11 units, which are not participating in load sharing, must not be connected to the load sharing signal line (terminal 29)

Prerequisite – The following values and adjustments of each unit in the load sharing system must be identical

- All units must have identical configured rated frequencies
- All units must have the "Load sharing" function configured to "ON"
- All units must have the same status signal for "Enable CB" (either all logic "1" or all logic "0")
- All units must have the same status signal for "Reply: CB closed" (either all logic "1" or all logic "0")
- Only one unit may have the parameter "Gen. circ.break. Dead bus op" configured as "ON"

The "Gen. circ.break. Dead bus op" parameter can be enabled for several units, provided that a control is available to override the function via the digital inputs "Enable CB" or "Enable isolated parallel operation".

var Sharing

The SPM-D2-11 is designed so that when several generators are operating in parallel (isolated operation) on a common mains bus, the reactive power of the isolated system (in reference to the relevant rated load) is shared equally among the generators.

Isolated/mains parallel operation. Each controller participating in var sharing influences the genset to which it is assigned in such a manner that the preset rated voltage (main control variable) remains constant. All units are interlinked via an analog signal against which any deviation in reactive power (generator power) can be determined for each genset. This control variable (secondary variable) is taken into consideration in controlling the voltage. The weighting, with which the secondary and the main control variable (= "reference variable") are processed, can be set via a weighting factor (parameters "React. load share Factor"). In settled state, the isolated system has the set rated voltage, whereby the total reactive power (in reference to the relevant rated power) is subdivided equally amongst those gensets involved.

Note – The voltage regulators of the generators must be suitably configured for parallel operation (i.e. droop operation mode)

Note – Other SPM-D2-11 units, which are not participating in var sharing, must not be connected to the load sharing signal line (terminal 30)

Prerequisite – The following values and adjustments of each unit in the var sharing system must be identical

- All units must have identically configured rated voltage
- All units must have the parameter "Reactive power Load-share" configured as "ON"
- All units must have the same status signal for "Enable CB" (either all logic "1" or all logic "0")
- All units must have the same status signal for "Reply: CB closed" (either all logic "1" or all logic "0")

The "Gen. circ.break. Dead bus op" parameter can be enabled for several units, provided that a control is available to override the function via the digital inputs "Enable CB" or "Enable isolated parallel operation".

LED "Gen CB - ON" Flashes

LED "Gen CB - ON" flashes: Incorrect signal state of the "Reply: CB is open" on terminal 4.
Possible faults:
- Reply "closed" is present (= 0 V) and the generator and mains/busbar voltage not synchronized

If the LED flashes, one must check to see whether the input on terminal 4 is wired correctly. If the terminal is wired correctly, there will be **0 V** applied to the input when the **power circuit breaker is closed**.

Control Outputs

========================

Synchronization pulse:
Command: Close CB
Terminals 14/15

Energizing this relay will close the CB. The relay de-energizes after the close pulse is output. Exception: "Synch-check" operating mode.

Readiness for operation
Terminals 18/19

The relay contact is closed when the control is ready for operation. The relay will de-energize if any of the following occurs:

a) The internal self-monitoring system signals an alarm condition. In this case a trouble-free function of the control cannot be guaranteed and other appropriate corrective measures must be taken.

b) The synchronization time monitoring system is enabled and the configured time has expired before synchronization has occurred.

Command: open CB
(for shut down)
Terminal 39/40

The contact for this function is a N.O. contact. In normal operations, this contact is continuously energized. It is de-energized when the "Shut down" function is enabled.

Prerequisites:
- The parameter "Download and open GCB" is configured to ON
- The circuit breaker is closed

The controller can be configured to perform a shutdown function in the following manner:
- Terminal 3 "Enable CB" is re-energized, initiating the shutdown
- The power will be reduced
- When the real power falls below 10 % of the generator rated power, the relay "Command: open CB" will open

This relay is reserved for shut down functions and operates independently from the watchdogs.

Power limit
Terminal 16/17

This relay serves for controlling the power to a configured limit. The relay opens when the power limit value is exceeded for the configured time and closes again, when the power falls below the limit value minus the configured hysteresis. Using this relay, it is possible for example to disconnect loads or activate further generators.

Analog Controller Outputs

The analog PID controller forms a closed-loop control loop together with the controlled system (usually a first-order lag element). The parameters of the PID controller (proportional-action coefficient K_P, derivative-action time T_V and reset time T_n) can be modified individually.
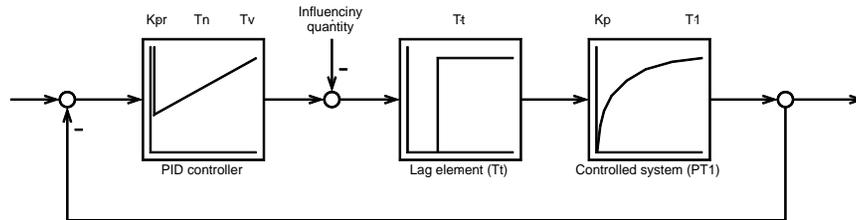
Figure 5-1: Control loop

If an abrupt disturbance variable is applied to the control loop, the reaction of the controlled system can be recorded at the output as a function of time (step response).
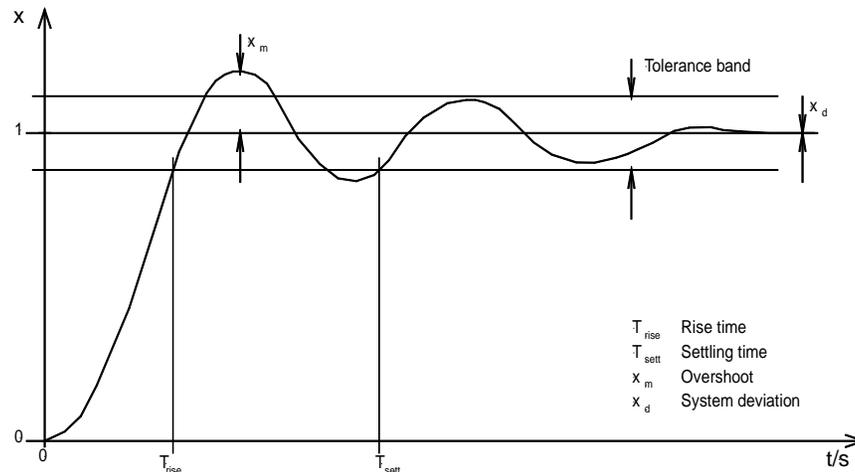
Figure 5-2: Step response (example)

Various values can be derived from the step response; these are required for adjusting the controller to its optimum setting:

Rise time T_{rise}: Period starting when the value of the control variable leaves a predefined tolerance range for this variable following a jump in the disturbance variable or reference input variable and ending the first time the value re-enters this range.

Settling time T_{sett}: Period starting when the value of the control variable leaves the predefined tolerance range for the control variable following a step in the disturbance variable or reference input variable and ending when the value re-enters this range permanently.

Overshoot x_m: Highest transient deviation from the set point value during the transition from one steady-state condition to a new steady-state condition, following a change in value of the disturbance variable or reference input variable ($x_{m\,Optimal} \leq 10\,\%$).

Permanent control deviation x_d: The resultant deviation between set point value and output variable in the steady-state condition (PID controller: $x_d = 0$).

From these values, the values K_P, T_n and T_V can be derived. It is possible, to determine the optimal controller settings by calculating compensation or adjustment of the time constants, T-sum rule, or symmetrical optimum. Other setting procedures and information may be obtained from current literature.

⚠️ **CAUTION**

The following must be observed regarding the controller setting:
- **Ensure that the emergency shutdown system is ready for use.**
- **While determining the critical frequency, pay attention to the amplitude and frequency.**
- **If the two values change in an uncontrollable manner:**

➜ **EMERGENCY SHUTDOWN** ⬅

Initial state: The initial state determines the start position of the controller. If the controller is switched off, the initial state can be used to output a fixed controller position. Even when the analog controller is switched off, the initial state can be freely adjusted (e.g. the speed controller can be controlled in a static manner).

```Controller output``` ```Initial state 000%```	**Initial state**	**0 to 100 %**
	Analog controller output setting with controller switched off.	

General settings: The setting rule described below only serves as an example. Whether this method is suitable for setting your particular control system is not and cannot be taken into account, as each controlled system behaves uniquely.

There are various methods of setting a controller. The setting rules of Ziegler and Nichols are explained below (determination for abrupt disturbances on the system input); this setting method assumes a pure lag element connected in series with a first-order lag system.

1.   Controller operated as a P-only controller
      (where $T_n = \infty$ [screen setting: $T_n = 0$], $T_V = 0$).
2.   Increase gain K_P (P gain) until the control loop oscillates continuously at $K_P = K_{Pcrit}$.

⚠️ **CAUTION**

If the control starts to oscillate uncontrollably, perform an emergency shutdown and change the screen setting accordingly.

3.   Measuring of the cycle duration T_{crit}
4.   Set the parameters:

PID controller   **PI controller**
  $K_P = 0{,}6 \quad \times K_{Pcrit}$ $K_P = 0{,}45 \quad \times K_{Pcrit}$
  $T_n = 0{,}5 \quad \times T_{crit}$ $T_n = 0{,}83 \quad \times T_{crit}$
  $T_V = 0{,}125 \times T_{crit}$

Step response		
Controller setting Optimum ($x_m \leq 10\ \%$)	Controller setting T_{crit}	Controller setting Incorrect
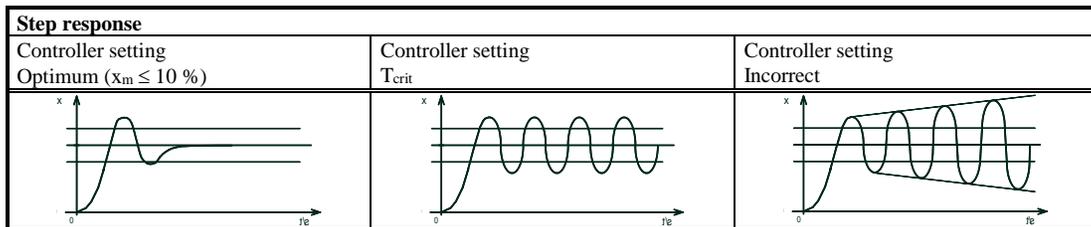
Figure 5-3: Step response - controller set-up

Pr.-sensitivity Kp = 000	**P gain** (K_P) Proportional-action coefficient	**1 to 240**

The proportional-action coefficient K_P indicates the closed-loop control system gain. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value.

Reset time Tn = 00.0s	**Reset time** (T_n)	**0.2 to 60.0 s**

The reset time T_n represents the I-component of the PID controller. The reset time corrects for any offset (between set point and process variable) over time until the process variable and the set point are the same. This parameter defines how quickly the reset attempts to correct for any offset. If T_n is configured as 0.00 s, the I-component of the PID loop is disabled.

Derivative act. time Tv=0.00s	**Derivative-action time** (T_V)	**0.00 to 6.00 s**

The derivative-action time T_V represents the D-component of the PID controller. The D-component of the controller output becomes effective with large variations of the offset, e.g. in case of load-shedding. The lower the derivative-action time is configured, the higher the controller reaction is. If T_V is configured as 0.00 s, the D-component of the PID loop is disabled.

Chapter 6.
Display and Operating Elements

The foil of the front plate is made of coated plastic. All keys have been designed as touch-sensitive membrane switch elements. The display is a LC-display, consisting of 2 rows each with 16 characters, which are indirectly illuminated red. Contrast of the display is infinitely variable by a rotary potentiometer at the left side.
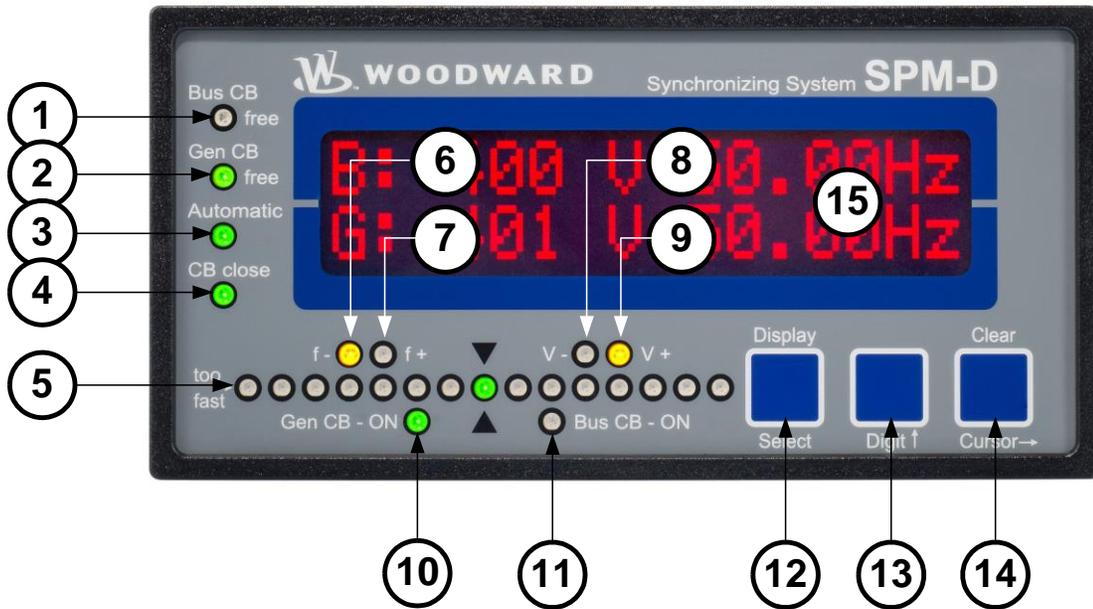
Figure 6-1: Front foil

Brief Explanation of the LEDs and Push Buttons

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LEDs

No	Description	Function
1	Bus CB Free	Non-functional
2	Gen CB Free	Enable CB
3	Automatic	Automatic mode
4	CB close	Close command to the CB issued
5	Synchroscope	Display of phase position
6	f-	Governor output: frequency lower (reduce speed)
7	f+	Governor output: frequency raise (increase speed)
8	V-	Governor output: voltage lower (reduce excitation)
9	V+	Governor output: voltage raise (increase excitation)
10	Gen CB - ON	Reply: CB is closed
11	Bus CB - ON	Non-functional

Buttons

No	Description	Function
12	Display↓	Scroll display
12	Select	Confirm selection
13	Digit↑	Increase digit
14	Clear	Acknowledge alarm
14	Cursor→	Shift input position one digit to the right

Others

No	Description	Function
15	LC-Display	LC-Display
	Potentiometer	Adjust LCD contrast

LEDs

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| 1 | **Bus CB Free**
here: non-functional
Color: green | **Enable mains circuit breaker** |
| | | **NOTE**: This LED is non-functional, as this is a "One-power-circuit-breaker configuration". |

| 2 | **Gen CB Free**
Color: green | **Enable generator circuit breaker** |
| | | The LED "Gen CB Free" indicates that the power circuit breaker has been enabled for operation. The status of the LED corresponds to the status of the discrete input "Enable CB". |

| 3 | **Automatic**
Color: green | **Automatic mode** |
| | | The LED "automatic" illuminates when the control is in automatic mode. It will extinguish as soon as you switch to the configuration mode. |

| 4 | **CB close**
Color: green | **CB close** |
| | | The LED "CB close" illuminates when the control outputs a close command to the power circuit breaker. The status of the LED corresponds to the status of the relay "synchronizing pulse command: close CB. |

| 5 | LED-row: **too fast→**
Color: red/yellow/green | **Phase position / synchroscope** |

The row of LEDs indicates the current phase position between the two voltages indicated on the display. The green LED in the middle of the 15 LEDs indicates that the measured phase angle between the voltage systems is less than 12 ° electrically. The phase position is only displayed in the automatic mode and only if the difference between the frequency values is smaller than 2 Hz and both voltages are within the specified permissible ranges. These ranges are defined as follows:

| **Frequency ranges** | Generator and mains | 80 to 110 % f_N |
| **Voltage ranges** | Generator and mains | 50 to 125 % V_N |

There are two different directions of rotation:

left → right . If the LED's run from left to right, the generator frequency is too high, i. e., the generator or the variable bus frequency is too fast.

right → left . If the LED's run from right to left, the generator frequency is too low, i. e., the generator or the variable bus frequency is too slow.

6	**f-** Color: yellow	**Governor output decrease frequency**
	Three position controller	The LED "f-" indicates if the control outputs a pulse to decrease the frequency. The status of the LED corresponds to the status of the relay "speed lower".
	Analog controller	If the actuator output signal of the controller is changing to reduce the frequency, the LED illuminates.
7	**f+** Color: yellow	**Governor output increase frequency**
	Three position controller	The LED "f+" indicates if the control outputs a pulse to increase the frequency. The status of the LED corresponds to the status of the relay "speed raise"."
	Analog controller r	If the actuator output signal of the controller is changing to increase the frequency, the LED illuminates.
8	**V-** Color: yellow	**Governor output reduce voltage**
	Three-position controller	The LED "V-" indicates if the control outputs a pulse to decrease voltage. The status of the LED corresponds to the status of the relay "voltage lower".
	Analog controller	If the actuator output signal of the controller is changing to reduce the voltage, the LED illuminates.
9	**V+** Color: yellow	**Governor output increase voltage**
	Three-position controller	The LED "V+" indicates if the control outputs a pulse to increase voltage. The status of the LED corresponds to the status of the relay "voltage raise".
	Analog controller r	If the actuator signal of the controller is changing to increase the voltage, the LED illuminates.
10	**Gen CB - ON** Color: green	**Power circuit breaker ON**
		The LED "Gen CB - ON" signals the response of the generator circuit breaker. The LED illuminates if the discrete input "Reply: CB is open" is not energized and will extinguish as soon as the discrete input is energized. (see also chapter "LED "Gen CB - ON" Flashes" on page 28).
11	**Bus CB – ON** here: non-functional Color: green	**Mains power circuit breaker ON**
		NOTE: This LED is non-functional, as this is a "One-power-circuit-breaker configuration".

Push Buttons

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Configuration may be performed by manually inputting the desired set points utilizing the pushbuttons and the LC display. In order to facilitate configuring the parameters, the push buttons have been enabled with an AUTOROLL function. This permits the user to advance to the next setting, configuration screen, digit, and/or cursor position more rapidly by pressing and holding the corresponding pushbutton.

12	Display / Select	**Display / Select**

Automatic mode: <u>Display</u> - By pressing this button, the user may navigate through the displayed measured parameters and alarm messages.

Configuration: <u>Select</u> - Advances the LC display to the next configuration screen. If any values in a configuration screen have been modified with the "Digit↑" or "Cursor→", then the "Select" button must be pressed to save the new setting. By pressing this pushbutton again, the user causes the system to display the next configuration screen.

13	Digit↑	**Digit ↑**

Automatic mode: <u>Digit↓</u> - no function

Configuration: <u>Digit↑</u> - Numerical values over the cursor are increased by one digit. The increase is restricted by the admissible limits (refer to the list of parameters included in the appendix). If the maximum admissible number is reached, the number automatically returns to the lowest admissible number.

14	Clear / Cursor →	**Clear / Cursor→**

Automatic mode: <u>Clear</u> - Alarms that have occurred may be acknowledged by pressing this button as long as the fault that triggered the alarm is no longer present.

Configuration: <u>Cursor→</u> - This button moves the cursor one position from left to right. When the cursor is under the last digit that may be changed, it may be moved to the first number of the value by pressing the "Cursor→" button again.

LC Display

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| 15 | LC-Display | **LC-Display** |

The two-line LC display outputs corresponding text messages and values depending on the mode that the SPM-D2 is operating. In the configuration mode, the monitoring parameters may be changed. When the SPM-D2 is in the automatic mode, the measured values are displayed.

Display Monitoring in Automatic Mode: Double Voltage / Frequency Display

LCD type 1 (V configured)

```
B: 000 V 00.00Hz
G: 000 V 00.00Hz
```

Double voltage and double frequency displays, Generator values

The generator and synchronization voltage and frequency are displayed. The phase angle between the generator and synchronization voltage is displayed by the synchroscope (LED strip).

LCD type 2 (kV configured)

```
B:00,0kV 00.00Hz
G:00,0kV 00.00Hz
```

B .... Synchronization voltage and frequency
G .... Generator voltage and frequency

LCD type 1 (V configured)

```
Gen  000V  i0.95
     000A  000kW
```

Generator values

Generator values are monitored:

LCD type 2 (V configured)

```
Gen 00,0kV i0.95
    000A  000MW
```

G .... Generator values
- upper line:
  - Line voltage L1-L2
  - phase angle
- bottom line:
  - current L1
  - Real power

NOTE

Refer to the appendix Power Factor Definition on page 76 for the phase angle display.

Display Monitoring in Automatic Mode: Alarm Indication

```
----------------
xxxxxxxxxxxxxxxx
```

Alarm indication, bottom line

The indications are displayed according to the following list:

Type of alarm	Displayed text
Synchronization time is exceeded	`Synchr. time`
Wire break 0/4-20mA input for set point value	`Wirebreak P`$_{set.}$
Generator underfrequency	`Gen. underfrequency.`
Generator overfrequency	`Gen. overfrequency.`
Generator undervoltage	`Gen.undervoltage.`
Generator overvoltage	`Gen.overvoltage.`
Generator overload	`Gen.overload.`
Generator reverse-/-reduced load	`Reverse/reduced load.`

Chapter 7.
Configuration

In order to configure the device via a PC/Notebook please proceed as follows.

1.   Install Toolkit[*1] and the USB Driver for the SPM-D2 from the CD that is provided with the product or from the webpage.

2.   Copy the *.wtool[*2] and *.sid[*2] file from the product CD to your PC or Notebook.

3.   Connect the PC or Notebook and the device via an USB cable.

4.   Start Toolkit

5.   Select "File –> open tool" and use the copied wtool file

6.   Click on the "connect button" and select the network type. The USB driver is listed as a COM port.

7.   "Toolkit" will establish the connection to the device and ask for a "SID" file. Please navigate to location from the copied *.sid file.

8.   Now the communication with the device is active and measured values and parameter settings will be displayed.

9.   Please note, that during the online communication all modified parameter will be automatically saved on the device.

10.   Back up your settings by "Settings -> Save from Device to file". A file with the extension "*.WSET" will be written to your storage media.

11.   Remove the USB cable not before all settings are done and backed up.

[*1]= To get the latest Toolkit software via the web:
- Call up http://www.woodward.com/software within your browser.
- Select ToolKit in the list and click the "Go" button.
- Click "More Info" to get further information about ToolKit.
- Choose the preferred software version and click "Download"
- Login with your e-mail address or register first.
  The download will start immediatly.

[*2]= To get the configuration files (WTool and the SID) from the website:
- Call up http://www.woodward.com/software/configfiles within your browser.
- Insert the part number (P/N) and revision of your device into
- the corresponding fields.
- Select "ToolKit" in the "application type" list.
- Click "Search" .
- Download the file displayed in the search result.
  The file is a ZIP archive which must be extracted for use
  in ToolKit.

⚠ **CAUTION**

Please note that configuration should not be carried out while the control unit is in operation.

ℹ **NOTE**

A list of parameters may be found in the List of Parameters on page 73.

The configuration mode will be enabled through the front face panel by simultaneously pressing the "Digit↑" and "Cursor→" buttons. The user may advance through the configuration screens by pressing the "Select" button. Pressing and holding the "Select" button will enable the "AUTOSCROLL" function, permitting the user to rapidly advance through the configuration screens. To access the previous parameter screen, press the "Select" and "Cursor→" push button simultaneously.. If the controller is left idle for 10 minutes, the controller automatically returns to the automatic mode.

Configure Basic Data

≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡≡

Parameter 1700

```
SPRACHE/LANGUAGE
---------------
```
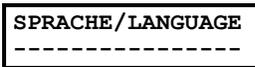
Language selection   **English / German**

The desired language for the controller to operate in is set by this parameter. The screens (configuration and display screens) can be displayed either in German or English.

Parameter 945

```
Softwareversion
x.x-y zzzzz
```

Softwareversion

x.x indicates the release.
-y indicates the hotfix version.
zzzzz indicates the build number (hand off)

Password Protection

The unit is equipped with a three-level code hierarchy. This permits access to different levels of selected parameters and configuration privileges. A distinction is made between:

- **Code level 0 (CL0) -** User: <u>Third party</u>
  This code level does not allow access to the parameters. The configuration function is locked.

- **Code level 1 (CL1) -** User: <u>Customer</u>
  This code level authorizes the user to change selected parameters. Authorization for changing the pass code is not permitted at this level.

- **Code level 2 (CL2) -** User: <u>Commissioner</u>
  This code level grants full access privileges to all parameters. Authorization is also granted to changing pass codes. In this level, the code protection can be turned OFF (see below).

Parameter 10400

```
Enter code
           XXXX
```

Enter code number   **0000 to 9999**

When entering the configuration mode, the unit generates a random number. The appropriate code in now entered and confirmed with the "Select" button. If the random number was confirmed without being changed, the code level of the unit remains unchanged. Two four-digit code numbers (0000-9999) exist for accessing the parameters. The "Third Party" level does not have a code assigned since this level does not obtain access privileges to the configuration (protected by the code). If an incorrect pass code is entered, the control unit changes to code level 0.

NOTE

Once the code level has been set, it will remain unchanged, even after repeatedly entering the configuration mode. In the event that an incorrect code number is entered, the code level is set to CL0 and locked to the third party user level, thus preventing access to any user (reference: change passwords on page 41). Two hours after the last operation, the unit automatically reverts to code level CL0. By entering the correct code number, the appropriate privileges will be granted again.
The default code number for code level 1 (CL1) is "0001"!
The default code number for code level 2 (CL2) is "0002"!
Only in code level 2 can the password protection be disabled!

Parameter 10419

```
Enter Password
Protection   ON
```

Password protection   **ON/OFF**

ON................The password for code level 1 or 2 must be entered to access configuration. If a wrong code number was entered, the configuration will be blocked.
OFF..............All users have direct access to all parameters, the pass code is not required.

Factory Defaults

Parameter 10417

```
Factory   default
settings       No
```

Factory default settings   **Yes/No**

Yes................Parameter 1701 (Set factory default values) will become visible.
No ....Parameter 1701 (Set factory default values) will be hidden.

Parameter 1701

```
Set factory default
values         No
```

Set factory default values   **Yes/No**

**Please note: This parameter will become visible only if parameter 10417
          "Factory default settings" is set to "Yes".**
Yes................All parameters that are accessible via the set code level will be set back
                   on factory defaults.
No ....All parameters will keep their current setting.

Configure Basic Settings

=========================

⚠️ **WARNING**

The following values must be entered correctly to ensure proper monitoring of the generator. Failure to do so may lead to incorrect measuring of parameters resulting in damage to or destruction of the generator and/or personal injury or death!

Parameter 1750	**Rated generator frequency**	**48.0 to 62.0 Hz**

```
Rated Frequency
     fn = 00.0Hz
```

Enter the rated frequency of the generator (or the utility mains) which in most cases is 50 Hz or 60 Hz.

Parameter 5500	**Generator set point frequency**	**48.0 to 62.0 Hz**

```
Generator freq.
Set point=00.0Hz
```

The set point frequency of the generator is to be entered in this screen. It will be needed for the frequency controller while in no-load operation.

Potential Transformer

Parameter 1800	**Secondary generator voltage (potential transformer)**	**1] 50 to 125 V, [4] 50 to 440 V**

```
Gen. voltage
secondary  000V
```

The secondary generator voltage (busbar voltage) is set here in V. This information serves to show the primary voltage in the display. For voltages of 400 V measured without a potential transformer, 400 V must be entered here.

Parameter 1803	**Secondary mains voltage (potential transformer)**	**1] 50 to 125 V, [4] 50 to 440 V**

```
Mains voltage
secondary  000V
```

Secondary mains voltage (busbar voltage) is set here in V. This entry serves to indicate the primary voltages in the display. In the case of measured voltages of 400 V without a potential transformer, 400 V must be entered here.

Parameter 1801	**Primary generator voltage (potential transformer)**	**0.1 to 65.0 kV**

```
Gen. voltage
primary 00.000kV
```

The primary generator voltage is set here in kV. This entry serves to show the primary voltage in the display. For voltages of 400 V measured without a potential transformer, 0.40 kV must be entered here.

Parameter 1804	**Primary mains voltage (potential transformer)**	**0.1 to 65.0 kV**

```
Mains voltage
primary 00.000kV
```

The primary mains voltage (busbar voltage) is set her in kV. The entry is serves to show the primary voltages on the display. In the case of measured voltages of 400 V without a potential transformer 0.40 kV must be set here.

Parameter 1767	**Rated voltage**	**[1] 50 to 125 V, [4] 70 to 420 V**

```
Rated voltage
     Vn = 000V
```

This value is used, among other things, to determine the permissible range for the synchronization.

Parameter 5600	**Generator set point voltage**	**[1] 50 to 125 V, [4] 50 to 440 V**

```
Gen. voltage
Set point   000V
```

This value of the voltage specifies the set point of the generator voltage for no-load and isolated operation.

Current Transformer

Parameter 1884

```
Current transf.
Generator 0000/x
```

Generator current transformer   **10 to 9.990/x A**

For the indication and control of the generator current, it is necessary to enter the current transducer ratio. The ratio must be selected in a manner to ensure that at maximum power, at least 60 % of the transformer rated current is flowing. Lower percentage values may lead to malfunctions. Moreover, additional inaccuracies occur in the control and monitoring functions.

{X} / 1 A ....Secondary rated current = 1 A at primary rated current = {X} A;
{X} / 5 A ....Secondary rated current = 5 A at primary rated current = {X} A;

Parameter 6673

```
Connection type
Gen.        1W2
```

from version 6.3640

Connection type generator   **1W / 1W2**

1W ....Power measurement in single-phase system
1W2 ....Power measurement in three-phase system

Parameter 1885

```
Generator   curr.
Measurem.   Phase
```

from version 7.10-0

Generator current measurement phase   **L1 /L2 / L3**

Phase that is used in order to measure the current. This current is used in order to calculate Power (balanced system assumed).

Parameter 1886

```
1Ph2W phase rot.
          right
```

from version 7.10-0

1 Ph2w phase rotation   **right / left**

Phase rotation definition. Based on the measured voltages, the phase current and the phase rotation, the power and power direction will be calculated (balanced current/load assumption).

Parameter 1752

```
Rated power
  Gen. = 0000kW
```

Generator rated power   **5 to 9,999 kW**

Value of the generator rated power.

Configure Controller

=========================

Entering the values in the subsequent screens will change the parameters of the controller.

⚠️ **CAUTION**

Incorrect entries may lead to wrong measuring values and result in damage to the generator!

Idle Control

Parameter 6662

```
Automatic idle
Running      ON
```

Automatic idle running   **ON/OFF**

ON................With the generator power circuit breaker open, frequency and voltage are controlled to the adjusted set point values in spite of the controller not being enabled (see also chapter "Function" on page 20).

OFF..............No-load control is carried out only with controller enabled (see also chapter "Function" on page 20).

Parameter 6674

```
Terminal 6
----------------
```

Function of terminal 6   **Release control / Set point power**

Release control The controller is enabled via the discrete input on terminal 6. The power circuit breaker is enabled separately via terminal 3 (Enable CB). Changing the set point value is not possible.

Set point power: The power set point value is changed by energizing terminal 6. Enabling of the controller occurs along with enabling of the power circuit breaker via terminal 3 (Enable CB).

Frequency Controller

Within the SPM-D2- 11/LSXR, several controller output signals can be selected via the screens, which are listed by the controller model.

Parameter 6670

```
f control type
       --------
```

LSXR Package only

Frequency controller type   **THREESTEP/ANALOG/PWM**

THREESTEP The frequency controller operates as three-step controller and issues raise (f+) and lower (f-) pulses via the configured relays. Only one of the two controllers (the frequency or the voltage controller) can be used for relay output at a time.

ANALOG ....The frequency controller operates as a continuous controller with an analog output signal (mA or V).

PWM ....The frequency controller operates as a continuous controller with a pulse-width-modulated output signal and constant level.

Note: The controller setting and the following screens differ, depending on which type of controller is selected here.

Three-Step Controller (SPM-D2-11/LSXR: Setting 'THREESTEP')

Parameter 5507

```
Freq. controller
              ON
```

LSXR Package:
setting 'THREESTEP'

Frequency controller ON/OFF

ON ....The generator frequency is controlled. The control is executed in various manners depending on the task (no load / isolated operation / synchronization). The following screens of this function are displayed.

OFF ....Control is not carried out, and the following screens of this function are not displayed.

Parameter 6655

```
Freq. controller
Isol. oper.   ON
```

LSXR Package:
setting 'THREESTEP'

Isolated operation frequency controller ON/OFF

The setting of this screen has no influence on the load sharing control.
ON ....In isolated operation the frequency controller is enabled.
OFF ....In isolated operation the frequency controller is disabled.

Parameter 5503

```
Freq. Controller
Ramp  =.00.0Hz/s
```

LSXR Package:
setting 'THREESTEP'

Frequency controller set point ramp 0.1 to 99.9 Hz/s

A change in set point is supplied to the controller via a ramp. The slope of the ramp is used to alter the rate at which the controller changes the set point value. The more rapidly the change in the set point is to be carried out, the greater the value must be which is entered here.

Parameter 5550

```
Freq. controller
Dead band=0.00Hz
```

LSXR Package:
setting 'THREESTEP' only

Frequency controller insensitivity 0.02 to 1.00 Hz

No load/Isolated operation: The measured generator frequency is controlled so that it does not deviate from the configured frequency by more than the value configured in this dead band setting while operating in a steady state.

Synchronization: The measured generator frequency is controlled so that the differential frequency does not exceed this dead band setting while operating in a steady state. The mains or busbar frequency is used as the set point value.

Parameter 5551

```
Freq. controller
Time pulse>000ms
```

LSXR Package:
setting 'THREESTEP' only

Minimum ON period – frequency controller 10 to 250 ms

The minimum ON period of the relay should be selected in such a manner that the downstream control element responds reliably to the pulse length set here. The smallest possible time must be set in order to ensure optimum control behavior.

Parameter 5552

```
Freq. controller
Gain Kp     00.0
```

LSXR Package:
setting 'THREESTEP' only

Frequency controller gain 0.1 to 99.9

The gain factor K_p influences the ON time of the relays. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled resulting in longer ON time periods. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value.

Analog Controller Outputs (SPM-D2-11/LSXR: Settings 'ANALOG' and 'PWM')

Parameter 5201

```
f control output
         xxxxxxx
```

only LSXR Package
with 'ANALOG' setting

Controller output signal   **see table**

This configuration screen only appears if the frequency controller is configured as
ANALOG type! The range of the analog output signal is adjusted here. To choose
between a current signal in mA or a voltage signal in V, the appropriate jumpers
must be connected to the output terminals. (see chapter "Controller Outputs" on
page 17). The following output signals are possible:

Type	Setting in above configu-ration screen	Jumper between terminal 8/9	Adjustment range	Adjustment range min.	Adjustment range max.
Current	+/-20mA (+/-10V)	no	+/-20mA	-20 mA	+20 mA
	+/-10mA (+/-5V)		+/-10mA	-10 mA	+20 mA
	0 to 10mA (0-5V)		0 to 10mA	0 mA	10 mA
	0 to 20mA (0-10V)		0 to 20mA	0 mA	20 mA
	4 to 20mA		4 to 20mA	4 mA	20 mA
	10 to 0mA (5 to 0V)		10 to 0mA	10 mA	0 mA
	20 to 0mA (10 to 0V)		20 to 0mA	20 mA	0 mA
	20 to 4mA		20 to 4mA	20 mA	4 mA
Voltage	+/-20mA (+/-10V)	yes	+/-10V	-10 Vdc	+10 Vdc
	+/-10mA (+/-5V)		+/-5V	-5 Vdc	+5 Vdc
	+/-3V		+/-3V	-3 Vdc	+3 Vdc
	+/-2.5V		+/-2,5V	-2,5Vdc	+2,5 Vdc
	+/-1V		+/-1V	-1 Vdc	+1 Vdc
	0 to 10mA (0- to 5V)		0 to 5V	0 Vdc	5 Vdc
	0.5V to 4.5V		0,5 to 4,5V	0,5 Vdc	4,5 Vdc
	0 to 20mA (0 to 10V)		0 to 10V	0 Vdc	10 Vdc
	10 to 0mA (5 to 0V)		5 to 0V	5 Vdc	0 Vdc
	4.5V to 0.5V		4,5 to 0,5V	4,5 Vdc	0,5 Vdc
	20 to 0mA (10 to 0V)		10 to 0V	10 Vdc	0 Vdc

Parameter 5210

```
f control output
Level PWM 00.0V
```

only LSXR Package
with 'PWM' setting

PWM signal level   **3.0 to 10.0 V**

This configuration screen only appears if the frequency controller is configured as
PWM type! The voltage level of the PWM signal is adjusted here.

Parameter 6656

```
PWM-signal
Logic    --------
```

only LSXR Package
with 'PWM' setting

PWM signal logic   **positive / negative**

This configuration screen only appears if the frequency controller is configured as
PWM type!

positive.........If the controller output signal is at 100 %, the adjusted PWM level is
output continuously, at 0 % output signal the output the PWM level is
0 V.

negative ....If the controller output signal is at 100 %, 0 V is output continuously,
0 % output signal corresponds to the adjusted PWM level.

Parameter 5508

```
f control output
Init.state  000%
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

Initial frequency controller state   **0 to 100%**

This parameter is the start point for the output signal when the frequency controller
parameter is configured as OFF. The percentage value relates to the range between
the minimum and maximum values that control unit can output (see below).

Parameter 5507

```
Freq. controller
              ON
```

LSXR Package
with 'ANALOG' or 'PWM' setting

Frequency controller   **ON/OFF**

ON................The generator frequency is controlled. The generator frequency is controlled in various manners depending on the task (no load / isolated operation / synchronization). The following screens of this function are displayed.

OFF..............Control is not carried out and the following screens of this function are not displayed.

Parameter 6655

```
Freq. controller
Isol. oper.   ON
```

LSXR Package
with 'ANALOG' or 'PWM' setting

Frequency controller – isolated operation   **ON/OFF**

The setting of this screen has no influence on the load share control.

ON................In isolated operation the frequency controller is enabled.

OFF..............In isolated operation the frequency controller is disabled.

Parameter 5503

```
Freq. controller
Ramp    00.0Hz/s
```

LSXR Package
with 'ANALOG' or 'PWM' setting

Frequency controller set point ramp   **0.1 to 99.9 Hz/s**

A change in set point is supplied to the controller via a ramp. The slope of the ramp is used to alter the rate at which the controller follows the set point value. The more rapidly the set point should change, the greater this setting should be.

Parameter 5209

```
f control output
(max.)      000%
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

Maximum value frequency controller   **0 to 100%**

Upper limit of the analog controller output.

Parameter 5208

```
f control output
(min.)      000%
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

Minimum value frequency controller   **0 to 100%**

Lower limit of the analog controller output.

Parameter 5510

```
Freq. controller
Gain Kp      000
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

P gain of the frequency controller   **1 to 240**

The proportional-action coefficient K_P indicates the closed-loop control system gain. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value. Refer to "Analog Controller Outputs" on page 30.

Parameter 5511

```
Freq. controller
Reset Tn   00.0s
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

Reset time frequency controller   **0.0 to 60.0 s**

The reset time T_n represents the I-component of the PID controller. The reset time corrects for any offset (between set point and process variable) over time until the process variable and the set point are the same. This parameter defines how quickly the reset attempts to correct for any offset. If T_n is configured as 0.00 s, the I-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Parameter 5512	**Derivative-action time frequency controller**	**0.00 to 6.00 s**

```
Freq. controller
Derivat.Tv 0.00s
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

The derivative-action time TV represents the D-component of the PID controller. The D-component of the controller output becomes effective with large variations of the offset, e.g. in case of load-shedding. The lower the derivative-action time is configured, the higher the controller reaction is. If TV is configured as 0.00 s, the D-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Voltage Controller

The SPM-D2-11 is provided with a three-step controller for voltages and does not contain the following screen. Moreover, only the screens for setting the three-step controller exist. Several controller output signals can be selected using the following screen with the SPM-D2-11/LSXR. Depending on the selected controller type, the following screens belonging to it appear.

Parameter 6671	**Voltage controller type**	**THREESTEP/ANALOG**

```
V contr. type
      xxxxxxx
```

LSXR Package only

THREESTEP: The voltage controller operates as three-step controller and issues raise (V+) and lower (V-) pulses via the respective relays. Only one of the two controllers (the frequency or the voltage controller) can be used for relay output at a time.

ANALOG .... The voltage controller operates as continuous controller with an analog output signal (mA or V).

Note: The controller setting and the following screens are different, depending on the controller type selected here.

Three-Position Controller (SPM-D2-11/LSXR: Setting 'THREESTEP')

Parameter 5607	**Voltage controller**	**ON/OFF**

```
Volt. controller
              ON
```

LSXR Package:
setting 'THREESTEP'

ON .... Generator voltage control is carried out. The generator voltage is controlled in various manners depending on the task (no load / isolated operation / synchronization). The following screens of this function are displayed.

OFF .... Control is not carried out, and the following screens of this function are not displayed.

Parameter 6657	**Voltage controller isolated mode**	**ON/OFF**

```
Volt. controller
Isol. oper.  ON
```

LSXR Package:
setting 'THREESTEP'

The setting of this screen has no influence on the load share control.
ON .... In isolated operation the voltage controller is enabled.
OFF .... In isolated operation the voltage controller is disabled.

Parameter 5603	**Voltage controller set point ramp**	**1 to 99 V/s**

```
Volt. controller
Ramp     = 00V/s
```

LSXR Package:
setting 'THREESTEP'

A change in set point is supplied to the controller via a ramp. The slope of the ramp is used to alter the rate at which the controller follows the set point value. The more rapidly the set point should change, the greater should be the value set here.

<table>
<tr><td>Parameter 5650</td><td>**Voltage controller insensitivity**</td><td>**[1] 0.1 to 15.V, [4] 0.5 to 60.0 V**</td></tr>
</table>

```
Volt. controller
Dead band= 00,0V
```

LSXR Package:
setting 'THREESTEP' only

No load/Isolated operation: The measured generator voltage is controlled so that it does not deviate from the configured voltage by more than the value configured in this dead band setting while operating in a steady state.

Synchronization: The measured generator voltage is controlled so that the differential voltage does not exceed this dead band setting while operating in a steady state. The mains or busbar voltage is used as the set point value.

Parameter 5651	**Minimum voltage controller ON period**	**20 to 250 ms**

```
Volt. controller
Time pulse>000ms
```

LSXR Package:
setting 'THREESTEP' only

The minimum ON period of the relay should be selected in such a manner that the downstream control element responds reliably to the pulse length that has been set here. The smallest possible time must be set in order to ensure optimum control behavior.

Parameter 5652	**Voltage controller gain factor**	**0.1 to 99.9**

```
Volt. controller
Gain Kp     00.0
```

LSXR Package:
setting 'THREESTEP' only

The gain factor K_p influences the ON time of the relays. The gain factor Kp influences the ON time of the relays. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled resulting in longer ON time periods. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value.

Analog Controller Outputs (SPM-D2-11/LSXR: Setting 'ANALOG')

Parameter 5215	**Controller output signal**	**see table**

```
V control output
         -------
```

only LSXR Package
with 'ANALOG' setting

The range of the analog output signal is adjusted here. To choose between a current signal in mA or a voltage signal in V, the appropriate jumpers must be connected to the output terminals. (see chapter Relay Outputs on page 16).
The following output signals are possible:

Type	Setting in above configuration screen	Jumper between terminal 11/12	Adjustment range	Adjustment range min.	Adjustment range max.
Current	+/-20mA (+/-10V)	no	+/-20mA	-20 mA	+20 mA
	+/-10mA (+/-5V)		+/-10mA	-10 mA	+10 mA
	0 to 10mA (0 to 5V)		0 to 10mA	0 mA	10 mA
	0 to 20mA (0 to 10V)		0 to 20mA	0 mA	20 mA
	4 to 20mA		4 to 20mA	4 mA	20 mA
	10 to 0mA (5 to 0V)		10 to 0mA	10 mA	0 mA
	20 to 0mA (10 to 0V)		20 to -0mA	20 mA	0 mA
	20 to 4mA		20 to 4mA	20 mA	4 mA
Voltage	+/-20mA (+/-10V)	yes	+/-10V	-10 Vdc	+10 Vdc
	+/-10mA (+/-5V)		+/-5V	-5 Vdc	+5 Vdc
	+/-3V		+/-3V	-3 Vdc	+3 Vdc
	+/-2.5V		+/-2,5V	-2,5Vdc	+2,5 Vdc
	+/-1V		+/-1V	-1 Vdc	+1 Vdc
	0 to 10mA (0 to 5V)		0-5V	0 Vdc	5 Vdc
	0.5V to 4.5V		0,5 to 4,5V	0,5 Vdc	4,5 Vdc
	0 to 20mA (0 to 10V)		0 to 10V	0 Vdc	10 Vdc
	10 to 0mA (5 to 0V)		5 to 0V	5 Vdc	0 Vdc
	4.5V to -0.5V		4,5 to 0,5V	4,5 Vdc	0,5 Vdc
	20 to 0mA (10 to 0V)		10 to 0V	10 Vdc	0 Vdc

```
V control output
Init.state   000%
```

Voltage controller - initial state   **0 to 100%**

This parameter is the start point for the output signal when the frequency controller parameter is configured as OFF. The percentage value relates to the range between the minimum and maximum values that control unit can output (see below).

```
Volt. controller
             ON
```

Voltage controller   **ON/OFF**

ON .... Generator voltage control is carried out. The generator voltage is controlled in various manners depending on the task (no load / isolated operation / synchronization). The following screens of this function are displayed.

OFF .... Control is not carried out, and the following screens of this function are not displayed.

```
Volt. controller
Isol. oper.  ON
```

Voltage controller isolated mode   **ON/OFF**

The setting of this screen has no influence on the load share control.

ON .... In isolated operation the voltage controller is enabled.

OFF .... In isolated operation the voltage controller is disabled.

```
Volt. Controller
Ramp     = 00V/s
```

Voltage controller set point ramp   **1 to 99 V/s**

A change in set point is supplied to the controller via a ramp. The slope of the ramp is used to alter the rate at which the controller follows the set point value. The more rapidly the set point should change, the greater should be the value set here.

```
V control output
(max.)       000%
```

Voltage controller maximum output   **0 to 100 %**

Upper limit of the analog controller output.

```
V control output
(min.)       000%
```

Voltage controller minimum output   **0 to 100 %**

Lower limit of the analog controller output.

```
Volt. controller
Gain Kp      000
```

Voltage controller P-gain   **1 to 240**

The proportional-action coefficient KP indicates the closed-loop control system gain. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value. Refer to "Analog Controller Outputs" on page 30.

```
Volt. controller
Reset Tn   00.0s
```

Voltage controller reset time   **0.0 to 60.0 s**

The reset time Tn represents the I-component of the PID controller. The reset time corrects for any offset (between set point and process variable) over time until the process variable and the set point are the same. This parameter defines how quickly the reset attempts to correct for any offset. If Tn is configured as 0.00 s, the I-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Parameter 5612	**Voltage controller - derivative-action time**
	0.00 to 6.00 s

```
Volt. controller
Derivat.Tv=0.00s
```

only LSXR Package
with 'ANALOG' setting

The derivative-action time TV represents the D-component of the PID controller. The D-component of the controller output becomes effective with large variations of the offset, e.g. in case of load-shedding. The lower the derivative-action time is configured, the higher the controller reaction is. If TV is configured as 0.00 s, the D-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Power Factor Control

ⓘ **NOTE**

Refer to the appendix Power Factor Definition on page 76 for this.

Parameter 6658	**Power factor controller** **ON/OFF**

```
Pow.fact.control
            ON
```

ON ....A load-independent control of the power φ factor is carried out during mains/parallel operation. The power factor cannot be measured accurately and the controller is automatically locked to prevent instability when small currents (less than 5 % of the CT secondary rated current) are detected. The following screen masks of this option will be displayed.

OFF ....The frequency is not controlled, and the following screens of this option will not be displayed.

Parameter 5620	**Power factor controller set point** **i0.70 to 1.00 to c0.70**

```
Pow.fact.control
Set point = 0.00
```

While operating in a mains/parallel operation, the reactive load is controlled so that this preset power factor is maintained when the generator is in a steady state. The letters "i" stands for "inductive = lagging" (overexcited generator) and "c" for "capacitive = leading" (underexcited generator) reactive load. This parameter is only enabled when operating in mains/parallel.

Parameter 5622	**Set point ramp of the power factor controller** **0.01 to 0.30 /s**

```
Pow.fact.control
Ramp      0.00/s
```

The set point ramp determines how fast the power factor set point approaches its target value. The slope of the ramp is linear.

![i](info icon) **NOTE**

Refer to the parameter settings for the voltage controller under Voltage Controller starting on page 49. The parameter settings performed for the voltage controller may be applied to the power factor controller as well.

Three-Position Controller (SPM-D2-11/LSXR: Setting 'THREESTEP')

Parameter 5660

```
Pow.fact.control
Dead band 00.0%
```

LSXR Package:
setting 'THREESTEP' only

Power factor controller insensitivity   **0.5 to 25.0 %**

The control automatically calculates the amount of reactive load which corresponds to the power factor $_{\text{set point}}$. In mains/parallel operation, the reactive load is controlled so that it does not deviate from the configured power factor set point by more than the value configured in this dead band (%) setting while operating in a steady state. The percentage value refers to the generator nominal power.

Parameter 5662

```
Pow.fact.control
Gain Kp=00.0
```

LSXR Package:
setting 'THREESTEP' only

Power factor controller gain   **0.1 to 99.9**

The gain factor Kp influences the ON time of the relays. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled resulting in longer ON time periods. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value.

Analog Controller (SPM-D2-11/LSXR: Setting 'ANALOG')

Parameter 5613

```
Pow.fact.control
Gain Kp      000
```

only LSXR Package
with 'ANALOG' setting

Power factor controller gain   **1 to 240**

The proportional-action coefficient KP indicates the closed-loop control system gain. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value. Refer to "Analog Controller Outputs" on page 30.

Parameter 5614

```
Pow.fact.control
Reset Tn   00.0s
```

only LSXR Package
with 'ANALOG' setting

Power factor controller reset time   **0.0 to 60.0 s**

The reset time Tn represents the I-component of the PID controller. The reset time corrects for any offset (between set point and process variable) over time until the process variable and the set point are the same. This parameter defines how quickly the reset attempts to correct for any offset. If Tn is configured as 0.00 s, the I-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Parameter 5615

```
Pow.fact.control
Derivat.Tv 0.00s
```

only LSXR Package
with 'ANALOG' setting

Power factor controller – derivative action time   **0.00 to 6.00 s**

The derivative-action time TV represents the D-component of the PID controller. The D-component of the controller output becomes effective with large variations of the offset, e.g. in case of load-shedding. The lower the derivative-action time is configured, the higher the controller reaction is. If TV is configured as 0.00 s, the D-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Real Power Controller

Parameter 6659

```
Power controller
            ON
```

Real power controller	**ON/OFF**

ON ....During mains/parallel operation the real power is controlled to the pre-selected set point value. The following screens of this option are displayed.

OFF ....The power is not controlled, and the following screens of this option not displayed.

Power Limitation

Parameter 5523

```
Power controller
P max.=    000 %
```

Maximum power limitation (maximum demand)	**10 to 120 %**

If limiting control of the generator maximum real power is required, a value in percent referring to the generator rated power is set in this screen. The value "Pmax" limits only the set value of the real power controller and has no function in isolated operation.

Parameter 5524

```
Power controller
P min.=    000 %
```

Minimum power limitation (minimum power)	**0 to 50 %**

If limiting control of the generator minimum real power is required, a value in percent referring to the generator rated power is set in this screen. The value "Pmin" limits only the set value of the real power controller and has no function in isolated operation.

Part Load Lead

Parameter 5532

```
Warm up load
Set point = 000%
```

Limit value partial load	**5 to 110 %**

If the engine requires a warming-up period a lower fixed power set point value can be specified. The limit value of partial load refers to the generator rated power.

Parameter 5534

```
Warm up load
time       000s
```

Period of partial load limit	**0 to 600 s**

If a warm up load set point value has been selected, the time period for this warm up is configured in this parameter. The time period for the partial load imitates at the closing of the generator circuit breaker. If a warm up period is not desired, enter "0" for this parameter.

Shut Down

Parameter 6660

```
Download and
open GCB       ON
```

Shut down	**ON / OFF**

ON ....The generator set will shut down if the input "enable GCB" is removed. Refer to the Shutdown section on page 27 for more information).

OFF ....If "enable GCB" is removed, the CB will not be opened in isolated operation. In parallel isolated operation the generator CB remains closed.

Power Set point Value

ⓘ NOTE

The SPM-D2-11 does not take the connection to the utility into consideration. This means that if the plant generates excess power, power will be exported to the utility. If the plant does not generate enough power to meet demand, then power will be imported from the utility. This power controller does not perform process control.

Parameter 5520

```
Power controller
P set1 =  0000kW
```

Set value 1 Real power controller   **0 to 9,999 kW**

Setting of the internal power set value 1(Pset 1). If this set point is selected, this is the reference value for controlling the real power.

Parameter 5521

```
Power controller
P set2 =  0000kW
```

Set value 2 Real power controller   **0 to 9,999 kW**

Setting of the internal power set value 2 (Pset2). If this set point is selected, this is the reference value for controlling the real power.

Parameter 6661

```
Power set point
External      ON
```

External set value   **ON/OFF**

Selection of the external power set point. If this set point is selected, the real power is controlled to the external power set reference value.

Parameter 6663

```
Analog input
        0..00mA
```

External set point value: Range   **0 to 20 / 4 to 20 mA**

The analog reference signal input of the real power controller can be switched between 0 to 20 mA and 4 to 20 mA depending on the remote set point signal.
0 to 20 mA ...Minimum value of the set point value: 0 mA; Maximum value: 20 mA.
4 to 20 mA ...Minimum value of the set point value: 4 mA; Maximum value: 20 mA. Wire break monitoring is performed.

Parameter 1001

```
External setp.
 0mA     0000kW
```

Scaling the minimum value   **0 to 9,999 kW**

The minimum value of the real power set point is defined here.

Parameter 1002

```
External setp.
20mA     0000kW
```

Scaling the maximum value   **0 to 9,999 kW**

The maximum value of the real power set point is defined here.

Parameter 6927

```
External setp.
Value =   000kW
```

Display of the current set point value   **0 to 9,999 kW**

This screen is not used to enter a value, but to display the current measured value, calculated into kW, of the analog input. This permits the mA signal to be validated even if the engine is stopped.

Parameter 5522

```
Power controller
Ramp    000 kW/s
```

Real power controller set point ramp   **1 to 999 kW/s**

A change in set point is supplied to the controller via a ramp. The slope of the ramp is used to alter the rate at which the controller follows the set point value. The more rapidly the set point should change, the greater should be the value set here. This ramp will also be used to reduce the power with a Shutdown (refer to page 27).

Three-Position Controller (SPM-D2-11/LSXR: Setting 'THREESTEP')

Parameter 5560

```
Power controller
Dead band= 00.0%
```

LSXR Package:
setting 'THREESTEP' only

Real power controller insensitivity   **0.1 to 25.0 %**

In mains/parallel operation the real power will be controlled so that it does not deviate from the configured power factor set point by more than the value configured in this dead band (%) setting while operating in a steady state. This percentage is based on the generator nominal power.

Parameter 5562

```
Power controller
Gain Kp     00.0
```

LSXR Package:
setting 'THREESTEP' only

Gain of real load controller   **0.1 to 99.9**

The gain factor Kp influences the ON time of the relays. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled resulting in longer ON time periods. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value.

Parameter 5563

```
Power controller
Sens.red.   *0.0
```

LSXR Package:
setting 'THREESTEP' only

Sensitivity reduction of real power controller   **1.0 to 9.9**

If the controller does not issue an actuating pulse at least 5 seconds after reaching steady state condition, the sensitivity will be reduced by the entered factor.

Example: In case of a dead band of 2.5 % and a factor 2.0 the dead band will be increased to 5.0 % after 5 seconds. If the system deviation afterwards exceeds 5.0 %, the original dead band (2.5 %) of the controller will be set automatically. Using this entry, frequent unnecessary actuation processes can be avoided, thus extending the life of the actuating device.

Analog controller (SPM-D2-11/LSXR: Setting 'ANALOG' & 'PWM')

Parameter 5513

```
Power controller
Gain Kp     000
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

P gain of the real power controller   **1 to 240**

The proportional-action coefficient KP indicates the closed-loop control system gain. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled. The optimum setting depends on the behavior of the system. If the gain is too low, the control action becomes slow. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value. Refer to "Analog Controller Outputs" on page 30.

Parameter 5514

```
Power controller
Reset Tn  00.0s
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

Reset time of the active load controller   **0.0 to 60.0 s**

The reset time Tn represents the I-component of the PID controller. The reset time corrects for any offset (between set point and process variable) over time until the process variable and the set point are the same. This parameter defines how quickly the reset attempts to correct for any offset. If Tn is configured as 0.00 s, the I-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Parameter 5515

```
Power controller
Derivat.Tv 0.00s
```

only LSXR Package
with 'ANALOG' or 'PWM' setting

Derivative action time of the active load controller   **0,00 to 6,00 s**

The derivative-action time TV represents the D-component of the PID controller. The D-component of the controller output becomes effective with large variations of the offset, e.g. in case of load-shedding. The lower the derivative-action time is configured, the higher the controller reaction is. If TV is configured as 0.00 s, the D-component of the PID loop is disabled. Refer to "Analog Controller Outputs" on page 30.

Power Limit

The generator power is monitored for exceeding the configured threshold value. The excess is signaled with the relay "Power limit". As long as the power is below the threshold value, the relay is energized (the contact is closed). If the power has exceeded the threshold value for at least the configured delay, the relay contact will be opened. The relay contact will close, after the power is below the threshold value minus the configured hysteresis for at least a fixed delay of 1 second. Using this relay and external circuits it is possible to disconnect loads or activate further generators.

NOTE

This watchdog is not part of the generator protection functions. No message is displayed when the watchdog is triggered, only a relay is energized.

The overload protection is intended for a generator that has been configured for equivalent operations (see page 64).

Parameter 2314	**Generator power monitoring**	**ON/OFF**

```
Gen.active-power
Monitoring    ON
```

ON................The generator real power is monitored. The following screens of this option are displayed.

OFF..............There is no active power monitoring performed and the following screens of this option are not displayed.

Parameter 2315	**Generator power monitoring threshold**	**0 to 150 %**

```
Power monitoring
Threshold  =000%
```

The threshold relates to the rated power of the generator.

Parameter 6664	**Generator power monitoring hysteresis**	**0 to 100 %**

```
Power monitoring
Hysteresis =000%
```

The hysteresis relates to the rated power of the generator. This value is how much below the threshold limit that the monitored power must drop for the controller to terminate the power threshold limit surpassed operations.

Parameter 2316	**Generator power monitoring delay**	**0 to 600 s**

```
Power monitoring
Delay time =000%
```

To open the relay contact, the threshold hast to be exceeded continuously for the time configured here.

Load/Var Sharing

Parameter 5531	**Load sharing**	**ON/OFF**

```
Active power
Load-share  ON
```

ON ....Real power is distributed among the generators operating in parallel.
The generator outputs are distributed depending on the set values.
The following screens of this function are displayed

OFF ....There is no load sharing control performed, and the following screens
of this function are not displayed.

Parameter 5530	**Load sharing reference variable**	**10 to 99 %**

```
Act. load share
Factor     =00%
```

The higher the weighing factor is configured, the more influence the main control variable (frequency) has on the control. The lower the weighing factor is configured, the greater the influence of the secondary control variable (generator real power).

The value of the analog signal depends on the measured real power in relation to the rated power.
Therefore, there is the following relation between real power and analog signal:

　　0 to 4 V of the analog signal corresponds with 0 to 100 % of the rated power

Example for a rated power of 400 kW:

Currently measured power	Analog signal
100 kW	1 V
200 kW	2 V
400 kW	4 V

Parameter 5631	**var sharing**	**ON/OFF**

```
Reactive power
Load-share  ON
```

ON ....Re-active power is distributed among the several generators operating
in parallel. The generator outputs are distributed depending on the set
values. The following screens of this function are displayed:

OFF ....There is no var sharing control performed, and the following screens
of this function are not displayed**.**

Parameter 5630	**var sharing reference variable**	**10 to 99 %**

```
React.load share
Factor     =00%
```

The higher the weighing factor is configured, the more influence the main control variable (voltage) has on the control. The lower the weighing factor is configured, the greater the influence of the secondary control variable (generator reactive power).

The value of the analog signal depends on the measured reactive power in relation to the rated power.
Therefore, there is the following relation between reactive power and analog signal:

　　0 to 5V of the analog signal corresponds with 85% of the capacitive rated power to 85% of the inductive rated power

Example reactive power:

Actual reactive power (without display)	Analog signal	
-340 kvar	0 V	85% of the rated power capacitive = negative reactive power
0 kvar	2.5V	0% of the rated power no reactive power
+340 kvar	5 V	85% of the rated power inductive = positive reactive power

Synchronization

===========================

Configure Synchronization

⚠️ **CAUTION**

Please consider that the unit does not have an internal rotating field monitoring.

The unit assumes always a clockwise phase rotation direction of all voltage systems, which are measured.

A rotating field monitoring must be provided by the customer in order to avoid a CB closure with a counter-clockwise rotating field.

Parameter 6665	**Synchronization functions** **ON/OFF**

```
Synchronizing
functions   ON
```

ON................Frequency and voltage matching for the generator and busbar is performed and a close command is issued. The subsequent screens of this function are displayed.

OFF..............No synchronization occurs, but no-load control functions are performed if necessary. No close command is issued. The subsequent screens of this function are not displayed.

Parameter 5701	**Max. permissible differential frequency (positive slip)** **0.02 to 0.49 Hz**

```
Synchronization
 df max = 0.00Hz
```

The prerequisite for initiating a close command that the differential frequency must be lower than the value configured here. This value specifies the upper frequency limit. A positive value indicates that the generator frequency is greater than the busbar frequency.

Parameter 5702	**Max. permissible differential frequency (negative slip)** **0.00 to 0.49 Hz**

```
Synchronization
 df min =-0.00Hz
```

The prerequisite for initiating a close command that the differential frequency must be higher than the value configured here. This value specifies the lower frequency limit. A negative value indicates that the generator frequency is less than the busbar frequency.

Parameter 5700	**Max. permissible differential voltage** **[1] 1 to 20 V, [4] 1 to 60 V**

```
Synchronization
 dV max  =  00V
```

A close command will not be issued until the measured differential voltage of the generator and busbar falls below the value configured here.

Parameter 3416	**Minimum pulse period of close relay** **0.04 to 0.50 s**

```
Synchronization
Brk.hold T>0.00s
```

The length of the close command pulse can be adjusted to the requirement of the subordinate switching circuit.

<table>
<tr><td>

Parameter 5729

```
Phase matching
            ON
```

</td><td>

Phase matching control   **ON/OFF**

ON ....The synchronization is performed with phase matching control and the power circuit breaker closure is dependent upon the phase angle (refer to "Phase Matching Synchronization" on page 25). Only the parameters relating to phase matching are displayed.

OFF ....Synchronization is performed when the frequency and voltage differential are within the specified ranges. The circuit breaker is closed at the synchronous point (refer to "Synchronization with slip" on page 25). Only the parameters relating to slip synchronization are displayed.

</td></tr>
</table>

<table>
<tr><td>

Parameter 6667

```
Slip synchroniz.
Max phase < 00°
```

Phase matching control = OFF

</td><td>

Max. perm. differential angle in case of phase-angle-zero-control   **0 to 60°**

This configuration screen is displayed only if the phase matching control is disabled! A connect command is only issued when the phase angle differential is less than the value configured in this screen.

Synchronization with slip - When operating in the "slip synchronization" mode this phase angle may be set as the maximum value that a close breaker command may be issued. This is determined by the formula:

$$\Delta\varphi = T_{Close} * 360° * \Delta f$$

Example: If the frequency difference is 0.5Hz and the delay of the circuit breaker delay is 80ms the delta phi is determined as follows:

$$T_{Close} = 80ms, \Delta f = 0.5Hz \quad \Rightarrow \quad \Delta\varphi = 0.08s*360*0.5 = 14.4°$$

As an example if the desired synchronization window is to be limited to a maximum of 10°, then the limit value of 10° would be entered here. If this parameter is not required, then the angle must be configured as 60°

Synch-check - In the operation mode "Synch-check" the phase angle differential must be less than the value configured here for the relay "Command: close CB" to be energized.

</td></tr>
</table>

<table>
<tr><td>

Parameter 5705

```
Slip synchroniz.
TClose GCB=000ms
```

Phase matching control = OFF

</td><td>

Inherent delay of CB   **40 to 300 ms**

This configuration screen is displayed only if the phase matching control is disabled! All circuit breakers have an inherent delay from the time the close command is issued until the circuit breaker contacts are closed. That time is configured in this screen. This permits the controller to issue the breaker closure command with enough lead-time so that the breaker contacts close at the synchronous point.

</td></tr>
</table>

<table>
<tr><td>

Parameter 6666

```
Phase matching
Max phase < 00°
```

Phase matching control = ON

</td><td>

Max. permissible differential angle   **0 to 60°**

This configuration screen is displayed only if the phase matching control is enabled! A connect command is only issued when the phase angle differential is less than the value configured in this screen.

</td></tr>
</table>

<table>
<tr><td>

Parameter 5707

```
Phase matching
Dwell time 00.0s
```

Phase matching control = ON

</td><td>

Phase matching control breaker transition dwell time   **0.2 to 10.0 s**

This configuration screen is displayed only if the phase matching control is enabled! Once the controller detects that the phase angle matching has been achieved, a timer is started. Only after the expiration of this dwell time is the connect command issued. If the controller detects that one of the synchronization parameters has left the required range, the dwell timer is reset.

</td></tr>
</table>

Parameter 5505 | **Phase matching control gain** | **1 to 36**

```
Phase matching
Gain        00
```

Phase matching control = ON

This configuration screen only appears, if the phase matching control is configured ON!

When phase matching control is enabled, this gain determines how much the output signal is changed depending on phase difference. By increasing the gain, the response is increased to permit larger corrections to the variable to be controlled resulting in longer ON time periods. The farther out of tolerance the process is the larger the response action is to return the process to the tolerance band. If the gain is configured too high, the result is excessive overshoot/undershoot of the desired value.

Prior to setting the value for this gain, the frequency controller must be enabled and properly adjusted.

Parameter 5506 | **Differential frequency for starting phase matching control** | **0.02 to 0.25 Hz**

```
Phase matching
df start  0.00Hz
```

Phase matching control = ON

This configuration screen is displayed only if the phase matching control is enabled! The control enables phase matching when the generator and busbar/mains frequency differential falls below the value configured here.

Synchronization Time Monitoring

Parameter 3060 | **Synchronization time monitoring** | **ON/OFF**

```
Sync.time contr.
Alarm       ON
```

ON................The synchronization timer is enabled. When a synchronization operation is initiated, this timer starts to count down. If the timer expires prior to the synchronization being completed and the breaker closing, the warning message "Synchronization time" is displayed. In addition to the warning message the "Ready for operation" relay is de-energized and the synchronization operation is terminated. The alarm condition may be reset by pressing and holding the "Clear" pushbutton for at least 3 seconds or removing one of the required conditions for synchronization (e.g. de-energize terminal 3 "Release CB"). The subsequent screens of this function are displayed.

OFF..............The synchronization time is not monitored and the control will continue to attempt to synchronize until the circuit breaker is successfully closed or the synchronization it terminated. The subsequent screens of this function are not displayed.

Parameter 3063 | **Final value for synchronization time monitoring** | **10 to 999 s**

```
Sync.time contr.
Delay time 000s
```

If the synchronization time monitoring has been enabled, the control will attempt to synchronize for up to the time period configured here.

Dead Bus Start

===========================

If the busbar is in a voltage-free state (dead bus), a direct closing (dead bus start) of the generator circuit breaker (GCB) may be carried out.

Parameter 3432	**Dead bus start of power circuit breaker**	**ON/OFF**

```
Gen. circ.break.
Dead bus op. ON
```

ON ....Enabling of the dead bus start function. To close the generator circuit breaker on to the voltage-free busbar additional conditions must be met [see chapter "Closing the CB Without Synchronization (Dead Bus Start)" starting on page 26]. The following screens of this function are displayed.

OFF ....Dead bus starts are not performed and the following screens of this function are not displayed.

Parameter 5802	**Maximum differential frequency for CB dead bus start**	**0.05 to 5.00 Hz**

```
Dead bus op. GCB
 df max = 0.00Hz
```

The prerequisite for issuing the close command is that the generator frequency may not deviate from the rated frequency by more than this set value.
Example: If the generator is rated at 60Hz and 5.00Hz is configured here, the circuit breaker will be issued a close command when the generator achieves 55Hz.

Parameter 5800	**Maximum differential voltage for CB dead bus start**	**[1] 1 to 20 V, [4] 1 to 60 V**

```
Dead bus op. GCB
 dV max =   00V
```

The prerequisite for issuing the close command is that the generator voltage may not deviate from the rated voltage by more than this set value.
Example: If the generator is rated at 460 Volts and 60V is configured here, the circuit breaker will be issued a close command when the generator achieves 400 Volts.

Configure Monitoring

=========================

Generator Reverse/Reduced Power Monitoring

Generator real power is monitored to ensure it does not fall below a preset limit. The watchdog assigned to this relay is at terminals 37/38. The relay contact is a N.O. contact. When operating in normal operations the relay is continuously energized. If the monitored values leave the configured range, the relay will de-energize, the contact will open, and the message "Reverse/reduced power" will be displayed. If the fault conditions exist for less than 1 second, the relay returns to normal operations. The fault message on the display may be cleared automatically or by pressing the "Clear" button (see chapter Auto Acknowledge Messages at page 66).

Parameter 2250	**Reverse/reduced load monitoring** **ON/OFF**

```
Reverse/min.pow.
Monitoring  ON
```

ON................Monitoring of reverse or reduced generator real power is performed. The following screens of this function are displayed.

OFF..............There is no reverse or reduced power monitoring and the following screens of this function are not displayed

Parameter 2254	**Reverse/reduced power monitoring threshold value** **-99 to 99 %**

```
Reverse/min.pow.
Threshold = 00%
```

The threshold value refers to the configured rated power of the generator.

Reduced power monitoring: A reduced power condition is detected if the measured real power drops below the (positive) limit value.

Reverse power monitoring: A reverse power condition is detected if the measured real power drops below the (negative) limit value.

A reverse power condition can only be detected if the current is at least 2% of the CT's rating. This must be considered when configuring the reverse power protection.

Parameter 2255	**Delay of reverse/reduced load monitoring** **0.1 to 99.9 s**

```
Reverse/min.pow.
Delay     00.0s
```

The generator real power must remain below the threshold value without interruption for at least the period of time specified in this screen for a fault condition to be recognized.

Generator Overload Monitoring

Generator real power is monitored to ensure it does not exceed a preset limit. The watchdog assigned to this relay is at terminals 37/38. The relay contact is a N.O. contact. When operating in normal operations the relay is continuously energized. If the monitored values leave the configured range, the relay will de-energize, the contact will open, and the message "Gen. overload" will be displayed. If the fault conditions exist for less than 1 second, the relay returns to normal operations. The fault message on the display may be cleared automatically or by pressing the ""Clear" button (see chapter Auto Acknowledge Messages at page 66).

Parameter 2300	**Overload monitoring**	**ON / OFF**

```
Gen. overload
Monitoring  ON
```

ON ....Monitoring of generator real power for overload is performed. The following screens of this function are displayed.

OFF ....There is no real power overload monitoring and the following screens of this function are not displayed.

Parameter 2304	**Generator overload threshold**	**0 to 150 %**

```
Gen. overload
Threshold =000%
```

The threshold value refers to the configured generator rated power.

Parameter 2305	**Generator overload monitoring delay**	**0 to 99 s**

```
Gen. overload
Delay time = 00s
```

The generator real power must remain above the threshold value without interruption for at least the period of time specified in this screen for a fault condition to be recognized. If 0 seconds if configured here, the delay time is approximately 80ms.

Generator Frequency Monitoring

Generator frequency is monitored to ensure it does not exceed or fall below the threshold value. The watchdog assigned to this relay is at terminals 43/44. The relay contact is a N.O. contact. When operating in normal operations the relay is continuously energized. If the monitored values leave the configured range, the relay will de-energize, the contact will open, and the message "Gen. overfreq." or. "Gen. underfreq." will be displayed. If the fault conditions exist for less than 1 second, the relay returns to normal operations. The fault message on the display may be cleared automatically or by pressing the "Clear" button (see chapter Auto Acknowledge Messages at page 66).

Parameter 1900	**Generator frequency monitoring**	**ON/OFF**

```
Gen.frequency-
Monitoring  ON
```

ON................Generator frequency monitoring is enabled. The generator frequency is monitored for overfrequency and underfrequency. The following screens of this function are displayed.

OFF..............There is no frequency monitoring, and the following screens of this function are not displayed.

Parameter 1904	**Threshold value: Generator overfrequency**	**40.0 to 70.0 Hz**

```
Gen. overfreq.
     f > 00.00Hz
```

If the value of the generator frequency exceeds the value set here, an overfrequency alarm is issued.

Parameter 1905	**Generator overfrequency threshold delay**	**0.04 to 9.98 s**

```
Gen. overfreq.
Delay time=0.00s
```

In order to initiate an overfrequency alarm, the measured frequency must exceed and remain above the configured threshold without interruption for at least the time specified in this screen.

Parameter 1954	**Threshold value: Generator underfrequency**	**40.0 to 70.0 Hz**

```
Gen. underfreq.
     f < 00,00Hz
```

If the value of the generator frequency falls below the value set here, an underfrequency alarm is issued.

Parameter 1955	**Generator underfrequency threshold delay**	**0.04 to 9.98 s**

```
Gen. underfreq.
Delay time=0.00s
```

In order to initiate an underfrequency alarm, the measured frequency must fall below and remain below the configured threshold without interruption for at least the time specified in this screen.

Generator Voltage Monitoring

The line voltages V_{L1}/V_{L2} of the generator are monitored to ensure they do not exceed or fall below the threshold values. The watchdog assigned to this relay is at terminals 41/42. The relay contact is a N.O. contact. When operating in normal operations the relay is continuously energized. If the monitored values leave the configured range, the relay will de-energize, the contact will open, and the message "Gen. overvoltage" or. "Gen. undervoltage" will be displayed. If the fault conditions exist for less than 1 second, the relay returns to normal operations. The fault message on the display may be cleared automatically or by pressing the "Clear" button (see chapter Auto Acknowledge Messages at page 66).

Parameter 2000	**Generator voltage monitoring**	**ON / OFF**

```
Gen.voltage-
Monitoring  ON
```

ON ....The generator voltage monitoring is enabled. The generator voltage is monitored with regard to overvoltage and undervoltage. The following screens of this function are displayed.

OFF ....No overvoltage or undervoltage monitoring is performed and the following screens of this function are not displayed.

Parameter 2004	**Threshold value: Gen. overvoltage**	**[1] 20 to 150 V; [4] 20 to 520 V**

```
Gen.overvoltage
      U > 000V
```

If the value of the generator voltage exceeds the value set here, an overvoltage alarm is issued.

Parameter 2005	**Generator overvoltage threshold delay**	**0.04 to 9.98 s**

```
Gen.overvoltage
Delay time=0.00s
```

In order to initiate an overvoltage alarm, the measured voltage must exceed and remain above the configured threshold without interruption for at least the time specified in this screen.

Parameter 2054	**Threshold value: Gen. undervoltage**	**[1] 20 to 150 V; [4] 20 to 520 V**

```
Gen.undervoltage
      U < 000V
```

If the value of the generator voltage falls below the value set here, an undervoltage alarm is issued.

Parameter 2055	**Generator undervoltage threshold delay**	**0,04 to 9,98 s**

```
Gen.undervoltage
Delay time=0.00s
```

In order to initiate an undervoltage alarm, the measured voltage must fall below and remain below the configured threshold without interruption for at least the time specified in this screen.

Auto Acknowledge Messages

Parameter 6668	**Messages auto acknowledgment**	**EIN/AUS**

```
Auto-acknowledge
messages      ON
```

ON ....When fault conditions are no longer detected and the clear message delay time has expired, the corresponding message is automatically deleted.

OFF ....When fault conditions are no longer detected and the corresponding message continues to be displayed. Pressing the "Clear" button for at least 3 seconds will clear the fault message. The following screen is not displayed.

Parameter 6669	**Clear messages delay**	**1 to 99 s**

```
Acknowledge
Message aft. 00s
```

This screen only appears if the screen "Messages auto-acknowledgement" is set to ON. Clearing the messages occurs after the specified time.

Password Configuration

===========================

> **NOTE**
>
> **Once the code level is entered, access to the configuration menus will be allowed for two hours or until another password is entered into the control. If a user needs to exit a code level then code level CL0 should be entered. This will block any configuration of the control. A user may return to CL0 by allowing the entered password to expire after two hours or by changing any one digit on the random number generated on the password screen and entering it into the unit.**

Parameter 10413

```
Define level 1
code        0000
```

Code level 1 (Customer)   **0000 to 9999**

This parameter is only accessible with code level 2 rights. After the password has been set for this parameter, only the personnel who are assigned this password will have access rights to this code level. When the CL1 (Customer) password is entered, only select parameters may be accessed. Refer to page 41 for more information to password protection.

The default setting for this code level is   **CL1 = 0 0 0 1**

Parameter 10411

```
Define level 2
code        0000
```

Code level 2 (Commissioner)   **0000 to 9999**

This parameter is only accessible with code level 2 rights. After the password has been set for this parameter, only the personnel who are assigned this password will have access rights to this code level. When the CS2 (Commissioner) password is entered, all parameters may be accessed. Refer to page 41 for more information to password protection.

The default setting for this code level is   **CL2 = 0 0 0 2**

Chapter 8.
Commissioning

DANGER - HIGH VOLTAGE

When commissioning the control, please observe all safety rules that apply to the handling of live equipment. Ensure that you know how to provide first aid in the event of an uncontrolled release of energy and that you know where the first aid kit and the nearest telephone are. Never touch any live components of the system or on the back of the system.

L I F E   T H R E A T E N I N G

WARNING

Only a qualified technician may commission unit. The "EMERGENCY-STOP" function must be operational prior to commissioning of the system, and must not depend on the unit for its operation.

CAUTION

Prior to commissioning ensure that all measuring devices are connected in correct phase sequence. The connect command for the unit circuit breaker must be disconnected at the unit circuit breaker. The field rotation must be monitored for proper rotation. Any absence of or incorrect connection of voltage measuring devices or other signals may lead to malfunctions and damage the unit, the engine, and/or components connected to the unit!

CAUTION

Please consider that the unit does not have an internal rotating field monitoring.

The unit assumes always a clockwise phase rotation direction of all voltage systems, which are measured.

A rotating field monitoring must be provided by the customer in order to avoid a CB closure with a counter-clockwise rotating field.

Procedure

1.   Disconnect the close command connections at the power circuit breaker.

2.   After checking the unit wiring and ensuring all voltage-measuring devices are phased correctly, apply the control system voltage (i.e. 12/24 Vdc).

3.   Before accessing the configuration mode, make sure to reset the discrete input "configuration locked" (connect to 0 V or disconnect). By simultaneously pressing the two push buttons "Digit↑" and "Cursor→", the configuration mode is accessed. After entering the access code number, the unit may be configured according to the application requirements (see the chapter regarding the parameters). The "automatic" LED will darken when in the configuration mode.

4.   Set all parameters according to Chapter Configuration on page 39. The setting limits can be either read from the description in the controller display or from the list of parameters at the end of the operating manual.

5.   After applying the measuring variables, the unit will display the measured values. These values should be confirmed with a calibrated measuring instrument. **It is possible to issue an asynchronous close command in case of an active dead bus start if a measuring voltage has been wired incorrectly or not at all!**

---

6.   Verify the status of all control and auxiliary inputs and the appropriate LEDs on the display of the control are illuminated. Verify the status of all control and auxiliary outputs as well as the settings of the controller outputs.

7.   Synchronizing the power circuit breaker:
   a) Disconnect the breaker operation connection to the power circuit breaker;
   b) The voltage to which the system has to synchronize must be within the permissible range
   c) The signal "Enable CB" must be enabled.
   e) When the generator voltage exceeds 50 % of the configured rated value, the frequency controller starts to operate. Set the parameters of the controller in such a way that the set point value is controlled in an optimum manner.
   f) Prior to the automatic closing of the circuit breaker ensure that all measuring inputs are wired and applied correctly. Upon reaching the synchronous point check whether all conditions for synchronizing have been met. This test is best done using a differential voltage meter direct at the power circuit breaker.

8.   Dead bus start
   a) Disconnect the breaker operation connection to the power circuit breaker.
   b) Check all conditions and measuring voltages and test the close command.
   c) Allow the generator circuit breaker to close automatically.

9.   After successful closing of the power circuit breaker the LED "Gen CB - ON" must illuminate.

Appendix A.
Dimensions

Configuration port

Configuration port

Front view

72

65

35

27

Back plate mount
option (please order
brackets P/N 8923-1023)

Bottom view

108.8

50

8

144

136

179

Back view with
connecting terminals

48

25

0 1

24
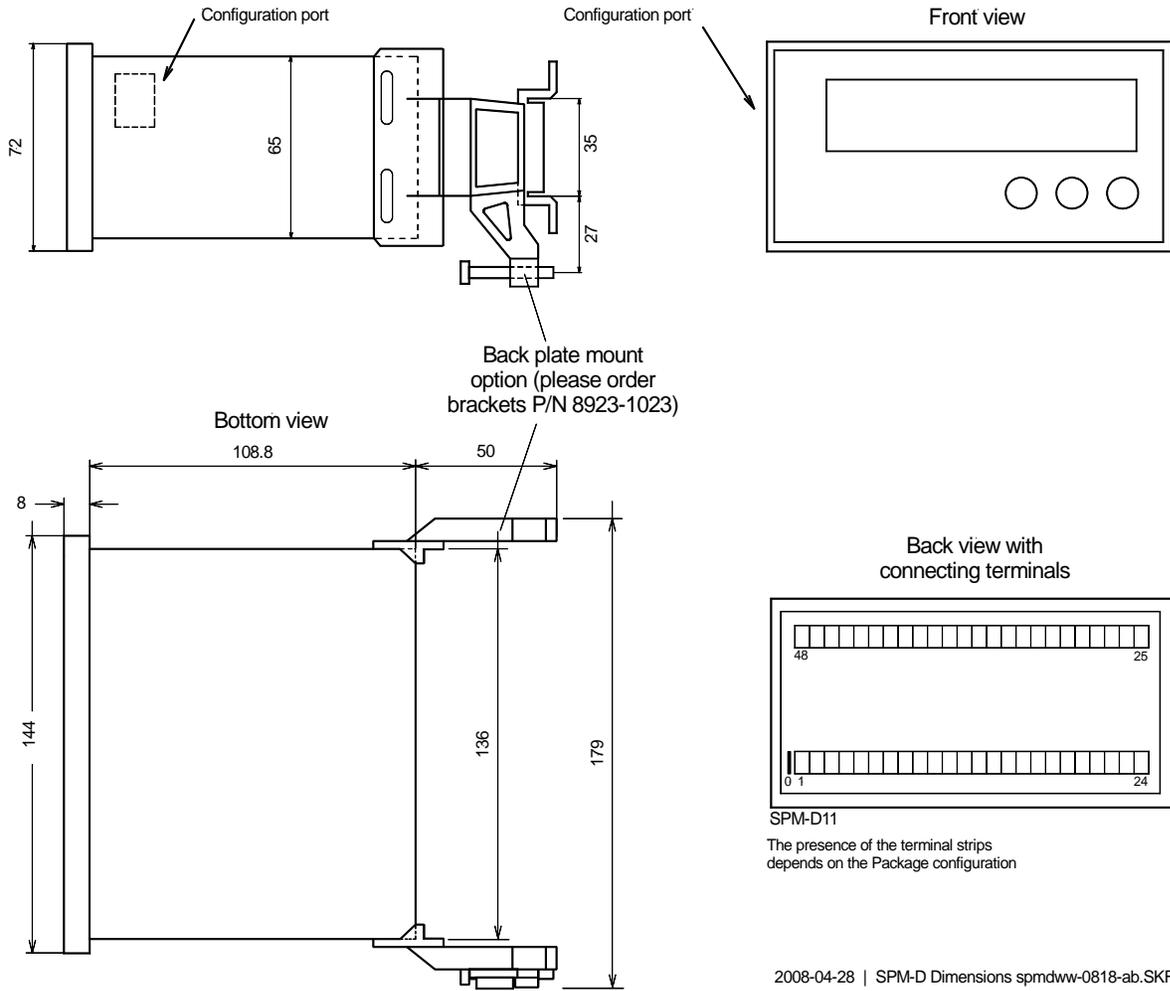
SPM-D11

The presence of the terminal strips
depends on the Package configuration

2008-04-28 | SPM-D Dimensions spmdww-0818-ab.SKF

Figure 8-1: Dimensions

Appendix B.
Technical Data

Measuring values, voltage --
- Measuring voltage   Rated value (V_{rated}) ⅄/Δ......................................[1] 63/110 Vac
                                                [4] 230/400 Vac

                Maximum value $V_{Ph\text{-}Ph}$ (UL/cUL)....................[1] max. 150 Vac
                                                [4] max. 300 Vac

                Rated voltage $V_{Ph\text{-}ground}$ [1] 150 Vac
                                                [4] 300 Vac

                Rated surge voltage   [1] 2.5 kV
                                                [4] 4.0 kV

- Measuring frequency ....40.0 to 70.0 Hz
- Accuracy...Class 1
- Linear measuring range up to...$1.25 \times V_N$
- Input resistance ....[1] 0.21 MΩ, or [4] 0.696 MΩ

Measuring values, current --**isolated**
- Measuring current... [1] ../1 A, or [5] ../5 A
- Accuracy...Class 1
- Linear measuring range up to... $3.0 \times I_N$
- Maximum power consumption per path..< 0.15 VA
- Rated short-time current (1 s) ....[1] $50.0 \times I_N$, or [5] $10.0 \times I_N$

Ambient variables **(Attention! Please observe actual ratings on data plate!)** --------------------
- Power supply (V_{aux}) .... 12/24 Vdc (9.5 to 32 Vdc)
- Intrinsic consumption .... max. 8 W
- Ambient temperature .... -20 to 70 °C
- Ambient humidity .... 95 %, not condensing

Discrete inputs **(Attention! Please observe actual ratings on data plate!)** -----------------**isolated**
- Input range ($V_{Cont, dig. input}$) .... 18 to 250 Vac/dc
- *or alternatively* ....12/24 Vdc
- Input resistance .... approx. 68 kΩ
- *or alternatively* .... approx. 6.8 kΩ

Relay outputs --**isolated**
- Make contact...potential free
- Contact material... AgCdO
- General purpose (GP) ($V_{Cont, relay output}$)
                     AC .... 2.00 Aac@250 Vac
                     DC ....2.00 Adc@24 Vdc
                                             0.36 Adc@125 Vdc
                                             0.18 Adc@250 Vdc

- Pilot duty (PD) ($V_{Cont, relay output}$)
                     AC B300
                     DC ....1.00 Adc@24 Vdc
                                             0.22 Adc@125 Vdc
                                              0.10 Adc@250 Vdc

Analog inputs --- **freely scaleable**
  - Resolution .... 10 Bit
  - 0/4 to 20 mA input .... load 250 Ω

Analog outputs --- **freely scalable**
  - Resolution .... 12 Bit
  - 0/4 to 20 mA ....external load max. 500 Ω
  - 0 to 10 Vdc...internal source resistance 500 Ω
  - PWM signal.. max. 10 Vdc, approx. 500 Hz

Load sharing ---
  - Voltage .... 0 to 4 Vdc
  - Resistance.. approx. 5 kΩ

Housing --
  - Type ....APRANORM DIN 43 700
  - Dimensions (W × H × D) ....144 × 72 × 122 mm
  - Front cutout (W×H) .... 138 [+1.0] × 68 [+0.7] mm

  - Wiring .... Screw-type terminals depending on
                                                                  plug connector 1.5 mm² or 2.5 mm²
  - Recommended tightening torque..0.4 Nm or 0.5 Nm
                                                                  use 60/75 °C copper wire only
                                                                  use class 1 wire only or equivalent
  - Weight... approx. 800 g
  -

Protection ---
  - Protection system ....IP42 from front with correct installation
                                                         IP54 from front with gasket (gasket: P/N 8923-1037)
                                                                                          IP20 from back
  - Front foil .... insulating surface
  - EMV test (CE) .... tested according to applicable EN guidelines
  - Listings... CE marking; UL listing for ordinary locations
                                                         UL/cUL listed, Ordinary Locations, File No.: E231544

Communication Interface --
  - USB.. Mini-Type B

Appendix C.
List of Parameters

Product number   P/N _____   Rev _____

Version   SPM-D2-11_____

Project   _____

Serial number   S/N _____   Date   _____

Option	Parameter 100/400V; 1/5 A	Adjustment range	Standard setting	Customer settings	
CONFIGURE GENERAL PARAMETERS					
	`SPRACHE/LANGUAGE`	german/english	english	☐ G ☐ E	☐ G ☐ E
	`Software version`		7.10-0		
	`Enter code`	0000 to 9.999	XXXX		
	`Password       Protection`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Reset on Factory Defautls`	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	`Allow Factory Defaults`	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
CONFIGURE BASIC SETTINGS					
	`Rated Frequency        fn`	48.0 to 62.0 Hz	50.0 Hz		
	`Generator freq.  Set point`	48.0 to 62.0 Hz	50.0 Hz		
	`Gen. voltage      secondary`	[1] 50 to 125 V, [4] 50 to 440 V	100/400 V		
	`Mains voltage     secondary`	[1] 50 to 125 V, [4] 50 to 440 V	100/400 V		
	`Gen. voltage        primary`	0.1 to 65.0 kV	0.1/0.4 kV		
	`Mains voltage       primary`	0.1 to 65.0 kV	0.1/0.4 kV		
	`Rated voltage         Vn`	[1] 50 to 125 V, [4] 70 to 420 V	100/400 V		
	`Gen. voltage     Set point`	[1] 50 to 125 V, [4] 50 to 440 V	100/400 V		
	`Current transf.   Generator`	10 to 9,999/x A	1000/x A		
	`Connection type      Gen.`	1W/1W2	1W2	☐ 1W ☐ 1W2	☐ 1W ☐ 1W2
	`Generator cur. Measurment-phase`	L1/L2/L3	L1		
	`1 Ph2w phase rotation`	right/left	right		
	`Rated power         Gen.`	[1] 100 to 9,999 kW [4] 5 to 9,999 kW	500kW/ 500 kW		
CONFIGURE CONTROLLER					
	`Automatic idle -    Running`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Terminal 6`	Release control/Set point power	Release control	☐ RC ☐ SP	☐ RC ☐ SP
	`f control type`	ANALOG/PWM	ANALOG		
	`Freq. controller`	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	`Freq. controllerIsol. oper.`	ON/OFF	AUS	☐ on ☐ off	☐ on ☐ off
	`Freq. controller     Ramp.`	0.1 to 99.9 Hz/s	5.0 Hz/s		
	`Freq. controller Dead band`	0.02 to 1.00 Hz	0.10 Hz		
	`Freq. controllerTime pulse`	10 to 250 ms	80 ms		
	`Freq. controller    Gain Kp`	0.1 to 99.9	15.0		
	`f control output`	see table	+/-20 mA (+/-10 V)		
	`f control output  Level PWM`	3.0 to 10.0 V	10.0 V		
	`PWM-signal          Logic`	positive/negative	positive		
	`f control output Init.state`	0 to 100 %	50 %		
	`f control output     (max.)`	0 to 100 %	100 %		
	`f control output     (min.)`	0 to 100 %	0 %		
	`Freq. controller    Gain Kp`	1 to 240	15		
	`Freq. controller   Reset Tn`	0.0 to 60.0 s	2.5 s		
	`Freq. controller Derivat.Tv`	0.00 to 6.00 s	0.00 s		

Option	Parameter 100/400V; 1/5 A	Adjustment range	Standard setting	Customer settings	
	`V contr. type`	THREESTEP/ANALOG	ANALOG	☐ T ☐ A	☐ T ☐ A
	`Volt. controller`	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	`Volt. controllerIsol. oper.`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Volt. controller    Ramp`	1 to 99 V/s	25 V/s		
	`Volt. controller Dead band`	[1] 0.1 to 15.V, [4] 0.5 to 60.0 V	1.0/2.0 V		
	`Volt. controllerTime pulse>`	20 to 250 ms	80 ms		
	`Volt. controller   Gain Kp`	0.1 to 99.9	15.0		
	`V control output`	see table	+/-20 mA (+/-10 V)		
	`V control output Init.state`	0 to 100 %	50 %		
	`V control output     (max.)`	0 to 100 %	100 %		
	`V control output     (min.)`	0 to 100 %	0 %		
	`Volt. controller   Gain Kp`	1 to 240	15		
	`Volt. controller  Reset Tn`	0.0 to 60.0 s	2.5 s		
	`Volt. controller Derivat.Tv`	0.00 to 6.00 s	0.00 s		
	`Pow.fact.control`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Pow.fact.control  Set point`	i0.70 to 1.00 to c0.70	1.00		
	`Pow.fact.control       Ramp`	0.01 to 0.30 /s	0.01 /s		
	`Pow.fact.control  Dead band`	0.5 to 25.00 %	2.5 %		
	`Pow.fact.control   Gain Kp`	0.1 to 99.9	15.0		
	`Pow.fact.control   Gain Kp`	1 to 240	15		
	`Pow.fact.control  Reset Tn`	0.0 to 60.0 s	2.5 s		
	`Pow.fact.control Derivat.Tv`	0.00 to 6.00 s	0.00 s		
	`Power controller`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Power controller      P max`	10 to 120 %	100 %		
	`Power controller      P min`	0 to 50 %	0 %		
	`Warm up load      Set point`	5 to 100 %	20 %		
	`Warm up load          time`	0 to 600 s	15 s		
	`Download and      open GCB`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Power controller   P set1 =`	0 to 9,999 kW	300 kW		
	`Power controller   P set2 =`	0 to 9,999 kW	500 kW		
	`Power set point    External`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Analog input`	0 to 20 / 4 to 20 mA	0 to 20 mA		
	`External setp.    0mA, 4mA`	0 to 9.999 kW	0 kW		
	`External setp.        20mA`	0 to 9.999 kW	500 kW		
	`Power controller      Ramp`	1 to 999 kW/s	50 kW/s		
	`Power controller Dead band=`	0.1 to 25.0 %	2.5 %		
	`Power controller   Gain Kp`	0.1 to 99.9	15.0		
	`Power controller  Sens.red.`	1.0 to 9.9	2.0		
	`Power controller   Gain Kp`	1 to 240	15		
	`Power controller  Reset Tn`	0.0 to 60.0 s	2.5 s		
	`Power controller Derivat.Tv`	0.00 to 6.00 s	0.00 s		
	`Gen.active-power Monitoring`	ON/AUS	OFF	☐ on ☐ off	☐ on ☐ off
	`Power monitoring threshold`	0 to 150 %	80%		
	`Power monitoring hysteresis`	0 to 100 %	20 %		
	`Power monitoring delay time`	0 to 60 s	10 s		
	`Active power     Load-share`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Act. load share      Factor`	10 to 99 %	50 %		
	`Reactive power   Load-share`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`React.load share     Factor`	10 to 99 %	50 %		

Option	Parameter 100/400V; 1/5 A	Adjustment range	Standard setting	Customer settings	
CONFIGURE SYNCHRONIZATION					
	`Synchronizing     functions`	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	`Synchronization     df max`	0.02 to 0.49 Hz	0.18 Hz		
	`Synchronization     df min`	0.00 to -0.49 Hz	-0.10 Hz		
	`Synchronization     dV max`	[1] 1 to 20 V, [4] 1 to 60 V	6/24 V		
	`Synchronization Brk.hold T>`	0.04 to 0.50 s	0.20 s		
	`Phase matching`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Phase matching  Max phase <`	0 to 60°	7 °		
	`Slip synchroniz. TClose GCB`	40 to 300 ms	80 ms		
	`Slip synchroniz.Max phase <`	0 to 60 °	7 °		
	`Phase matching   Dwell time`	0.2 to 10.0 s	10.0 s		
	`Phase matching       Gain`	1 to 36	2		
	`Phase matching    df start`	0.02 to 0.25 Hz	0.20 Hz		
CONFIGURE SYNCHRONIZATION TIME MONITORING					
	`Sync.time contr.`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Sync.time contr. Delay time`	10 to 999 s	120 s		
CONFIGURE DEAD BUS START					
	`Gen. circ.break.Gen.schalte:`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Dead bus op. GCB     df max`	0.05 to 5.00 Hz	0.25 Hz		
	`Dead bus op. GCB     dV max`	[1] 1 to 20 V, [4] 1 to 60 V	10/40 V		
CONFIGURE MONITORING					
	`Reverse/min.pow. Monitoring`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Reverse/min.pow.   Threshold`	-99 to 99 %	-20 %		
	`Reverse/min.pow.      Delay`	0.1 to 99.9 s	1.0 s		
	`Gen. overload    Monitoring`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Gen. overload    Threshold.`	0 to 150 %	120 %		
	`Gen. overload    Delay time`	0 to 99 s	20 s		
	`Gen.frequency-   Monitoring`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Gen. overfreq.        f >`	40.0 to 70.0 Hz	55.0 Hz		
	`Gen. overfreq.   Delay time`	0.04 to 9.98 s	3.00 s		
	`Gen. underfreq.       f <`	40.0 to 70.0 Hz	45.0 Hz		
	`Gen. underfreq.  Delay time`	0.04 to 9.98 s	3.00 s		
	`Gen.voltage-     Monitoring`	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	`Gen.overvoltage       U >`	[1] 20 to 150 V; [4] 20 to 520 V	115/460 V		
	`Gen.overvoltage  Delay time`	0.04 to 9.98 s	3.00 s		
	`Gen.undervoltage      U <`	[1] 20 to 150 V; [4] 20 to -520 V	85/340V		
	`Gen.undervoltage Delay time`	0.04 to 9.98 s	3.00 s		
	`Auto-acknowledge   Messages`	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	`Acknowledge     Message aft`	1 to 99 s	1 s		
CONFIGURE PASSWORD					
	`Define level 1      code`	0000 to 9999	0001		
	`Define level 2      code`	0000 to 9999	0002		

Appendix D.
Power Factor Definition

The phasor diagram is used from the generator's view. This defines the following definitions.

Power Factor is defined as a ratio of the real power to apparent power. In a purely resistive circuit, the voltage and current waveforms are instep resulting in a ratio or power factor of 1.00 (often referred to as unity). In an inductive circuit the current lags behind the voltage waveform resulting in usable power (real power) and unusable power (reactive power). This results in a positive ratio or lagging power factor (i.e. 0.85lagging). In a capacitive circuit the current waveform leads the voltage waveform resulting in usable power (real power) and unusable power (reactive power). This results in a negative ratio or a leading power factor (i.e. 0.85leading).

Inductive: Electrical load whose current waveform lags the voltage waveform thus having a lagging power factor. Some inductive loads such as electric motors have a large startup current requirement resulting in lagging power factors.	Capacitive: Electrical load whose current waveform leads the voltage waveform thus having a leading power factor. Some capacitive loads such as capacitor banks or buried cable result in leading power factors.

Different power factor displays at the unit:

i0.91 (inductive) lg.91 (lagging)	c0.93 (capacitive) ld.93 (leading)

Reactive power display at the unit:

70 kvar (positive)	-60 kvar (negative)

Output at the interface:

+ (positive)	- (negative)

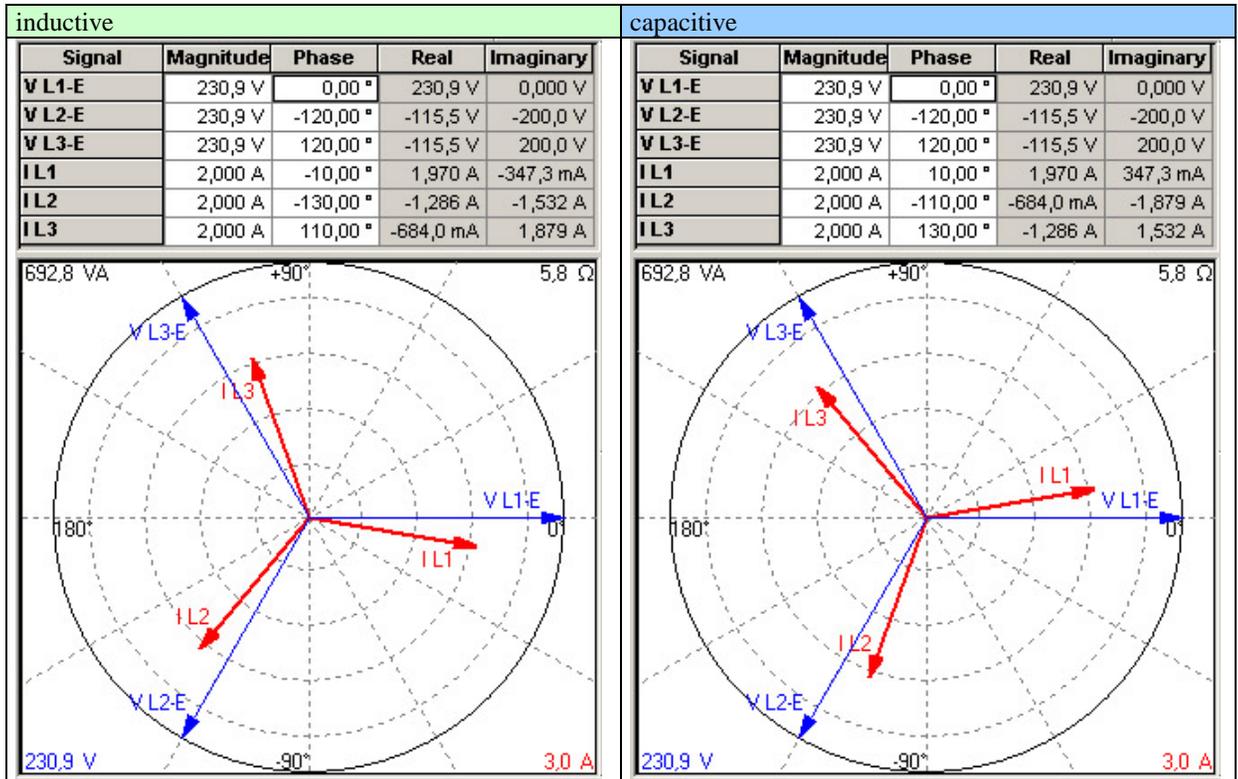In relation to the voltage, the current is

lagging	leading

The generator is

over excited	under excited

Control: If the control unit is equipped with a power factor controller

A voltage lower "-" signal is output as long as the measured value is "more inductive" than the reference set point Example: measured = i0.91; set point = i0.95	A voltage raise "+" signal is output as long as the measured value is "more capacitive" than the reference set point Example: measured = c0.91; set point = c0.95

Phasor diagram:

inductive				
Signal	**Magnitude**	**Phase**	**Real**	**Imaginary**
V L1-E	230,9 V	0,00 °	230,9 V	0,000 V
V L2-E	230,9 V	-120,00 °	-115,5 V	-200,0 V
V L3-E	230,9 V	120,00 °	-115,5 V	200,0 V
I L1	2,000 A	-10,00 °	1,970 A	-347,3 mA
I L2	2,000 A	-130,00 °	-1,286 A	-1,532 A
I L3	2,000 A	110,00 °	-684,0 mA	1,879 A

capacitive				
Signal	**Magnitude**	**Phase**	**Real**	**Imaginary**
V L1-E	230,9 V	0,00 °	230,9 V	0,000 V
V L2-E	230,9 V	-120,00 °	-115,5 V	-200,0 V
V L3-E	230,9 V	120,00 °	-115,5 V	200,0 V
I L1	2,000 A	10,00 °	1,970 A	347,3 mA
I L2	2,000 A	-110,00 °	-684,0 mA	-1,879 A
I L3	2,000 A	130,00 °	-1,286 A	1,532 A

Appendix E.
Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed. If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the control(s), attach a tag with the following information:

- name and location where the control is installed
- name and phone number of contact person
- complete Woodward part numbers (P/N) and serial number (S/N)
- description of the problem
- instructions describing the desired repair

CAUTION
To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors
- antistatic protective bags on all electronic modules
- packing materials that will not damage the surface of the control
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material
- a packing carton with double walls
- a strong tape around the outside of the carton for increased strength

Return Authorization Number RAN

When returning equipment to Woodward, please telephone and ask for the Customer Service Department in Stuttgart [+49 (0) 711-789 54-0]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the control(s) to be repaired. No work can be started until a purchase order is received.

NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at +49 (0) 711-789 54-0 for instructions and for a Return Authorization Number.

Replacement Parts

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When ordering replacement parts for controls, include the following information:
- the part numbers P/N (XXXX-XXX) that is on the enclosure nameplate
- the unit serial number S/N, which is also on the nameplate

How to contact Woodward

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Please contact following address if you have questions or if you want to send a product for repair:

Woodward GmbH
Handwerkstrasse 29
70565 Stuttgart - Germany

Phone: +49 (0) 711-789 54-0   (8.00 - 16.30 German time)
Fax: +49 (0) 711-789 54-100
e-mail: stgt-info@woodward.com

For assistance outside Germany, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone number
USA	+1 (970) 482 5811
India	+91 (129) 409 7100
Brazil	+55 (19) 3708 4800
Japan	+81 (476) 93 4661
The Netherlands	+31 (23) 566 1111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, go to **www.woodward.com/ic/locations**.]

Engineering Services

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Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by e-mail, or through the Woodward website.

- Technical support
- Product training
- Field service during commissioning

Technical Support is available through our many worldwide locations, through our authorized distributors, or through GE Global Controls Services, depending on the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical engineering support, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference technical support.

Product Training is available on-site from several of our worldwide facilities, at your location, or from GE Global Controls Services, depending on the product. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference *customer training*.

Field Service engineering on-site support is available, depending on the product and location, from our facility in Colorado, or from one of many worldwide Woodward offices or authorized distributors. Field engineers are experienced on both Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference *field service*.

Technical Assistance

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If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Contact

Your company _____

Your name _____

Phone number _____

Fax number _____

Control (see name plate)

Unit no. and Revision: P/N: _____   REV: _____

Control type   SPM-D2-11 _____

Serial number   S/N _____

Description of your problem

_____

_____

_____

_____

_____

_____

Please be sure you have a list of all parameters available.