37259C

SPM-D11
Synchronizing Unit

Manual
Software version 6.3xx

Manual 37259C

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. 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 (overtemperature, or overpressure, where applicable) shutdown unit(s), that operates totally independently of the prime mover control unit(s) to protect against runaway or damage to the engine, turbine, or other 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 linkage(s), or the controlled unit(s) fail.

CAUTION

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

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage 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 units.**

Important Definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury. Appropriate precautions have to be taken.

CAUTION

Indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment. This note should absolutely be observed when connecting the unit.

NOTE

References to other notes and supplements as well as tables and lists are identified by means of the "i" symbol. Most of the referenced sections are included in the Annex.

Revision History

Rev.	Date	Editor	Change
B	04-08-04	TP	LSR/LSXR update
C	04-10-19	TP	1/3-phase measurement functionality updated; linguistic update

Contents

Illustrations and Tables

Illustrations

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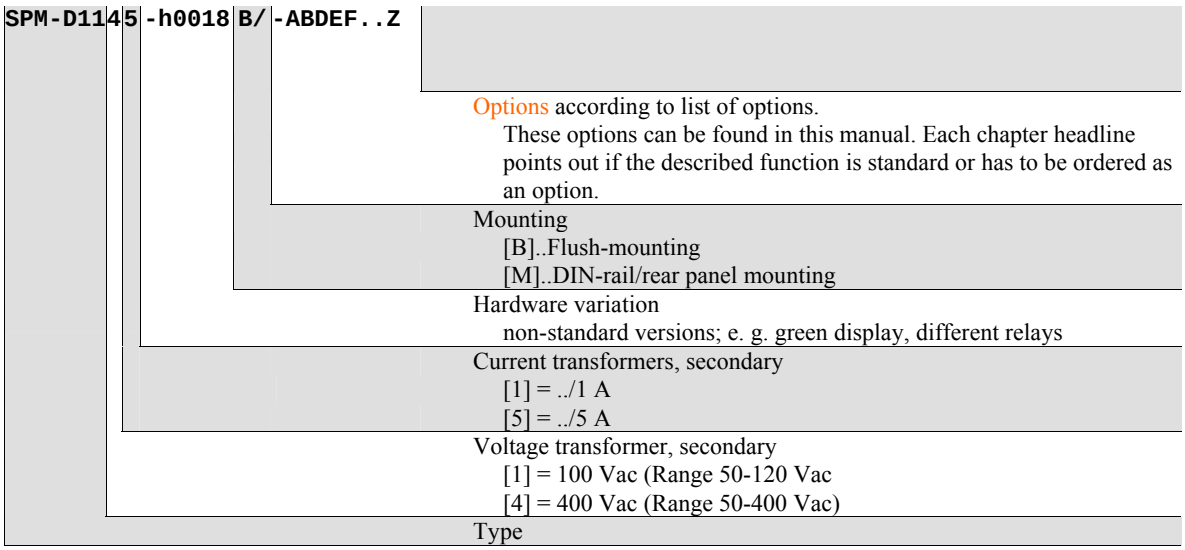
Chapter 1.
General Information

The SPM-D11 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 and
- Load/var sharing.

Type designation of the SPM-D comprises a standard control plus options as follows:



Examples:
- SPM-D1145B/LSR (LSR package with 50-400 Vac voltage and ../5 A current measuring inputs)
- SPM-D1111B/LSXR (LSXR package with 50-120 Vac voltage and ../1 A current 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 2.
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 doing 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. **With the opening of the control the guarantee expires!**
   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:

   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive controls or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective 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 antistatic protective bag.

WARNING

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 3.
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.

Wiring Diagram

SPM-D11/LSR

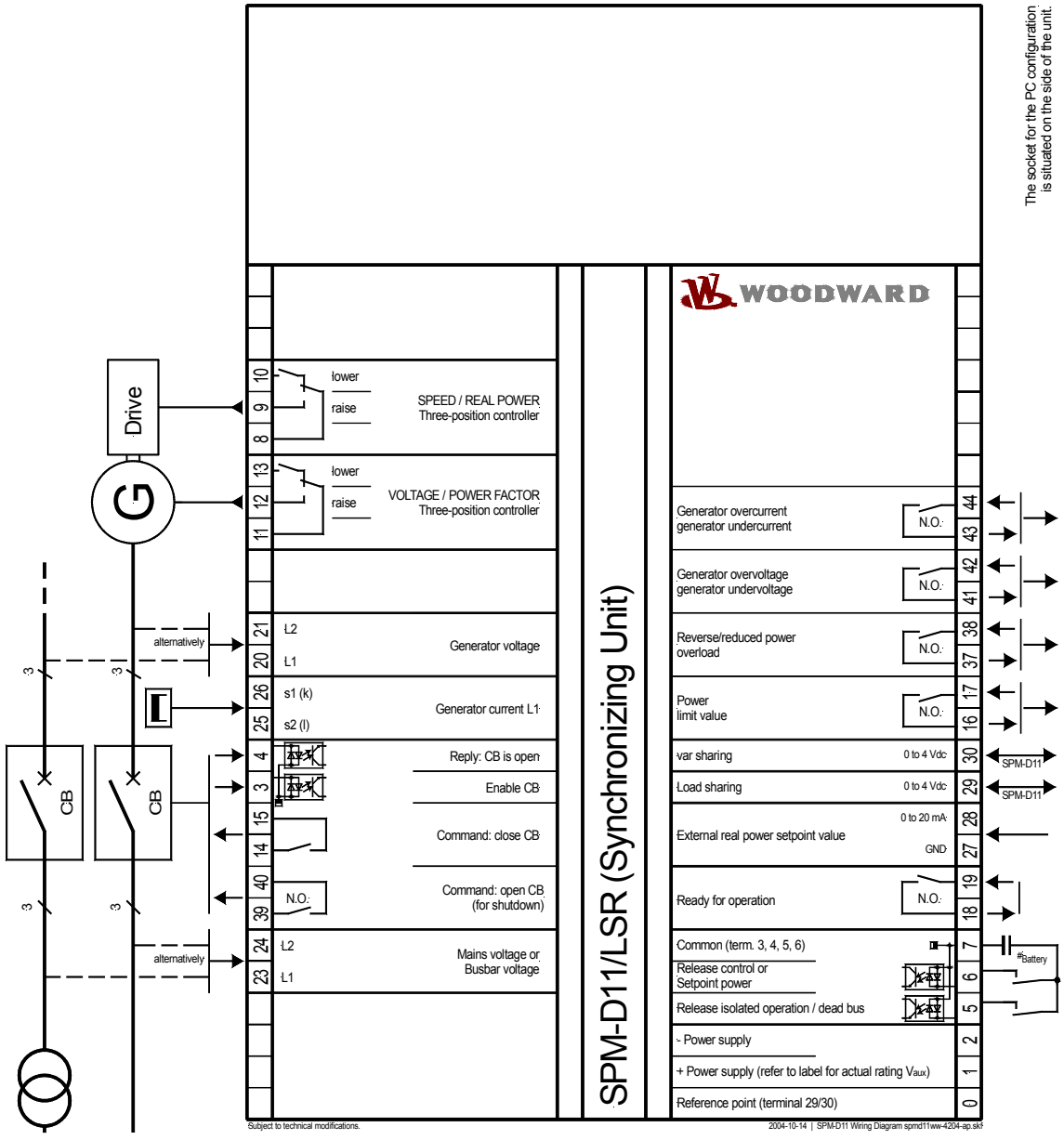


Figure 3-1: Wiring diagram SPM-D11/LSR

SPM-D11/LSXR

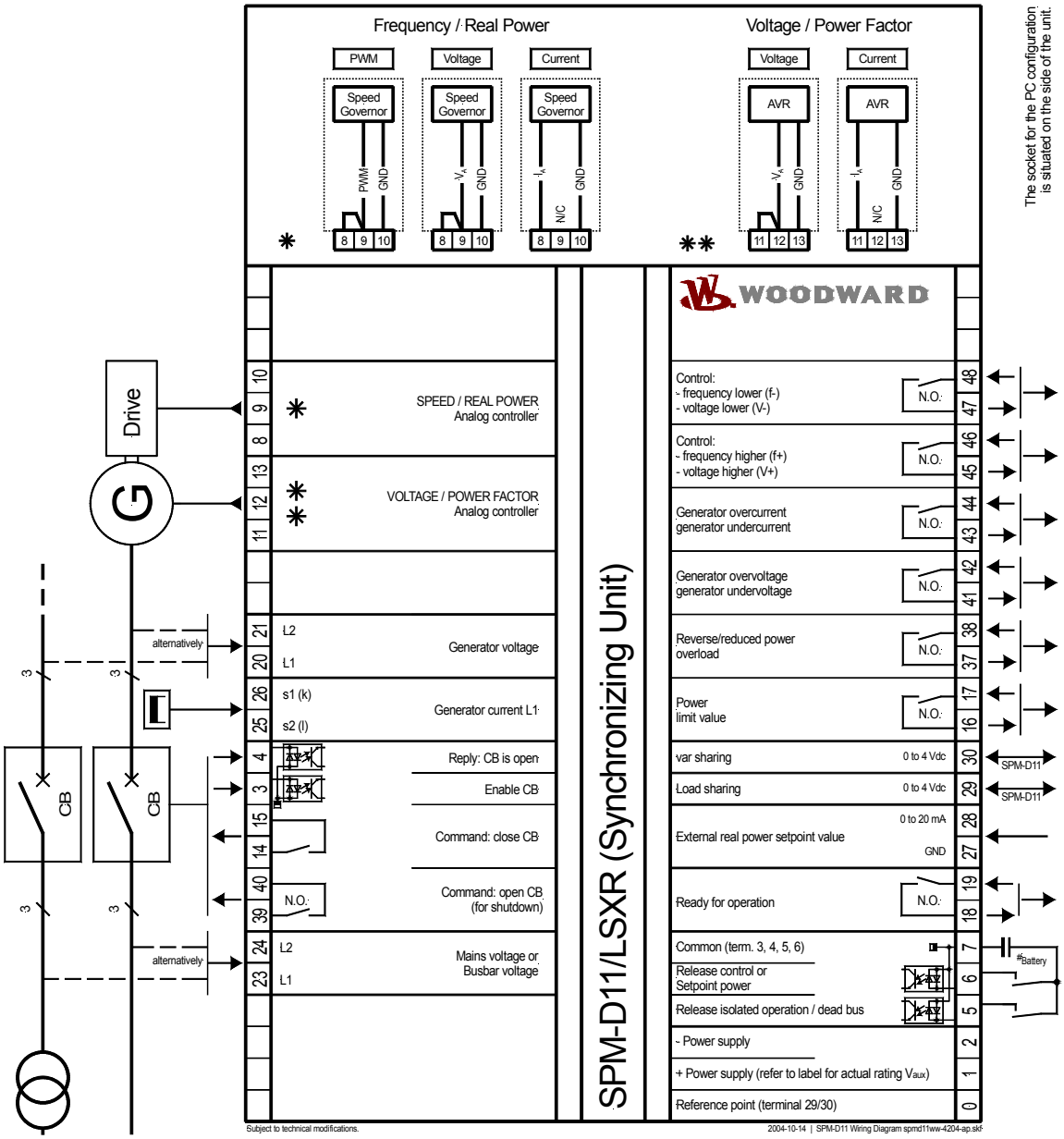


Figure 3-2: Wiring diagram SPM-D11/LSXR

Reference Point

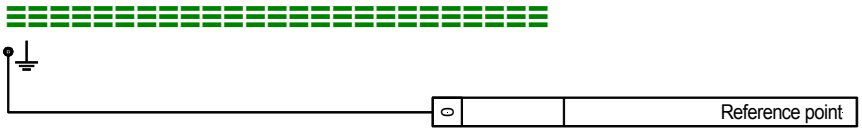


Figure 3-3: Reference point

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**

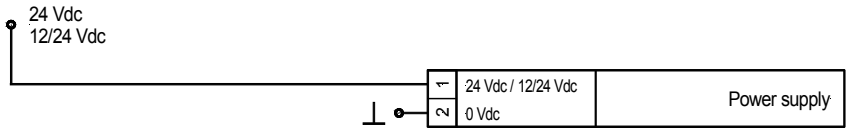


Figure 3-4: Power supply

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

Measuring Inputs

Voltage

NOTE

The SPM-D11 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-D11 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-D11 is configured accordingly (refer to CTs (Current Transformer) on page 42).

Generator

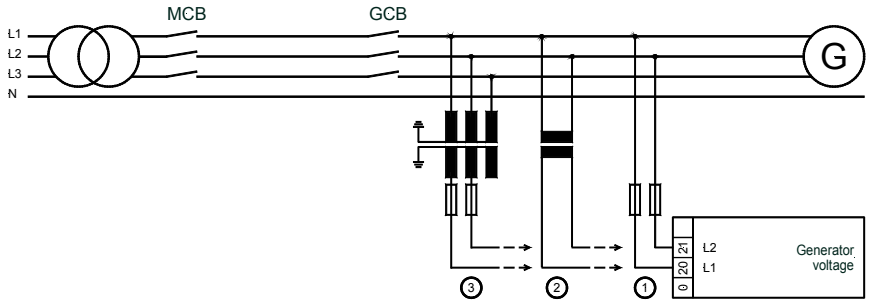


Figure 3-5: Measuring inputs - Generator

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

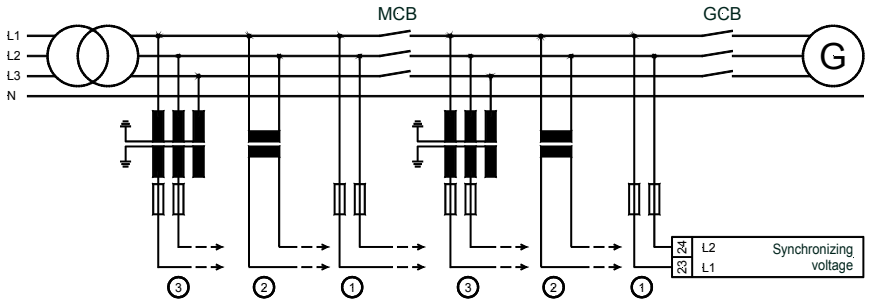


Figure 3-6: Measuring inputs - Synchronization voltage

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.

NOTE

Current transducers are generally to be grounded on one side of the secondary.

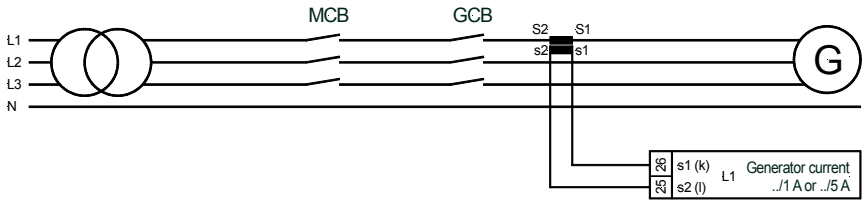


Figure 3-7: Measuring inputs - Current

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

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-D11 (refer to CTs (Current Transformer) on page 42). If there is a possibility that the load may be asymmetrical, the current must be measured in L1.

Discrete Inputs

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**

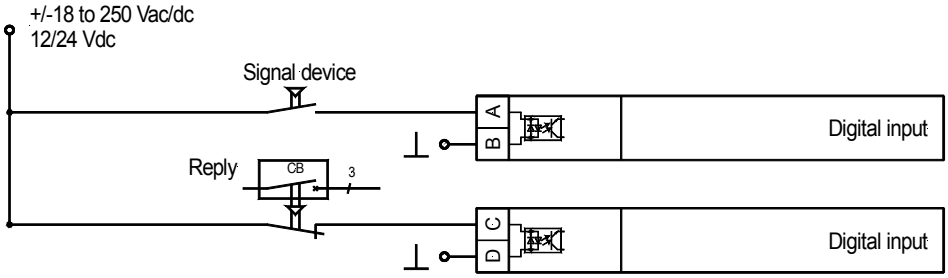


Figure 3-8: Digital inputs

Terminal	Associated zero-terminal	Description (to DIN 40 719 part 3, 5.8.3)	A_{max}
Make contact			
A	***B***		
3	7	Enable CB	2.5 mm²
5		Enable isolated operation / dead bus start	2.5 mm²
6		Enable control or release power set point value 2 *	2.5 mm²
Normally closed contact			
C	***D***		
4	7	Reply: CB is open	2.5 mm²

* see parameter "Terminal 6" on page 43

Analog Inputs

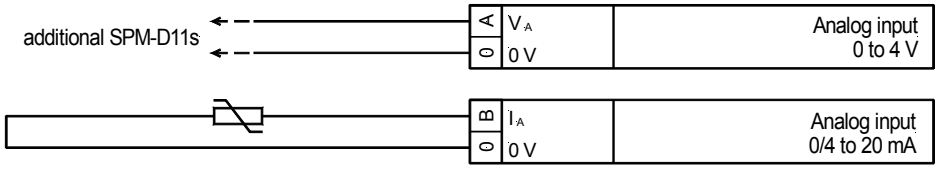


Figure 3-9: Analog inputs

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-D11 is switched off, the load/var sharing line must be disconnected to prevent the disabled SPM-D11 from influencing the other controls.

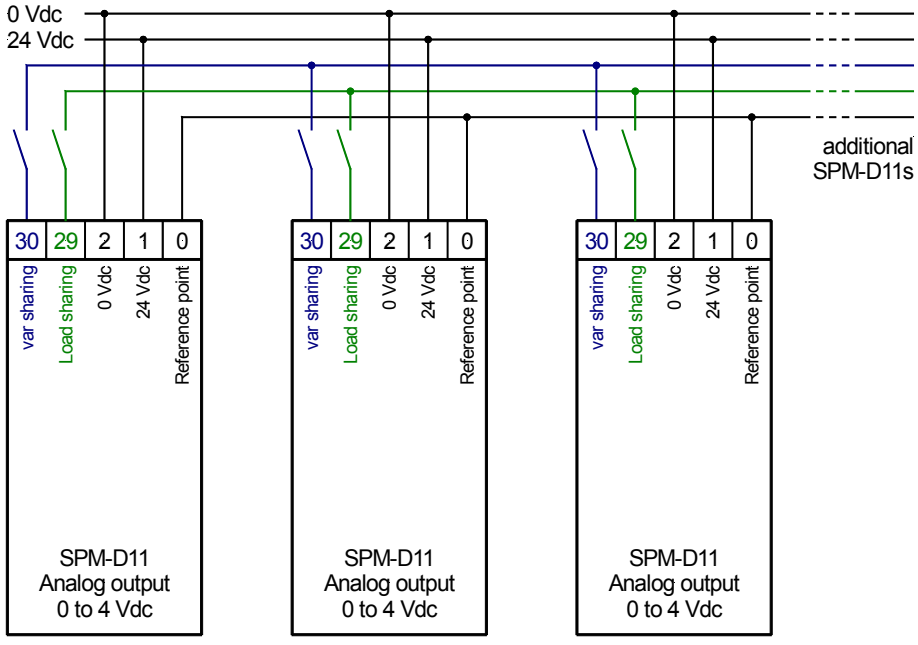


Figure 3-10: Load sharing

Relay Outputs

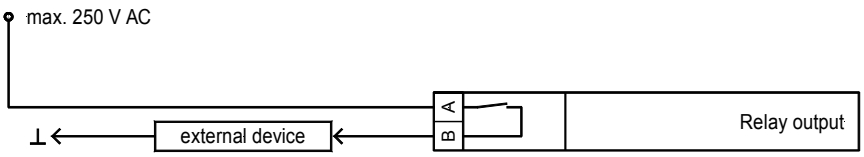


Figure 3-11: Relay outputs – control outputs I (CB control)

Root ***A***	Switched ***B***	Description	A_{max}
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 28). This relay is not controlled by monitoring functions.

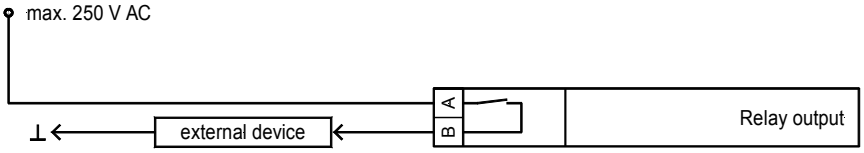


Figure 3-12: Relay outputs – control outputs II (acknowledgements)

Monitoring relay

N.O. functionality

Root ***A***	Switched ***B***	Description **Note:** The relays are de-energized and open in case of an fault.	A_{max}
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 ***A***	Switched ***B***	Description **Note:** The relay is energized and closed when the function is fulfilled.	A_{max}
18	19	Ready for operation	2.5 mm²

N.O. functionality

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

Controller Outputs

The SPM-D11/LSR is equipped with two three-position controllers for voltage and frequency (each comprising a form C and form A relay). The SPM-D11/LSXR permits various analog or PWM output signals to be selected by configuration, which can then be utilized in different ways.

SPM-D11/LSR

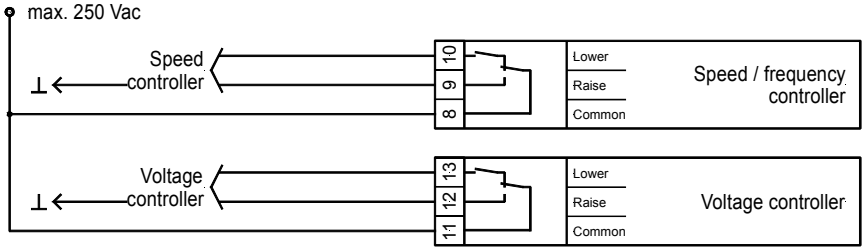


Figure 3-13: Controller - SPM-D11/LSR – three-position controller

Terminal		Description	A_{max}
8	common	Speed/frequency controller Real power controller	2.5 mm²
9	raise		2.5 mm²
10	lower		2.5 mm²
11	common	Voltage controller Power factor controller	2.5 mm²
12	raise		2.5 mm²
13	lower		2.5 mm²

SPM-D11/LSXR

The SPM-D11/LSXR has various controller outputs with the following types of signal, which can be changed by configuration as well as an external bridge/jumper.

Versions

- **Three-step controller** via the relay manager
  - Controlling n/f: Parameter "**f-controller type**" = THREE-STEP
    n+/f+ = relay at terminals 45/46
    n-/f- = relay at terminals 47/48
  - Controlling V: Parameter "**V-controller type**" = THREE-STEP
    V+ = relay at terminals 45/46
    V-- = relay at terminals 47/48

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

Connecting the Controllers

Setting: 'THREE-STEP' (Three-step controller)

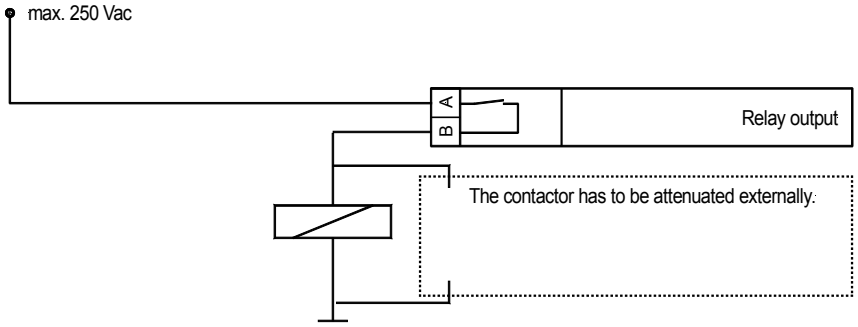


Figure 3-14: Controller - SPM-D11/LSXR - Three-step controller

Terminal		Description	A_{max}
45 / 46	higher	Speed / frequency controller or voltage controller	2.5 mm²
47 / 48	lower		2.5 mm²

Setting: 'ANALOG' and 'PWM' (Analog Controller)

Frequency/real power controller

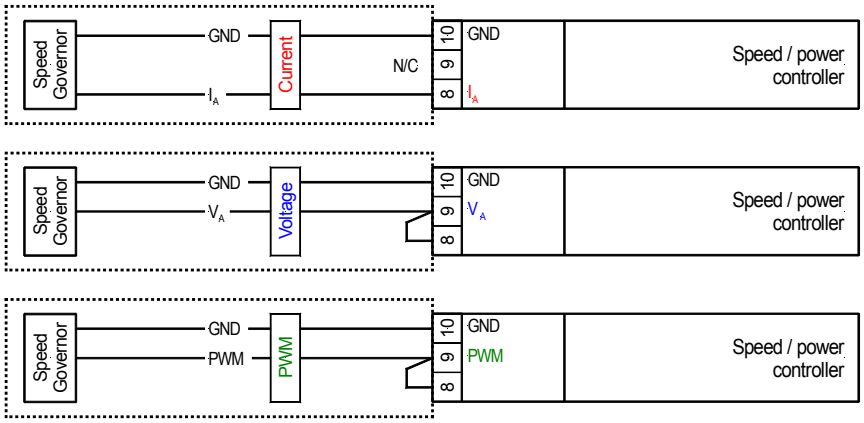


Figure 3-15: Controller - SPM-D11/LSXR - Analog controller output - Speed/frequency/real power

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

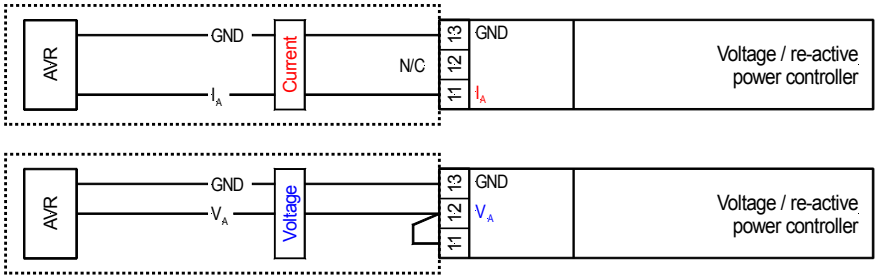


Figure 3-16: Controller - SPM-D11/LSXR - Analog controller output - Voltage/power factor

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

Chapter 4.
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 4-3: 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 control	- C1	OFF OFF	OFF
0	0	x	1	Idle operation or synchronization	C A	OFF OFF	CHECK
0	1	0	0	OFF	A	Slip or phase matching	PERMISSIVE
0	1	0	1	Idle operation or synchronization	C A	OFF Slip or phase matching	RUN
0	1	1	0	OFF	A	Synchro-Check	-
0	1	1	1	Idle 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	Distribution control or Isolated operation	F D	OFF OFF	-
1	0	1	1	Distribution control 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 4-1: 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 4-3: 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/ Blackstart"			
0	0	x	OFF or idle operation	- C1	OFF OFF
0	1	0	Idle operation or synchronization	C A	OFF Slip or phase matching
0	1	1	Idle 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 4-2: 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)
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 no-load control	- Parameter "Automatic no-load control 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 4-3: 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

If "**terminal 6 = Release control**" is energized,, 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.

If "**terminal 6 = Set point power**" is energized, the second set point value or the set point value via analog input is enabled.

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 Modes

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

Synchronization with zero phase control

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

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	x	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 4-4: 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".

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 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

Load and/or Var Sharing

The SPM-D11 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/var 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/React. 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 and voltage regulators of the generators must be suitably configured for parallel operation (i.e. droop operation mode)

Note – Other SPM-D11 units, which are not participating in load/var sharing, must not be connected to the load sharing signal line (terminals 29 and 30)

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

Load sharing of active power:

- 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".

Load sharing of reactive power:

- 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")

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.

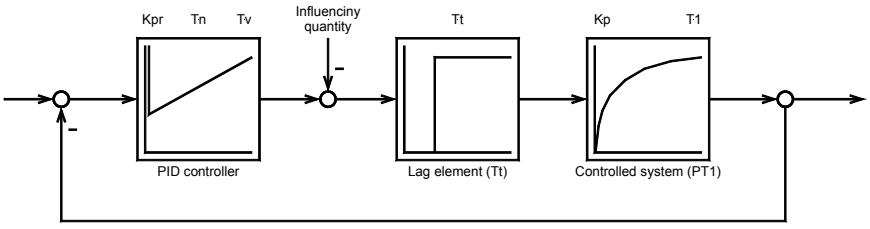


Figure 4-1: Control loop

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).

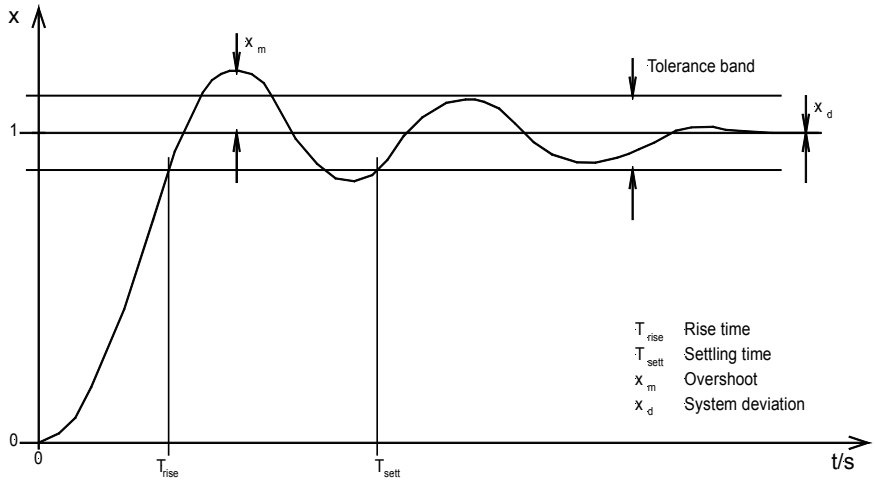


Figure 4-2: Step response (example)

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.

5. Controller operated as a P-only controller
   (where $T_n = \infty$ [screen setting: T_n =0], $T_V = 0$).
6. 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.

7. Measuring of the cycle duration T_{crit}
8. Set the parameters:

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

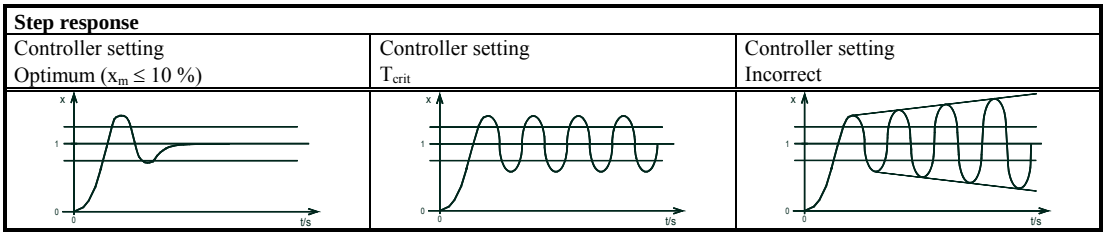


Figure 4-3: Step response - controller set-up

P gain (K_P) Proportional-action coefficient **1 to 240**

```
Pr.-sensitivity
        Kp = 000
```

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 (T_n) **0.2 to 60.0 s**

```
Reset time
      Tn = 00.0s
```

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-action time (T_V) **0.00 to 6.00 s**

```
Derivative act.
time    Tv=0.00s
```

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 5.
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.

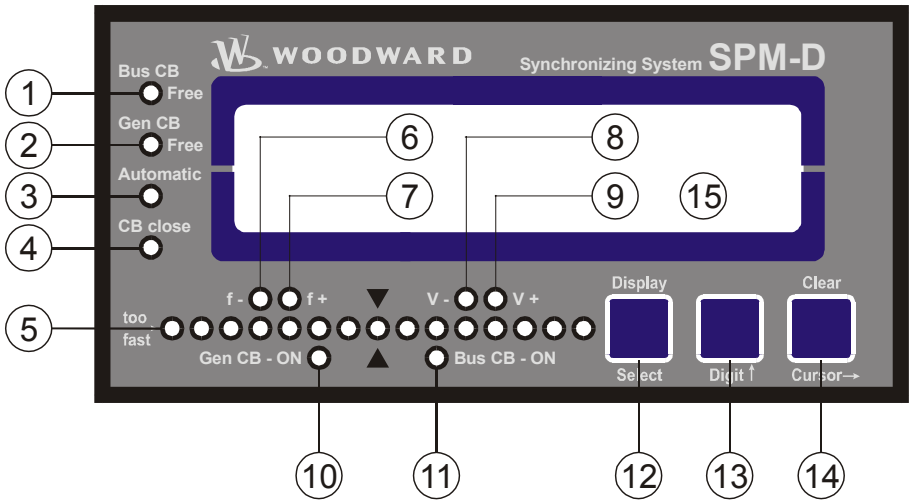


Figure 5-1: Front foil

Brief Explanation of the LEDs and Push Buttons

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: lower frequency (reduce speed)
7	f+	Governor output: raise frequency (increase speed)
8	V-	Governor output: lower voltage (reduce excitation)
9	V+	Governor output: raise voltage (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

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	80-110 % f_N
Voltage ranges	Generator and mains	50-125 % 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 27).

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

In order to facilitate the setting of the parameters the buttons are equipped with an "AUTOSCROLL" function while the controller is in the configuration mode. It permits the user to rapidly advance to the next setting and configuration screens, the digits, or the cursor position. The "AUTOSCROLL" function will only be enabled when the user presses and holds the corresponding buttons.

12 Display / Select **Display / Select**

Automatic mode: Display - By pressing this button, one advances through the display of operating and alarm messages.
Configuration: Select - By pressing the button the user advances to the next configuration screen. If the value originally displayed has been changed via the "Digit↑" or "Cursor→" push-buttons the newly set value is saved by pressing the "Select" push-button once. By pressing this push-button again, the user causes the system to advance to the next configuration screen.

13 Digit↑ **Digit ↑**

Automatic mode: Digit↓ - non-functional
Configuration: Digit↑ - With this push-button, the number at which the cursor is currently located is increased by one digit. The increase is restricted by the permissible limits (see list of parameters included in the appendix). If the highest permissible number has been reached, the number automatically returns to the lowest permissible number.

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

Automatic mode: Clear - By pressing this button, all alarm messages are deleted, provided that they are no longer detected.
Configuration: Cursor→ - This push-button is used to move the cursor one position to the right. When the cursor reaches the extreme right position it may be returned to the extreme left position by pressing the Cursor→ button again.

LC Display

15 LC-Display **LC-Display**

Performance values can be monitored from the two-line display, provided that the control is in automatic mode. In configuration mode, the individual parameters 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
```

LCD type 2 (kV configured)

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

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

LCD type 1 (V configured)

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

LCD type 2 (V configured)

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

Generator values

Generator values are monitored:

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

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 6.
Configuration

CAUTION

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

NOTE

A list of parameters may be found in Appendix B in this manual.

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. Note that it is possible to back up to previous configuration screens, but the user may only move back up to four (4) screens and cannot back up from the first configuration screen to the last configuration screen. If the controller is left idle for 10 minutes, the controller automatically returns to the automatic mode.

Basic Data

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.

Software version x.xxxx	**Software version**

Indicates the software version currently installed.

Password Protection

The control is equipped with a three-level code and configuration hierarchy, which enables it to project various configuration screens for different categories of users. A distinction is made between:

- **Code level 0 (CL0) -** User: Third party
  The user assigned this code level may view the monitored values but is prohibited from accessing any parameters. All configuration operations are blocked.

- **Code level 1 (CL1) -** User: Operator
  This code level entitles the user to change selected parameters. Changing a password is not permitted at this level. This password expires two hours after entering the password and the user is returned to the CL0 level.

- **Code level 2 (CL2) -** User: Commissioning personnel
  Allows direct access to all parameters (displaying and changing). In addition, the user may also set the password for levels CL1 and CL2. This password expires two hours after entering the password and the user is returned to the CL0 level.

```
Enter code
          XXXX
```

Enter code number **0-9999**

Upon enabling the configuration mode, the user is required to enter an access code number, which identifies the various users. The displayed number XXXX is a randomly generated number (RN). If the random number is confirmed by pressing the "Select" button without being changed, the current level of access is maintained. Upon entering either a level 1 or level 2 access code the corresponding level of access is granted. If an incorrect access code is entered the control unit changes to code level 0 and all access is blocked until a code level 1 or 2 access code is entered.

NOTE

Two hours after entering a code level 1/2 access number, the code level automatically returns to CL0!
The default code number for code level 1 (CL1) is "0001"!
The default code number for code level 2 (CL2) is "0002"!
The password protection can only be disabled in code level 2!

```
Password
Protection    ON
```

Password protection **ON/OFF**

ON..... Access to configuration is achieved by entering the correct code number (code level 1/2). If a wrong code number is entered, the configuration will be blocked.
OFF..... The user has direct access to all parameters, the code number is not requested.

Direct Configuration

NOTE

To carry out direct configuration, you require a direct configuration cable (Part #5417-557), the LeoPC 1 program (supplied with the cable), and the corresponding configuration files. Please consult the online help installed when the program is installed for a description of the LeoPC 1 PC program and its setup.

Direct configuration permits the user to display the control's parameters at any time. If the password protection is disabled or the control has had the code level 2 access code entered, the user may change all of the parameters via direct configuration. If the password protection has been enabled or the control has access code levels 0 or 1 entered, the access code for code level 2 must be entered via direct configuration, to modify any of the parameters. The ability to modify parameters through the display is not affected.

```
Direct para.
          YES
```

Configuration via the programming jack **YES/NO**

YES .....Configuration via the DPC cable is possible. The following additional conditions must be met:
- A connection between the control and the PC via the direct configuration cable must be available
- the baud rate of the LeoPC program must be 9.600 Baud
- the corresponding configuration file (filename: "*.cfg" and "*.asm") must be installed properly in the LeoPC1 program being used.

NO .....Configuration via programming plug cannot be carried out.

Basic Settings

WARNING

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

PTs (Voltage Transformers)

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

Rated generator frequency **48.0 to 62.0 Hz**

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

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

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

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.

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

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

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.

```
Mains voltage
secondary  000V
```

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

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.

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

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

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.

```
Mains voltage
primary 00.000kV
```

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

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.

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

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

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

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

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

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

CTs (Current Transformer)

```
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;

NOTE

Starting with software version 6.3640 it is possible to perform power measurement for single-phase or three-phase generators with the SPM-D11. The necessary settings have to be made in the following two screens.

```
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

```
Angle adjustment
Gen. Curr.   000
```

from version 6.3640

Angle adjustement generator current **-180° to 180°**

The angle adjustment allows the use of current transformers, which are installed in a different current path than L1, for measurement. The angle adjustment serves to adjust the shift between current and voltage.

Single-phase System

The voltage V_{L1N} is shifted by 30° compared with V_{L1L2}. This difference must be corrected for power measurement. Additionally, the phase of the current measurement must be taken in consideration.

Current transformer in phase	Connection type generator	Angle adjustment
L1	1W	-030°
L2	1W	090°
L3	1W	-150°

Three-phase System with Symmetrical Load

For three-phase systems, the angle must be corrected only if the current is measured in L2 or L3, or if a counter clockwise rotating field is present. If the load is not symmetrical, the current **must** be measured in L1.

Current transformer in phase	Connection type generator	Angle adjustment for rotating field right	Angle adjustment for rotating field left
L1	1W2	000	-060
L2	1W2	120	060
L3	1W2	-120	-180

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

Generator rated power **[1] 100 to 9,999 kW; [4] 5 to 9,999 kW**

Value of the generator rated power.

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

```
Automatic idle
Running      ON
```

Automatic no-load control **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).

```
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

The SPM-D11/LSR is equipped with a three-position controller for frequency and does not contain the following screens. Only the screens for setting the three-position controller are available. With the extended version SPM-D 11/LSXR, several controller output signals can be selected via the screens, which are listed by the controller model.

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

SPM-D11/LSXR only

Frequency controller type **THREE-STEP/ANALOG/PWM**

THREE-STEP 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-D11/LSR and SPM-D11/LSXR, Setting 'THREE-STEP')

```
Freq. controller
          ON
```

for SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

for SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

for SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

for SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

for SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

for SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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-D11/LSXR, Settings 'ANALOG' and 'PWM')

```
f control output
        xxxxxxx
```

SPM-D11/LSXR 'ANALOG'

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 configuration 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

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

SPM-D11/LSXR 'PWM'

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.

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

SPM-D11/LSXR 'PWM'

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.

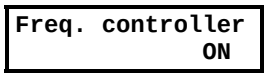
negative ..... If the controller output signal is at 100 %, 0 V is output continuously, 0 % output signal corresponds to the adjusted PWM level.

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

SPM-D11/LSXR 'ANALOG'& 'PWM'

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

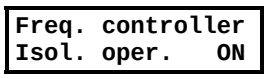
This parameter is the start point for the output signal when the frequency controller parameter is configured as OFF. The percentage value relates to the range between the minimum and maximum values that control unit can output (see below).



SPM-D11/LSXR
'ANALOG'& 'PWM'

Frequency controller **ON/OFF**

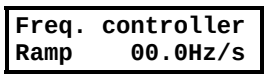
ON .....The generator frequency is controlled. The generator frequency is controlled in various manners depending on the task (no load / isolated operation / synchronization). The following screens of this function are displayed.
OFF .....Control is not carried out and the following screens of this function are not displayed.



SPM-D11/LSXR
'ANALOG'& 'PWM'

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

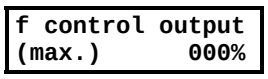
The setting of this screen has no influence on the load share control.
ON .....In isolated operation the frequency controller is enabled.
OFF .....In isolated operation the frequency controller is disabled.



SPM-D11/LSXR
'ANALOG'& 'PWM'

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

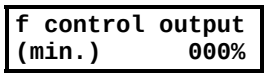
A change in set point is supplied to the controller via a ramp. The slope of the ramp is used to alter the rate at which the controller follows the set point value. The more rapidly the set point should change, the greater this setting should be.



SPM-D11/LSXR
'ANALOG'& 'PWM'

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

Upper limit of the analog controller output.



SPM-D11/LSXR
'ANALOG'& 'PWM'

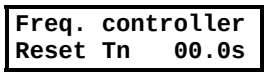
Minimum value frequency controller **0 to 100%**

Lower limit of the analog controller output.

SPM-D11/LSXR
'ANALOG'& 'PWM'

P gain of the frequency 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 29.



SPM-D11/LSXR
'ANALOG'& 'PWM'

Reset time frequency 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 29.

SPM-D11/LSXR
'ANALOG'& 'PWM'

Derivative-action time frequency 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 29.

Voltage Controller

The SPM-D11/LSR 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-D11/LSRX. Depending on the selected controller type, the following screens belonging to it appear.

```
V contr. type
        xxxxxxx
```

only SPM-D11/LSRX

Voltage controller type **THREE-STEP/ANALOG**

THREE-STEP: 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-D11/LSR and SPM-D11/LSXR, Setting 'THREE-STEP')

```
Volt. controller
              ON
```

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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
```

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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
```

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

Voltage controller insensitivity **[1] 0.1 to 15.V, [4] 0.5 to 60.0 V**

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.

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

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

Minimum voltage controller ON period **20 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 that has been set here. The smallest possible time must be set in order to ensure optimum control behavior.

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

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

Voltage controller gain factor **0.1 to 99.9**

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-D11/LSXR, Setting 'ANALOG')

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

SPM-D11/LSXR 'ANALOG'

Controller output signal **see table**

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 8/9	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%
```

SPM-D11/LSXR 'ANALOG'

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
```

SPM-D11/LSXR 'ANALOG'

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
```

SPM-D11/LSXR 'ANALOG'

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
```

SPM-D11/LSXR 'ANALOG'

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%
```

SPM-D11/LSXR 'ANALOG'

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

Upper limit of the analog controller output.

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

SPM-D11/LSXR 'ANALOG'

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

Lower limit of the analog controller output.

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

SPM-D11/LSXR 'ANALOG'

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 29.

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

SPM-D11/LSXR 'ANALOG'

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 29.

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

SPM-D11/LSXR
'ANALOG'

Voltage 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 29.

Power Factor Control

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

Power factor controller **ON/OFF**

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.

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

Power factor controller set point **i0.70 to 1.00 to k0.70**

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.

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

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

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

NOTE

Refer to the parameter settings for the voltage controller starting on page 47. The parameter settings performed for the voltage controller may be applied to the power factor controller as well.

Three-Position Controller (SPM-D11/LSR and SPM-D11/LSXR, Setting 'THREE-STEP')

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

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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-D11/LSXR, Setting 'ANALOG')

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

SPM-D11/LSXR 'ANALOG'

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 29.

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

SPM-D11/LSXR 'ANALOG'

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 29.

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

SPM-D11/LSXR 'ANALOG'

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 29.

Real Power Controller

```
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

```
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.

```
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

```
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.

```
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

```
Download and
open GCB     ON
```

Shut down **ON / OFF**

ON .....The generator set will shut down if the input "enable GCB" is removed.

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-D11 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.

```
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.

```
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.

```
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.

```
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.

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

Scaling the minimum value **0 to 8,000 kW**

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

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

Scaling the maximum value **0 to 8.000 kW**

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

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

Display of the current set point value **0 to 8,000 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.

```
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.

Three-Position Controller (SPM-D11/LSR and SPM-D11/LSXR, Setting 'THREE-STEP')

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

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

```
Power controller
Gain Kp    00.0
```

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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.

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

only SPM-D11/LSR and SPM-D11/LSXR 'THREE-STEP'

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-D11/LSXR, Setting 'ANALOG' & 'PWM')

```
Power controller
Gain Kp    000
```

SPM-D11/LSXR 'ANALOG' & 'PWM'

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 29.

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

SPM-D11/LSXR 'ANALOG' & 'PWM'

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 29.

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

SPM-D11/LSXR 'ANALOG' & 'PWM'

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 29.

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 62).

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

Generator power monitoring **ON/OFF**

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.

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

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

The threshold relates to the rated power of the generator.

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

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

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.

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

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

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

Load/Var Sharing

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

Load sharing **ON/OFF**

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.

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

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

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).

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

var sharing **ON/OFF**

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**.**

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

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

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).

Synchronization

Functions of Synchronization

```
Synchronizing
functions   ON
```

Synchronization functions **ON/OFF**

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.

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

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

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.

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

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

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.

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

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

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

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

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

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

```
Phase matching
          ON
```

Phase matching control **ON/OFF**

ON .....The synchronization is performed with Phase matching control and circuit breaker closure operations are dependent upon the phase angle. The relevant phase matching screens are displayed.

OFF .....The synchronization is performed with frequency and voltage matching for the generator and busbar with the circuit breaker being closed at the synchronous point. The relevant screens for adjusting the synchronizing slip are displayed.

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

Zero phase control = OFF

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

This configuration screen appears only if the phase matching control is configured as OFF. The prerequisite for the close command to be issued is that the phase angle differential must be less than the value configured here.

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:

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

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 "Synch-check" operation mode, the phase angle differential must be less than the value configured here in order to energize the relay "Close CB".

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

Zero phase control = OFF

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

This configuration screen only appears, if the phase matching control is configured OFF. This parameter is the close time of the circuit breaker. The time configured here is the amount of time from when a breaker receives a close command until the breaker contacts actually close. This permits the control to issue a close command just prior to the synchronization point so that the breaker closes at that point.

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

Zero phase control = ON

Max. permissible differential angle for phase matching control **0 to 60°**

This configuration screen only appears, if the phase matching control is configured ON! This is the maximum phase angle difference between the generator voltage and the busbar/mains voltage that a CB close command will be issued.

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

Zero phase control = ON

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

This configuration screen only appears, if the phase matching control is configured ON!
Once the synchronization window parameters have been met, a dwell timer is started. The close breaker pulse will not be issued until this dwell time has expired. If any of the required parameters leave the required ranges, the dwell timer will be reset.


```
Phase matching
Gain          00
```

Zero phase control = ON

Phase matching control gain **1 to 36**

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.

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

Zero phase control = ON

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

This configuration screen only appears, if the phase matching control is configured ON!
The phase matching control is not enabled, until the differential frequency between generator and busbar/ mains is lower than the value configured here.

Synchronization Time Monitoring

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

Synchronization time monitoring **ON/OFF**

ON..... This setting ensures that the synchronization time is monitored. A timer is started when synchronization is initiated. If the circuit breaker has not closed prior the timer expiring, the warning message "Synchronization time" is displayed. In addition, the synchronization procedure is cancelled and the "Ready for operation" relay is de-energized. By pressing the "Clear" button for at least 3 seconds or by removing one of the conditions which are necessary for the synchronization (e.g. terminal 3 "Release CB"), the synchronization timer is reset. The following screens of this function are displayed.

OFF..... The synchronization time will not be monitored. The following screens of this function are not displayed.

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

Final value for synchronization time monitoring **10 to 999 s**

Please refer to the above description of the configuration screen.

Dead Bus Operation

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.

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

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

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 25]. 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.

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

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

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.

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

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

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.

Protection

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 64).

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

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

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

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

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

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

Reduced power monitoring: A reduced power condition is detected if the 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.

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

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

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 recogonized.

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 64).

```
Gen. overload
Monitoring  ON
```

Overload monitoring **ON / OFF**

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.

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

Generator overload threshold **0 to 150 %**

The threshold value refers to the configured generator rated power.

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

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

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 64).

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

Generator frequency monitoring **ON/OFF**

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.

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

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

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

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

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

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.

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

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

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

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

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

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 64).

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

Generator voltage monitoring **ON / OFF**

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.

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

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

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

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

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

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.

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

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

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

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

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

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

```
Auto-acknowledge
messages      ON
```

Messages auto acknowledgment **EIN/AUS**

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.

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

Clear messages delay **1 to 99 s**

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

Password

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 CS0 should be entered. This will block any configuration of the control. A user may return to CS0 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.

```
Define level 1
code        0000
```

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

This code level entitles the user to change selected parameters. Changing a password is not permitted at this level. This password expires two hours after entering the password and the user is returned to the CS0 level. For more information on password protection refer to page 39.

```
Define level 2
code        0000
```

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

This screen appears only in code level 2 (password protection enabled). The code number entered here in this screen permits direct access to all parameters (displaying and changing). In addition, the user may also set the password for levels CL1 and CL2. This password expires two hours after entering the password and the user is returned to the CL0 level. For more information on password protection refer to page 39.

Chapter 7.
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.

LIFE THREATENING

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!

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 38. 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

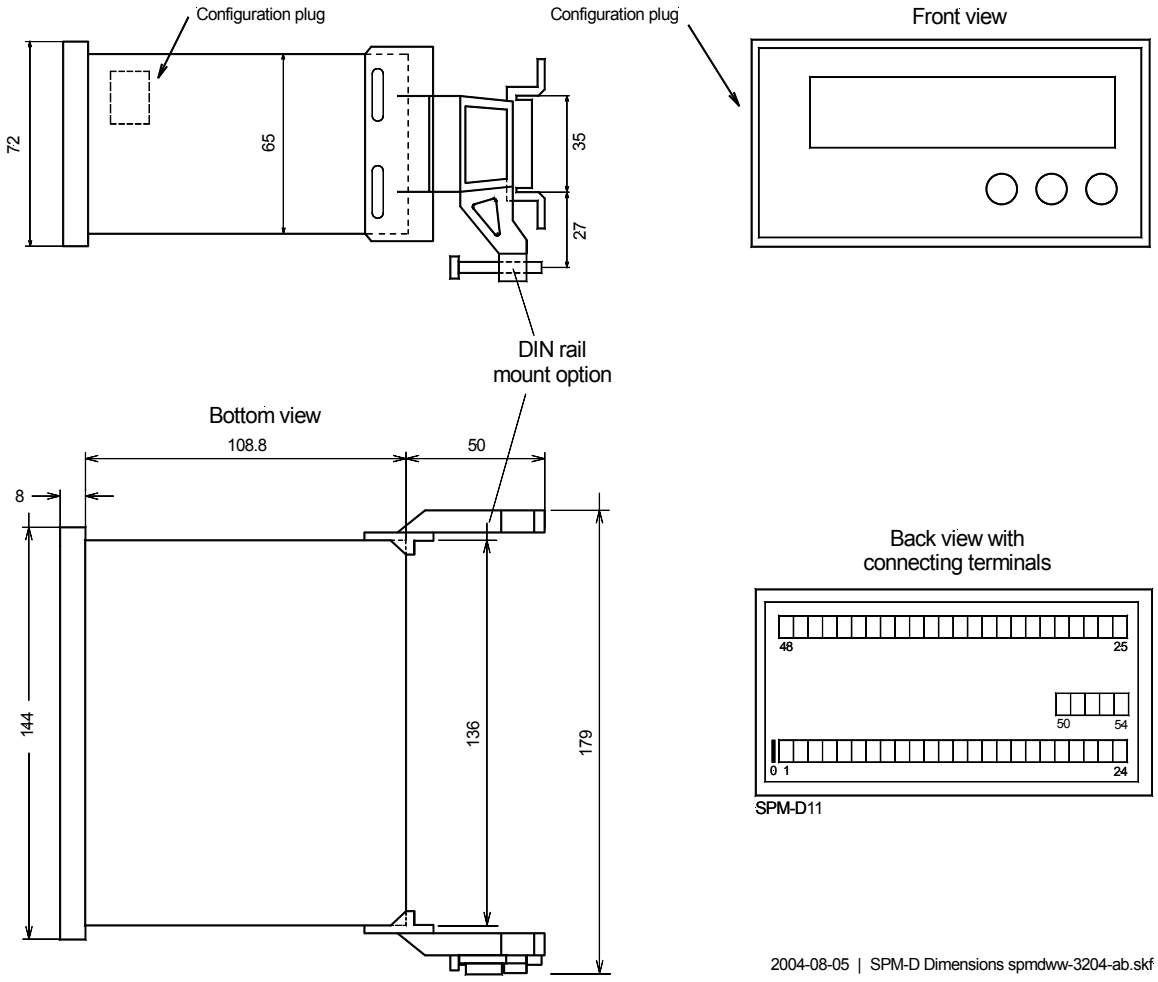


Figure 7-1: Dimensions

Appendix B.
List of Parameters

Product number P/N _____ Rev _____

Version SPM-D11 _____

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		6.1xx		
	Enter code	0000 to 9.999	XXXX		
	Password Protection	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Direct para.	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	400 V		
	Mains voltage secondary	[1] 50 to 125 V, [4] 50 to 440 V	400 V		
	Gen. voltage primary	0.1 to 65.0 kV	0.4 kV		
	Mains voltage primary	0.1 to 65.0 kV	0.4 kV		
	Rated voltage Vn	[1] 50 to 125 V, [4] 70 to 420 V	400 V		
	Gen. voltage Set point	[1] 50 to 125 V, [4] 50 to 440 V	400 V		
	Current transf. Generator	10 to 9,999/x A	1000/x A		
	Connection type Gen.	1W/1W2	1W2	☐ 1W ☐ 1W2	☐ 1W ☐ 1W2
	Angle adjustment Gen. Curr	-180° to 180°	000		
	Rated power Gen.	[1] 100 to 9,999 kW [4] 5 to 9,999 kW	100 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	THREE-STEP/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	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	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					
	Sync.time contr.	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Sync.time contr. Delay time	10 to 999 s	120 s		
CONFIGURE DEAD BUS					
	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	40 V		
CONFIGURE WATCHDOGS					
	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	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	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 PASSWORDS					
	Define level 1 code	0000 to 9999	0001		
	Define level 2 code	0000 to 9999	0002		

Appendix C.
Technical Data

Measuring values, voltage ----------

- Measuring voltage — Standard (V_N) ..... [1] 57/100 (120) Vac; [4] 230/400 Vac
  Measuring range ..... [1] 50 to 120 Vac; [4] 50 to 400 Vac
- Measuring frequency ..... 40.0 to 70.0 Hz
- Accuracy ..... Class 1
- Continuous voltage input ..... 1.3 × V_N
- Input resistance ..... [1] 0.21 MΩ, [4] 0.696 MΩ
- Maximum power consumption per path ..... 0.15 W

Measuring values, current ---------- **galvanically isolated**

- Measuring current ..../1 A, ../5 A
- Accuracy ..... Class 1
- Maximum continuous current ..... 3.0 × I_N
- Maximum power consumption per path ..... < 0.15 VA
- Rated short-time current (1 s) ..... [../1 A] 50.0 × I_N, [../5 A] 10.0 × I_N

Ambient variables (Attention! Please observe actual ratings on data plate!) ----------

- Power supply (V_{aux}) ..... 24 Vdc (18 to 32 Vdc)
- *or alternatively* ..... 12/24 Vdc (9.5 to 32 Vdc)
- Intrinsic consumption ..... max. 12 W
- Ambient temperature ..... -20 to 70 °C
- Ambient humidity ..... 95 %, not condensing

Discrete inputs (Attention! Please observe actual ratings on data plate!)----- galvan. 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 ---------- **galvanically 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 × B × H) ..... 144 × 72 × 116.8 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
  use 60/75 °C copper wire only
  use class 1 wire only or equivalent
- Weight ..... approx. 800 g

Protection----------
- Protection system ..... IP42 from front for proper installation
  IP54 from front with gasket (gasket: P/N 8923-1037)
  IP21 from back
- Front foil ..... insulating surface
- EMV test (CE) ..... tested according to applicable EN guidelines

Listings CE marking

Appendix D.
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 type of 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

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

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

Woodward Governor Company
Leonhard-Reglerbau 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: sales-stuttgart@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 5881
India	+91 (129) 230 7111
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

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

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-D11 _____

Serial number S/N _____

Description of your problem

_____

_____

_____

_____

_____

_____

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

We appreciate your comments about the content of our publications.

Please send comments to: icinfo@woodward.com

Please include the manual number from the front cover of this publication.

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Homepage

http://www.woodward.com/smart-power

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address/phone/fax/e-mail information for all locations is available on our website (www.woodward.com).

04/10/S