SPM–D Synchronizer

Operating Instructions

Manual 26126
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 device(s), that operates totally independently of the prime mover control device(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 device(s) fail.

CAUTION

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

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent 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 devices.

IMPORTANT DEFINITIONS

WARNING—indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION—indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment.

NOTE—provides other helpful information that does not fall under the warning or caution categories.
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Chapter 1.
General Information

Introduction

The Woodward SPM–D is a micro–processor based synchronizer designed for use on three phase AC generators equipped with Woodward or other compatible speed controls and compatible Automatic Voltage Regulators.

These operating instructions have been developed are intended for a unit fitted with all available options. Inputs/outputs, functions, parameterization screens and other details described, which do not exist on your unit may be ignored.

CAUTION
The present Operating Instructions have been prepared to enable the installation and commissioning of the device. On account of the large variety of parameter settings, it is not possible to cover every possible combination. The Operating Instructions are therefore only a guide. In case of incorrect entries or a total loss of functions, the default settings can be taken from the enclosed list of parameters.

Part Numbers

<table>
<thead>
<tr>
<th>Part number</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>5448–890</td>
<td>Discrete Speed/voltage</td>
</tr>
<tr>
<td>5448–891</td>
<td>VJH, UF, R2, Discrete Speed/voltage</td>
</tr>
<tr>
<td>5448–893</td>
<td>Qf, Qu, Analog Speed/voltage</td>
</tr>
<tr>
<td>5448–894</td>
<td>VJH, UF, R2, Qf, Qu, Analog Speed/voltage</td>
</tr>
</tbody>
</table>

Option Descriptions

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qf</td>
<td>+/- 3 Vdc frequency bias signal</td>
</tr>
<tr>
<td>Qu</td>
<td>+/- 5</td>
</tr>
<tr>
<td>R2</td>
<td>Reverse, reduced and overload power monitoring</td>
</tr>
<tr>
<td>UF</td>
<td>1-ph. Generator over/under voltage monitoring; over/under frequency monitoring</td>
</tr>
<tr>
<td>VJH</td>
<td>3-ph. Mains over/under voltage monitoring; over/under frequency monitoring; phase shift monitoring</td>
</tr>
</tbody>
</table>
SPM-D Outline drawing

Housing

- Type APRANORM DIN 43700
- Dimensions: 144 × 72 × 122 mm
- Front cutout: 138 × 67 mm
- Connection: 1.5 mm or 14 AWG screw terminals depending on the plug connector
- Degree of protection: IP 21, front IP 54
- Weight, depending on model, approx. 800 g
- Disturbance test (EC): Tested according to valid EN codes of practice
- Pressure-sensitive front membrane: isolating surface
Connection diagram

Controller with analog outputs

SPM-D Synchronizer System

Synchronizing pulse:
close GCB

5448-890 & 5448-893

Drive

G

GCB

MCB

Busbar voltage

Generator voltage L1

Generator voltage L2

Lower

Higher

Higher

Lower

SPEED

Three-position controller

Alternatively Option Qf:

Analog controller

VOLTAGE

Three-position controller

Alternatively Option Qu:

Analog controller

Reply: GCB is open

Release GCB

Synchronizing pulse: close GCB

Parameterization locked

Readiness for operation

Common (term. 3, 4, 5, 6, 53, 54)

0 V DC

24 V DC

Make-contact

Woodward
Controller with analog outputs

5448-891 & 5448-894

SPM-D Synchronizer System

Three-position controller
Alternatively Option Qf:
Analog controller

Generator over frequency
Generator under frequency

Generator over voltage
Generator under voltage

Mains over frequency
Mains under frequency
Phase shift

Mains over voltage
Mains under voltage

Generator over frequency
Generator under frequency

Breaker contact

Make contact

Release GCB

Synchronizing pulse, close GCB

Ready for operation

5448-894 (5448-891)

Release isolated operation

Parameterization locked

24 V DC

0 V DC

7

19

18

Parameterization locked
Measurement Data

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

NOTE
Connected inductances (i.e. Coils of operating current or undervoltage tripping devices, auxiliary contactors and power contactors) must be wired with an appropriate interference protection.

Power supply

24 V DC (+/-25 %)

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Description</th>
<th>$I_{\text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Neutral point of the three-phase system or neutral terminal of the voltage transformer (Measuring reference point); with three-conductor systems, do not connect</td>
<td>Sold. lug</td>
</tr>
<tr>
<td>1</td>
<td>Power supply: +24 V DC, 10 W</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>2</td>
<td>Power supply: -24 V reference point</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
</tbody>
</table>

The SPM–D+ can operate (monitor) only one synchronization position (one power circuit breaker), because it is a 1-power-circuit-breaker configuration. The voltage at terminals 23/24 is the voltage to which the assessment of the synchronization at terminals 20/21 refers. The synchronization voltage can be, i.e., the mains or busbar voltage.

Voltage measuring inputs

The SPM–D+ can operate (monitor) only one synchronization position (one power circuit breaker), because it is a 1-power-circuit-breaker configuration. The voltage at terminals 23/24 is the voltage to which the assessment of the synchronization at terminals 20/21 refers. The synchronization voltage can be, i.e., the mains or busbar voltage.

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

1. Direct connection to the low voltage system,
2. Connection to medium voltage via two-pole isolated transformer (i.e. in the case of a V-connection) and
3. Connection to medium voltage via single-pole isolated transformer (i.e. Y-connection).
Generator

Note: Connection corresponding to the mains configuration (see connection plan).

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Measurement</th>
<th>Description</th>
<th>$\Lambda_{\text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>direct or</td>
<td>Generator voltage L1</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td></td>
<td>Transformer</td>
<td>/120 V</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>Generator voltage L2</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>Sold.lug</td>
</tr>
</tbody>
</table>

Mains/busbar

Note: Connection corresponding to the mains configuration (see connection plan).

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Measurement</th>
<th>Description</th>
<th>$\Lambda_{\text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>120 V</td>
<td>Synchronization voltage L1</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>Synchronization voltage L2</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
</tbody>
</table>
Mains

Note: The connection is only made if options V, J and H are installed; otherwise, these terminals remain unused.

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Measurement</th>
<th>Description</th>
<th>A&lt;sub&gt;max&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>measuring transformer ..120 V</td>
<td>Mains voltage L1 for protection (Options VJH)</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>51</td>
<td></td>
<td>Mains voltage L2 for protection (Options VJH)</td>
<td>14 AWG</td>
</tr>
<tr>
<td>52</td>
<td></td>
<td>Mains voltage L3 for protection (Options VJH)</td>
<td>14 AWG</td>
</tr>
</tbody>
</table>

Auxiliary and control inputs

Digital inputs

Controller inputs  Part 1

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Accompanying Zero terminals</th>
<th>Name (according to DIN 40 719 Part 3, 5.8.3)</th>
<th>A&lt;sub&gt;max&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>7</td>
<td>GCB release</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>Reply: GCB is open</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
</tbody>
</table>

Control inputs  Part 2

Woodward
Auxiliary and control outputs

Power circuit breaker actions

max. 250 V AC

<table>
<thead>
<tr>
<th>Root</th>
<th>Switched</th>
<th>Description</th>
<th>$\Lambda_{\text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>15</td>
<td>Synchronizing pulse: GCB close</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
</tbody>
</table>

max. 250 V AC

Other actions

Monitor relay      Normally closed contact function

<table>
<thead>
<tr>
<th>Root</th>
<th>Switched</th>
<th>Description</th>
<th>$\Lambda_{\text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>34</td>
<td>Mains over-/undervoltage (Option V)</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>35</td>
<td>36</td>
<td>Mains over-/underfrequency (Option J, H)</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>41</td>
<td>42</td>
<td>Generator over-/undervoltage (Option U)</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
<tr>
<td>43</td>
<td>44</td>
<td>Generator over-/underfrequency (Option F)</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
</tbody>
</table>

Alarm relay      Normally open contact function

<table>
<thead>
<tr>
<th>Root</th>
<th>Switched</th>
<th>Description</th>
<th>$\Lambda_{\text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>19</td>
<td>Readiness for operation</td>
<td>2.5 mm² / 14 AWG</td>
</tr>
</tbody>
</table>

Controller outputs

The controllers are configured in standard version as a three-point controller (made of a changeover contact and a normally open contact; the above description applies). If the options Qu or Qf are ordered, they are configured as a quasi-continuous controller with analog outputs. The description below, as well as the one of the analog controller that follows, are needed. In addition, other parameterization screens appear.
Three–position controller (standard)

Terminal Assignment Description $A_{max}$
---
8 common 2.5 mm² / 14 AWG
9 higher speed-/frequency controller 2.5 mm² / 14 AWG
10 lower 2.5 mm² / 14 AWG
11 common 2.5 mm² / 14 AWG
12 higher voltage controller 2.5 mm² / 14 AWG
13 lower 2.5 mm² / 14 AWG

Analog controller outputs (options Qf.Qu)

Terminal Assignment Description $A_{max}$
---
8 $I_A$ 2.5 mm² / 14 AWG
9 ±3 Vdc ±3 Vdc speed-/frequency controller 2.5 mm² / 14 AWG
10 common common 2.5 mm² / 14 AWG
11 $I_A$ 2.5 mm² / 14 AWG
12 ±24 V ±5 Vdc voltage controller 2.5 mm² / 14 AWG
13 common common 2.5 mm² / 14 AWG
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. 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 devices 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.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.
## Chapter 3. Description of Functions

### Introduction

<table>
<thead>
<tr>
<th>Digital signal: &quot;Release isolated operation&quot;</th>
<th>Input signal</th>
<th>Function</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED message on the pressure-sensitive front membrane: &quot;Gen - LS ON&quot;</td>
<td>LED message on the pressure-sensitive front membrane: &quot;Gen-LS FREE&quot;</td>
<td>No-load operation of the generator</td>
<td>C</td>
</tr>
<tr>
<td>x 0 0</td>
<td>No-load operation of the generator</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>0 0 1</td>
<td>Synchronization generator power circuit breaker</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>0 1 x</td>
<td>Isolated controller OFF</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>1 0 1</td>
<td>Generator power circuit breaker synchronization</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>1 1 x</td>
<td>Isolated operation</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-1. Functions

**Conditions** The function of the device is also dependent, apart from the digital input signals, on the state of the available measured voltages. The particular function must also be activated in parameterization mode:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Input signal 1</th>
<th>Input signal 2</th>
<th>Input signal 3</th>
<th>Input signal 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Synchronization</td>
<td>Mains voltage within the permissible range</td>
<td>Generator voltage within the permissible range</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Black start</td>
<td>Mains voltage less than 5% (U_N) (busbar)</td>
<td>Generator voltage within the permissible range</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>No-load operation</td>
<td>Generator voltage (&gt; 50% U_N)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Isolated operation</td>
<td>Generator voltage (&gt; 50% U_N)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0: OFF 1: ON  x: Signal of no significance (0 or 1)
Fault Messages

The unit is equipped with various monitoring devices. A state that is not permissible for faultless operation is automatically displayed.

**LED "Gen CB ON" flashes** Incorrect signal state of the reply "Generator power circuit breaker OPEN" on terminal 4.

Possible faults:
- Reply present on (= –24 V) generator and busbar voltage not synchronous
- Reply missing (= 24 V) generator and main voltage synchronous

With this fault message, check to see whether the input on terminal 4 is correctly wired. For the wiring to be correct, there must be a closed power circuit breaker on the input in question –24 V.

Control Inputs

<table>
<thead>
<tr>
<th>Input</th>
<th>Set</th>
<th>Release for operation of the power circuit breaker</th>
</tr>
</thead>
</table>
| Release GCB              | Terminal 3           | Release voltage/frequency control in the case of missing "Reply: GCB is open" (the LED "Gen CB ON" on the pressure-sensitive front membrane lights up).
|                           |                      | Release black start for present "Reply: GCB is open" (the LED "Gen CB ON" on the pressure-sensitive front membrane does not light up).
|                           |                      | Shut down voltage/frequency controller in the event of a missing "Reply: GCB is open" (the LED "Gen CB ON" on the pressure-sensitive front membrane lights up).

| Input blocked            | Terminal 6           | By setting this input, entering into parameterization mode from pressing "+" "Digit↑" and "+" "Cursor→" can be prevented. Blocking can be carried out using a keylock switch.

Reply: GCB is open
Terminal 4

With this Input (logical "1") the unit is signaled that the generator or mains power circuit breaker is opened (the light-emitting diode "Gen CB ON" is off if the reply is correctly detected as logic; otherwise, it flashes).
Control outputs

**Synchronization pulse:**
- **Close GCB**
  - Terminals 14/15
  By setting this relay the generator power circuit breaker (GCB) will be closed. The relay drops out after the pulse is output.

**Operational readiness**
- Terminals 18/19
  Setting the relay signals the readiness for operation of the unit. If this relay drops out, a faultless function of the unit can be guaranteed. Appropriate measure must be introduced if this relay has dropped out (i.e. open GCB, shut down motor).

**NOTE**
You must externally evaluate the following messages (i.e. by looping in the corresponding relay in the self-holding chain of the power circuit breaker). The output of the following messages is always carried out and is independent of the power circuit breaker state. The blocking of the corresponding message (i.e. when the machine is stopped) must be carried out externally.

<table>
<thead>
<tr>
<th>Fault output</th>
<th>Mains overvoltage, mains undervoltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminals 33/34</td>
<td>If the fault &quot;Mains overvoltage&quot; or &quot;Mains undervoltage&quot; occurs, this relay is <strong>opened.</strong></td>
</tr>
<tr>
<td>only with Option V</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fault output</th>
<th>Mains overfrequency, mains underfrequency, phase shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminals 35/36</td>
<td>If the fault &quot;Mains overfrequency&quot;, &quot;Mains underfrequency&quot; or &quot;Phase shift&quot; occurs, this relay is <strong>opened.</strong></td>
</tr>
<tr>
<td>only for Options J and H</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fault output</th>
<th>Generator overvoltage, generator undervoltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminals 41/42</td>
<td>If the fault &quot;Generator overvoltage&quot; or &quot;Generator undervoltage&quot; occurs, this relay is <strong>opened.</strong></td>
</tr>
<tr>
<td>only for Option U</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fault output</th>
<th>Generator overfrequency, Generator underfrequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminals 43/44</td>
<td>If the fault &quot;Generator overfrequency&quot; or &quot;Generator underfrequency&quot; occurs, this relay is <strong>opened.</strong></td>
</tr>
<tr>
<td>only with Option F</td>
<td></td>
</tr>
</tbody>
</table>

Potential Separation Between the Power Supply and the Digital Inputs

By means of appropriate external wiring, the common reference point of the digital inputs (terminal 7) can be electrically isolated from the supply voltage (–24 V, terminal 2). This is necessary, for example, if the digital inputs are not to be driven with +24 V DC and an electrical isolation of the control voltage (i.e. 220 V DC, 220 V AC) must be guarantee for the power supply.

Wiring should be as follows:

- Reference points connected with –24 V:
  - Bridge between terminal 7 and terminal 2 (–24 V)
- Reference point of the digital inputs potential-free:
  - Terminal 2: –24 V (Power supply)
  - Terminal 7: –24 V or N (control voltage)
Operating States

Synchronization generator power circuit breaker

The generator power circuit breaker (GCB) will be synchronized with frequency and voltage correction if the following conditions are met simultaneously.

- The synchronization function is turned on parameterization mode,
- the busbar has been energized,
- the generator voltage and frequency are within the predetermined limits (three-phase),
- the input "Release GCB" is set and
- the input "Reply: GCB is open" is set.

Closing the generator circuit breaker without synchronization (GCB dead bus)

The generator power circuit breaker is closed without synchronization if the following conditions are met simultaneously:

- the option "GCB black start" has been set to "ON",
- the bus bar is not energized ($U_{SS} < 5\%$),
- the generator voltage and frequency are within the predetermined limits,
- the input "Isolated operation" is not set,
- the input "Release GCB" is set and
- the input "Reply: GCB is open" is set.

Analog Controller Outputs (option Qf/Qu)

As an alternative to a three-position controller output, the unit may also be equipped with an analog controller output. Other parameterization masks then appear during the parameterization mode. 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 $K_{PR}$, derivative-action time $T_V$ and reset time $T_n$) can be modified individually. The parameterization screens are used for this purpose.

![Control loop diagram](image)

Figure 3-1. 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).
Various values can be obtained from the step response; these are required for adjusting the controller to its optimum setting:

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

**Setting time** $T_{\text{off}}$  
Period starting when the value of the control variable leaves a 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 setpoint value deviation during the transition from one steady-state condition to a new steady-state condition following modification of the disturbance variable or reference input variable ($x_m \text{ Optimal} \leq 10\%$).

**System deviation** $x_d$  
Permanent deviation from the final value (PID controller: $x_d = 0$).

From these values, the values $K_P$, $T_n$ and $T_V$ can be determined. It is also possible to determine the optimal controller settings, i.e. by calculating compensation or adjustment of the time constants, T-sum rule, symmetric optimum, Bode-diagram. Other setting procedures and information may be obtained from current literature.
Controller settings

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 uncontrollably:

  ➔ EMERGENCY SHUTDOWN

Initial state

The start position of the controller is determined using the initial state 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 (i.e. the speed controller can be controlled in a linear manner).

<table>
<thead>
<tr>
<th>Freq. ctrl sig.</th>
<th>Initial state frequency controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>000%</td>
<td>Analog controller output setting with controller switched off.</td>
</tr>
</tbody>
</table>

General settings

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

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

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

CAUTION
If the unit starts to oscillate uncontrollably, carry out an emergency shutdown and alter the screen setting accordingly.

3. Simultaneous: measure the critical cycle duration $T_{crit}$
4. Set the parameters:

<table>
<thead>
<tr>
<th>PID controller</th>
<th>PI controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_{PR} = 0.6 \times K_{Perit}$</td>
<td>$K_{PR} = 0.45 \times K_{Perit}$</td>
</tr>
<tr>
<td>$T_n = 0.5 \times T_{crit}$</td>
<td>$T_n = 0.83 \times T_{crit}$</td>
</tr>
<tr>
<td>$T_V = 0.125 \times T_{crit}$</td>
<td></td>
</tr>
</tbody>
</table>
### Step response

<table>
<thead>
<tr>
<th>Controller setting</th>
<th>Controller setting</th>
<th>Controller setting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimum</strong> <em>(x_m ≤ 10 %)</em></td>
<td><strong>T_{crit}</strong></td>
<td><strong>Incorrect</strong></td>
</tr>
<tr>
<td><img src="image1" alt="Optimum" /></td>
<td><img src="image2" alt="T_{crit}" /></td>
<td><img src="image3" alt="Incorrect" /></td>
</tr>
</tbody>
</table>

**P gain** *(K_{PR})* Proportional-action coefficient

The proportional-action coefficient *K_{PR}* indicates the closed-loop control system gain. The variable to be controlled is achieved more rapidly by increasing the P-gain.

**Reset time** *(T_n)*

The reset time *T_n* belongs to the I-part of the PID controller. The I-component results in permanent control deviation being eliminated in the controlled state.

**Derivative-action time** *(T_v)*

The derivative-action time *T_v* belongs to the D-part of the PID controller. An increase in the phase reserve (stability) and the attenuation results from increasing this parameter.

---

**Pr.-sensitivity**

*K_{PR}=0.00*

**Reset time**

*T_n=0.00 s*

**Derivative act. time**

*T_v=0.00 s*
Chapter 4.
Display Elements and Controls

Operator Interface

The front panel incorporates a touch screen interface. All keys have been designed as touch-sensitive membrane switch elements. The display is an LC display, comprising 2 × 16 characters, that are indirectly illuminated in red. Contrast of the display is infinitely variable by a rotary potentiometer at the left side.

Configuration of Faceplate LEDs and Buttons

![Figure 4-1. Touch screen faceplate](image)

**Light-emitting diodes**

1. "mains c.b. rel." ................................................................. without function
2. "gen c.b. rel." .............................................................. Release generator CB
3. "automatic" ................................................................. Automatic mode
4. "connect" ........................................................................ Connection pulse
5. "synchroscope" .......................................................... Display of phase angle
6. "f-" ............................................................. Controller output: frequency lower (reduce speed)
7. "f+" ............................................................. Controller output: frequency higher (increase speed)
8. "V-" ............................................................. Controller output: voltage lower (reduce excitation)
9. "V+" ............................................................. Controller output: voltage higher (increase excitation)
10. "gen c.b. ON" ....................................................... Reply GCB closed
11. "mains c.b. ON" ........................................................ without function

**Buttons**

12. "display ↓" ........................................................................ Scroll display
13. "select" ........................................................................... Confirm selection
14. "digit↑" .......................................................................... Increase digit
15. "clear" ............................................................................. Acknowledge fault
16. "cursor→" ...................................................................... Input cursor 1 to the right

**Display**

17. "LC display" ....................................................................... LC display

---

CB = Power circuit breaker
GCB = Generator power circuit breaker
MCB = Mains power circuit breaker
### Light Emitting diodes

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Color</th>
</tr>
</thead>
</table>
| 1 | "mains c.b. rel." | "GREEN"

**Release mains power circuit breaker**<br>
NOTE: In the unit versions this light-emitting diode has no significance, because it is a "1-power-circuit-breaker configuration".

The light emitting diode ① "mains c.b. rel." indicates that the mains power circuit breaker is released for operation and synchronization. This occurs via the signal to terminal 53 (reference point 7).

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Color</th>
</tr>
</thead>
</table>
| 2 | "gen c.b. rel." | "GREEN"

**Release generator power circuit breaker**

The light-emitting diode ② "gen c.b. rel." indicates that the generator power circuit breaker is released for operation and synchronization. This is accomplished via that signal on terminal 3 (Reference point terminal 7).

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Color</th>
</tr>
</thead>
</table>
| 3 | "automatic" | "GREEN"

**Automatic mode**

The light-emitting diode ③ "automatic" indicates that the unit is in automatic mode. It will extinguish as soon as you switch to the parameterization mode.

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Color</th>
</tr>
</thead>
</table>
| 4 | "connect" | "GREEN"

**Connection**

The LED ④ "connect" lights up if the device outputs a switching pulse to the corresponding power circuit breakers (Selection of the power circuit breaker via the digital inputs "Release generator power circuit breaker" and "Release mains power circuit breaker" via terminals 3 and 53).

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Color</th>
</tr>
</thead>
</table>
| 5 | "LED row: too rapid→..." | "RED/YELLOW/GREEN"

**Phase angle / synchronoscope**

The row of LED's indicates the current phase position between the two voltages indicated on the display. The green LED in the middle of the 15 LED's indicates that the measured phase angle between the voltage systems is less than 12° electrical. The indication of the phase angle only occurs if both voltages are within the specified permissible ranges. These ranges are defined as follows:

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Generator</th>
<th>Mains</th>
</tr>
</thead>
<tbody>
<tr>
<td>88..112 % f_N</td>
<td>96..104 % f_N</td>
<td></td>
</tr>
</tbody>
</table>

There are two phase sequences:

- **left → right**: If the LED's run from left to right, the generator frequency is too high, i.e., the generator or the variable mains turn too rapidly;
- **right → left**: If the LED's run from right to left, the generator frequency is too low, i.e., the generator or the variable mains turn too slowly.

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Color</th>
</tr>
</thead>
</table>
| 6 | "f-" | "YELLOW"

**Reduce controller frequency controller output**

The LED ⑥ "f-" indicates that the unit outputs a pulse to reduce the setpoint frequency. The output is issued via the terminals 8/10 to the speed controller.
Controller output increase frequency

- LED "f+": The LED "f+" indicates that the unit outputs a pulse to increase the setpoint frequency. The output is issued via terminals 9/10 to the speed controllers.

Reduce controller output voltage (excitation)

- LED "V-": The LED "V-" indicates that the unit outputs a pulse to reduce the setpoint voltage. The output is issued via terminals 11/13 to the generator voltage controller.

Increase controller output voltage (excitation)

- LED "V+": The LED "V+" indicates that the unit outputs a pulse to increase the setpoint voltage. The output is issued via terminals 11/12 to the generator voltage controller.

Generator power circuit breaker ON

- LED "gen c.b. ON": If the generator power circuit breaker (GCB) is closed, the unit displays this by illumination of the LED "gen c.b. ON". This LED signals the reply of the power circuit breaker (possibly flashing).

Mains power circuit breaker ON

- LED "mains c.b. ON": If the mains power circuit breaker (MCB) is closed, the unit displays this by illumination of the LED "mains c.b. ON". This LED signals the Reply of the power circuit breaker (possibly blinking).

Buttons

In order to facilitate the setting of the parameters, the buttons have an "AUTOROLL function." It allows switching to the next setting and parameterization screens, the digits, or the cursor position. The "AUTOROLL function" will continue as long as the Select button is depressed.

Display ↓...Select

- "display ↓...select": Automatic Parameterization

- "display ↓": No function

- "select": The jump to the next input screen occurs. If the originally displayed value has been changed by the buttons "digit ↑" or "cursor →", then the newly set value is saved by pressing the "select" button. By pressing this button again, the user causes the system to display the next entry screen.

Digit ↑

- "digit ↑": No Function

- "digit ↑": This button is used to raise the cursor position one digit from where the cursor is. The increase is restricted by the admissible limits (see list of parameters included in the Annex). In case the maximum number is reached which can be set, the number automatically returns to the lowest admissible number.
By pressing this button all fault messages are deleted if they are no longer detected.

This button is used to move the cursor one position to the right. When the last right-hand position is reached, the cursor automatically moves to the first position left-hand of the value to be entered.

The LC display marked outputs particular messages and values depending on the particular mode. Parameters are changed in parameterization mode, and voltages, i.e. voltages are displayed.

The standard feature two-line LC display may be used to retrieve performance quantities when the automatic mode is activated. While in parameterization mode, the individual parameters are indicated (see below).

Automatic mode: Double voltage/frequency display during synchronization

The "Display ↓" button can be used to scroll through both displays. It is also possible, to scroll through the faults using the "Display ↓" button.

<table>
<thead>
<tr>
<th>Mask pattern 1 (V parameterized)</th>
<th>Mask pattern 2 (kV parameterized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS: 000 V 00.0Hz</td>
<td>SS: 00.0kV 00.0Hz</td>
</tr>
<tr>
<td>GN: 000 V 00.0Hz</td>
<td>GN: 00.0kV 00.0Hz</td>
</tr>
</tbody>
</table>

Double voltage and double frequency display

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, marked with 5).

SS: Synchronization voltage and frequency
GN: Generator voltage and frequency

Automatic mode: Measuring values

The "Menu" button can be used to scroll through the display of both lines. It is also possible, to scroll through any faults that may be present using the "Menu" button.

<table>
<thead>
<tr>
<th>Gen. 00.0kV</th>
</tr>
</thead>
</table>

Display in automatic mode, measuring values

The generator variables are displayed.
The indications are displayed according to the following list:

<table>
<thead>
<tr>
<th>Type of fault</th>
<th>Fault display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains undervoltage (Option V)</td>
<td>Mains-undervolt.</td>
</tr>
<tr>
<td>Mains overvoltage (Option V)</td>
<td>Mains-overvolt.</td>
</tr>
<tr>
<td>Mains underfrequency (Option J)</td>
<td>Mains-underfreq.</td>
</tr>
<tr>
<td>Mains overfrequency (Option J)</td>
<td>Mains-overfreq.</td>
</tr>
<tr>
<td>Phase shift (Option H)</td>
<td>Phase shift</td>
</tr>
<tr>
<td>Generator under frequency (Option F)</td>
<td>Gen.-underfreq.</td>
</tr>
<tr>
<td>Generator overfrequency (Option F)</td>
<td>Gen.-overfreq.</td>
</tr>
<tr>
<td>Generator under voltage (Option U)</td>
<td>Gen.-undervolt.</td>
</tr>
<tr>
<td>Generator overvoltage (Option U)</td>
<td>Gen.-overvolt.</td>
</tr>
<tr>
<td>Synchronization time of the GCB is overwritten</td>
<td>Synchron. time!</td>
</tr>
</tbody>
</table>
Chapter 5
Parameterization Screens
(Input of the Parameters)

Introduction

The input screens can be scrolled, when you are in parameterization mode (simultaneously pressing "digit↑" and "cursor→"), via "select". If the "select" button is pressed for a longer period of time, the scroll function will be activated, and the screens will be browsed rapidly. Please make sure that it is possible to scroll in the reverse direction of the last four parameterization screens. To do this you must simultaneously press the buttons "select" and "cursor→". If no entry, modification or any other action is carried out for 60 seconds, the unit automatically returns to the automatic mode.

It is only possible to change into the parameterization mode if the digital input "input locked" (terminal 6) is either not connected or not set.

Programming the SPM-D
via the front panel
P/N 5448-890 and 5448-893

When unit is first powered up this display appear. This will indicate voltage and frequency of the generator and the buss.

This is the display when the unit is operating.

To enter the Parameterization mode press the digit button and Clear/Cursor button at the same time. If it should indicate German change it by pressing the Clear/Cursor button this will allow you to scroll though the options - German or English. Press the display/select button to go to the next menu.

Press Select

NOTE
You must press Select twice:
1. The first time you press select allows the controller to accept the values you changed.
2. The second time you press select it allows you to advance to the next menu.
Adjust Settings
[Press “Select”]
When this menu appears, press select as prompted. It will then indicate software version.

Software version
5.102
This indicates software version used by unit. Press Select

Password
Protection off
Pressing select again will show password protection feature. Leave this off until programming is completed. Press Select

Load Conf. Direct
no
Pressing select again will indicate the use of the direct parameterization mode P.C (Side port). LEO P.C. allows parameterization with a P.C. If not, continue on to the next menu by pressing Select.

System set up
This will prompt for the rated frequency. Enter the rated frequency by pressing the digit button - the numbers will change. Pressing the cursor button will change the desired digit. Entering this number enters the system frequency. Press Select.

Rated Frequency
Fn = 60.0Hz

Generator Frequency
F set = 60.0
When prompted by the menu for the generator frequency, enter it the same as for the rated frequency. Press Select

Gen. voltage
Secondary 120 V
When prompted for the Generator secondary voltage, enter the voltage 50 to 125 range. Press Select.

Mains voltage
Secondary 120 V
When prompted for the Mains voltage secondary, enter the voltage 50 to 125 range and then enter the Mains secondary voltage. Press Select.

Gen. voltage
Primary 0.480 kV
When prompted for the generator voltage primary, enter the voltage – this is done in Kv to enter 480 volt system
Gen. voltage
Primary 04.160 kV

4160 volt system (Example)
Press select

Mains voltage
Primary 00.480 kV

This menu will prompt for Mains voltage primary Enter the voltage – this is done in kV to enter 480 volt system.
(Example)

Mains voltage
Primary 04.160 kV

This menu will prompt for Mains voltage primary 4160 volt system
Press Select.

Rated voltage
Un = 120 V

When prompted for the rated voltage of the secondary of the systems PT’s (BUS PT’S), enter value then press Select.

Gen. Voltage
Set point 120 V

This menu prompts for the generator voltage set point on the secondary side of the PT’s.

Auto. Idle running
contr off

The automatic idle running is a frequency trim option used in a droop system if necessary.
If set to ON, the SPM-D is allowed to control the frequency and voltage before the generator breaker closes. This trims both the voltage and frequency to their set points.
If load sharing is being done by other means keep this off.
Press Select

Frequency Controller menus

Freq. Controller
ON

This turns on the frequency controller. It also allows for programming the frequency controller menus if turned to on. If turned off it will do the following:
- Skip the frequency control menus and go to the voltage control menus.
- Will not allow for any frequency control of the unit before or after breaker closes
Press Select
If set to ON, the frequency menus will appear. The first menu is the frequency ramp menu. This is the ramp rate to which it will ramp if the frequency is below or above the rated frequency. Press Select.

Example: If the unit’s started and the frequency of the generator is 50 Hz, it will raise the unit 5 Hz per sec. It may not achieve this rate due to limitation of the controllers and the governor controller that is being used (controller ramp rate) and other settings in the frequency controller menus.

Model 5448-890
This is the dead band which the controller will operate in, prior to synchronizing or in the isolated mode. The range is from .02 to 1Hz

Model 5448-890
This is the time at which the raise and lower relay will pulse. This range is from 10 to 250 ms. This rate also affects the ramp rate. Longer duration = quicker ramp rate. NOTE: Having this at a too long of rate may produce over and under shoots or instability.

Model 5448-890
The gain factor also influences the time duration of the relay. If this value is high it may produce over and under shoot of the controller

Model 5448-894
This is setting of proportional gain. Press Select

This setting is the integral gain setting for the analog Model 5448–894. Press Select

This setting is the derivative action setting for the analog Model 5448–894. Press select
Voltage controller menus

**Volt. Controller ON**

This turns on the voltage controller. It allows programming of the voltage controller menus if turned to on. If turned off, it will do the following:
- Skip the voltage control menus and go to the synchronizing control menus.
- Will not allow for any voltage control of the unit before or after breaker closes.

**Volt. Controller Isol.oper. off**

If set to ON, the voltage menus will appear. The first menu to appear is voltage controller isolated operation. (Isolated operation is preferred.) When the unit is on the buss by its self Isolated from any other generators and mains. Terminal 5 also must be enable to enable isolated operation. Press Select.

**Volt. Controller Dead band = 1.00 V**

This is the dead band the controller will operate in prior to synchronizing or in the isolated mode. The range is from 0.5 to 60 volts.

**Volt. Controller Time pulse >063 ms**

This is the time at which the raise and lower relay will pulse. This range is from 10 to 250 milli seconds. This rate also affects the ramp rate. Longer duration = quicker ramp rate. NOTE: Too long of rate may produce over and under shoots or instability.

**Volt. Controller Gain Kp = 15.0**

The gain factor also influences the time duration of the relay. If this value is high it may produce over and under shoot of the controller.

**Pre. Sensitivity Volt.. kpr 1.2000**

This is setting of proportional gain for the analog Model 5448-894. Press Select.

**Reset time Volt 80**

This setting is the integral gain setting for the analog Model 5448–894. Press Select.

**Derivative action 1.00**

This setting is the derivative action setting for the analog Model 5448-894.
Synchronizing menus

This enables the synchronizing menus. If set to off, none of the menus will be displayed, and no synchronizing function will be carried out.

This is amount of positive slip (+) the synchronizer controls and allows the synchronizer positive slip (+) window that enables breaker comm. Increasing this number allows the controller increase the positive slip.

This is the minimum value that the synchronizer allows the synchronizer negative slip (-) window that enables breaker command.

This is maximum value voltage between the bus and the gen that allows for breaker command.

This is the duration of the breaker connect pulse terminal 14 and 15 breaker close command – CLOSE time; once the synchronizer is in the allowable windows, voltage and frequency.

This is the time when the breaker has a delay time or breaker delay time. This is the time it takes the synchronizer in the allowable limits it will then delay the breaker close command

Dead bus option

This enables dead bus option menus

This is maximum allowable hertz above the set point hertz that the allows breaker close command to operate. i.e. If system is 60 Hz, the maximum would be 60.05 Hz and still allow for breaker CLOSE command.

This is maximum allowable voltage above and below the set point voltage that allows the breaker CLOSE command to operate
Synchronization delay time menus

This enables the menus for the delay synchronization delay menu.

This is the amount of time the synchronizer will run once you close Terminal 3. At the end of this time an alarm message will be received indicating that the units (synchr. Time Gen.) time out.

Fault Messages

This allows you to see error massages.
ON enables
OFF disables

This delays the Fault (Fault messages) once unit is in run mode.

<table>
<thead>
<tr>
<th>Fault type</th>
<th>xxxxxxxxxxxxxxxxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator over frequency</td>
<td>Gen.overfreq.</td>
</tr>
<tr>
<td>Generator under voltage</td>
<td>Gen.undervolt.</td>
</tr>
<tr>
<td>Generator over voltage</td>
<td>Gen.overvolt.</td>
</tr>
<tr>
<td>Synchronization time of the GCB exceeded</td>
<td>Synchr.time Gen.</td>
</tr>
</tbody>
</table>
Programming the SPM-D 11 MAX via the Front Panel
P/Ns 5448-891 and 5448-894

When unit is first powered up this display appears. This will indicate voltage and frequency of the generator and the bus.

This menu displays the indicated voltage L-L with the frequency of Generator and Mains/Bus.

To enter the Parameterization mode press the digit button and Clear / Cursor button at the same time. This will bring up the parameterization mode. If it should indicate German change it by pressing the Clear / Cursor button this will allow you to scroll though the options - German or English. Press the display / select button to go to the next menu. Press Select

**NOTE**

Select must be pressed twice.
1. The first time you press select this allows the controller to accept the values you changed.
2. The second time you press select it will allow you to advance to the next menu

When this menu appears, press Select. It will then indicate software version.

This will indicate software version used in unit. Press Select

By pressing select again it will then show password protection feature. Leave this off until your done programming. Press Select

By pressing select again this will indicate if you want to use the direct parameterization mode (Side port) P.C. If you have the LEO P.C. software this will allow you to parameterize with a P.C. If not continue on to the next menu by pressing Select.
System set up

When prompted for the rated frequency, enter the rated frequency by pressing the digit button this will change the numbers. Pressing the cursor button will change the digits. This enters the system frequency. Press Select.

When this menu asks for the generator frequency, enter it in the same manner as for the rated frequency. Press Select.

When this menu asks for the generator secondary voltage, enter the voltage - 50 to 125 V range. Press Select.

This menu will prompt for Mains voltage secondary. Enter the voltage 50 to 125 V range. Press Select.

This menu will prompt for generator voltage primary. Enter the voltage – i.e. this is done in kV to enter 480 volt system.

i.e. this is done in kV to enter 4160 volt system
Press Select (Example)

This menu will prompt for Mains voltage primary. Enter the voltage - i.e. this is done in kV to enter 480 volt system.
Press Select

i.e. this is done in kV to enter 4160 volt system
This menu will prompt for Mains voltage primary. Press Select (Example)
**Rated voltage**

Un = 120 V

When prompted for the rated voltage of the secondary of the system’s PTs (BUS PTs), enter value.

Press Select

**Gen. Voltage**

Set point 120 V

When prompted for the generator voltage set point on the secondary side of the PT's, enter value.

Press Select.

**Auto. Idle running**

contr. OFF

The automatic idle running is a frequency trim option used in a droop system if necessary.

When set to ON the SPM-D will control the frequency and voltage **before** the generator breaker closes. This trims both the voltage and frequency to the set points.

If load sharing is being done by other means, keep this off.

Press Select

**Output freq. contr**

Init. State 050%

This is the analog output at which the output will be zeroed. Since the output is a 3 Volts +/-, it will be zero at 50%.

(See page 16.)
Frequency Controller Menus

**Freq. Controller ON**
This turns on the frequency controller and also allows for programming of the frequency controller menus. If turned OFF it will do the following:
- Skip the frequency control menus and go to the voltage control menus.
- Will not allow for any frequency control of the unit before or after breaker closes.
Press Select

**Freq. Controller Ramp = 05.0 Hz/s**
If set to ON the frequency menus will appear. The first menu is the frequency ramp menu. This is the ramp rate to which it will ramp to if the frequency is below or above the rated frequency.
Example:
If the unit is started and the frequency of the generator is 50 Hz. It will raise or lower the unit 5 Hz per sec. It may not achieve this rate due to limitation of the controller and the customer’s controller, controller ramp rate and other settings in the frequency controller menus.
Press Select

**Output freq. contr (max) 100%**
This is a limiter that can be placed on the analogue output of +3 volts. Changing this value can lower the voltage to < +3 V.
Press Select

**Output freq. contr (min) 000%**
This is a limiter that can be adjusted to the analogue output of -3 volts. Changing this value can raise the voltage to > -3 V.
Press Select

![MinMax](image)

Example min set at 10 % = 4
Max set at 90 % = 4+

**Freq. Controller Dead band = 0.11Hz**
Model 5448-891
This is the deadband in which the controller will operate prior to synchronizing or in the isolated mode. The range is from .02 to 1 Hz.

**Freq. Controller Gain Kp = 15.0**
Model 5448-891
The gain factor also influences the time duration of the relay. Again, if this value is high it may produce over and under shoot of the controller.
Freq. Controller
Time pulse >063 ms

Model 5448-891
This is the time when the raise and lower relay will pulse.
This range is from 10 to 250 ms. This rate also affects the ramp
rate. Longer duration = quicker ramp rate.
NOTE: Too long of rate may produce over and under shoots or
instability.

Reset time
Freq. .80

This setting is the integral gain setting for the analog Model
5448–894.
Press Select

Freq. Sensitivity
Freq. kpr 1.2000

Model 5448-894
This is setting of proportional gain.
Press Select.

Derivative action
1.00

This setting is the derivative action setting for the analog
Model 5448–894.
Press Select

Voltage Controller Menus

Output Vol. Controller
Init. State 050%ON

This is the analog output at which the output will be zeroed.
Since the output is a +/- 5 V, it will be zero at 50%.
Press Select.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5-</td>
<td>2-</td>
<td>1-</td>
<td>0</td>
<td>1+</td>
<td>2+</td>
</tr>
<tr>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initial state</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Volt. Controller ON

This turns on the voltage controller; it also allows you to
program the voltage controller menus if turned to on.
If turned off, it will do the following:
• Skip the voltage control menus and go to the synchronizing
control menus.
• Will not allow for any voltage control of the unit before or
after breaker closes.
Press Select

Volt. Controller Isol. oper. off

If set to ON the voltage menus will appear. The first to appear is
**Voltage Controller Isolated operation.** Isolated operation is
preferred.
This is when the unit is on the bus but isolated from any other
generators and mains. Terminal 5 also must be enabled to
permit isolated operation.
Press Select
Output volt. control (max) 100 %
This is a limiter that can be adjusted on the analog output 5+.
By changing this value you can lower the 5 V +

Output volt. control (min) 000 %
This is a limiter that can be placed on the analog output – 5 V.
By changing this value you can raise the - 5 V.
Press Select

<table>
<thead>
<tr>
<th>5-</th>
<th>2-</th>
<th>1-</th>
<th>0</th>
<th>1+</th>
<th>2+</th>
<th>5+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>50%</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>min</td>
<td>→</td>
<td>max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example min set at 10 % = 4-
Max set at 90 % = 4+

Volt Controller
Dead band=1.00 V
This is the dead band which the controller will operate in prior to synchronizing or in the isolated mode. The range is from .5 to 60 volts. Model 5448-891

Volt. Controller
Time pulse>063 ms
This is the time at which the raise and lower relay will pulse.
This range is from 10 to 250 milli seconds. This rate also affects the ramp rate. Longer duration quicker the ramp rate.
NOTE: Having this at a too long of rate may produce over and under shoots or instability. Model 5448-891

Volt. Controller
Gain Kp = 15.0
The gain factor also influences the time duration of the relay.
Again if this value is high it may produce over and under shoot of the controller. Model 5448-891

Pre. Sensitivity
Volt., kpr 1.2000
This is setting of proportional gain.
Press Select. Model 5448-894

Reset time
Volt 80
This setting is the integral gain setting for the analog
Model 5448 -894
Press Select

Derivative action
1.00
This setting is the Derivative action setting for the analog
Model 5448 -894
Press Select
Synchronizing menus

- **Synchronizing Functions**: ON
  - This enables the synchronizing menus. If set to OFF, none of the menus will be displayed and no synchronizing function will be carried out.

- **Synchronizing Df max = 0.03 Hz**
  - This is amount of positive slip that the synchronizer will control and still allow the synchronizer to enable breaker command within the controllable window (range).
  - Increasing this number makes the controller increase the positive slip.

- **Synchronizing Df min = 0.10 Hz**
  - This is amount of negative slip that the synchronizer will control and still allow the synchronizer to enable breaker command within the controllable window (range).

- **Synchronizing du max = 07 V**
  - This is maximum voltage value between the bus and the gen. that will allow for breaker command.

- **Synchronizing Time pulse > 200 ms**
  - This is the duration of the breaker connect pulse terminal 14 and 15, breaker close comm and close time once synchronizer is in the allowable voltage and frequency windows.
  - Press Select

- **Closing time GCB = 080**
  - This is the allowable time need for the breaker contact to close.

---

**Dead bus option**

- **Note**: Discrete input 5 must be set to carry out this operation. See page 6 Control Input part 2

- **Gen. circ. break Dead bus op. ON**
  - This enables dead bus option menus
  - Press Select

- **Dead bus op GCB Do max = 0.05 Hz**
  - This is maximum allowable hertz above the set point Hz that allows the breaker close command to operate. If 60 Hz systems, it would be 60.05 and still allow for breaker close command.
  - Press Select

- **Dead buss op GCB du max = 09 V**
  - This is maximum allowable voltage above and below the set point voltage that will still allow the breaker close command operation.
### Synchronizing delay time menus

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sync. Time contr.</td>
<td>ON</td>
</tr>
<tr>
<td>Delay time</td>
<td>010 s</td>
</tr>
</tbody>
</table>

This enables the menus for the delay synchronizer delay.

This is the length of time the synchronizer will be enabled once you close Terminal 3. At the end of this time an alarm message appears that the unit (synchronizer Time!!) has timed out.

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Transf.</td>
<td>Generator 1000/5</td>
</tr>
</tbody>
</table>

This is current transformer rating of the generator.

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power</td>
<td>Gen. = 0500 kW</td>
</tr>
</tbody>
</table>

Rated kW of the generator.

### Reverse power menus

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse /min.pow Monitoring</td>
<td>off</td>
</tr>
</tbody>
</table>

This menu turns on reverse power/min power monitoring. If set to OFF, the following reverse power menus will not appear and all monitoring will be turned off.

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse power/min power</td>
<td>-03%</td>
</tr>
</tbody>
</table>

This is the reverse power level in negative percentage as it relates to the rated power menu.

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse power / Delay</td>
<td>03.00s</td>
</tr>
</tbody>
</table>

This is the amount of delay time once the reverse power reaches its level.

### Overload menus

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overload Monitoring</td>
<td>ON</td>
</tr>
</tbody>
</table>

Setting this to ON enables all overload menus.

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen. –overload Resp.val</td>
<td>030%</td>
</tr>
</tbody>
</table>

This is the ratio of overload to rated kW setting above the rated setting.

<table>
<thead>
<tr>
<th>Description</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen. –overload Delay time</td>
<td>20s</td>
</tr>
</tbody>
</table>

This is the time delay of the overload relay.
Generator Frequency monitor menus

**Gen. Frequency-Monitoring ON**

Setting this to ON will enable all frequency monitoring menus

**Gen. over Frequency-**

F > 55.00 Hz

Sets the level of over frequency

**Gen. over Frequency- Delay time =3.00s**

Sets the level of over frequency time delay.

**Gen. under Frequency-**

F= < 45.00 Hz

Sets the level of under frequency.

**Gen. Under Frequency- Delay time =3.00s**

Sets the level of under frequency delay.

Generator voltage monitor menus

**Gen. Voltage Monitoring ON**

This enables voltage monitoring for the generator

**Gen. Over voltage**

V > 135 V

This sets the level of over voltage

Example: 480v =120v secondary

510v =127.5 secondary

This sets the level of over voltage time delay.

**Gen. Undervoltage**

V => 85 V

This sets the level of under voltage.

**Gen. Under Frequency**

Delay time=3.00 s

This sets the level of under voltage time delay.
Mains frequency monitoring

This enables frequency monitoring for the mains.

Mains over frequency -
F > 55.00 Hz

This sets the level of over frequency.

Mains over frequency -
Delay time = 3.00 s

This sets the level of over frequency time delay.

Mains under frequency -
F = < 45.00 Hz

This sets the level of under frequency.

Mains voltage monitoring

This enables mains voltage monitoring.

Mains over voltage -
V > 135 V

This is the level of the over voltage. It is set to the secondary voltage PT.
Example: 480 V = 120 V secondary
10 V = 127.5 secondary

Mains over voltage -
Delay time = 3.00 s

This is amount of time delay before overvoltage will be initiated.

Mains undervoltage -
V = < 85 V

This is the level of the under voltage. It is set to the secondary voltage PT.
Example: 480 V = 120 V secondary
430 V = 107 V secondary

Mains undervoltage -
Delay time = 3.00 s

This is amount of time delay before undervoltage will be initiated.
Phase shift monitoring (df/dt)

During single-phase shift monitoring, tripping occurs if the phase shift exceeds phase jump value.

Indicates the amount of phase jump value if single phase is selected.

Indicates amount of phase shift if 3-phase is selected.

Fault Messages

This will allows error messages to be seen.
ON enables
OFF disables

This delays the Fault (Fault messages) once unit is in run mode.

<table>
<thead>
<tr>
<th>Fault type</th>
<th>xxxxxxxxxxxxxxxxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator over frequency</td>
<td>Gen.overfreq.</td>
</tr>
<tr>
<td>Generator under voltage</td>
<td>Gen.undervolt.</td>
</tr>
<tr>
<td>Generator over voltage</td>
<td>Gen.overvolt.</td>
</tr>
<tr>
<td>Synchronization time of the GCB exceeded</td>
<td>Synchr.time Gen.</td>
</tr>
</tbody>
</table>
Watchdog Configuration

Generator frequency monitoring (option F)
(Part number 5448-891 & 5448-894)

Function
"Generator frequency not within the permissible range"
The generator frequency lies within the limit values set for
overfrequency and underfrequency. The "Generator
overfrequency/Generator under frequency" relay is picked up, i.e. the
contact is closed.

Function
"Generator frequency not within the permissible range"
The generator frequency lies outside of the limit values set for
overfrequency and underfrequency. The "generator
overfrequency/generator underfrequency" relay has dropped out, i.e.,
the contact is opened.

The message is output via contacts 43/44.

<table>
<thead>
<tr>
<th>Gen. frequency- Monitoring</th>
<th>Generator frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>Generator frequency monitoring is carried out. The generator frequency is monitored for overfrequency and underfrequency. The subsequent screens of this option are displayed.</td>
</tr>
<tr>
<td>OFF</td>
<td>Monitoring is not carried out, and the subsequent screens of this option are not displayed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gen. overfreq.</th>
<th>Generator overfrequency threshold value</th>
</tr>
</thead>
<tbody>
<tr>
<td>f &gt; 00.00Hz</td>
<td>40.00..70.00 Hz</td>
</tr>
<tr>
<td>Delay time=0.00s</td>
<td>The overfrequency value that is to be monitored is set in this screen. If the value is reached or exceeded, the unit outputs a message via the appropriate relay.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gen. underfreq.</th>
<th>Generator underfrequency threshold value</th>
</tr>
</thead>
<tbody>
<tr>
<td>f &lt; 00.00Hz</td>
<td>The underfrequency value to be monitored is set in this screen. If the value is reached or fallen below, the unit outputs a message via the appropriate relay.</td>
</tr>
<tr>
<td>Delay time=0.00s</td>
<td>Generator underfrequency pickup delay</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>For tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.</td>
<td></td>
</tr>
</tbody>
</table>
Generator voltage monitoring (Option U)
(Part number 5448-891 & 5448-894)

Three-phase monitoring is carried out in which the phase-to-phase voltages are monitored.

**Function**
"Generator voltage within the permissible range"
The generator voltage lies within the limit values set for overvoltage and undervoltage. The relay "generator overvoltage/generator undervoltage" is picked up, i.e., of the contact is **closed**.

**Function**
"Generator voltage not within the permissible range"
The generator voltage lies outside of the limit values set for overvoltage and undervoltage. The "generator overvoltage/undervoltage" relay has dropped out, i.e., the contact is **opened**.

The message is output via contacts 41/42.

**Gen.voltage-monitoring ON**
**Generator voltage monitoring**

| ON | Generator voltage monitoring is carried out. Generator voltage monitoring is carried out. The subsequent screens of this option are displayed. |
| OFF | Monitoring is not carried out, and the subsequent screens of this option are not displayed. |

**Gen.overvoltage**

| V > 000V | Generator overvoltage threshold value |
| Delay time=0.00s | To trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen. |

**Gen.undervoltage**

| V < 000V | Generator undervoltage threshold value |
| Delay time=0.00s | For tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen. |
Overfrequency monitoring (Option J)
(Part number 5448-891 & 5448-894)

Monitoring the mains frequency is absolutely vital if a generator is operated within a public network. In the event of mains failure (i.e. short interruption) the generator that is operating in parallel with the mains must be automatically disconnected from the mains. The message can be processed in various manners. If emergency power is possible, in the event of a mains failure, the mains power circuit breaker should be opened. However, if the generator cannot cover the power circuit breaker of the isolated system in the event of a mains failure, the generator power circuit breaker should be opened.

NOTE
Mains voltage is applied separate from synchronization voltage at terminals 50, 51 and 52. The message "mains frequency fault" is output independent of the power circuit breaker. Logically, the message should only lead to a solution (i.e. mains power circuit breaker OPEN) if the generator operates parallel to the mains. In order to avoid (an unnecessary and, for this operating process, disruptive) triggering when a generator is in service, an external locking should be carried out in each case.

Function
"Mains frequency within the permissible range"
The mains frequency is within the set limit values for over- and underfrequency. The "Mains overfrequency/mains underfrequency" relay is picked up, i.e., the contact is closed.

Function
"Mains frequency within the permissible range"
The mains frequency is outside of the set frequency for over and underfrequency. The "Mains overfrequency/mains underfrequency" relay has dropped out, i.e., the contact is opened.

The message is output via contacts 35/36.

<table>
<thead>
<tr>
<th>Mains frequency monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
</tr>
<tr>
<td>OFF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mains overfrequency threshold value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The overfrequency value that is to be monitored is set in this screen. If the value is reached or exceeded, the unit outputs a message via the appropriate relay.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mains overfrequency pickup delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>In order to trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mains underfrequency threshold value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The underfrequency value that is to be monitored is set in this screen. If the value is reached or fallen below, the unit outputs a message via the appropriate relay.</td>
</tr>
</tbody>
</table>
Mains underfreq.  
Delay time=0.00s

Mains underfrequency pickup delay
In order for tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.

Mains voltage monitoring (option V)  
(Part number 5448-891 & 5448-894)
A three-phase monitoring is carried out in which the phase-to-phase voltages are monitored.

Monitoring the mains voltage is absolutely vital if a generator is operated within a public network. In the event of mains failure (i.e. short interruption) the generator that is operating in parallel with the mains must be automatically disconnected from the mains. The message can be processed in various manners. If emergency power is possible, the mains power circuit breaker should be opened in the event of mains failure. However, if the generator cannot cover the power circuit breaker of the isolated system in the event of a mains failure, the generator power circuit breaker should be opened.

NOTE
Mains voltage is applied separate from synchronization voltage at terminals 50, 51 and 52. The "Mains frequency fault" message is output independent of the power circuit breaker states. Logically, the message should only lead to triggering (i.e. mains power circuit breaker OPEN), if the generator operates in parallel to the mains. In order to avoid (an unnecessary and, for this operating process, disruptive) triggering when a generator is in service, an external locking should be carried out in each case.

Function
"Mains voltage not within the permissible range"
The mains voltage is within the set limit values for overvoltage and undervoltage. The "Mains overvoltage/undervoltage" has been picked up, i.e., the contact is closed.

Function
"Mains voltage not within the permissible range"
The generator voltage lies outside of the limit values set for overvoltage and undervoltage. The "Mains over-/undervoltage" relay has dropped out, i.e., the contact is opened.

The message is output via contacts 33/34.

Mains voltage Monitoring ON  
Mains over volt.  
V > 000V

Mains voltage monitoring
ON  Mains voltage monitoring is carried out. The mains voltage is monitored with regard to overvoltage and undervoltage. The subsequent screens of this option are displayed.
OFF Monitoring is not carried out, and the subsequent screens of this option are not displayed.

Mains overvoltage threshold value
The overvoltage value that is to be monitored is set in this screen. If the value is reached or exceeded, the unit outputs a message via the appropriate relay.
Mains over volt.  
Delay time=0.00s

Mains overvoltage pickup delay
In order to trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen.

Mains under volt.  
V < 000V

Mains undervoltage threshold value
The undervoltage value that is to be monitored is set in this screen. If the value is reached or fallen below, the unit outputs a message via the appropriate relay.

Mains under volt.  
Delay time=0.00s

Mains undervoltage pickup delay
In order for tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.

Phase shift monitoring (option H)  
(Part number 5448-891 & 5448-894)

A phase shift is a sudden change in the voltage curve, and may be caused by a major generator load change. In this case, the measuring circuit detects a change in the cycle duration once. This change in the cycle duration is compared with a calculated mean value from previous measurements. Monitoring encompasses all three phases. The threshold value in degrees specifies the difference in time between the mean and the current value in reference to a full cycle. Monitoring can be set in various manners. The phase shift watchdog may be used as an additional facility for decoupling from the mains

Function
"Mains voltage cycle duration not within the permissible range"
The mains voltage cycle duration exceeds the set limit values for the phase shift. The relay "phase shift" is picked up, i.e., the contact is closed.

Function
"Mains voltage cycle duration not within the permissible range"
The mains voltage cycle duration exceeds the set limit values for the phase shift. The "Phase shift" relay has dropped out, i.e., the contact is open.

The message is output via contacts 35/36.

Phase shift Monitoring  ON  

Phase shift monitoring
ON  Mains frequency monitoring is carried out, and any phase shift within the defined range is registered. The subsequent screens of this option are displayed.

OFF  Monitoring is not carried out, and the subsequent screens of this option are not displayed.
Phase shift monitoring

**one/three phase**... During single-phase voltage phase shift monitoring, tripping occurs if the phase shift exceeds the specified threshold value in at least one of the three phases. This type of monitoring is very sensitive, and may lead to false tripping if the selected phase angle settings are too small.

**3 phase only**... During three-phase voltage phase shift monitoring, tripping occurs only if the phase shift exceeds the specified threshold value in all three phases within 2 cycles.

**NOTE**
If monitoring is set to "Three-phase only", only the bottom of the two following screens is visible; if monitoring is set to "single-phase/three-phase", both parameterization screens are visible.

**Phase shift value (One phase) 00°**
This screen is only visible if monitoring is set to single-phase/three-phase.

**Phase shift value (3-phase) 00°**
Phase-angle phase shift monitoring, single-phase
Tripping occurs if the electrical angle of the voltage curve shifts in one phase by more than the specified angle.

Phase-angle phase shift monitoring, three-phase
Tripping occurs if the electrical angle of the voltage curve simultaneously shifts in all three phases by more than the specified angle.

**Alarm relay**

**Auto-acknowledge messages**

**Auto-acknowledge relays**

**Message auto-acknowledgement**

**ON**  After the fault state is no longer detected, the message in the display is deleted.

**OFF**  After the fault condition is no longer detected, the message in the display is not deleted, and the following screen of this option is not indicated. The deletion of the display is carried out via "Acknowledge" display.

**Dropout delay messages**

The automatic acknowledgement of the corresponding fault messages occurs according to the indicated time (measured starting at the point in time: Threshold value + hysteretic fallen below/exceeded).
Chapter 6
Commissioning

WARNING
When commissioning the unit, please observe the five safety rules that apply to the handling of live equipment. Make sure that you know how to provide first aid in current-related accidents 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

CAUTION
The unit may only be commissioned by a qualified technician. The "EMERGENCY-SHUTOFF" function must function safely before the commissioning and must not depend on the particular machine.

CAUTION
Prior to commissioning, check that all measuring voltages are correctly connected with regard to phases. The rotating field must be measured. Any lack or incorrect connection of measuring voltages or other signals may lead to incorrect functions and damage the unit as well as engines and components connected to the unit.

Procedure:

1. The supply voltage (24 V_{DC}) must be applied following a check to ensure that all measuring voltages have been connected in the correct phase relation.

2. By simultaneously pressing the two buttons "Digit↑" and "Cursor→" you arrive in input and test mode. The digital input "Parameterization blocked" must be applied in this case to negative potential (= –24 V). The LED "Automatic" will be extinguished.

3. Input of the operating data in the sequence of the different screens. The setting limits can be derived from both the screen description (to the right next to the screens) and also the parameter list at the end of the operating instructions.

4. Encoding function
   a) Encoding not desired (Simultaneous pressing of the buttons "Digit↑" and "Cursor→"; activation of automatic mode).
   b) Encoding desired (Describe procedure in further detail in the explanations for the screens).
Chapter 7. 
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:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

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.

Replacement/Exchange

Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is also a flat rate structured program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]
SPM–D Operating Manual

Return Shipment Authorization Label. To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

Flat Rate Repair

Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture

Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

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 item(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 number(s) and serial number(s);
• 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 unit;
- 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

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. 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 item(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 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.
How to Contact Woodward

In North America use the following address when shipping or corresponding:
Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

For assistance outside North America, 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.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>+61 (2) 9758 2322</td>
</tr>
<tr>
<td>Brazil</td>
<td>+55 (19) 3708 4800</td>
</tr>
<tr>
<td>India</td>
<td>+91 (129) 523 0419</td>
</tr>
<tr>
<td>Japan</td>
<td>+81 (476) 93-4661</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>+31 (23) 5661111</td>
</tr>
</tbody>
</table>

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward’s website ([www.woodward.com](http://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](http://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
- Customer Training
- Field Service

Contact information:
Telephone—+1 (970) 482-5811
Toll-free Phone (in North America)—1 (800) 523-2831
E-mail—icinfo@woodward.com
Website—[www.woodward.com/ic](http://www.woodward.com/ic)
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.

Customer 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:

**General**

Your Name__________________________________________
Site Location________________________________________
Phone Number________________________________________
Fax Number__________________________________________

**Prime Mover Information**

Engine/Turbine Model Number_________________________
Manufacturer________________________________________
Number of Cylinders (if applicable)____________________
Type of Fuel (gas, gaseous, steam, etc)__________________
Rating_____________________________________________
Application________________________________________

**Governor Information**

Please list all Woodward governors, actuators, and electronic controls in your system:

<table>
<thead>
<tr>
<th>Woodward Part Number and Revision Letter</th>
<th>Control Description or Governor Type</th>
<th>Serial Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.
## Appendix
### Parameter List

**SPM–D Synchronizing system**

**Parameter list**

<table>
<thead>
<tr>
<th>Option/PN</th>
<th>Row 1 - Text - Row 2</th>
<th>Range of settings</th>
<th>Default settings</th>
<th>Customer settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>Language</td>
<td>GERMAN/ENGLISH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>ADJUST SETTINGS</td>
<td>select</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>SOFTWARE VERSION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>PASSWORD PROTECTION</td>
<td>Yes/NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Load conf.direct</td>
<td>Yes/NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>System set up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Rated frequency</td>
<td>48.0..62.0 Hz</td>
<td>50.0 Hz</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Generator freq. f set</td>
<td>48.0..62.0 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Generator voltage secondary</td>
<td>50..125</td>
<td>120v</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Mains voltage secondary</td>
<td>50..125</td>
<td>120v</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Gen. voltage primary</td>
<td>0.1..65.0 kV</td>
<td>0.4 kV</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Mains voltage primary</td>
<td>0.1..65.0 kV</td>
<td>0.4 kV</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Gen. Voltage set point</td>
<td>50..120V</td>
<td>400 V</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Autom. Idler running control</td>
<td>On /off</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CONTROL SETTINGS**

<table>
<thead>
<tr>
<th>Option/PN</th>
<th>Parameter</th>
<th>Range of settings</th>
<th>Default settings</th>
<th>Customer settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>Frequency controller</td>
<td>ON/OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Freq. Controller ramp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>890/891</td>
<td>Freq. controller dead band</td>
<td>0.02..1.00 Hz</td>
<td>0.10 Hz</td>
<td></td>
</tr>
<tr>
<td>890/891</td>
<td>Freq. controller Time pulse</td>
<td>10..250 ms</td>
<td>80 ms</td>
<td></td>
</tr>
<tr>
<td>890/891</td>
<td>Freq. controller Gain Kp</td>
<td>0..1.999</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>893/894</td>
<td>P gain</td>
<td>Freq. Kpr</td>
<td>1..240</td>
<td></td>
</tr>
<tr>
<td>893/894</td>
<td>Der. action time Freq. Tn</td>
<td>0..60.0 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>893/894</td>
<td>Reset time Freq. Tn</td>
<td>0.00..6.00 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Volt. Controller</td>
<td>ON/OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>890/891</td>
<td>Volt. controller insens</td>
<td>0.5..60.0 V</td>
<td>2.0 V</td>
<td></td>
</tr>
<tr>
<td>890/891</td>
<td>Volt. controller Time pulse</td>
<td>20..250 ms</td>
<td>80 ms</td>
<td></td>
</tr>
<tr>
<td>890/891</td>
<td>Volt. controller Gain Kp</td>
<td>0..1.999</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>893/894</td>
<td>P gain</td>
<td>Volt. Kpr</td>
<td>1..240</td>
<td></td>
</tr>
<tr>
<td>893/894</td>
<td>Der. action time Volt. Tn</td>
<td>0..60.0 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>893/894</td>
<td>Reset time Volt. Tn</td>
<td>0.00..6.00 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Synchronizing- functions</td>
<td>ON/OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Synchronization df max</td>
<td>0.02..0.49 Hz</td>
<td>0.18 Hz</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Synchronization df min</td>
<td>0.00..-0.49 Hz</td>
<td>-0.10 Hz</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Synchronization dU max</td>
<td>1..60 V</td>
<td>24 V</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Synchronizing Time pulse</td>
<td>50..250 ms</td>
<td>200 ms</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Closing time GCB</td>
<td></td>
<td>80ms</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Gen.circ.break. dead bus option</td>
<td>OFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Dead bus op.GCB df max</td>
<td>= 0.05Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Dead bus op.GCB dv max</td>
<td>= 11v</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Synh.time contr. Delay time</td>
<td>10..999 s</td>
<td>120 s</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Acknowledgment messages</td>
<td>ON/OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>Acknowledgment mess. after</td>
<td>1.99 s</td>
<td>1 s</td>
<td></td>
</tr>
<tr>
<td>Option/ PN</td>
<td>Parameter</td>
<td>Range of settings</td>
<td>Standard settings</td>
<td>Customer settings</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>891/894</td>
<td>Gen.frequency- monitoring</td>
<td>ON/OFF</td>
<td>ON</td>
<td>□ ON □ OFF</td>
</tr>
<tr>
<td></td>
<td>Gen.overfreq.</td>
<td>f &gt; 40.00..70.00 Hz</td>
<td>50.20 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gen.overfreq. Delay time</td>
<td>0.04..9.98 s</td>
<td>0.10 s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gen.underfreq.</td>
<td>f &lt; 40.00..70.00 Hz</td>
<td>49.80 Hz</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Gen underfreq. Delay time</td>
<td>0.04..9.98 s</td>
<td>0.10 s</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Gen.voltage monitoring</td>
<td>ON/OFF</td>
<td>ON</td>
<td>□ ON □ OFF</td>
</tr>
<tr>
<td></td>
<td>Gen.overvoltage</td>
<td>U &gt; 75.480 V</td>
<td>460 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gen.overvoltage Delay time</td>
<td>0.04..9.98 s</td>
<td>0.04 s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gen.undervoltage</td>
<td>U &lt; 75.480 V</td>
<td>340 V</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Gen.undervoltage Delay time</td>
<td>0.04..9.98 s</td>
<td>0.04 s</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Mains frequency- monitoring</td>
<td>ON/OFF</td>
<td>ON</td>
<td>□ ON □ OFF</td>
</tr>
<tr>
<td></td>
<td>Mains overfreq.</td>
<td>f &gt; 40.00..70.00 Hz</td>
<td>50.20 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mains overfreq. Delay time</td>
<td>0.04..9.98 s</td>
<td>0.10 s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mains underfreq.</td>
<td>f &lt; 40.00..70.00 Hz</td>
<td>49.80 Hz</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Mains underfreq. Delay time</td>
<td>0.04..9.98 s</td>
<td>0.10 s</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Mains voltage monitoring</td>
<td>ON/OFF</td>
<td>ON</td>
<td>□ ON □ OFF</td>
</tr>
<tr>
<td></td>
<td>Mains overvoltage</td>
<td>U &gt; 75.480 V</td>
<td>440 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mains overvoltage Delay time</td>
<td>0.04..9.98 s</td>
<td>0.10 s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mains undervoltage</td>
<td>U &lt; 75.480 V</td>
<td>360 V</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Mains undervoltage Delay time</td>
<td>0.04..9.98 s</td>
<td>0.10 s</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Phase jump monitoring</td>
<td>ON/OFF</td>
<td>ON</td>
<td>□ ON □ OFF</td>
</tr>
<tr>
<td></td>
<td>Phase jump monit.</td>
<td>one/three phase</td>
<td>one/three phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phase jump value (One-phase)</td>
<td>3..90 °</td>
<td>30 °</td>
<td></td>
</tr>
<tr>
<td>891/894</td>
<td>Phase jump value (3-phase)</td>
<td>3.90 °</td>
<td>8 °</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acknowledgment messages</td>
<td>ON/OFF</td>
<td>ON</td>
<td>□ ON □ OFF</td>
</tr>
<tr>
<td></td>
<td>Acknowledgment mess. after</td>
<td>1.99 s</td>
<td>1 s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preselection of set of para.</td>
<td>1..6</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
SPM–D Control Specifications

Woodward Part Numbers:

5448-890  
Digital Synchronizer, 1 synch point  
Raise/Lower discrete outputs  
UL Listed

5448-893  
Digital Synchronizer, 1 synch point  
(includes options Qf, Qu)  
Analog Bias signals  
UL Listed

5448-891  
Digital Synchronizer, 1 synch point  
(includes options VJH, UF, R2)  
Raise/Lower discrete outputs  
Mains Failure Recognition and Generator Protection  
UL Listed

5448-894  
Digital Synchronizer, 1 synch point  
(includes options VJH, UF R2, Qf, QU)  
Analog Bias signals  
Mains Failure Recognition and Generator Protection  
UL Listed

Measuring values
- Measuring voltages  
  100/110 V
- Rated frequency  
  40.0..70.0 Hz

Environmental variables
- Power supply  
  24 V dc (±25 %)
- Intrinsic consumption  
  max. 10 W
- Ambient temperature  
  -20..70 °C
- Ambient humidity  
  95 %, non-condensing

Measuring inputs
  Voltage
- Continuous load capacity  
  2.0 × U_N
- Linear measuring range up to  
  1.3 × U_N
- Input resistance  
  0.696 MΩ
- Max. power consumption per path  
  0.15 W
- Temperature coefficient  
  ± 15 ppm/K
- Max. change after endurance test  
  ≤ 0.3 %

Digital inputs
- Electrically isolated  
  Isolation voltage min. 2,200 V_{eff}
- Input range  
  18..250 V dc or ac
- Input resistance  
  68 kΩ

Potential-free outputs
- Contact material  
  AgCdO
- Electrical service live (ohmic load)  
  min. 100,000 switching cycles at 2 A / 250 V ac
- Load  
  max. 2 A at 250 V_{ac} or 24 V_{dc}
- Switching capacity DC  
  45 W
- Max. switching voltage  
  250 V_{ac}
- Isolation voltage  
  2,200 V_{eff}

Analog outputs
- For actual value output freely scalable,  
  electrically isolated, isolation voltage 2,200 V_{eff}
- 0..10 V, 0..20 mA
- Triggering PWM  
  8 bits
- Output 0/4..20 mA, max. load (U_i=24 V)  
  400 Ω