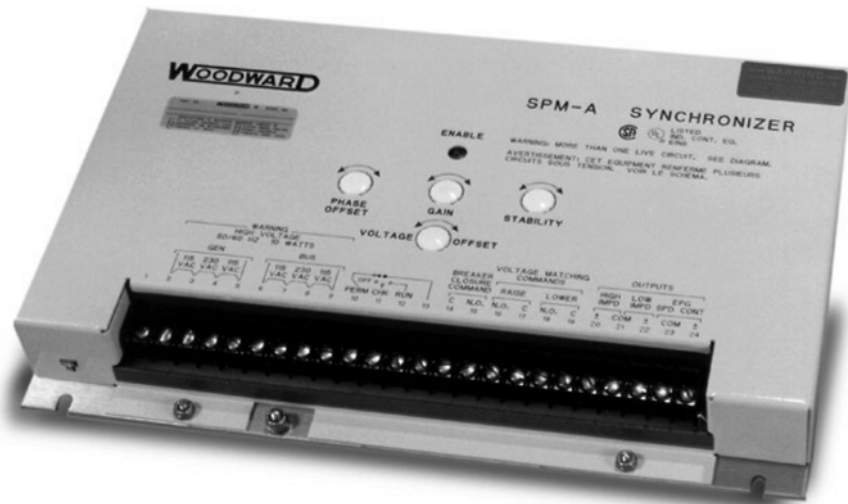


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Product Manual 82384

Original Instructions



SPM-A Synchronizer

Installation and Operation Manual



General Precautions

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.



Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual **26311**, *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications* page of the Woodward website:

www.woodward.com/publications

The latest version of most publications is available on the *publications* page. If your publication is not there, please contact your customer service representative to get the latest copy.



Proper Use

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



Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual **26311**, *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with . Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Woodward reserves the right to update any portion of this publication at any time. Information provided by Woodward is believed to be correct and reliable. However, no responsibility is assumed by Woodward unless otherwise expressly undertaken.

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Warnings and Notices

Important Definitions



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- Eye Protection
- Hearing Protection
- Hard Hat
- Gloves
- Safety Boots
- Respirator

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE**Battery Charging
Device**

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.

Electrostatic Discharge Awareness

NOTICE**Electrostatic
Precautions**

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.

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*.

Follow these precautions when working with or near the control.

1. 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.
2. 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.

Regulatory Compliance

North American Compliance:

The SPM-A Synchronizer is suitable for use in Ordinary Locations per CSA and/or UL for Canada and the U.S. or non-hazardous locations only. See table below for agency listed options.

Wiring must be in accordance with the authority having jurisdiction.

- UL:** UL Listed for use in Ordinary Locations for Canada and the United States. UL File E97763
- CSA:** CSA Certified for use in Ordinary Locations in Canada.
CSA Certificate LR 46653-12

IMPORTANT

These listings are limited only to those units bearing the (UL and/or CSA) agency identification.

Item Number	CSA (Canada Only)	UL (US and Canada)
9905-001	X	X
9905-002	X	X
9905-003	X	X
9905-004	X	X
9905-005	X	X
9905-008		
9905-009		
9905-107		X
9907-028		X
9907-029		X

Chapter 1.

General Information

Introduction

This manual covers the installation, theory of operation, and calibration of the SPM-A Synchronizers. The synchronizers are used in generator applications for speed and phase matching of the generator before paralleling with other generators or the utility bus. These synchronizers have adjustable dynamics to match the dynamics of the engine. Small- to medium-size diesel engines require a synchronizer with fast dynamics. Turbomachinery, large diesel, gas or gasoline engines, and steam and gas turbines require slower dynamics.

Two versions of SPM-A Synchronizers are available, with or without voltage matching. Both versions are designed for a wide range of generator applications.

For additional information on adjusting SPM-A Synchronizers used on lean-burn spark-ignited gas engines, see Application Note 01301.

Description

The SPM-A Synchronizer biases the speed of an off-line generator set so that the frequency and phase match those of another generator or the utility bus. Then it automatically issues a contact closure signal to close the circuit breaker between the two when frequency and phase are matched within limits for a specified match-up time.

The SPM-A is a phase-locked-loop synchronizer and strives for a perfect match of frequency and phase. The SPM-A Synchronizer with voltage matching generates additional raise and lower signals (relay contact closures) to the generator's voltage regulator. Voltages must match within the SPM-A's tolerance before breaker closure occurs.

For single-unit synchronization, installation of one synchronizer on each generator allows each unit to be individually paralleled to the bus. For multiple-unit synchronization, one synchronizer can synchronize up to seven paralleled generator units simultaneously to another bus.

Both synchronizers versions have three output options: high impedance, low impedance, and EPG. Select the high impedance output for single-unit synchronization when the engine is controlled by a Woodward 2301 control. Select the low impedance output for single-unit synchronization when the engine is controlled by a Woodward 2301A, 2500, or Electrically Powered Governor (EPG) control through a Generator Load Sensor. Use the EPG output when using a Woodward EPG control without load sensing. Both units have the following features:

- 120 or 208/240 Vac input
- 10 degree phase window
- 1/8, 1/4, 1/2, or 1 second dwell time (internally switch selectable, factory set for 1/2 second)

The SPM-A Synchronizer with voltage matching has a 1% voltage match as standard. See the part number chart for other options.

Option Chart			
Part Number	Frequency	Phase Angle	Voltage Matching
9905-001 9907-028	50/60 Hz	$\pm 10^\circ$	No
9905-002 9907-029	50/60 Hz	$\pm 10^\circ$	1%
9905-003	50/60 Hz	$\pm 10^\circ$	5%
9905-004	50/60 Hz	$\pm 5^\circ$	No
9905-005	50/60 Hz	$\pm 5^\circ$	1%
9905-006	50/60 Hz	$\pm 10^\circ$	0.5%
9905-008	400 Hz	$\pm 10^\circ$	1%
9905-009	50/60 Hz	$\pm 10^\circ$	10%
9905-107	50/60 Hz	$\pm 15^\circ$	5%

Theory of Operation

This section describes the general theory of operation of the two versions of the SPM-A Synchronizer. Figure 1-1 shows the SPM-A Synchronizer with voltage matching. Figure 1-2 shows a typical synchronizer system block diagram. Figure 1-3 shows a functional block diagram of the synchronizer.

Synchronizer Inputs

The SPM-A Synchronizer checks the phase angle and frequency of the bus and an off-line generator which is to be paralleled. The voltage inputs from the bus and generator are first applied to separate signal conditioner circuits. Each signal conditioner is a filter which changes the shape of the voltage input signals so they can be accurately measured. A phase offset potentiometer in the signal conditioner circuit is adjusted to compensate for phase errors. (This adjustment is factory set with identical bus and generator inputs. It should be readjusted only where a phase offset has been caused through the line transformers of the installation.) The signal conditioners also amplify the bus and generator signals and apply them to the phase detector.

Operating Modes

A user-installed mode switch (single-pole, four-position) controls the relay driver. The switch must be wired to synchronizer contacts 10 through 13 (see the plant wiring drawing). The four positions are OFF, RUN, CHECK, and PERMISSIVE.

When the switch is OFF, the synchronizer is out of operation.

The RUN mode allows normal synchronizer operation and breaker closure signals. The speed bias circuit continues to operate to maintain synchronization for one second to allow time for the breaker closure signal. When one second has elapsed, the lockout circuit activates to disable the synchronizer. The lockout circuit is reset automatically when the relative phase angle exceeds the window limit after the generator is disconnected from the bus.

The CHECK mode allows normal synchronizing and voltage matching, but does not permit a breaker closure signal.

The PERMISSIVE mode allows synchronizer checks for proper synchronization, but synchronizer operation does not affect the engine's speed (nor voltage, in the voltage matching version). If phase and frequency are within proper limits, the synchronizer issues the breaker closure command. (Voltage is not checked in the Permissive Mode.)

See Woodward Application Note 50511 for information on the prediction of the phase angle at paralleling breaker closure.

Synchronizing the Generator

The phase detector compares the two signals and determines any difference between the generator and bus phases. When there is a difference, the speed bias circuit sends a correction signal to the Load Sharing and Speed Control. The correction signal increases or decreases engine speed depending on whether the generator is lagging or leading the bus. Correction signal amplitude is proportional to the amount of lead or lag (phase difference).

The phase window, dwell time, and breaker close circuit receive inputs from the phase detector. Using signals derived from the generator and bus inputs, the phase window circuit checks the phase angle. When the phase angle is less than the selected angle (inside the window) the dwell time circuit begins to measure the amount of time (dwell) the input signals are in phase and makes sure the signals remain in phase during breaker closure. When phase angle and dwell time requirements are correct, the breaker closing circuit sends a signal to the relay driver/inhibitor. The enable circuit gives a secondary relative phase angle check and turns on an indicator. When both the breaker closure circuit and enable circuit say the conditions have been satisfied, a signal is sent to the breaker closure relay. Then the breaker changes state for about one second. Connections for normally open contacts are provided.

The synchronizer, with or without voltage matching, will not close the circuit breaker connecting the generator to a dead bus. If there is no voltage to the bus then no correction signal is sent to the Load Sharing and Speed Control and no breaker closure signal is sent to the breaker.

If a dead-bus relay is used to close the breaker, the synchronizer mode switch must be in the OFF position until the synchronizer is required to synchronize and close the breaker to a live bus.

Voltage Matching

The voltage comparator circuit compares the generator and bus voltages. If there is a difference, the circuits issue appropriate raise or lower commands to the voltage regulator through relay contacts (see Figures 1-3 and 1-4). A voltage offset potentiometer (factory set with identical bus and generator inputs) is included in the voltage matching circuit to compensate for internal circuit differences. This voltage offset should be readjusted only when the bus and generator are paralleled.

The voltage comparator circuit also provides input to the relay driver/inhibitor. Any voltage difference between the generator and bus must be within the selected voltage range before the close breaker command may be given.

The voltage matching circuit is disabled when the breaker closure signal is issued.

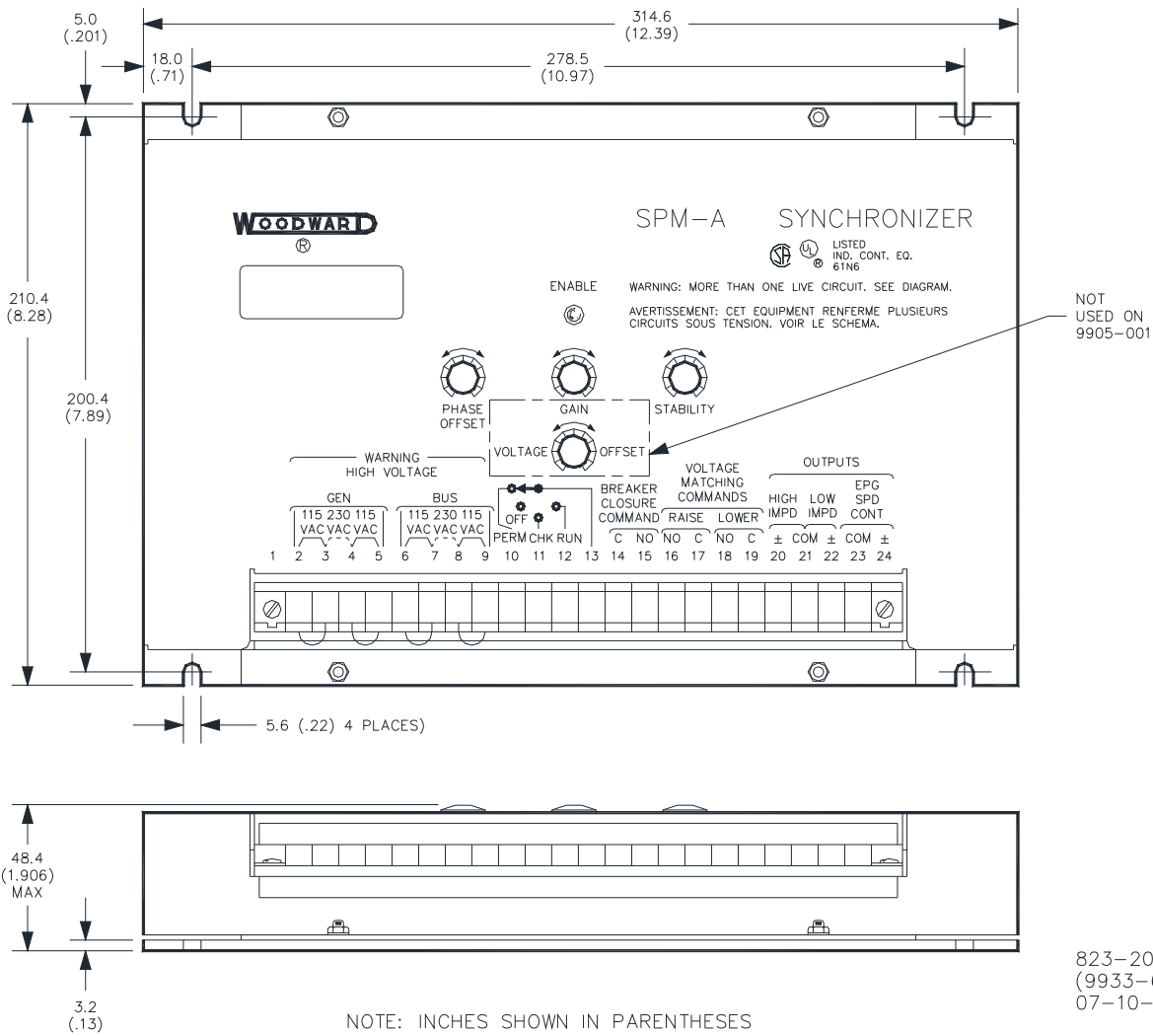


Figure 1-1. Control Outline Drawing

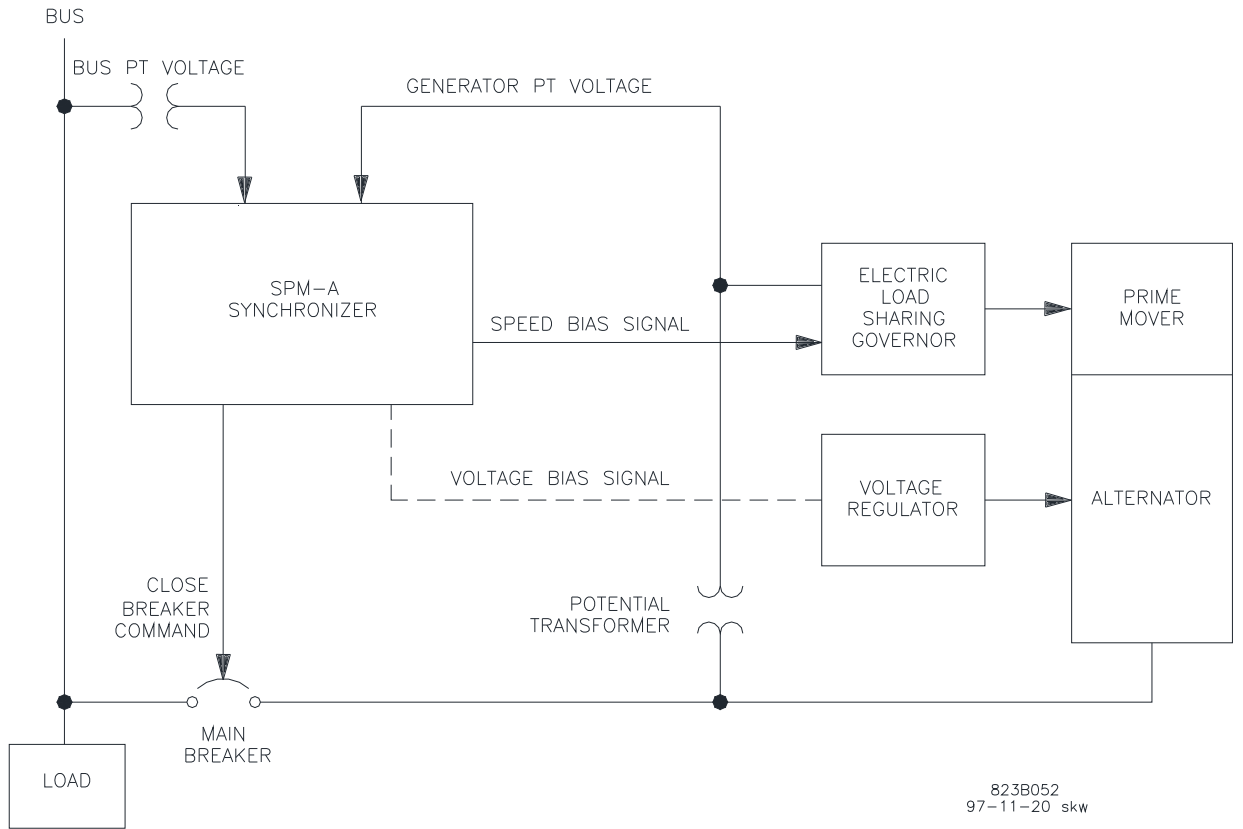


Figure 1-2. System Block Diagram

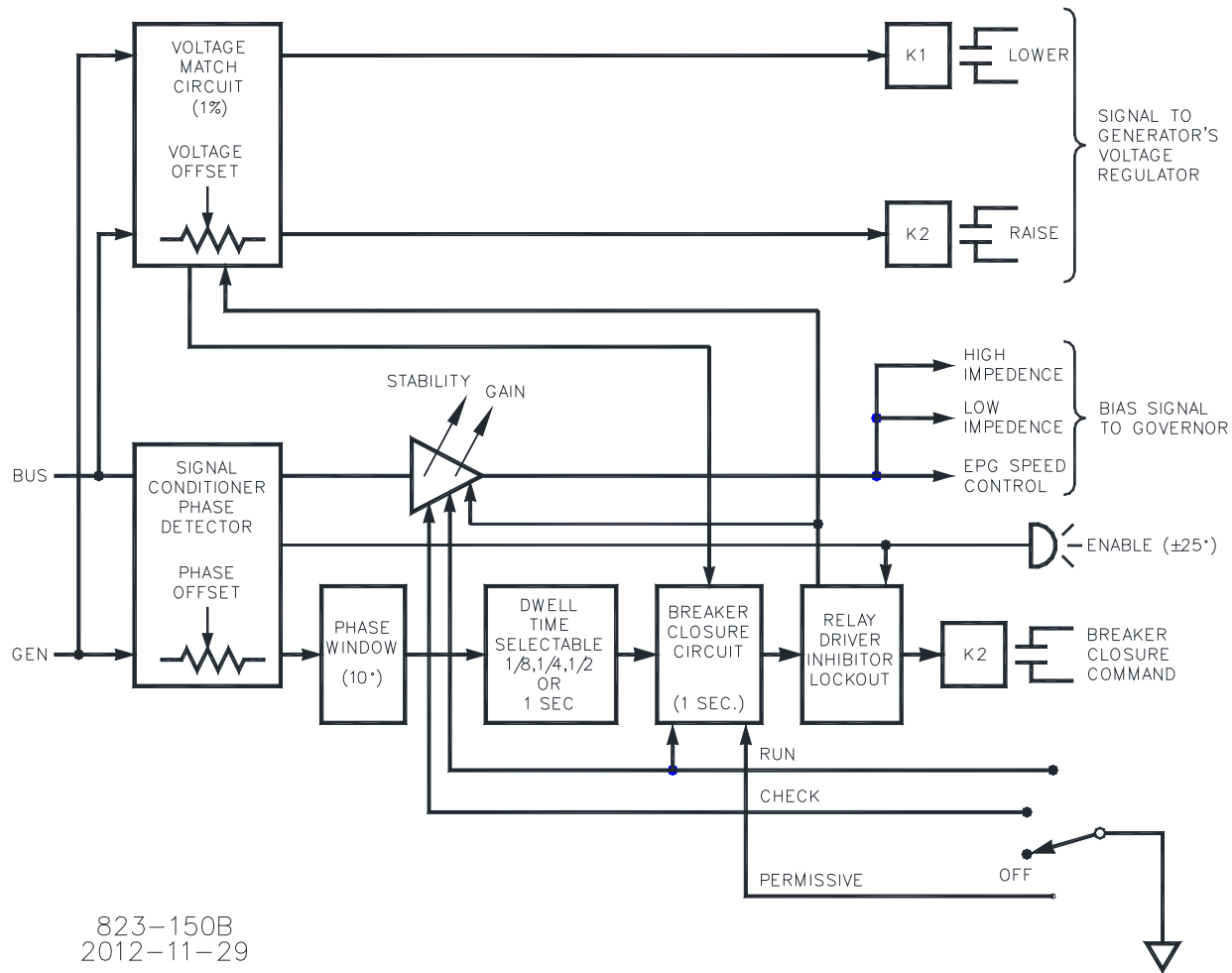
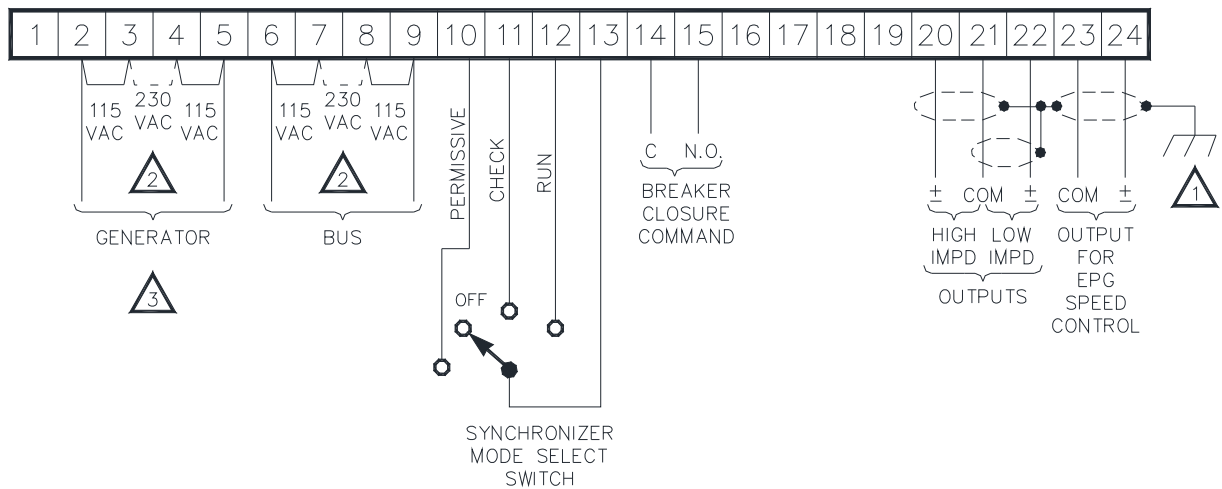
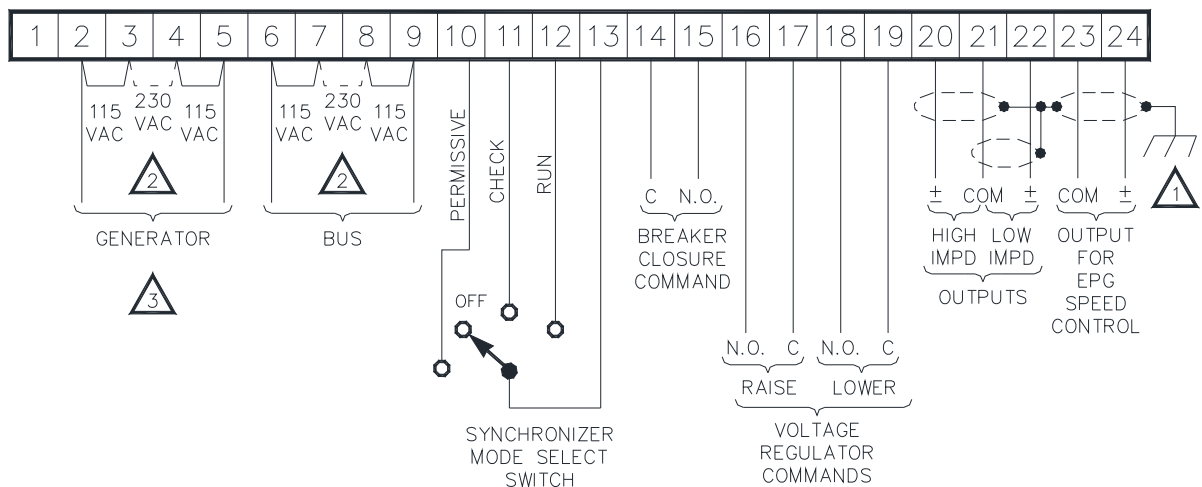


Figure 1-3. Functional Block Diagram

9905-001 (STANDARD MODEL WITHOUT VOLTAGE MATCHING)



9905-002 (STANDARD MODEL WITH VOLTAGE MATCHING)



NOTES:

- 1** SHIELDED WIRES TO BE TWISTED PAIRS WITH SHIELD GROUNDED AT ELECTRIC CONTROL END ONLY.
- 2** FOR 115 VAC OPERATION JUMPER TERMINALS 2&3, 4&5, 6&7, AND 8&9. FOR 230 VAC OPERATION JUMPER TERMINALS 3&4 AND 7&8.
- 3** IF A DEAD-BUS RELAY IS USED TO CLOSE THE GENERATOR BREAKER, THE MODE SELECT SWITCH MUST BE IN THE OFF POSITION UNTIL THE SYNCHRONIZER CAN CLOSE TO A LIVE BUS.

823-151
91-04-04 MCL

Figure 1-4. Plant Wiring Diagram

Chapter 2. Installation

Introduction

This chapter provides the general information for site selection, installation, and wiring of the SPM-A Synchronizer.

Unpacking

Before unpacking the synchronizer, refer to the inside front cover and to pages ii and iii of this manual for hazard alerts. Be careful when unpacking the synchronizer. Check for signs of damage such as bent or dented panels, scratches, loose or broken parts. If any damage is found, immediately notify the shipper.

Location

When selecting a location for mounting the SPM-A Synchronizer, consider the following:

- Protect the unit from direct exposure to water or to a condensation-prone environment.
- The operating range of the synchronizer is -45 to $+70$ °C (-49 to $+158$ °F). For best operation, maintain the ambient air temperature between $+10$ and $+30$ °C ($+50$ and $+86$ °F).
- Provide adequate ventilation for cooling. Shield the synchronizer from radiant heat sources.
- Do not install the synchronizer near high-voltage high-current devices.
- Allow adequate space in front of the unit for servicing.
- Do not install the synchronizer where objects can be dropped on it or its terminals.
- Ground the synchronizer for proper shielding.

Installation

Select a mounting location for the SPM-A Synchronizer (see considerations above).

Locate and drill four holes for mounting hardware (not furnished; see Figure 1-1 for locations). Tap the holes for machine screws or bolts.

Install the synchronizer and secure with the mounting hardware.

Electrical Connections

The following instructions and wiring diagrams illustrate typical wiring connections. For applications not shown in Figures 2-1 and 2-2, refer to the plant wiring diagram (Figure 1-4) or contact Woodward for assistance.

Connect the synchronizer terminals as shown in Figure 1-4. When making the connections, observe the following:

- Make all connections using insulated terminals.
- Use 0.5 mm² (20 AWG) or larger stranded, twisted shielded wire.
- Make sure that all wires shown as shielded on the plant wiring diagram, are shielded.
- Do not place shielded wires in the same cable conduits with high-voltage or high-current carrying cables.
- Do not connect the cable shields to any external grounds. The shields are grounded at the control end only.
- Make sure that cable shields are carried through all intermediate terminal blocks from signal source to signal termination.
- Do not subject any wiring to temperatures above 100 °C (212 °F).
- Avoid kinks or sharp bends in the wiring.
- Make sure that all connections are tight.

For additional wiring information, see Woodward Manual 25070, *Electric Governor Installation Guide*.

Install and wire the other units and actuators in your system using instructions in applicable manuals.

Connections to the Generator

The synchronizer is powered by voltage supply connections to the generator potential transformers (PTs). It uses a standard 120 Vac or 208/230 Vac, 50/60 Hz input. The synchronizer can use the same voltage connections to the generator PTs as the electronic governor's load sensor. Power consumption of the synchronizer is 5 W maximum.

1. Connect the generator PT neutral to synchronizer terminal 5 (Figure 2-1).
2. Connect one phase of the generator PT (usually phase A) to synchronizer terminal 2.
3. Connect the same phase from the bus PT to synchronizer terminal 6.
4. Connect bus neutral to terminal 9.

Connections to Load Sharing and Speed Control

Speed Bias Output

Make connections to synchronizer terminals as shown and connect the cable shields to the control end only.

For single-unit 2301 application, use:

High impedance—terminal 20 ($\pm$) and 21 (common).

For 2301A, Load Sharing Modules (LSM), EPG, 2500 load control systems, and EGA or EGM with external resistors, use:

Low impedance—terminal 22 ($\pm$) and 21 (common).

For EPG speed controls without load sensors, use:

SPM-A terminal 24 ($\pm$) to EPG terminal 10;

SPM-A terminal 23 (common) to EPG terminal 5.

Paralleling a Bus to a Bus

The synchronizer can be used to parallel an isolated bus to another bus, as shown in Figure 2-2. Up to seven generators operating in parallel on an isolated bus may be synchronized to another bus. In this case, the synchronizer's low impedance output to the load sharing and speed control's SPM input is tied to each control (through a resistor if the control is not normally connected to the low impedance output). The resistor value is determined by the kind of control used (refer to the table below). A resistor with a wattage rating between 1/4 and 1 watt may be used. The resistor should be installed in the line from the synchronizer output terminal designated $\pm$ (terminals 20, 22, or 24 depending on type of control) and located close to the control to reduce noise pickup.

Type Control	Acceptable Resistance Value	Woodward Part Number
2301	1.6 to 2.0 M Ω	1649-333
2500 Load Sensor	No resistor required	
EGA	196 to 226 k Ω	1649-605
EG Load Signal Control or EGM	665 to 765 k Ω	1649-277
2301A	No resistor required	
Generator Load Sensor	No resistor required	

Sequentially Paralleling Generator to a Bus

Although the synchronizer can be switched to parallel generators in sequence to a bus, Woodward Governor Company does not recommend this option.

Voltage Regulator Relay Output Connections

Make the connections as required to terminals 16 through 19 of the synchronizer. Terminals are shown in Figure 1-4, which give normally open contacts for operation to the voltage regulator. The ratings for the voltage raise and lower relay contacts are:

Resistive Loads:

10 A at 28 Vdc

3 A at 120 Vac, 50/60 Hz

Inductive Loads:

6 A at 28 Vdc

2 A at 120 Vac, 50/60 Hz

Breaker Closure Relay Connections

Make connections from the breaker closure relay to terminals 14 and 15 of the synchronizer. These terminals, shown in Figure 1-4, give normally open contacts. The ratings for the breaker closure relay contacts are:

Resistive Loads:

10 A at 28 Vdc

3 A at 120 Vac, 50/60 Hz

Inductive Loads:

6 A at 28 Vdc

2 A at 120 Vac, 50/60 Hz

IMPORTANT

If a dead-bus relay is used to close the breaker, the synchronizer mode switch must be in the OFF position until the synchronizer is required to synchronize and close the breaker to a live bus.

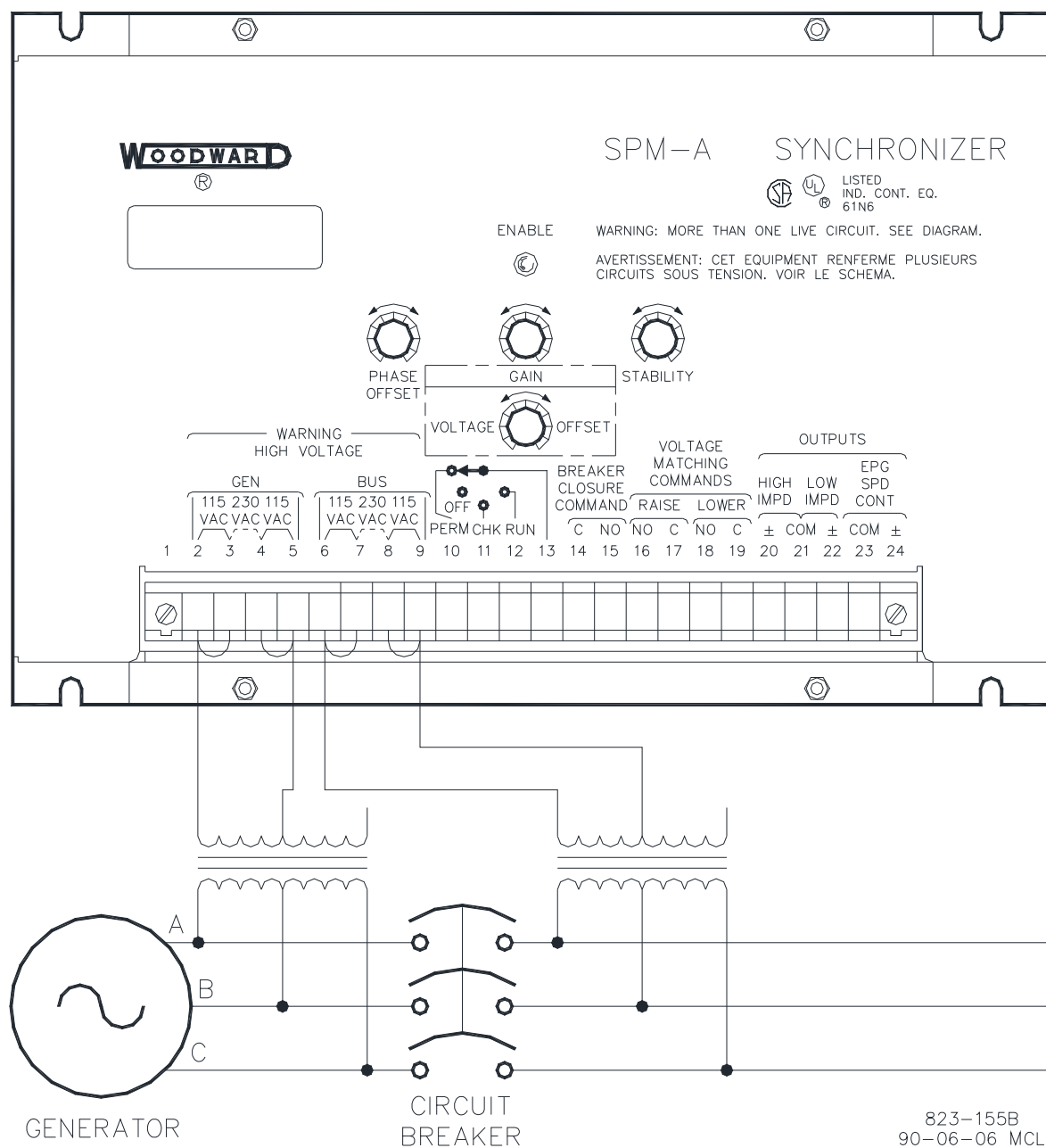


Figure 2-1. Typical SPM-A Synchronizer Wiring

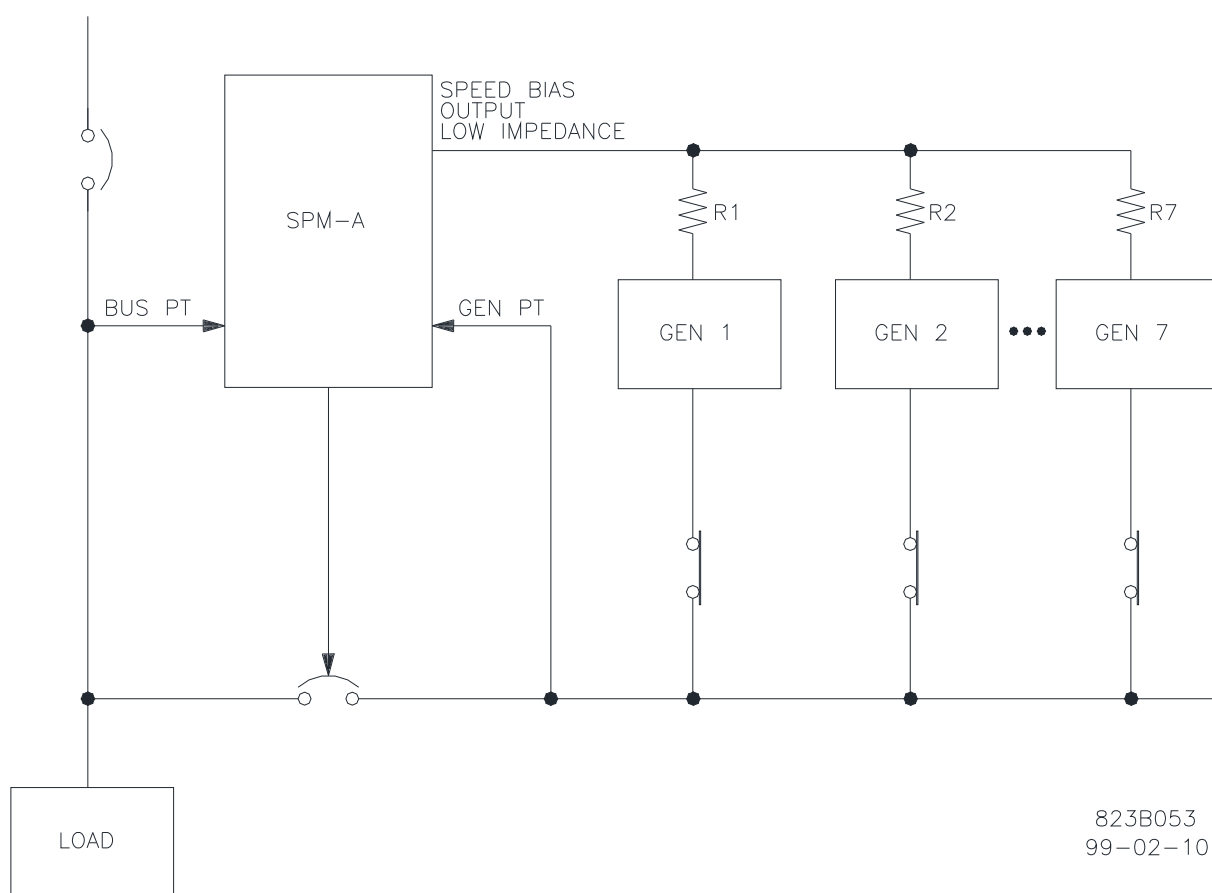


Figure 2-2. Synchronizing Bus to Bus

Chapter 3.

Calibration and Checkout Procedure

Introduction

This chapter covers the checkout and calibration of the SPM-A Synchronizer. These procedures must be followed in sequence for proper calibration of the synchronizer. Notes in the text indicate when procedures are different for each SPM-A model.

NOTICE

Before attempting to calibrate the synchronizer, read Woodward Manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

General Information

Read and follow these instructions carefully when checking or calibrating the synchronizer:

- Observe precautions for handling static-sensitive devices (see page iii).
- Use battery-operated test equipment whenever possible.
- Isolate the test equipment from all grounds, including the chassis.
- Use a digital multimeter (DMM) for all measurements and a volt-ohmmeter (VOM) when checking indicators and relay contacts.
- Apply power to the synchronizer before applying power to any test equipment connected to it.
- Make sure that the wiring connections have been made in accordance with the plant wiring diagram (Figure 1-4) and that the connections are tight.
- The values given in this procedure are the values used by the factory for calibration of the new synchronizer. Be sure that no specification changes or modifications have been made that will change these values.

Pre-Checkout

All other units in the engine control system must be adjusted and working correctly before operating the synchronizer. While operating the engine to make adjustments on the other units, the synchronizer mode switch (user supplied) must be in the OFF position.

Dwell Time Adjustment

The dwell time is factory set at 1/2 second. To set the dwell time for one of the other settings (1/8, 1/4, or 1 second) do the following:

1. Turn off the power to all voltage inputs to the synchronizer.
2. Remove the four elastic nuts securing the synchronizer cover. Remove the cover.

NOTICE

To prevent damage to the components of the synchronizer, read and follow the Electrostatic Discharge Awareness precautions on page iii.

- Set the dwell time using the four-position gang switch located in the upper left corner of the circuit board (see Figure 3-1). The settings are as follows:

Dwell Time (second)	Switch			
	1	2	3	4
1/8	ON	OFF	OFF	OFF
1/4	OFF	ON	OFF	OFF
1/2	OFF	OFF	ON	OFF
1	OFF	OFF	OFF	ON

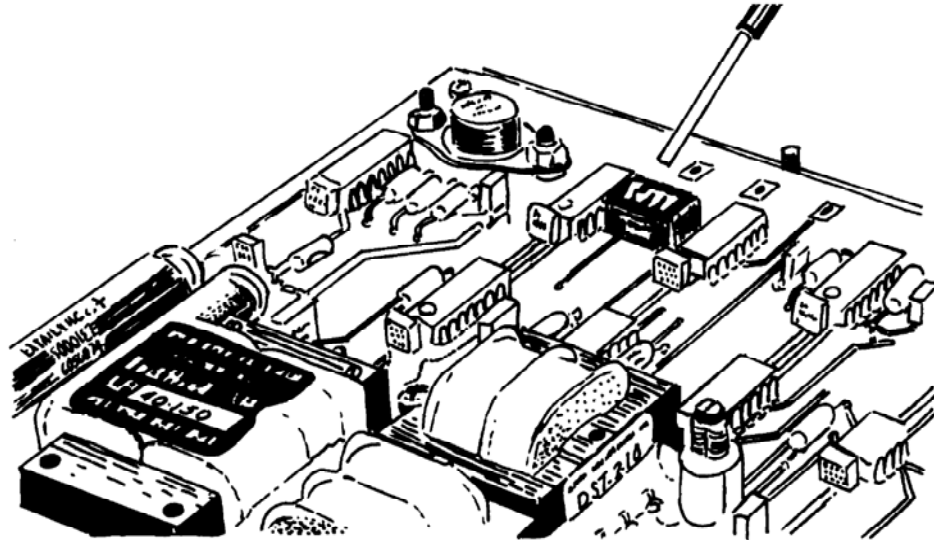


Figure 3-1. Dwell Time Setting Switches

- Replace the cover and secure with the four elastic hex nuts.

Test and Adjustment

Bench Test

A simple bench test may be done prior to installing the synchronizer. No adjustments can be made as a result of this test. The bench test only provides an indication of proper basic operation.



HIGH VOLTAGE—The following procedures uses high voltage power for testing. Personal injury or death can occur if normal safety precautions are not used when working with high voltage.

- Connect a utility power source (wall outlet) of 115 Vac, 60 Hz through single-pole single-throw switches to the BUS and GENERATOR input terminals. Leave the switches turned off.
- Connect a mode switch, single-pole four-throw, to terminals 10 through 13 as shown on the diagram on the synchronizer. Place the mode switch in the OFF position.

3. This test checks for breaker closure with matching live bus and generator inputs.
 - a. Turn on both the BUS and GENERATOR power switches. The ENABLE indicator will illuminate and the BREAKER CLOSURE contact terminal will be open.
 - b. Place the mode switch in the RUN position. The ENABLE indicator will remain illuminated and the BREAKER CLOSURE contacts will close for 1 second then open.
 - c. Place the mode switch in the OFF position. The ENABLE indicator will remain illuminated and the BREAKER CLOSURE contacts will be open.
 - d. Turn off the power switches.
4. This test checks the power up in run mode interlock protection.
 - a. Place the mode switch in the RUN position.
 - b. Turn on both the BUS and GENERATOR power switches. The ENABLE indicator will be illuminated and the BREAKER CLOSURE contacts will be open.
 - c. Turn off the power switches.
5. This test checks for live bus to dead generator breaker closure interlock.
 - a. Place the mode switch in the OFF position.
 - b. Turn on the power switch to the BUS. Leave the GENERATOR power switch off.
 - c. The ENABLE indicator will be off and the BREAKER CLOSURE contacts will be open.
 - d. Place the mode switch in the RUN position. The ENABLE indicator will be off, and the BREAKER CLOSURE contacts will be open.
 - e. Place the mode switch in the OFF position. The ENABLE indicator will be off, and the BREAKER CLOSURE contacts will be open.
 - f. Turn the BUS power switch off, then turn it on.
 - g. Turn the GENERATOR power switch on.
 - h. With the mode switch in the OFF position, the ENABLE indicator will be illuminated and the BREAKER CLOSURE contacts will be open.
 - i. Place the mode switch in the RUN position. The ENABLE indicator will be illuminated and the BREAKER CLOSURE contacts will be closed for 1 second then open.
 - j. Place the mode switch in the OFF position. Turn off the BUS and GENERATOR power switches.
6. This test checks the live generator to dead bus breaker closure interlock.
 - a. Place the mode switch in the OFF position.
 - b. Turn on the GENERATOR power switch, leave the BUS power switch off.
 - c. With the mode switch in the OFF position, the ENABLE indicator will be off and the BREAKER CLOSURE contacts will be open.
 - d. Place the mode switch in the RUN position. The ENABLE indicator will be off and the BREAKER CLOSURE contacts will be open.
 - e. Place the mode switch in the OFF position.
 - f. Turn off the GENERATOR power switch.
 - g. Turn on the BUS power switch and then turn on the GENERATOR power switch.
 - h. With the mode switch in the OFF position, the ENABLE indicator will be illuminated and the BREAKER CLOSURE contacts will be open.
 - i. Place the mode switch in the RUN position. The ENABLE indicator will be illuminated and the BREAKER CLOSURE contacts will close for 1 second then open.
 - j. Place the mode switch in the OFF position.
 - k. Turn off the BUS and GENERATOR power switches.

Dynamic Check

The best way to test and adjust the synchronizer is to operate it while in the CHECK mode.

1. Place the mode switch (user supplied) in the OFF position for starting.
2. Apply power to the electronic governor and start the engine according to the manufacturer's instructions.



Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

3. Go to rated speed for the specified generator frequency.
4. Place the mode switch in the CHECK position.
5. Watch the panel meter to make sure that the synchronizer is matching frequency and phase (and, in the voltage matching model, the voltage of the generator to the bus). When these are matched within the limits, the ENABLE indicator will illuminate.

IMPORTANT

The phase offset potentiometer (and on the voltage match model, the voltage match potentiometer) are calibrated at the factory. They do not normally require adjustment by the user for operation.

If the panel meters show incorrect phase or voltage matching, verify that they are calibrated and adjust if necessary.

Stability and Gain Adjustments

Place the mode switch in the OFF position. Adjust the generator approximately 1 Hz higher than the specified frequency. When the phase angle reaches 180 degrees, place the mode switch in the CHECK position. Watch the synchronizer's control action. Adjust the gain potentiometer for faster response and the stability potentiometer for minimum overshoot and settling time at 0 degrees phase angle. Return the generator to correct frequency.

Frequency Adjustment

To set an oncoming generator frequency to the system being paralleled, place the mode switch in the CHECK mode. Measure the synchronizer output with a high-impedance voltmeter. Adjust the rated speed potentiometer of the oncoming unit for 0 (zero) output voltage from the synchronizer.

An alternate method, where the system includes a synchroscope, is to leave the synchronizer in the off position and adjust the rated speed potentiometer of the oncoming unit until the synchroscope stops. The closer the frequencies are set, the better the load sharing action.

Phase Offset Adjustment

If the synchroscope steadies at other than 0 (zero) degrees (in the CHECK mode), the phase offset potentiometer may need adjustment.

1. Note the potentiometer position before changing the setting.
2. Turn the potentiometer as necessary to center the indicator of the synchroscope.

Voltage Offset Adjustment (Voltage Matching Model Only)

If the panel meters show that the generator voltage is different from that of the bus, the voltage offset potentiometer may need adjustment. Make sure that the panel meters are accurate, calibrated, and at operating temperature. Most panel meters are accurate to $\pm 3\%$ and are not temperature compensated.

1. Note the potentiometer position before changing the setting.
2. Disconnect all wiring from the voltage matching terminals (16 through 19) to the voltage regulator.
3. Operate the synchronizer in the CHECK mode.
4. Attach the leads of an ohmmeter to synchronizer terminals 16 and 17.
5. Turn the voltage offset potentiometer counterclockwise and make a note of its setting when the ohmmeter first indicates a relay contact closure (the voltage matching circuit is issuing a raise command to the voltage regulator).
6. Repeat the procedure with the ohmmeter leads on terminals 18 and 19 (lower command). Turn the potentiometer clockwise and note the setting.
7. Adjust the voltage offset potentiometer to the correct setting, halfway between the two settings.

IMPORTANT

If the voltage offset potentiometer is misadjusted, the generator's voltage regulator may drive in the opposite direction from what is needed. The voltage offset potentiometer sets the voltage match window. The potentiometer must be adjusted so that the line voltage is contained within the window. Otherwise, the voltage regulator on the generator will be run in the opposite direction of the voltage mismatch. This will take the generator off line on reverse current.

8. Attach the original wiring to the voltage matching terminals.

IMPORTANT

When the breaker close signal is initiated, the voltage match circuit is disabled.

For operation of the synchronizer once it has been adjusted and tested, set the mode switch to the RUN or PERMISSIVE position. The ENABLE indicator will illuminate while the phase (and voltage in the voltage matching model) are near breaker closure limits. After the generator set is paralleled, under control of the synchronizer, the synchronizer is disabled.

Chapter 4. Service Options

Product Service Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM and Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

You can locate your nearest Woodward distributor, AISF, RER, or RTR on our website at:

www.woodward.com/directory

Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

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

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 a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call your Full-Service Distributor 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 Full-Service Distributor.

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 within 60 days, a credit for the core charge will be issued.

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 for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return authorization number;
- 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.

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.

NOTICE

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*.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website: www.woodward.com.

How to Contact Woodward

For assistance, call one of the following 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.

Electrical Power Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

You can also locate your nearest Woodward distributor or service facility on our website at:

www.woodward.com/directory

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:

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Engine/Turbine Model Number _____

Manufacturer _____

Number of Cylinders (if applicable) _____

Type of Fuel (gas, gaseous, steam, etc) _____

Rating _____

Application _____

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

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.

SPM-A Synchronizer Specifications

Woodward Part Numbers:

9905-001/9907-028	50/60 Hz, $\pm 10^\circ$ phase angle, no voltage matching
9905-002/9907-029	50/60 Hz, $\pm 10^\circ$ phase angle, 1% voltage matching
9905-003	50/60 Hz, $\pm 10^\circ$ phase angle, 5% voltage matching
9905-004	50/60 Hz, $\pm 5^\circ$ phase angle, no voltage matching
9905-005	50/60 Hz, $\pm 5^\circ$ phase angle, 1% voltage matching
9905-006	50/60 Hz, $\pm 10^\circ$ phase angle, 0.5% voltage matching
9905-008	400 Hz, $\pm 10^\circ$ phase angle, 1% voltage matching
9905-009	50/60 Hz, $\pm 10^\circ$ phase angle, 10% voltage matching
9905-107	50/60 Hz, $\pm 15^\circ$ phase angle, 5% voltage matching

Inputs

Voltage (bus and generator)	115 or 230 Vac rms, 50/60 Hz
Voltage Tolerance	$\pm 10\%$
Power Consumption	5 W maximum

Outputs

Control Compatibility	high impedance output for 2301 load sharing controls low impedance output for 2301A, EPG, and 2500 load sharing controls; and EGA, and EGM controls with external resistor EPG output for EPG controls without load sharing normally open contact provided
Breaker Close Relay	
Breaker Close Relay	
Contact Ratings	Resistive Loads: 10 A at 28 Vdc 3 A at 120 Vac, 50/60 Hz Inductive Loads: 6 A at 28 Vdc 2 A at 120 Vac, 50/60 Hz
Breaker Close	
Command Duration	approx. 1 second

Selections and Adjustments

Operating Modes	RUN, CHECK, PERMISSIVE, OFF
Synchronizer Reset	automatic reset
Phase Match Window	$\pm 5^\circ$, $\pm 10^\circ$, $\pm 15^\circ$ available
Match-up Time	1/8, 1/4, 1/2, 1 second field-selectable internally (factory default is 1/2 second)
Voltage Matching Range	0.5%, 1%, 5%, 10% available

Physical Installation

Location	mount with switch gear
Weight	2.2 kg (5 lbs)
Maximum Operating	
Temperature Range	-45 to $+70^\circ\text{C}$ (-49 to $+158^\circ\text{F}$)
Optimal Operating	
Temperature Range	$+10$ to $+30^\circ\text{C}$ ($+50$ to $+86^\circ\text{F}$)



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

Complete address / phone / fax / email information for all locations is available on our website.