

Process and Import/Export Control

9905-089, -090, -091, -092
for use with load sharing controls
CSA Approved

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

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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.



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Contents

WARNINGS AND NOTICES	II
ELECTROSTATIC DISCHARGE AWARENESS	III
CHAPTER 1. GENERAL INFORMATION.....	1
Introduction	1
General Information	1
Description	2
CHAPTER 2. INSTALLATION AND SETUP	4
Introduction	4
Installation of the Panel	4
Power Supply	4
Wiring.....	5
CHAPTER 3. CALIBRATION AND OPERATION.....	12
Introduction	12
Line Power.....	12
Setting the Output Range	12
External High Limit (optional)	15
Control Point Adjustments	15
Input Connections.....	16
Start-up and Dynamic Adjustments	17
Final Adjustments	17
Bench Test	17
Two Engine Compressor Control System	19
CHAPTER 4. PRODUCT SUPPORT AND SERVICE OPTIONS.....	21
Product Support Options	21
Product Service Options.....	21
Returning Equipment for Repair	22
Replacement Parts	22
Engineering Services.....	23
Contacting Woodward's Support Organization	23
Technical Assistance	24

Illustrations and Tables

Figure 2-1. Internal Mini-Switches	5
Figure 2-2. Plant Wiring Diagram for Process and Import/Export Control	7
Figure 2-3. Output Transducer for Direct Process (exhaust)	8
Figure 2-4. Output Transducer for Inverse Process (inlet pressure)	8
Figure 2-5. Import or Export Control.....	9
Figure 2-6. Import/Export Control.....	10
Figure 2-7. Outline Drawing of Process and Import/Export Control.....	11
Figure 3-1. Differential Control Block Diagram (9905-089 or 9905-091)	18
Figure 3-2. Low Signal Select Control Block Diagram (9905-090 or 9905-092) ..	18
Figure 3-3. Using a Single Process Control for Two Load Sharing Engines	20
Table 2-1. Mini-Switch Settings.....	6

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.

Chapter 1.

General Information

Introduction

This manual provides the installer and operator of the Woodward Process and Import/Export Control with the information needed to successfully install the unit and to provide for operation, maintenance, and troubleshooting of the system.

General Information

The Process and Import/Export Control output is connected to a load and speed control, directly into the speed-control circuit or through load-sharing lines, to control the prime-mover output according to the sensed process parameter.

The unit is available for use with low- or high-voltage supply in either Differential Process or Low Signal Select configurations.

Models Available:

Part Number	Supply Voltage	Type of Control
9905-089	10–45 Vdc	Differential Process
9905-090	10–45 Vdc	Low Signal Select
9905-091	88–132 Vac or 90–150 Vac	Differential Process
9905-092	88–132 Vac or 90–150 Vac	Low Signal Select

The Woodward Process and Import/Export Control, with a Woodward load-sharing or speed control, provides control of a prime-mover system or process. The process controls will control any process where the controlled parameter is determined by the load or speed of a prime mover, and where the controlled parameter can be monitored as a 1 to 5 Vdc or a 4 to 20 mAdc input signal. An input signal of 0 to 10 Vdc may be used with an external control set-point potentiometer.

9905-089 is a direct replacement for 9905-015 and 8272-351. 9905-090 is a direct replacement for 9905-016 and 8272-350.

Low Signal Select (Inverse/Direct) and Either Import or Export Control (9905-090 or 9905-092)

The control compares the input signals to operator-set references. The difference between each input and the reference setting is sent to a circuit which selects the lower speed or power output from the prime mover. The output of this circuit is sent, as an operating voltage, to a load or speed control. The load or speed control then changes or maintains the prime-mover load or speed, and controls the Process and Import/Export rate to maintain the desired set point.

Low Signal Select Modes of Action

Inverse Process Control—Controls a process where the sensed input signal decreases as the load or speed increases. (Example: where the sensed process is inlet pressure.) The pressure in the steam chest will decrease if turbine speed or load is increased. Also used for import-power control. (Import power will decrease as the local generating system picks up more of the local load.)

Direct Process Control—Controls a process where the sensed input signal increases as the load or speed increases. (Example: where the sensed input is exhaust pressure.) Also used for export power control.

Inverse and Direct Process Control—Uses both inverse and direct process inputs to control a process. The controlling action of the Process Control is determined by the sensed-input signal which requires the lowest prime-mover load or speed. (Examples: The process control acts as an inverse process control when the controlling input is inlet pressure. The process control acts as a direct process control when the controlling input is outlet pressure.)

Differential Process Control and Import/Export Control (9905-089 or 9905-091)

The Differential Process Control subtracts the inverse-process input from the direct-process input and compares the difference to an operator-set reference. The process control output voltage is then sent to a load or speed control, which changes or maintains the load or speed of the prime mover to maintain the required differential input to the process control.

A differential control is required for Import/Export control of generation.

Description

The process control has built-in, adjustable high and low limits to restrict the output range in case of excessive input. An external high-limit potentiometer can be used to supplement the internal high limit. This allows the operator to limit output without changing set points and to externally manipulate the rate of loading. The external high limit can be used to soft load, by setting the gain adjustment for best transient response.

The output amplifier of the process control tracks the voltage present on the leads connected to the Process Control output terminals. This voltage represents system speed or load condition at the time the Process Control is activated. When the control is activated, the output starts at the existing system speed or load and integrates to obtain a system speed or load which matches the Process Control set point. This minimizes speed or load transients upon activation of the control.

Gain and Droop

The process control gain function governs process or import/export control response time and sets process loop stability.

Droop is available, if required, to achieve proper controlling action. Droop may be used when the prime mover cannot be stabilized through normal gain adjustments, when several controls are controlling the same pressure on a common header pipe, or when paralleling mechanical loads. The droop pot is normally turned fully counterclockwise, setting the process control for zero droop. (Input will equal the reference when the unit is in control.)

Import/Export Applications

Generator load control is achieved by connecting the Process and Import/Export Control output through the load-sharing lines to a 2301 or 2301A Load Sharing and Speed Control, a 2500 Load Sensor, or an Electrically Powered Governor (EPG) Load Sensor. The control output will then set the voltage on the load-sharing lines and change the generator load as required by the controlled parameter.

In import/export generator systems, the output is connected to system load-sharing lines and the controlled parameter input is provided by the real power (kilowatt) sensor/transducer.

Systems using a 2500 speed control or an EPG governor without a load sensor are controlled by biasing or providing the speed-setting signal with the output of the Process and Import/Export Control.

An internal mini-switch on the printed-circuit board, inside the cover of the Process and Import/Export Control, sets the output level for compatibility with the type of electronic governor being controlled.

Transient, Interference (EMI), and Power Supply

The Process and Import/Export Control is designed to reduce ground loop or other interference problems through the use of an isolated, internal power supply. Shielding is specified for all signal connections to the control to reduce EMI problems.

Chapter 2. Installation and Setup

Introduction

This chapter contains information on installation of the control in the control panel, the power supply, and wiring of the control into the system.

Installation of the Panel

Mount the control in a location with an ambient temperature within -40 to $+71$ °C (-40 to $+160$ °F), away from radiant heat sources, and protected from direct exposure to water or to any condensation-prone environment. Do not install the Process and Import/Export Control near high-voltage/high-current devices. Allow adequate space in front of the unit for servicing. Installation dimensions are provided in the outline drawing, Figure 2-1.

Power Supply

Control numbers 9905-089 and 99005-090 are compatible with 12, 24, or 32 Vdc power systems (10 Vdc min, 45 Vdc max). Control numbers 9905-091 and 9905-092 are compatible with 88 to 132 Vac or 90 to 150 Vdc.

All Process and Import/Export Controls can supply 50 mAdc current for either 12 or 24 Vdc process sensors.

IMPORTANT

Do not use this power source to power devices other than process sensors.

Output Selection

Use the internal mini-switch, shown in Figure 2-1, to set the output for your system and requirements. Table 2-1 shows which setting to use and how to position the internal switch. There are three general categories of controls to which the Process and Import/Export Control output may be connected: Load Control or Load Sensor (through the load-sharing lines), or Speed Control (through either the speed-setting input or the auxiliary input). Table 2-1 shows the setups for compatible Woodward controls.

WARNING

Set the internal mini-switch to match the specifications shown in Table 2-1 before any other adjustments are made. Only one switch should be in the closed position at a time. Closing more than one switch at a time could make the control operate improperly and could cause overspeed or other damage.

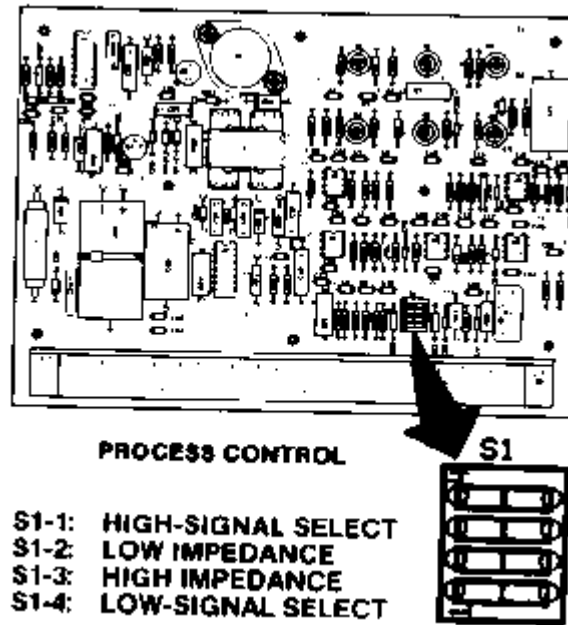


Figure 2-1. Internal Mini-Switches

The Process and Import/Export control is shipped from the factory with mini-switch number 4 closed and the other three switches open. If your control is to be set up in an application to use output from the low-signal select features, do not move the mini-switch. If one of the other output features is necessary, open switch 4 and close the appropriate switch to use the control for the desired function.

Wiring

Connect the control to the specified connections on the speed and load control or to the load-sharing lines.

Use shielded wire in twisted pairs or three conductors for all signal inputs and outputs from the Process and Import/Export Control. Ground the shield at one end of the wire only (usually at the process control end). Connect wiring according to the plant wiring diagram, Figure 2-2.

Chapter 3 contains detailed information on the wiring and testing of various uses of the Process Control and Import/Export Control.

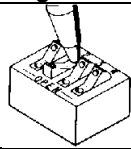
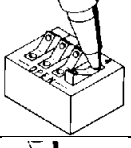
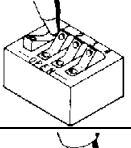
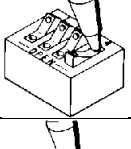
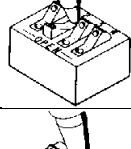
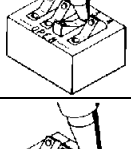
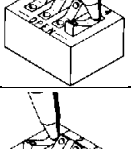
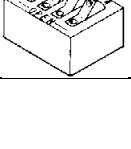
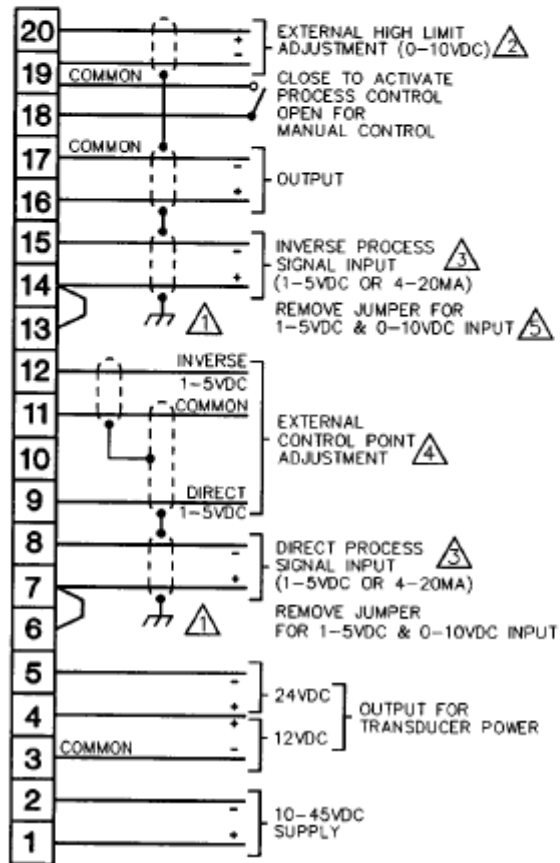
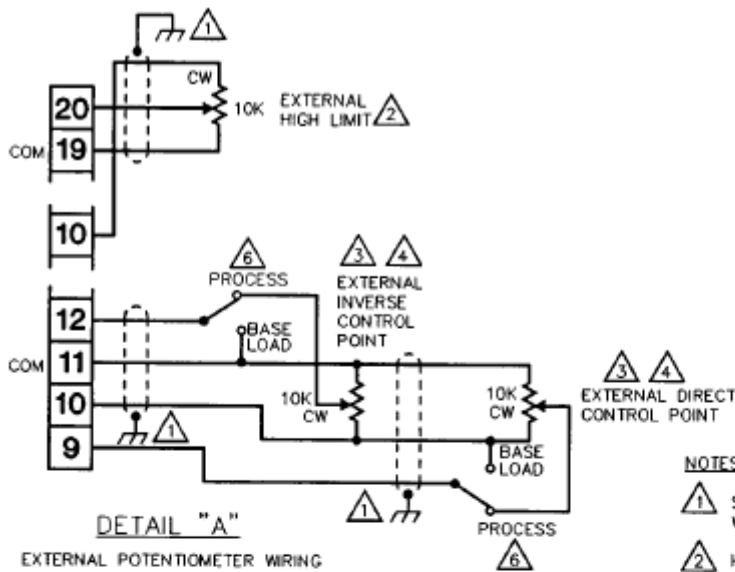
Process control output terminals 16 and 17 connected to:	Process control output required:	Process control internal mini switch setting
1712/1724 EPG terminals 11+ and 12– (auxiliary input)	LO IMP (low impedance)	Switch 2 
1712/1724 EPG terminals 10+ and 12– (speed setting input)	LO SIG SEL (low signal select)	Switch 4 
or Terminals 8+ and 5– (speed setting input with single phase droop)	HI SIG SEL (high signal select)	Switch 1 
2500 Speed Control terminals 10+ and 2– (speed setting input)	LO SIG SEL	Switch 4 
2500 Speed Control terminals 11+ and 12– (auxiliary input)	LO IMP	Switch 2 
Load Sharing Lines to: 2301, 2301A Load Sharing and Speed Control	HI IMP * (high impedance)	Switch 3 
or 2500 Load Sensor	LO SIG SEL *	Switch 4 
or EPG Load Sensor terminals 10+ and 11–	HI SIG SEL *	Switch 1 

Table 2-1. Mini-Switch Settings

* Either the HI IMP, LO SIG SEL, or HI SIG SEL setting may be used when the Process Control output is tied to load-sharing lines. Use HI IMP when you need direct control of the system. Use LO SIG SEL when the process Control is used only to lower load or speed. Use HI SIG SEL when the Process Control is used only to raise load or speed.



NOTES:

- ¹ SHIELDED WIRES TO BE TWISTED PAIRS OR 3 CONDUCTOR WITH SHIELD GROUNDED AT ONE END ONLY.
- ² HIGH LIMIT ADJUSTMENT MAY BE MADE BY INTERNAL POTENTIOMETER, EXTERNAL POTENTIOMETER OR EXTERNAL VOLTAGE. IF LEFT OPEN, LIMIT IS BIASED HIGH AND INTERNAL ADJUSTMENT WILL BE IN CONTROL. LOWEST SETTING OF INTERNAL OR EXTERNAL ADJUSTMENT SETS MAXIMUM OUTPUT. SEE DETAIL "A" FOR EXTERNAL HIGH LIMIT POTENTIOMETER WIRING.
- ³ SIGNAL INPUT VOLTAGES OF 0-10 VDC MAY BE USED IF EXTERNAL CONTROL POINT POTENTIOMETERS ARE USED.
- ⁴ CONTROL POINT ADJUSTMENTS MAY BE MADE BY INTERNAL POTENTIOMETER, EXTERNAL POTENTIOMETER OR EXTERNAL VOLTAGE. EXTERNAL SETTINGS WILL OVERRIDE INTERNAL SETTINGS. SEE DETAIL "A" FOR EXTERNAL CONTROL POINT POTENTIOMETER WIRING. EXTERNAL POTENTIOMETER REQUIRED ONLY FOR REMOTE ADJUSTMENT OR AS IN NOTE 3. "BASE LOAD" MODE REQUIRES CONTROL MODE SWITCH.
- ⁵ REMOVE JUMPER AND SET INTERNAL INVERSE CONTROL POINT CCW IF INVERSE PROCESS SIGNAL INPUT IS NOT USED.
- ⁶ CONTROL MODE SWITCH "PROCESS" MODE ALLOWS CONTROL POINT ADJUST. "BASE LOAD" MODE SETS CONTROL POINT FOR MAX DEMAND. EXTERNAL HIGH LIMIT CAN THEN BE USED TO BASE LOAD THE SYSTEM FROM ZERO TO FULL LOAD.
7. WHEN USED AS A PRESSURE CONTROL :
USE INVERSE FOR INLET PRESSURE
USE DIRECT FOR EXHAUST PRESSURE
- 8 VOLTAGE AT TERMINALS 10-11 IS ABOUT 11 VDC. USE A 10 K Ω POTENTIOMETER ACROSS 10 TO 11 FOR 0-10 VOLT SIGNAL. IF SIGNAL IS 0-5 VDC USE A 5K Ω PADDING RESISTOR IN SERIES WITH A 5K Ω POTENTIOMETER FOR BETTER RESOLUTION.
9. VOLTAGE AT TERMINALS 10-19 IS ABOUT 11 VDC. USE PADDING RESISTOR FOR BETTER RESOLUTION. IE. ONLY 0-3 VDC IS REQUIRED FOR OUTPUT TO LOAD-SHARING LINES. TOTAL RESISTANCE FROM 10-19 SHOULD BE 10K Ω .

Figure 2-2. Plant Wiring Diagram for Process and Import/Export Control

Use as a Process Control

Figures 2-3 and 2-4 show wiring of a Process and Import/Export Control for use as a process control. The control maintains the desired load by comparing a 1–5 Vdc or 4–20 mA process signal with the control point adjustment and then either biasing the load sharing lines of 2301 and 2301A load sharing and speed controls or adjusting the speed setting of 2301A, 2500, or EPG controls.

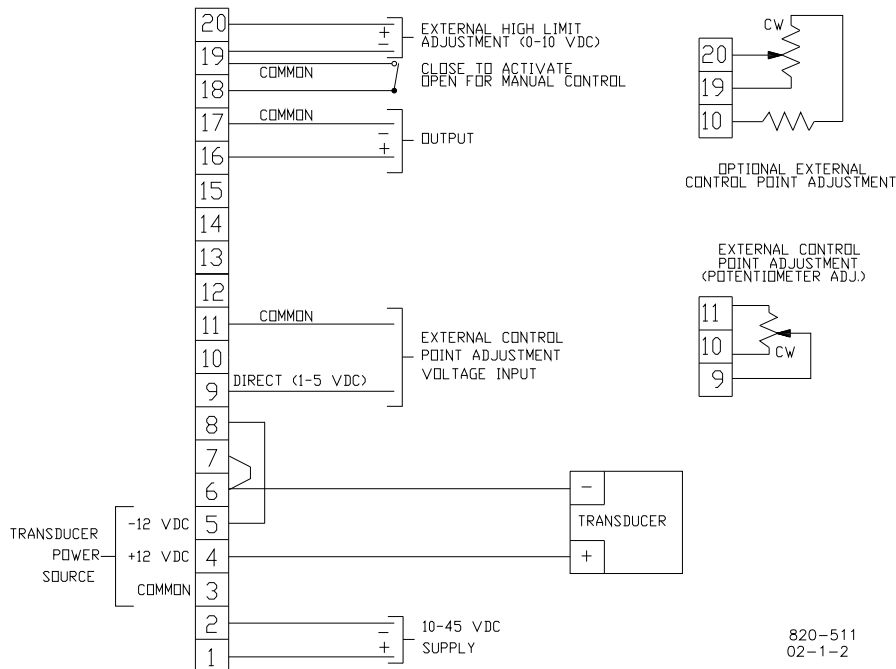


Figure 2-3. Output Transducer for Direct Process (exhaust)
(24 Vdc, 2-wire, 4–20 mA)

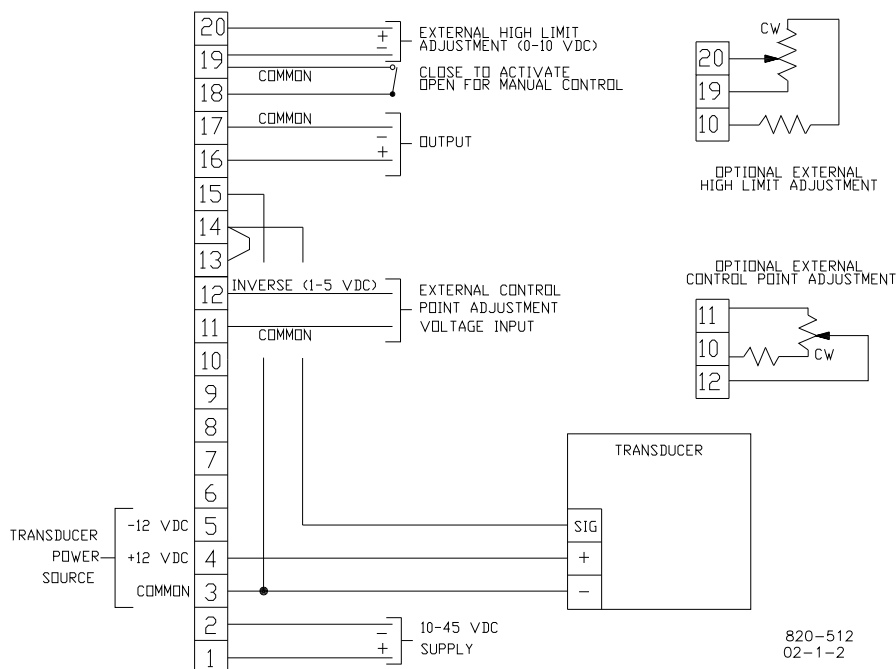


Figure 2-4. Output Transducer for Inverse Process (inlet pressure)
(12 Vdc, 3-wire, 4–20 mA)

Import or Export Control

Low-signal select controls (9905-090 or 9905-092) are used for import or export load control.

Connect the direct inputs from the real power sensor to terminals 7 (+) and 8 (–) for export control. Connect the inverse inputs from the real power sensor to terminals 14 (+) and 15 (–) for import control.

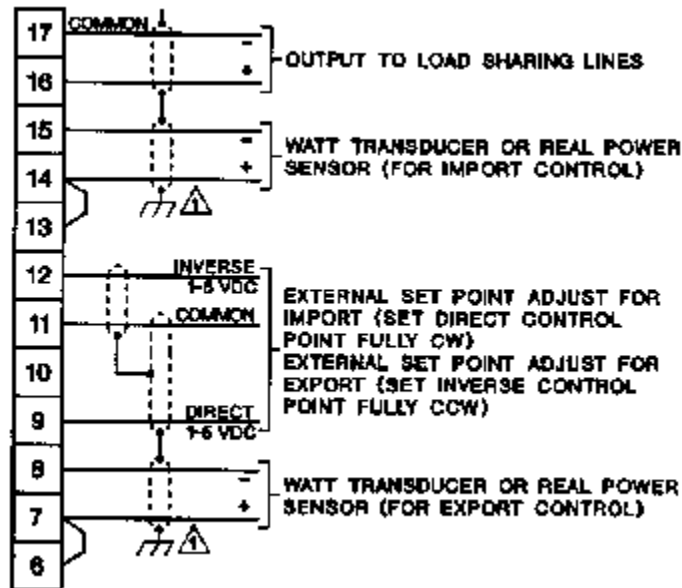


Figure 2-5. Import or Export Control

Import/Export Control

Differential controls (9905-089 or 9905-091) are used for import/export load control.

For import/export control, connect an external direct control point pot across terminals 9, 10, and 11 as shown and set the inverse control point pot full clockwise. Connect the direct input so that exporting will correspond to a positive signal and importing will correspond to a negative signal.

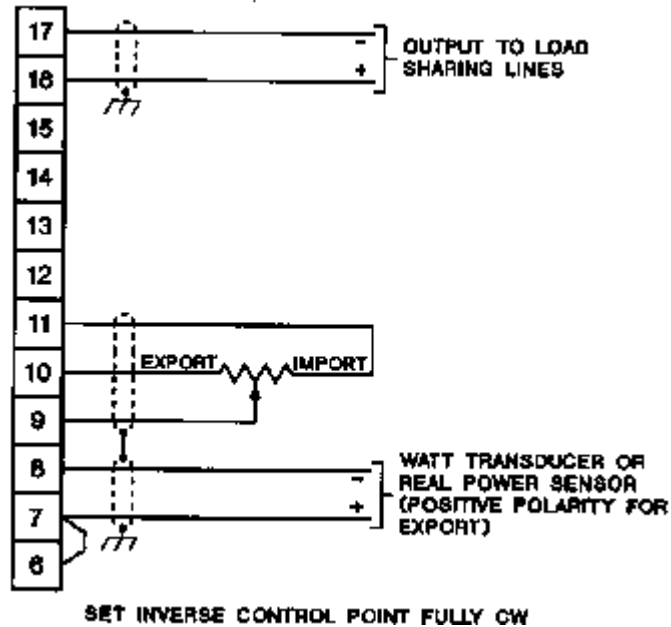


Figure 2-6. Import/Export Control

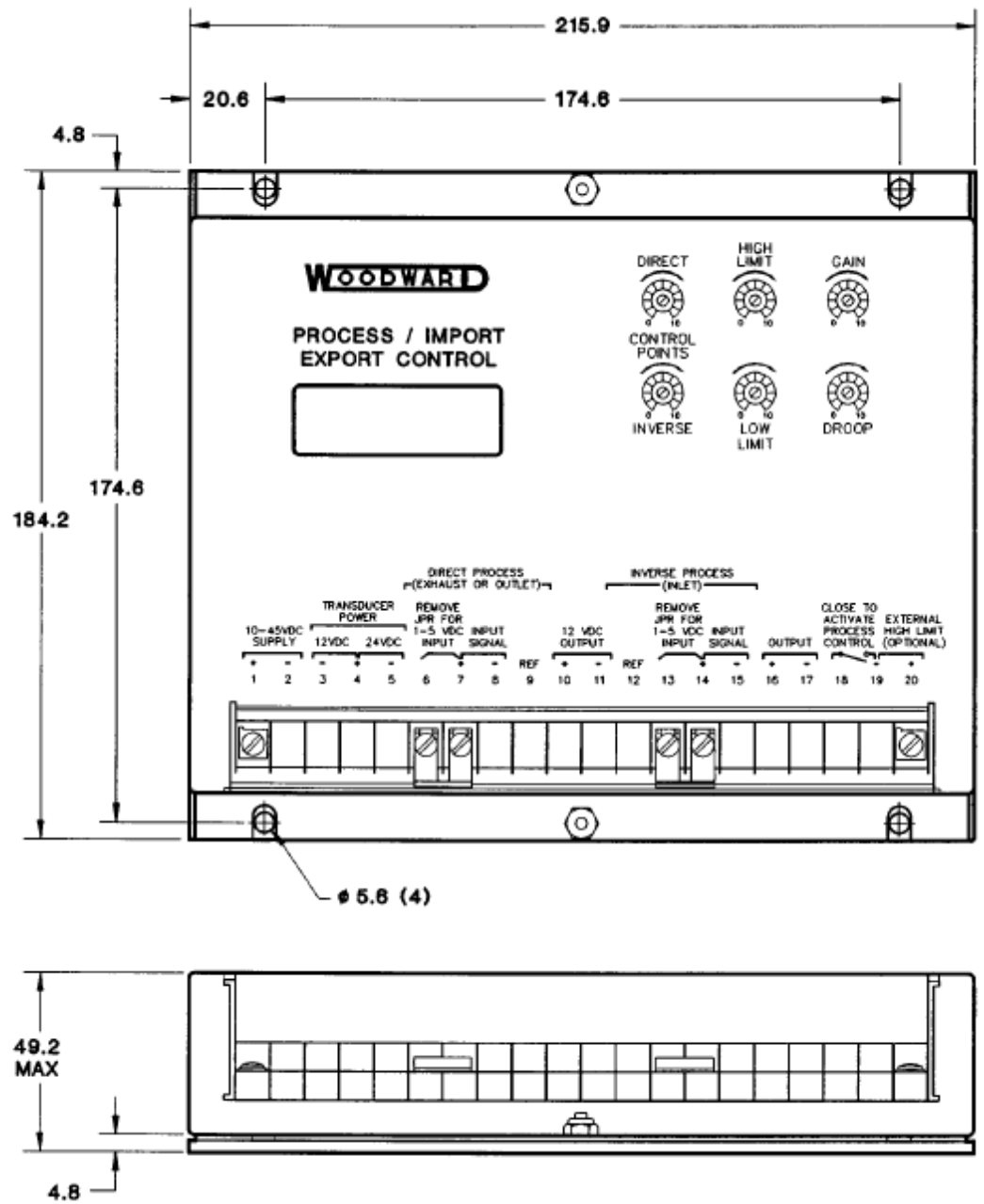


Figure 2-7. Outline Drawing of Process and Import/Export Control

Chapter 3. Calibration and Operation

Introduction

This chapter contains information on connecting and adjusting the Process and Import/Export Control to your system. Since the output voltage of the process control is dependent on the speed control setting, make sure that the speed control is properly calibrated before connecting the Process and Import/Export Control.

Line Power

Connect the power supply for the Process and Import/Export Control to terminals 1 (+) and 2 (-). Connect any optional external pots as shown in the plant wiring diagram, Figure 2-2.

Where the shield is shown, use twisted, shielded wire only, and ground (terminate) the shields on the load and speed control chassis or on the shield terminal provided on the load and speed control. Only one end of each shield (the end nearest the electronic control) should be tied to ground.

Setting the Output Range (High/Low Limit Calibration)

The procedure for calibrating the Process and Import/Export Control output range differs depending on whether the Process and Import/Export Control output is connected to (A) the speed-setting inputs of the speed control, (B) the auxiliary inputs of the speed control, or (C) the load sharing lines.

The calibration procedure for each of these possibilities follows. ***Use only the section which applies to your system.***

A voltmeter capable of reading 0–10 Vdc with 3.5 digits (Fluke 70 series or equivalent) is needed to accomplish the following calibration procedures.

(A) Speed Setting Inputs

The Process and Import/Export Control, when connected to the speed control speed-setting input, has the capability of controlling prime-mover speed throughout the full range of the speed control.

With the mini-switch set on LO SIG SEL (switch 4), the Process and Import/Export Control acts as a high limit on the speed control, and will only lower the speed setting. With HI SIG SEL (switch 1) activated, the Process and Import/Export Control acts as a low limit, and will only raise the speed setting.

High Limit

1. Set the HIGH LIMIT, LOW LIMIT, INVERSE CONTROL POINT, and DROOP potentiometers fully counterclockwise (ccw).
2. Set the DIRECT CONTROL POINT potentiometer fully clockwise (cw).
3. Remove the jumper, if one exists, between terminals 13 and 14.
4. Set the internal mini-switch on LO SIG SEL (4) or HI SIG SEL (1).
5. Connect a 10 k Ω resistor between terminals 10 and 16 if the internal mini-switch is set on Low Signal Select, and between terminals 16 and 17 if the mini-switch is set on High Signal Select. (This resistor will be removed when the Process and Import/Export Control is ready for operation.)
6. Note that the Process and Import/Export Control is not connected to the speed or load control at this time. (The close-to-activate switch across terminals 18 and 19 is open and the output from terminals 16 and 10 or 17 is connected to the 10 k Ω resistor, not to the speed or load control or the parallel lines.)
7. Start the prime mover according to the prime mover manufacturer's and speed and load control 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.

8. Activate the Process and Import/Export Control by closing the switch between terminals 18 and 19.
9. Use the Speed Control speed setting to raise prime-mover speed to maximum. Measure the voltage at the speed-setting input. Then, adjust the Process and Import/Export Control High Limit pot until the Process and Import/Export Control output (across the 10 k Ω resistor) equals the voltage at the Speed Control speed-setting input.

10.

Low Limit

Complete the internal High Limit adjustments first, since the Low Limit is dependent on the High Limit setting.

11. Set the INVERSE CONTROL POINT potentiometer fully cw and the DROOP and LOW LIMIT potentiometers fully ccw.
12. Activate the Process and Import/Export Control by closing the switch between terminals 18 and 19.
13. Use the speed control idle speed setting to lower prime-mover speed to minimum. Measure the voltage at the speed-setting input. Adjust the Process and Import/Export Control LOW LIMIT pot until the Process and Import/Export Control output equals the voltage at the speed control speed-setting input.
14. Remove the 10 k Ω resistor and connect the Process and Import/Export Control to the speed-setting input on the Speed Control.

(B) Speed Control Auxiliary Input

When the Process and Import/Export Control is connected to the speed control auxiliary input, the Process and Import/Export Control will have a limited range within which it can raise the speed setting. This range will vary from 15 to 30 percent, depending on the type of speed control and the rated speed setting.

High Limit

1. Set the HIGH LIMIT, LOW LIMIT, INVERSE CONTROL POINT, and DROOP potentiometers full ccw. Set the DIRECT CONTROL POINT potentiometer fully cw. Do not connect the inputs or outputs.
2. Remove the jumper, if one exists, between terminals 13 and 14.
3. Start the prime mover according to the manufacturer's instructions. Using the speed control, set the prime mover speed to minimum.



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.

4. Activate the Process and Import/Export Control by connecting terminals 18 and 19. Attach a voltmeter to the Process and Import/Export Control output (terminals 16 (+) and 17 (-) and verify that the output is 0.00 ± 0.05 Vdc.
5. Connect the Process and Import/Export Control to the auxiliary input on the speed control. Turn the Process and Import/Export Control HIGH LIMIT pot cw until the prime mover is running at the desired maximum speed.

Low Limit

Complete the High Limit adjustments first, since the Low Limit setting is dependent on the internal High Limit setting.

6. Disconnect the Process and Import/Export Control from the speed control and measure the output of the Process and Import/Export Control.
7. Set the LOW LIMIT potentiometer and the DROOP potentiometer fully ccw, and the INVERSE CONTROL POINT potentiometer fully cw.
8. Activate the Process and Import/Export Control by connecting terminals 18 and 19.
9. Adjust the LOW LIMIT pot until the Process and Import/Export Control output voltage is 0.00 ± 0.05 Vdc.

(C) Load Sharing Lines

If the internal mini-switch is set to the low-signal select mode (switch 4), a 10 k Ω resistor must be connected between terminals 16 and 10 during this setup procedure. This resistor is removed before the Process and Import/Export Control is connected to the speed/load control.

High Limit

1. Set the HIGH LIMIT, LOW LIMIT, INVERSE CONTROL POINT, and DROOP potentiometers full ccw. Set the DIRECT CONTROL POINT potentiometer full cw. Do not connect the inputs or outputs.
2. Remove the jumper, if one exists, between terminals 13 and 14.
3. Connect a voltmeter to the Process and Import/Export Control output terminals 16 (+) and 17 (–).
4. Connect terminals 18 and 19 (process control activated) and set the HIGH LIMIT potentiometer for half the maximum desired load signal (normally $0.5 \times 6 = 3$ Vdc).

Low Limit

Complete the High Limit adjustments first, since the Low Limit setting is dependent on the internal high limit.

5. Set the INVERSE CONTROL POINT potentiometer fully cw and the DROOP and LOW LIMIT potentiometers ccw.
6. Activate the Process and Import/Export Control by connecting terminals 18 and 19.
7. Measure the output voltage at Process and Import/Export Control terminals 16 (+) and 17 (–) and adjust the LOW LIMIT potentiometer until the voltage measures 0.05 ± 0.05 Vdc.

External High Limit (optional)

The optional External High Limit pot (terminals 19 and 20) on the Process and Import/Export Control is adjustable from 0 to the internal high-limit set point. (Note that the lower of the two set points will limit the operation.) The external high limit can be used to soft load the unit or to set maximum load or speed as a remote high limit.

Control Point Adjustments

Internal adjustments using the Control Point pots may be made within the range of 0 to 5.5 Vdc or 0 to 22 mAdc. External adjustments, or trim, may be made within the range of 0 to 11.0 Vdc. External adjustments can be made using an optional, external 10 k Ω control point potentiometer or potentiometers attached from terminals 10 (+) to 9 (–) or 11 (–) for direct control or terminals 10 (+) to 12 (–) or 11 (–) for inverse control.

These adjustments may be made either while the prime mover is running or when it is shut down. If the prime mover is running, inactivate the Process and Import/Export Control by disconnecting terminals 18 (+) and 19 (–).

The Control Point potentiometers provide reference voltages to the Process and Import/Export Control. Each reference voltage will equal its corresponding controlled parameter voltage when the process (prime mover) is operating as desired. Using a voltmeter, set the reference potentiometers to the voltage at which the inputs will produce the desired controlling action.

When using current inputs, multiply the input current by $250\ \Omega$ to obtain an input voltage.

If the required input voltage is unknown at start-up, disable the Process and Import/Export Control by disconnecting terminals 18 and 19. Start the prime mover under manual control according to the prime mover manufacturer's instructions. Determine the required input voltage by measuring the input voltage at the Process and Import/Export Control when the controlled parameter is at the desired level.



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.

Inverse Process Control—Deactivate the direct process control circuitry by turning the DIRECT CONTROL POINT potentiometer fully cw. Leave the direct process input (terminals 7 to 8 or 6) open. Measure the inverse-process reference voltage across terminal 12 (+) and 11 (–). Adjust the INVERSE CONTROL POINT potentiometer until the reference voltage equals the voltage required for the inverse process input. (Example: If the control point is at 16 mAdc, $16\ \text{mA} \times 250\ \Omega = 4\ \text{V}$.)

Direct Process Control—Deactivate the inverse process control circuitry by turning the INVERSE CONTROL POINT pot fully ccw and removing the jumper between terminals 13 and 14. Leave the inverse process input (terminals 14 to 13 or 15) open. Measure the direct process reference voltage across Terminals 9 (+) and 11 (–). Adjust the DIRECT CONTROL POINT potentiometer until the reference voltage equals the voltage required for the direct process input.

Inverse and Direct Process Control (Low Signal Select Mode)—Measure the voltage across both references: Terminals 14 (+) to 13 (–) for Inverse (15 (–) if jumper is in); Terminals 7 (+) to 6 (–) for Direct (8 (–) if jumper is in). Adjust both control point potentiometers to correspond to the input voltages at which controlling action is desired. In operation, the process control will then act on the input signal which requires the lower load or speed setting.

Input Connections

This table shows how the inputs should be connected to match the characteristics of your system. These characteristics apply to both inverse process and direct process inputs.

Input Signal	Jumper	Comments	Process Control Internal Input Impedance
1–5 Vdc	No	Optional use of external control point pot	499 k Ω (inverse) 100 k Ω (direct)
0–10 Vdc	No	Required use of external control point pot	499 k Ω
4–20 mA	Yes	Install jumper across terminals 6 (–) and 7 (+)	250 Ω

Start-up and Dynamic Adjustments

Remove the connection between terminals 18 and 19. Set the GAIN potentiometer to mid position. The INVERSE CONTROL POINT, DIRECT CONTROL POINT, HIGH LIMIT, and LOW LIMIT potentiometers should be set as previously described. If droop is required, set the DROOP pot to mid position; otherwise set this pot fully ccw.

Final Adjustments

When the system is in operation and the process control is controlling the system, fine tune the control points until the controlled parameters are correct.

Bench Test

If the Process and Import/Export Control appears to be operating incorrectly, you can check most of its circuitry with the following test:

1. Disconnect all wiring leading to and from the Process and Import/Export Control. Be sure the control is free from all external connections before proceeding.
2. Connect a 12, 24, or 32 Vdc power source to terminals 1 (+) and 2 (–) on the Process and Import/Export Control.
3. If the low-signal select output is used, connect a 10 k Ω resistor between terminals 16 and 10. Do not connect this resistor if low or high output impedance is used (mini-switch 2 or 3 on). If the HI SIG SEL is used (mini-switch 1 on), connect a 10 k Ω resistor between terminals 16 and 17.
4. Set the DROOP, GAIN, and LOW LIMIT potentiometers fully ccw. Set the HIGH LIMIT DIRECT CONTROL POINT, and INVERSE CONTROL POINT pots fully cw.
5. Connect terminal 18 to 19 to activate the control.
6. Measure the output voltage between terminals 16 (+) and 17 (–). The output voltage should be -0.5 ± 1.0 Vdc.
7. Quickly turn the INVERSE CONTROL POINT adjustment fully ccw. The output should slowly ramp up to 9.4 ± 2.0 Vdc. If it does not, the unit is defective.

If the Process and Import/Export Control output voltage ramps properly, but the control is still operating incorrectly, check the system for correct wiring. Examine other components in the system for correct operation. Verify that the input-sensing device is wired to the correct terminals necessary for the desired controlling action (inverse or direct, as described under general information).

Contact Woodward if the control problem persists.

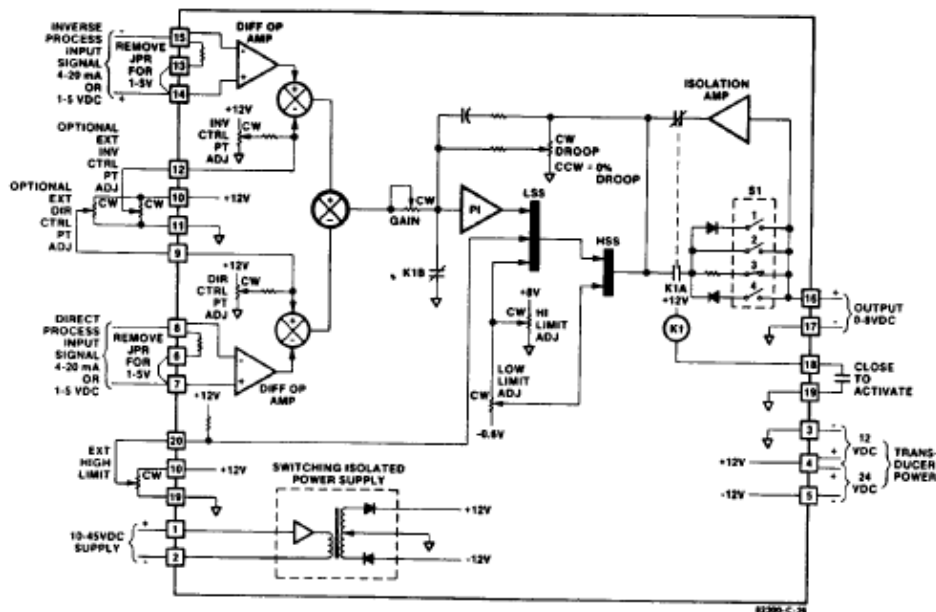


Figure 3-1. Differential Control Block Diagram (9905-089 or 9905-091)

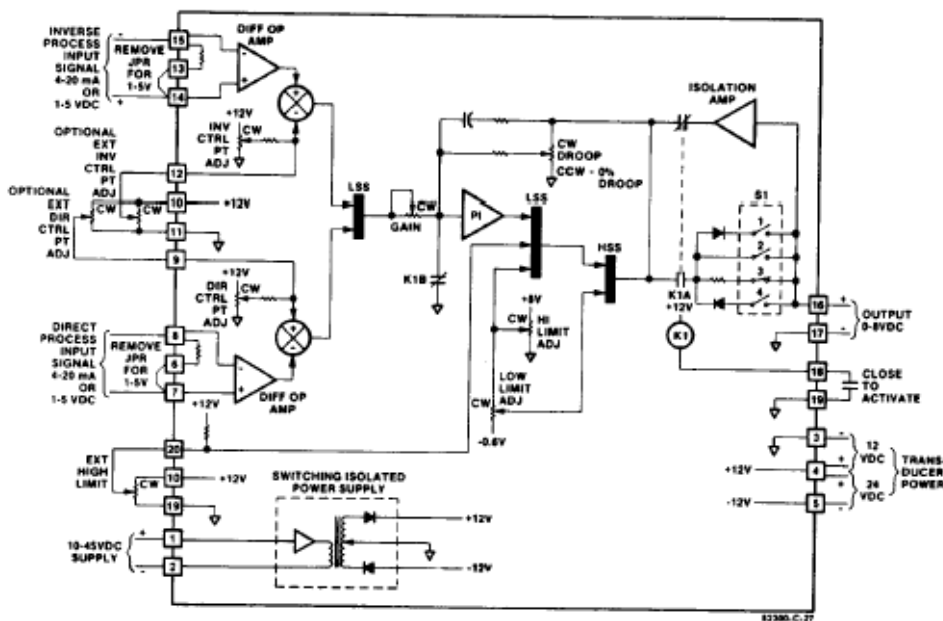


Figure 3-2. Low Signal Select Control Block Diagram (9905-090 or 9905-092)

IMPORTANT

To use two Direct Process input signals, reverse the input polarity at terminals 14 and 15.

To use two Inverse Process input signals, reverse the input polarity at terminals 8 and 7.

Action of the set point adjustments will remain the same.

Two Engine Compressor Control System

The actuator feedback droop setting can be adjusted to provide load sharing between engines. The Process-Import/Export output will integrate to a value where engine speed will drive the compressors at the correct speed to maintain the pressure set point. (Droop also provides more solid control, referred to as “stiffness”.)

1. The pressure set point can be adjusted using the direct control point adjustment provided through the cover, using the external potentiometer as shown, or by providing a voltage or current from an external source connected across terminals 9 (+) and 11 (–).
2. If supply power is 88–132 Vac or 90–150 Vdc, use 2301A speed control 9905-149 and Process-Import/Export control 9905-092. Switching power for the 2301A speed controls would then come from terminal 6 instead of terminal 2. Other wiring would remain the same.

This drawing represents a typical installation and is believed to be accurate. This drawing should not be used for construction without first consulting the installation and operation manuals for the individual controls.

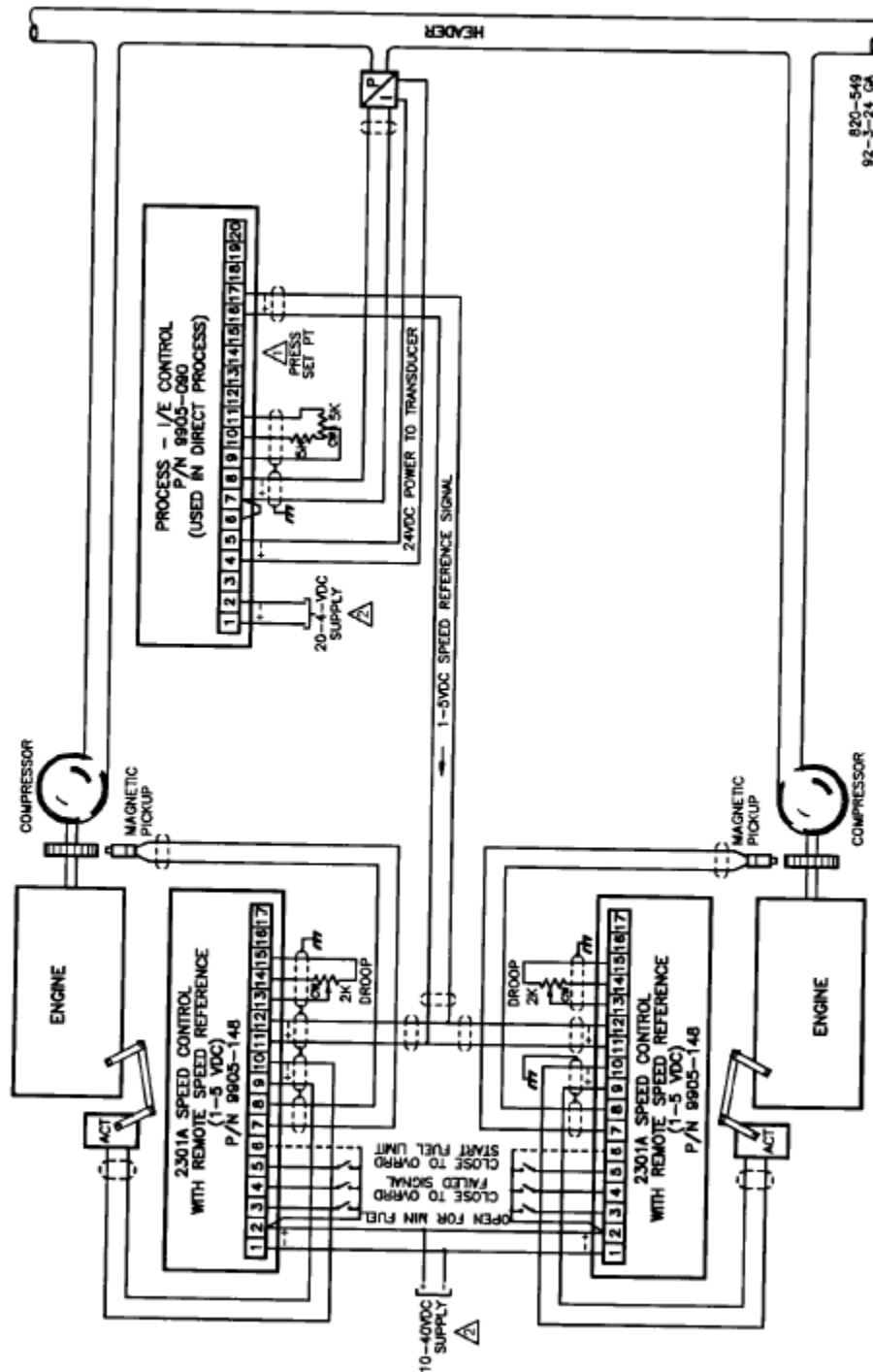


Figure 3-3. Using a Single Process Control for Two Load Sharing Engines

Chapter 4.

Product Support and Service Options

Product Support Options

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

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (EngineHelpDesk@Woodward.com) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or 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 current list of Woodward Business Partners is available at www.woodward.com/directory.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- 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 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.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic 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.

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. 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 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's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- 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.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor 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 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 one of the Full-Service Distributors listed at www.woodward.com/directory.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at www.woodward.com/directory.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used In Electrical Power Systems

<u>Facility</u> -----	<u>Phone Number</u>
Brazil -----	+55 (19) 3708 4800
China -----	+86 (512) 6762 6727
Germany:	
Kempen----	+49 (0) 21 52 14 51
Stuttgart--	+49 (711) 78954-510
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

Products Used In 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

Products Used In Industrial Turbomachinery 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

For the most current product support and contact information, please visit our website directory at www.woodward.com/directory.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name

Site Location

Phone Number

Fax Number

Prime Mover Information

Manufacturer

Engine Model Number

Number of Cylinders

Type of Fuel (gas, gaseous, diesel,
dual-fuel, etc.)

Power Output Rating

Application (power generation, marine,
etc.)

Control/Governor Information

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

Symptoms

Description

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.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication **82010D**.



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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.