



CPC Current-to-Pressure Converter

**Standard Version: 8901-457, 8901-459
[see manual 26248 for explosion-proof version]**

Installation and Operation Manual

IMPORTANT



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.

DEFINITIONS

- **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

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.



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.



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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.

NOTICE

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.

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*.

Revisions—Text changes 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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Electrostatic Discharge Awareness

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

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).
2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.
4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
 - Do not touch any part of the PCB except the edges.
 - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
 - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

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*.

Chapter 1.

Description

Introduction

The Woodward CPC (Current-to-Pressure Converter) is intended for positioning steam and/or fuel valves and/or associated servo systems. The CPC supplies a hydraulic fluid output pressure proportional to the (4 to 20) mA input current signal.

Apart from accurate pressure control, the CPC is designed for easy mounting and servicing. The flat surface with three hydraulic connections mounts to an adapter plate with the actual hydraulic fittings. This plate remains a part of the installation when removing the CPC, for example, during flushing of the lines when commissioning the installation.



Figure 1-1. Front View of the CPC

The customer's cable enters the CPC via a cable gland. Unscrewing the cap reveals the easy-to-access printed circuit board. The wires are connected to board-mounted terminals. Two sets of potentiometers on the board allow calibration and dynamic settings.

Construction

The CPC consists of the following main parts:

- Housing
- Hydraulic valve
- Actuator
- Printed circuit board
- Pressure sensor

Housing

The housing is a cast-aluminum, black anodized block, supporting all other parts. It contains the hydraulic ports and the mounting holes on one side of the square section and the cable gland on the other.

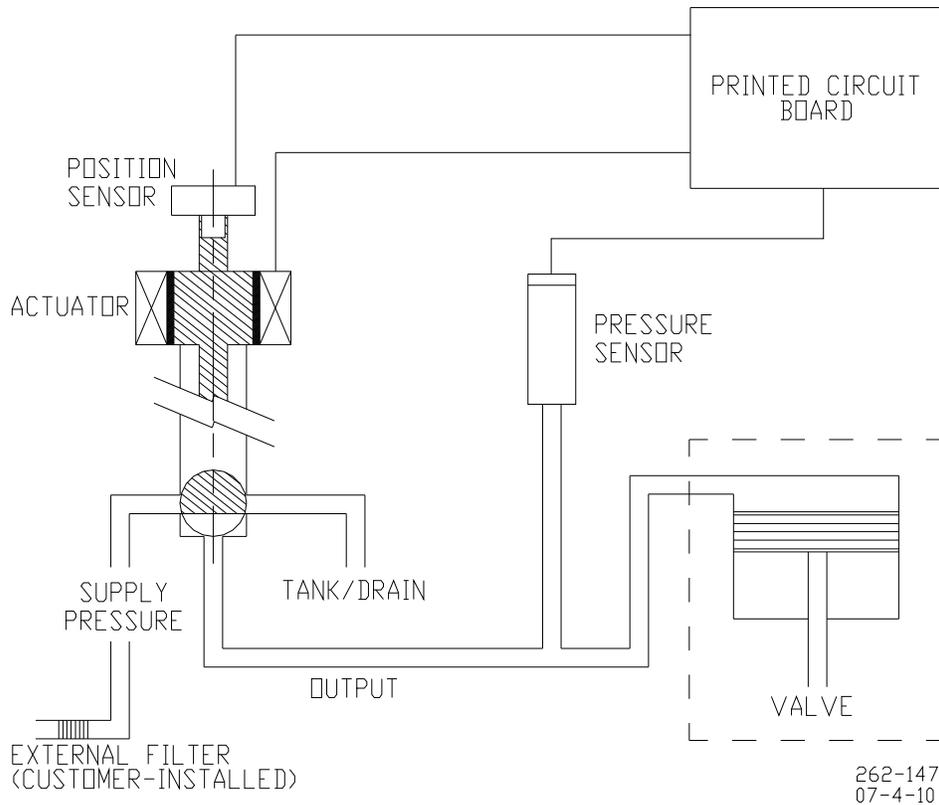


Figure 1-2. Hydraulic Schematic

Together with the aluminum cover, the enclosure contains the electronics, the actuator, and the pressure sensor.

The spiral return spring is installed on the base and protected by a cover.

The CPC is water- and dust-resistant, in accordance with EN 60529 IP65.

Hydraulic Valve

An innovative hydraulic valve controls the oil flow from supply to output port, or from output to tank. (see Figure 1-2). The valve consists of a steel bushing in which a steel plunger moves. The special construction ensures proper, reliable, and contaminant-tolerant operation, using standard lube oil.

Actuator

The CPC uses a Woodward-developed, rotary limited angle torque (LAT) actuator. It is a type of stepping motor with steps of 90 degrees, operated using a mini-stepping technique in one quadrant. The rotating angle is mechanically limited to $\pm 22.5^\circ$. The rotor, with the permanent magnet, is directly coupled to the hydraulic valve. The current signal to the coils is generated by the driver circuit of the electronics.

Printed Circuit Board

The printed circuit board is mounted on top of the housing (see Figure 1-3). The printed circuit board performs the following tasks:

- Power supply
- Signal conditioning of input and output signals
- PID output loop for output pressure
- PID output loop for valve position
- Actuator driver
- Current limiting
- Fault detection
- Dither generation

The power supply section performs the EMI filtering on the (18 to 32) V (dc) input voltage and generates an internal +10 V (dc). The internal voltage powers the circuit. The filtered input voltage is used to power the pressure sensor and the actuator driver.

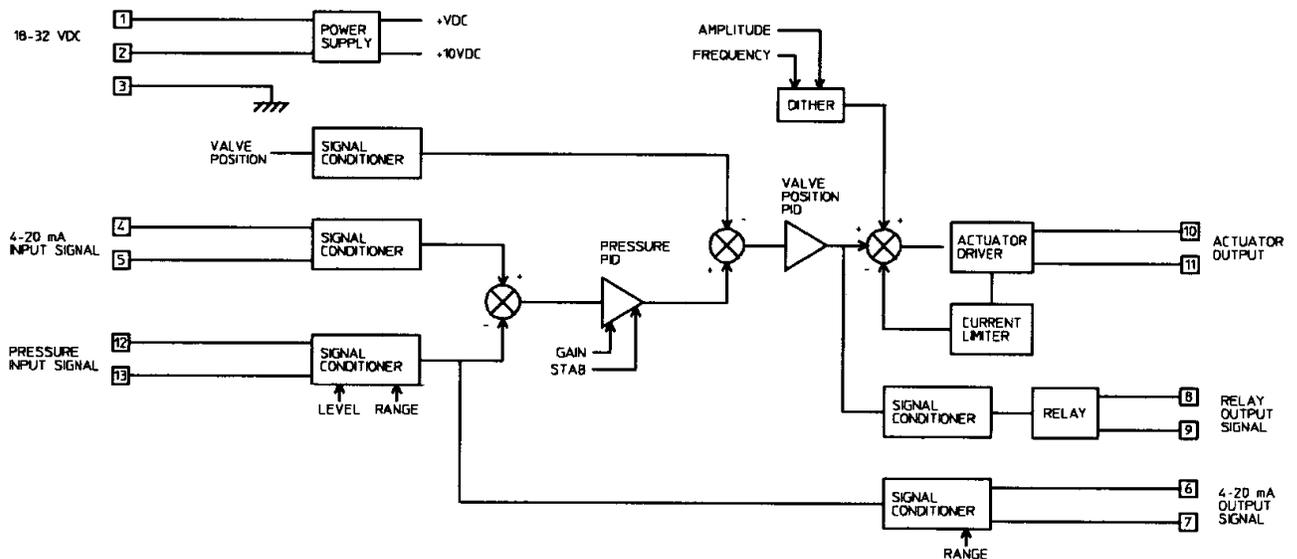


Figure 1-3. Functional Block Diagram (CPC electronics)

Each input and output signal from the printed circuit board is EMI protected.

The (4 to 20) mA pressure signal from the internal pressure transmitter is transformed into a voltage signal. The Pressure Level and Pressure Range potentiometers tune this signal for the specified output pressure range.

The (4 to 20) mA input signal gives a (1 to 5) V (dc) signal via a 250 Ω resistance.

A relay provides a discrete contact for fault detection. A red lamp will light when the relay is active. The drive signal is monitored, and is detected when it exceeds its range for longer than two seconds. This indicates that the required level of output pressure is either too high or too low. When this occurs, the relay will change state. Set jumper to either JPR1 or JPR2. JPR1 gives a normally-open alarm, and JPR2 gives a normally-closed alarm.

The Signal Range potentiometer adjusts the current output signal so that the minimum and maximum pressures correspond with 4 mA and 20 mA respectively.

The actual valve position is measured by a non-contacting position sensor, integrated into the board.

The pressure output loop, with adjustable gain and stability, generates a valve position reference signal for the valve position output loop, depending on the pressure reference signal and measured pressure signal. The dynamic settings can be adjusted to match the characteristics of the controlled servo system.

The driver provides the actuator with a high-current, pulse-width-modulated (PWM) signal, depending on the drive demand signal.

The current passing through the actuator is monitored. It can go up to 5 A for a period of three seconds, boosting the torque of the actuator to its maximum. Then the current is limited to approximately 1.5 A, in order to protect the circuitry.

The drive demand signal checks that the CPC is functioning correctly. When the signal exceeds its normal operating window for longer than two seconds, the CPC is presumably unable to maintain the required pressure level, and the relay will change state. A red lamp indicates when the alarm relay is active

A dither signal can be superimposed on the drive signal. The amplitude and frequency can be adjusted. The dither signal is intended to give a relatively high frequency ripple on the output pressure. It can be used to reduce the effect of static friction in the CPC and the attached servo system.

Pressure Sensor

The pressure sensor is a two-wire (4 to 20) mA transmitter (with a third wire for shielding purposes).

When the CPC is supplied with hydraulic and electric power, and a current input signal between 4 mA and 20 mA, it will output a certain pressure within the factory set pressure range. The operation is as follows. See also Figures 1-3 and 1-4.

1. The pressure reference and actual pressure signals are compared by the pressure output loop, and generate a reference valve position signal.
2. The valve position is measured with a board-mounted sensor. The position signal, together with the valve position reference, is used by the position output loop with fixed dynamics. This provides a fast and stable valve position output.
3. The output loop outputs a drive signal. The driver generates the correct PWM high current signal to the actuator, which results in the valve position as required.
4. The hydraulic valve has two ports: Supply to Output and Output to Tank. The three hydraulic connections are indicated on the CPC.
5. With the hydraulic valve in its mid position, both ports are closed, and assuming no leakage is present, the output or output pressure is maintained at its level.

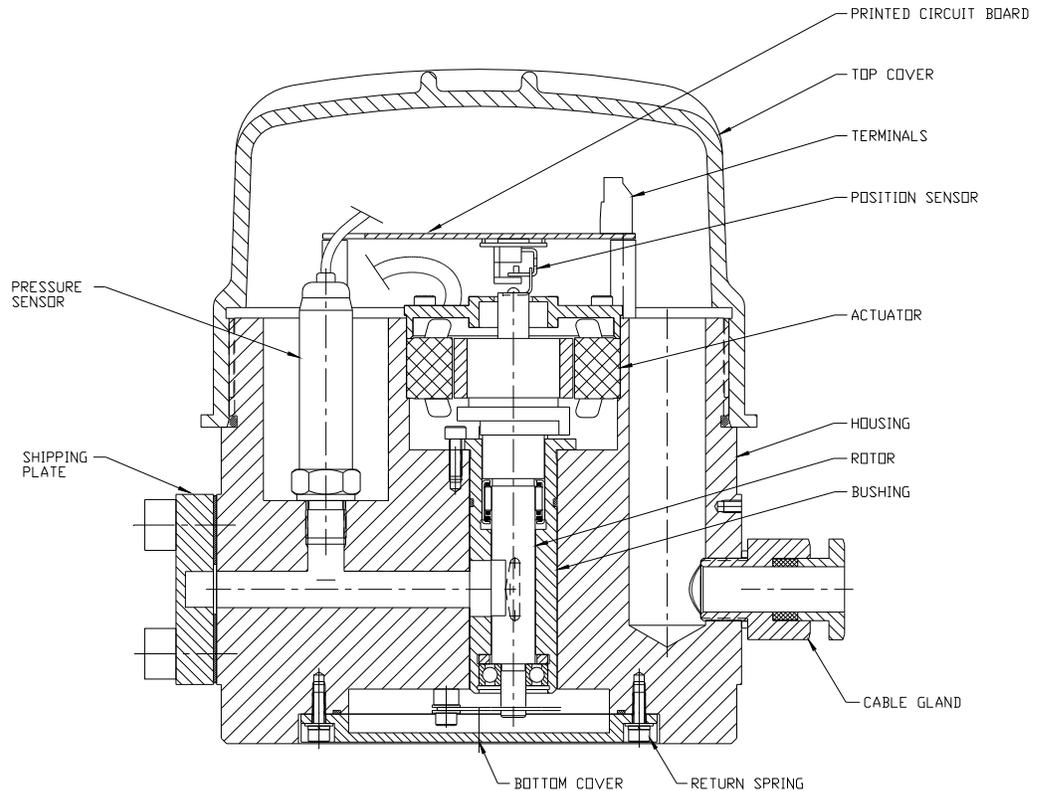


Figure 1-4. CPC Cross Section

6. The output pressure is measured by the pressure transmitter. When either the output pressure or the pressure reference changes, it is detected by the electronics. As previously described, the valve position will change.
7. For an increase in output pressure, the change will result in an opening of the Supply to Output port, resulting in a flow from high pressure oil to the output port. For a decrease in pressure the Output to Tank port will be opened, allowing the oil to flow from the servo system to the tank.
8. With leakage of the servo system, the valve will always open the Supply to Output connection to a certain extent to maintain the output pressure.
9. A small difference in desired and actual valve position will cause the position output loop to integrate to one of the extremes, thus assuring that the full actuator force is available for changing position.
10. Should this not result in the correct match of pressure reference and measured pressure, the electronics will detect that the valve position requirement has been extreme. After two seconds, the relay will change state, giving an external signal of a failing pressure output.
11. A return spring forces the valve to open the Output to Tank port on loss of power. This assures a fail-safe operation.

Chapter 2. Specifications

Electrical Specifications

Connections	9 terminals on the internal printed circuit board suitable for 0.5 mm ² to 4 mm ² solid or 0.5 mm ² to 2.5 mm ² stranded wire (22 AWG to 12 AWG)
Cable	Entry via cable gland. Cable dia. 10.5 mm to 13 mm
Supply Voltage	(18 to 32) V (dc) / 24 V (dc) nominal (use cable at least 1.5 mm ² /16 AWG)
Power Consumption	8 W during steady state, 48 W maximum, 120 W peak (3 s maximum)
Current Input Signal	(4 to 20) mA into 250 Ω . CMRR max. ± 20 V (dc)
Analog Output Signal	(4 to 20) mA. Maximum external load: 300 Ω Accuracy ± 1 % of full scale
Discrete Output Signal	Relay, jumper selectable for NO or NC, 100 000 operations 1.0 A at 30 V (dc), max. 33 V (dc) 0.75 A inductive at 28 V (dc) 0.2 henry
Dither Frequency	10 Hz to 30 Hz. Default setting is 30 Hz
Dither Amplitude	Zero is minimum and default. Maximum depends on adjusted frequency and dynamic characteristics of the entire system.

Hydraulic Specifications

Connections	Flat mounting face with 3 holes. See Figure 3-6 for hydraulic connections, and Figures 3-7 or 3-8 for mounting via an adapter plate (optional).
Supply Pressure	17 bar (250 psi) maximum. At least 0.5 bar higher than the maximum output pressure.
Tank Pressure	At least 0.5 bar lower than the minimum output pressure.
Output Pressure	Min. level: 1 bar (14.5 psi), max. level: 15 bar (217.5 psi) Min. range: 1 bar (14.5 psi), max. range: 14 bar (203 psi)
Recommended External Filter Rating (customer-installed)	40 μ m nominal, 75 μ m absolute or better ($\beta_{40} = 75$ or better)
Viscosity	20 cSt to 100 cSt
Leakage	Depends on viscosity and supply pressure. See Figure 2-1.
Flow Capacity	Depends on viscosity and pressure difference. See Figure 2-1. Reverse flow is 30 % to 50 % greater than forward flow, due to the external (customer-supplied) filter near the supply input.

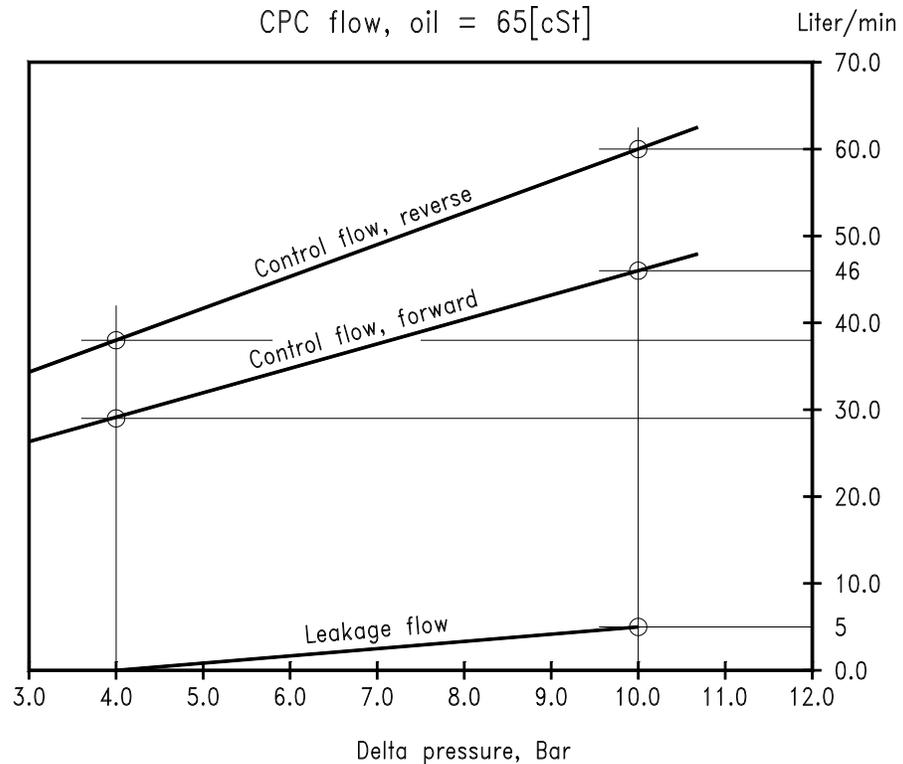


Figure 2-1. Flow Characteristics

Performance

Frequency Response 10 ms to 30 ms, time constant at small step, blocked load (no servo systems connected to the CPC). Time constant 30 ms to 300 ms with a total settle time of 100 ms to 500 ms if the hydraulic load has a time constant of up to two seconds. Ultimate dynamic response depends on total servo system and dynamic adjustments of the CPC.

Linearity	0.2 % of full range
Hysteresis	0.1 % of full range
Repeatability	0.1 % of full range
Temperature Drift	< 0.01 % full range / °C

Environmental

Ambient Temperature	(–20 to +85) °C
Humidity	95 % relative humidity
Oil Temperature	Continuously 60 °C max. Peak 80 °C (2–3 days)
Max. Surface Temperature	85 °C
Vibration	Lloyd's LR type approval test spec. 1 and 2 (5 Hz to 100 Hz at 4G)
Ingress Protection	IP65 in accordance with EN 60529

Physical

See also Figure 3-6, CPC Outline Drawing.

Height x Width x Depth	Approx. (220 x 170 x 170) mm / (8.7 x 6.7 x 6.7) inches
Weight	Approx. 10 kg without oil
Mounting	Four M10 threaded holes, 20–24 mm deep, on the face with the hydraulic ports

Default Factory Settings

Gain	= 30 % (1 turn potentiometer)
Stability	= 30 % (1 turn potentiometer)
Dither Amplitude	= 0 % (1 turn potentiometer)
Dither Frequency	= 30 Hz (1 turn potentiometer)
Output Pressure Range	= 1.5 bar to 4.5 bar (4 mA to 20 mA)

Chapter 3. Installation

Receiving Instructions

The CPC is carefully packed at the factory to protect it from damage during shipping. However, careless handling during shipment can result in damage. If any damage to the CPC is discovered, immediately notify both the shipping agent and Woodward. When unpacking the CPC, do not remove the hydraulic blanking plugs until you are ready to mount the unit.

Unpacking Instructions

Carefully unpack the CPC and remove it from the shipping container. Do not remove the shipping plate or plugs, until ready to mount.

**CAUTION**

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the CPC.

**CAUTION**

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

Mounting Instructions

Location Considerations

When selecting a location for the CPC, consider the following:

- Provide adequate ventilation and avoid placing or attaching the CPC to heat generating or conducting parts of the installation.
- Locate the CPC as close as possible to the servo: short hydraulic lines (and volume) help to achieve optimum response.
- Avoid mounting the CPC at places with excessive vibration.

Mounting the CPC (Figure 3-5)

The CPC is designed for vertical or horizontal mounting.

The CPC mounts to an adapter block (or plate). The adapter block connects the three hydraulic CPC ports with the external oil supply, turbine drain, and control-output of the steam valve servo. The CPC is attached (clamped) to the adapter block by M10 screws. The screws should screw into the CPC a minimum of 20 mm for a reliable and solid mounting.

Construction should allow easy removal and re-connection of the CPC by loosening or fastening the M10 bolts and electrical connections.

Allow space for removal of the cover, to gain access to the adjustments on the printed circuit board.

Place the CPC against the adapter plate with the gasket in between and secure it with M10 screws and appropriate locking devices. Be sure that the hydraulic ports correspond with their designation. Optionally, Woodward can provide a mounting plate. This plate is made of steel (see Figure 3-7). These plates can be joined to the turbine frame using two M12 screws or can be welded in place.

Hydraulic Connections

Three hydraulic lines must be connected to the adapter block (or plate; see Figure 3-5):

- S (supply)—Left
- O (Output)—Center
- T (Tank/Drain)—Right

S, O and T are marked on the CPC.

The pipe inner diameters should be large enough to prevent excessive pressure loss during transient flow conditions. A minimum inner diameter of 12 mm is required.

The CPC must be installed correctly. The pump capacity and/or associated accumulators must be large enough for the required slew rate of the attached servo system.

Before installing the CPC, the hydraulic lines, supply, tank, and the line from CPC to the controlled servo system, should be thoroughly flushed.

I/H to CPC Special Mounting Adapter

A special mounting pad is available to exchange the CPC's predecessor, the I/H converter, with a CPC. See Figures 3-1 and 3-2.

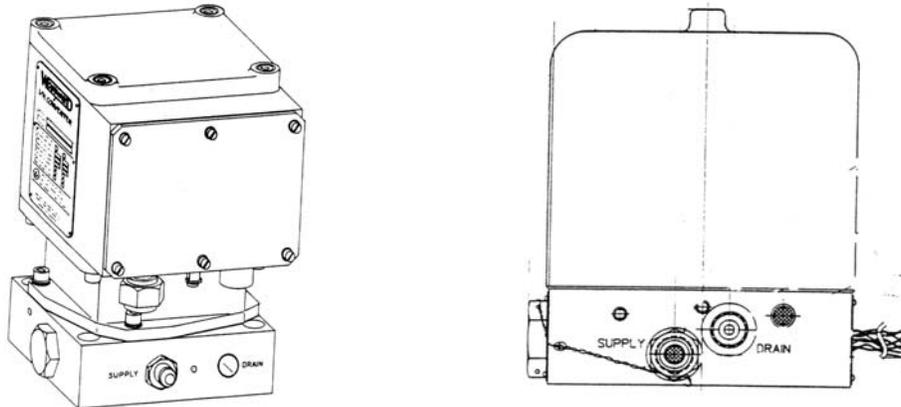


Figure 3-1. Obsolete I/H Converters
(European design, left; US design, right)

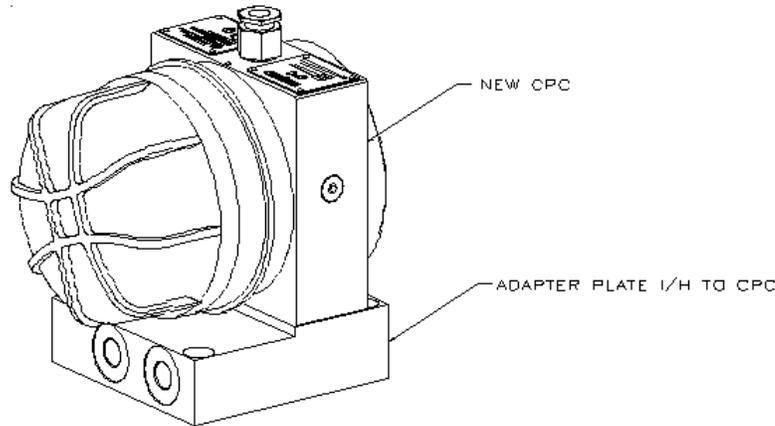


Figure 3-2. New CPC with I/H Adapter Block
(existing hydraulic tubing left in place)

Electrical Connections

Follow local and national procedures, codes, and directives for installing electrical/electronic equipment.

Input Power

The electrical power supply should be able to output 2 A at 24 V (dc) continuously, with a peak of 5 A for three seconds.

The CPC requires a power source capable of a certain dc output voltage and current. The maximum power in watts of a dc source can be calculated by multiplying the rated output voltage times the maximum output current at that voltage. The calculated power rating of the supply should be greater than or equal to the CPC requirements.

The CPC is not equipped with input power switches. Some means of switching input power to the CPC supply must be provided for installation and servicing. A circuit breaker meeting the above requirements or a separate switch with the appropriate ratings may be used for this purpose. Refer to Table 3-1 for recommended fuse ratings or circuit breakers.

Component	Input Voltage	Maximum Current	Maximum Power	Maximum Fuse/C.B. Rating
CPC	(18 to 30) V (dc) / 24 V (dc) nominal	5 A	120 W (3 s)	6 A

Table 3-1. Fuse/Breaker Requirements

Transient Suppression

Protecting electrical loads and sensitive digital equipment from hazardous power disturbances is critical. This is required when the transients exist, I/O cabling is long (>30 m long) or when the power cable is not connected to local or distributed power and is not relatively short (<10 m long).

Transient voltage on the input power lines can be caused by external events such as lightning, or from power factor corrections and grid switching on the utility network. Transients can also be caused internally by turning on and off large inductive loads with long cable length. To avoid this problem, **Transient Voltage Suppression (TVS or MOV devices)** must be installed.

Figure 3-3 shows an example of input power transient suppression. The return line-to-ground device (MOV shown) is required. The line-to-line (TVS shown) devices are required only if a battery charging or large current load can be switched on the bus. Woodward recommends that the TVS devices be always used.

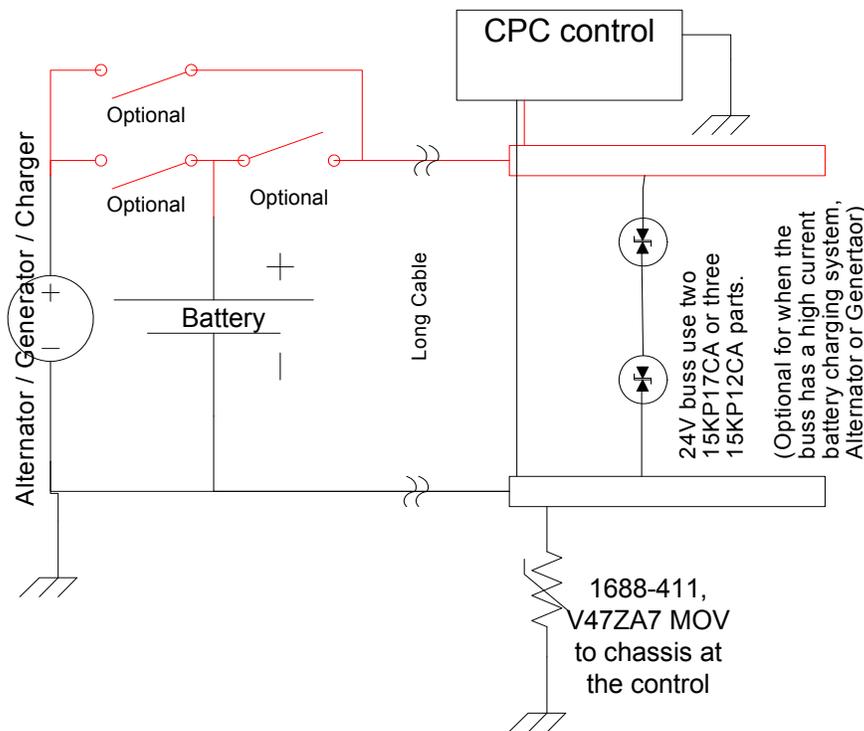


Figure 3-3. Example of Power Transient Suppression

The parts used for the example may be replaced with comparable or higher capability parts. The critical parameters are the energy handling capabilities and the clamping voltages.

Transient voltage on the input and output lines can also be caused by external events such as lightning or running in close proximity to other cables with large transients. As a result Transient Voltage Suppression (TVS or MOV devices) must be installed to avoid this problem.

Figure 3-4 shows an example of Transient suppression.

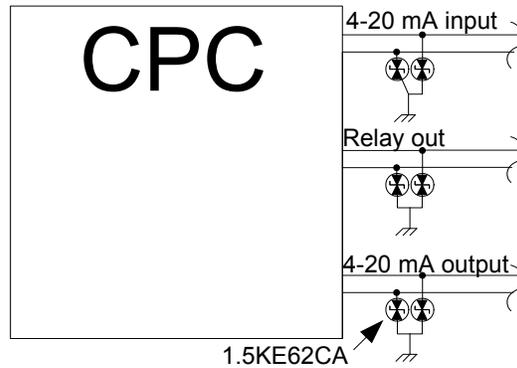


Figure 3-4. Example of I/O Transient Suppression

Grounds

The unit metal frame must be grounded to PE ground. Use a short, low impedance strap or cable (typically >3 mm²/12 AWG and <46 cm/18 inches in length).

Shielded Cable

Use shielded cable for all analog signals, and avoid routing power supply wires and signal wires within the same conduit.

The use of cable with individually-shielded twisted pairs is recommended. All analog signal lines should be shielded to prevent picking up stray signals from nearby equipment. Installations with severe electromagnetic interference (EMI) may require shielded cable run in conduit, double-shielded wire, or other precautions. Connect the shields at the control system side (not the CPC side) or as indicated by the control system wiring practices, but never at both ends of the shield such that a ground loop is created. Wires exposed beyond the shield must be less than 51 mm (2 inches). The shield should provide signal attenuation to greater than 60 dB.

Power Cable

The power and return must be paired and placed in the same cable.

The CPC has one cable entry, for cable sizes between 10.5 and 13 mm. The cable insulation must have a temperature rating of more than 80 °C continuous.

1. Strip the cable insulation (not the individual wire insulation) 12 cm down. Strip the wire insulation 5 mm down. Mark the wires according to their designation and install connectors, if required.
2. Remove the clamp screw and the rubber grommet of the cable gland and slide them over the wires in the correct order, until the grommet is at the end of the cable insulation.
3. Remove the CPC cover. Move the wires through the cable gland and up to the printed circuit board.

4. Re-install and tighten the clamp screw. The Teflon tubing provided with the CPC can be used to protect the wires inside the CPC.
5. Connect the wires to the terminals on the printed circuit board. The terminals accept wires as specified in the Electrical Specifications section in Chapter 2. A wire size of at least 1 mm² or 18 AWG is recommended for signals. A minimum wire size of 1.5 mm² is recommended for power. The terminal designations are shown in Table 4-1. Terminals 10 to 13 are pre-wired at the Woodward factory and should not be changed.
6. Secure the cable outside the CPC to prevent pull forces on the cable gland.

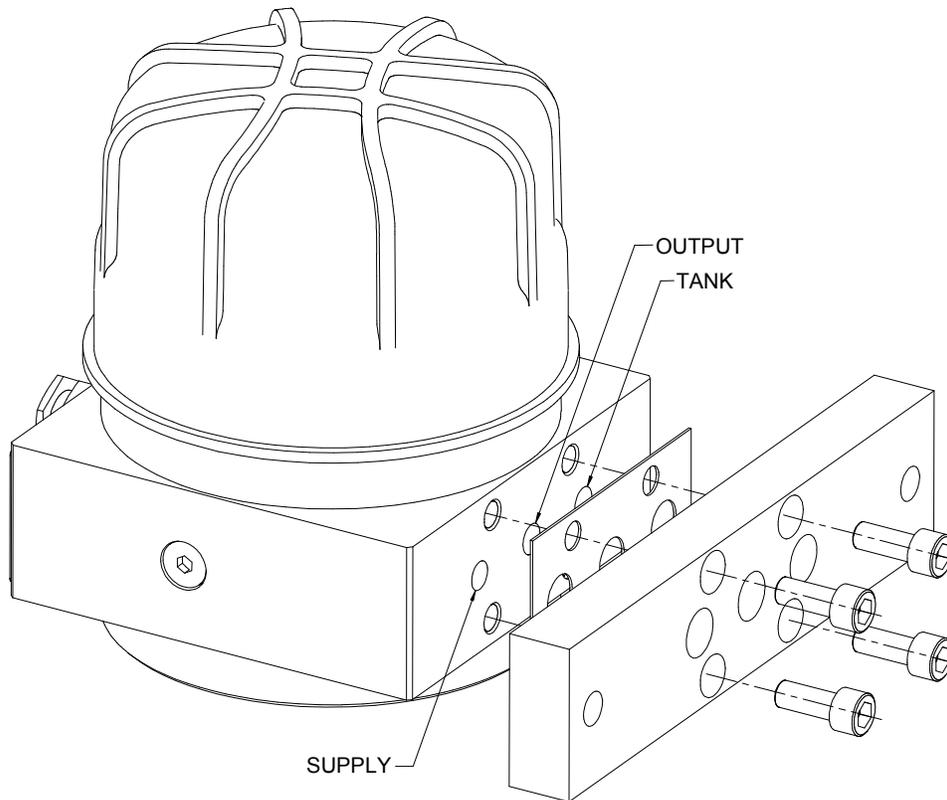


Figure 3-5. Mounting the CPC

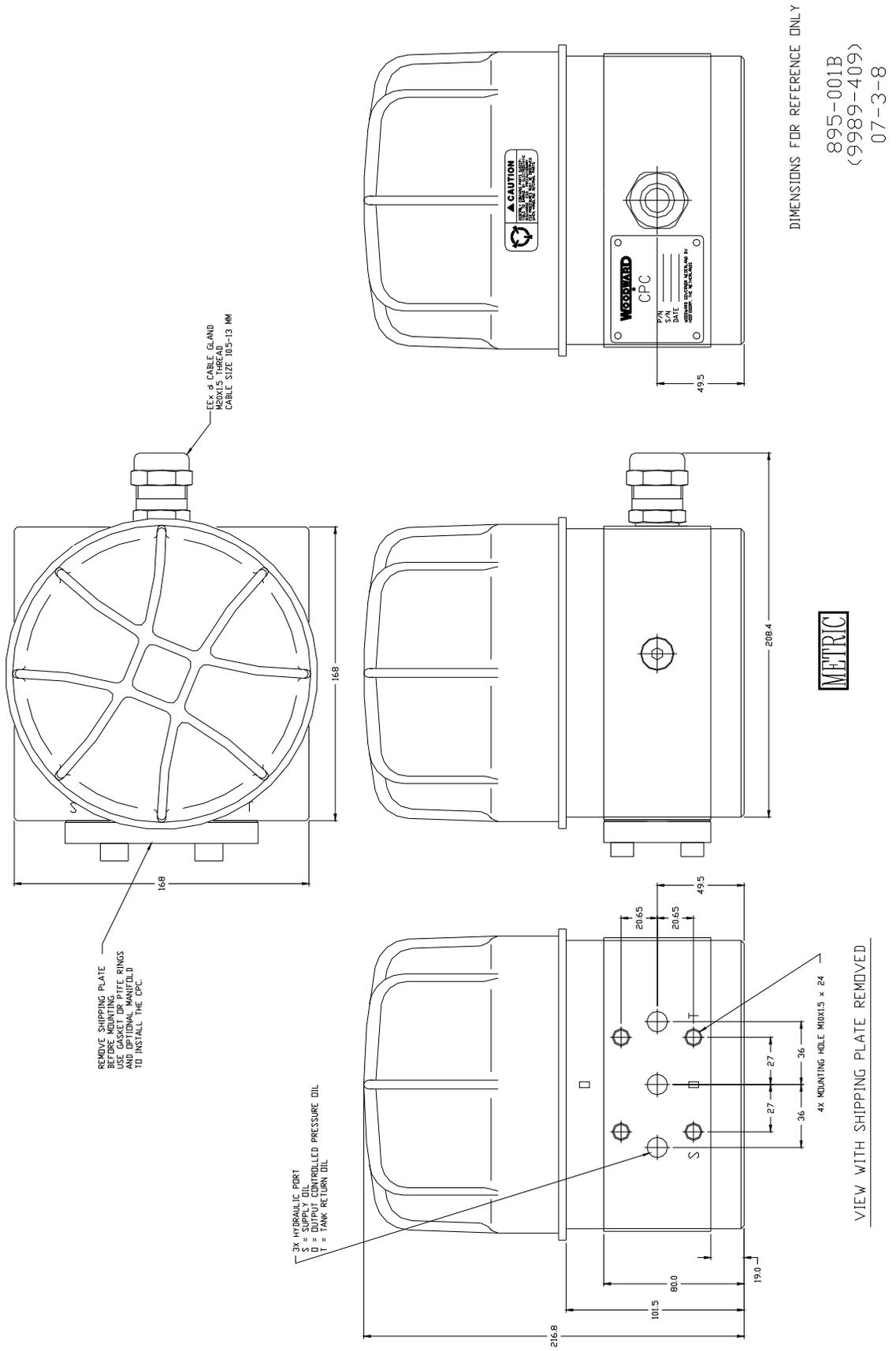


Figure 3-6. CPC Outline Drawing

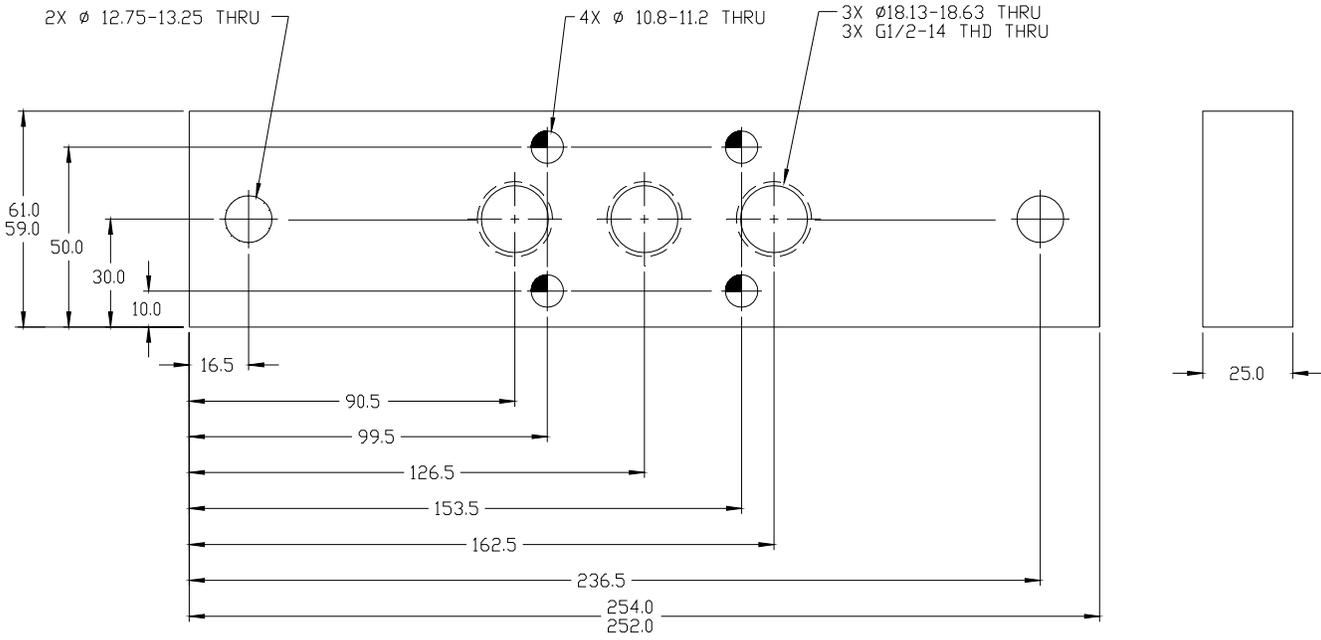
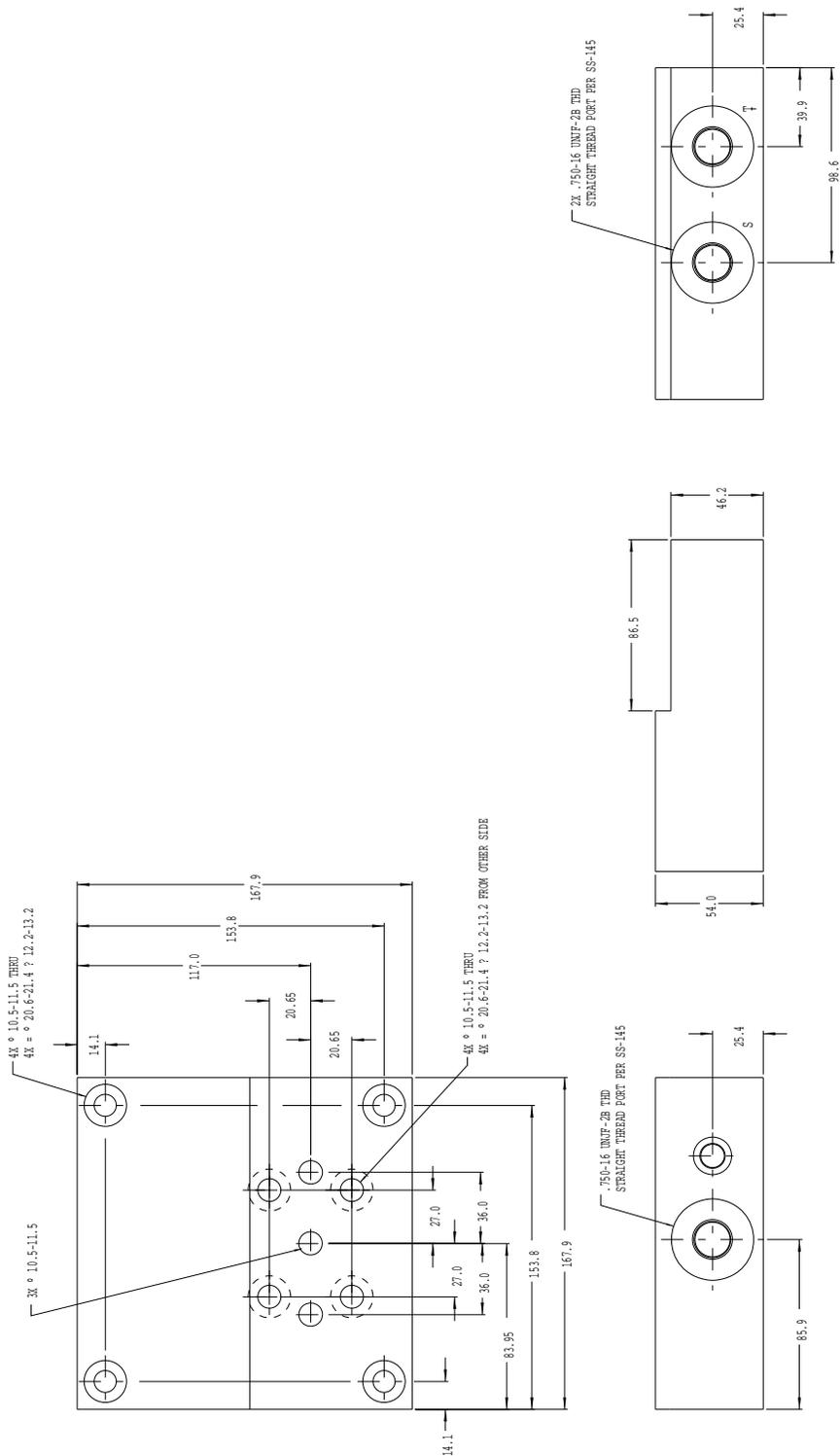


Figure 3-7. Woodward Adapter Plate



IMPORTANT The Woodward I/H converter is obsolete. It can easily be replaced by the CPC using Woodward adapter plate 3689-097.

Figure 3-8. I/H to CPC Adapter Plate

Chapter 4. Calibration

Introduction

After installation, the CPC must be checked for proper operation and calibration before use. The factory has conducted a functional test. Final checkout and customer calibration must be completed after installation. For default factory settings, see Chapter 2.

WARNING

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.

Checkout

A checkout of the CPC is done to verify proper installation, wiring, and connection of the hydraulic lines.

IMPORTANT

The checkout procedure will verify correct installation. This procedure is a bench test of the CPC.

The checkout procedure cannot be run, if the prime mover is running.

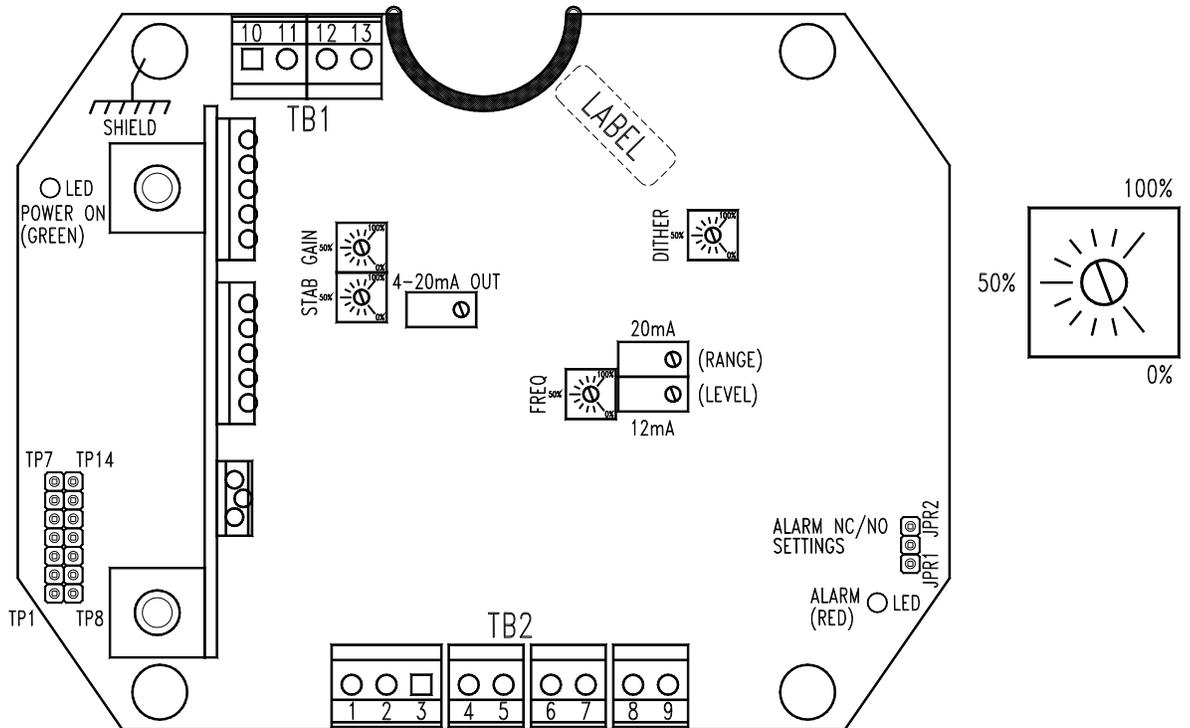


Figure 4-1. PCB Component Location

Table 4-1. CPC Wiring

Wiring List of Terminal Block 2 (for customer)	
Pin 1 and 2	+ 24 V (dc) Power Supply
Pin 3	Ground (Shield, if used)
Pin 4 and 5	+ (4 to 20) mA Input Signal
Pin 6 and 7	+ (4 to 20) mA Output Signal
Pin 8 and 9	Relay Output Signal
Wiring List of Ground Lugs (for customer)	
Internal Chassis Ground Lug	PE Ground Connection
Terminal Block 1 (factory connected)	
Pin 10	Actuator (yellow)
Pin 11	Actuator (green)
Pin 12	Pressure Sensor (white)
Pin 13	Pressure Sensor (gray)
To shield via screw (only standard version)	Pressure Sensor (black)
Jumper Setting	
JPR1 Connected	NO
JPR2 Connected	NC (factory set)

Explanation of Adjustments and Test Points

Seven adjustments can be made, and 14 test points have been provided. The adjustments are explained below. See Figure 4-1 for the location of the potentiometers and test points (TPs). For default factory settings, see Chapter 2.

- Pressure Level** This adjustment sets the level of output pressure. Adjusting the level changes all points of the output pressure uniformly. Adjusting clockwise increases the level. See Figure 4-2.
- Pressure Range** This adjustment sets the slope of the output pressure. Adjusting clockwise increases the amount of slope of the line. See Figure 4-2.

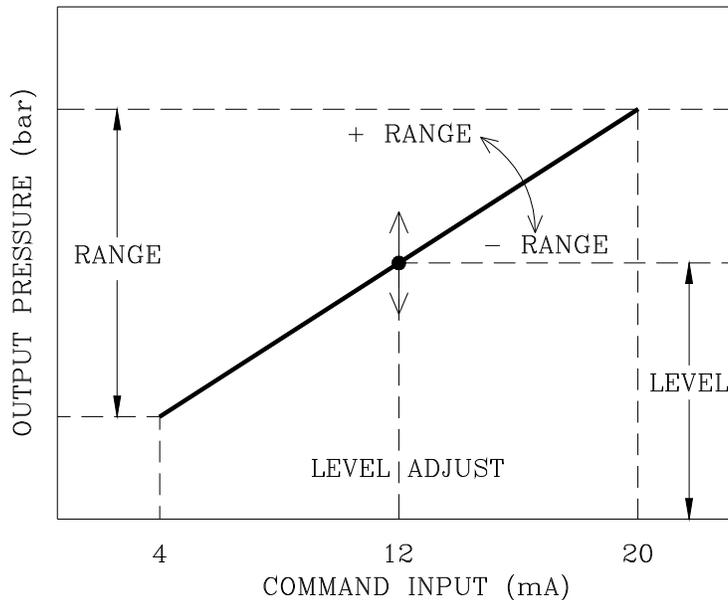


Figure 4-2. Output Pressure vs. Command Input

- Gain** This adjustment sets the amount of gain (proportional action) for the pressure control circuit. In most cases, 50 % gain can be used. High gain provides a fast response time, but can cause instability.
- Stability** This adjustment sets the stability (integration action) of the controller circuit. The stability cooperates with the Gain setting to provide stable operation. Adjusting clockwise increases the stability.
- Dither Amplitude** This adjustment sets the amplitude of the output dither. Dither is used to keep the hydraulic part of the CPC and attached servo systems from sticking, if necessary. The amplitude should be kept at a minimum to prevent objectionable oscillation. It is factory set to zero. Adjusting clockwise increases dither amplitude.
- Dither Frequency** This adjustment sets the frequency of the dither. It can be changed to accommodate different servo systems. It is factory set to maximum (~30 Hz). Adjusting counterclockwise decreases the frequency.

Signal Range	This adjustment sets the range of the (4 to 20) mA output signal. The level is fixed.
Relay Jumper	Using a jumper, the relay contact can be set to normally open (NO) or normally closed (NC).

The printed circuit board is provided with 14 test points (for use only by Woodward personnel). The voltages, measured at those test points, represent the following signals:

TP1	Alarm
TP2	Pressure (1.5 V to 7.5 V)
TP3	Error Signal (5 V = no error)
TP4	Position
TP5	Correct Position
TP6	Drive Signal (desired current through the core)
TP7	23 V (18 V to 23 V)
TP8	μ – 4 mA to 20 mA input signal, 4 mA = 8.5 V, 20 mA = 2.5 V
TP9	Internal Power Supply (+10 V)
TP10	Ref. 5 V
TP11	GND internal CPC (not the same as +24 V GND)
TP12	Triangle Wave Signal
TP13	PWM Signal to Driver
TP14	Current through Coil, 6 V = +0.83 A, 5 V = 0 A, 4 V = –0.83 A

Set-up/Checkout Procedure

1. Verify that the correct hydraulic and electrical connections are complete, according to Chapter 3.
2. Confirm that the hydraulic and electrical power to the CPC is turned off.
3. Remove the top cover of the CPC.
4. Connect a calibrated pressure gauge to the control output line, in order to measure output pressure.
5. Connect a mA current source with a current meter, in series, to terminals 4 (+) and 5 (–).



WARNING To prevent personal injury or death and damage to equipment, the controlled device must not be allowed to run or operate during this procedure. The main steam valve or main fuel control must be turned off to prevent operation of the controlled device.

6. Apply electrical power to the CPC. The green LED will illuminate.
7. Check the power supply by measuring the voltage at terminal 1 and 2.
8. Check internal power supply at test pins TP9 and TP11. The reading should be (+10 ± 0.1) V (dc).
9. Start the hydraulic supply system and turn the current source on. Check that the oil is up to operating temperature and that all air has been purged from the system. The air can be purged by adjusting the current input signal up and down several times. Allow for warm-up time.
10. Observe the pressure gauge when changing the current input signal. The pressure level should correspond with the default values specified in Chapter 2.

Calibration

This section covers calibration and other electrical adjustments of the CPC. Refer to Figure 4-1 for the location of the different potentiometers.

Output Pressure vs. Command Input

1. Set the current source to 12 mA and measure the output pressure.
2. Adjust the Pressure Level for the desired output pressure.
3. Adjust the current source to 20 mA and measure the output pressure.
4. Adjust the Pressure Range for the desired output pressure.
5. Check the 12 mA setting again, and adjust the level if necessary.
6. Check the 4 mA setting again, and adjust the output with range if necessary. Note that turning the range clockwise results in a decrease of pressure.
7. Repeat steps 1 through 6 until the output pressures at both extremes fall in the desired tolerance.

IMPORTANT

The pressure level and pressure range adjustments are 25-turn potentiometers.

Dynamic Adjustments

1. Adjust the current source to 12 mA.
2. Adjust the Gain slowly clockwise to the middle position. If the controlled output pressure becomes unstable, adjust the Gain counterclockwise. Normally 50 % gain can be used for all types of loads.
3. Turn the Gain counterclockwise for small servo volumes, and clockwise for bigger servo volumes.
4. Use 10 % to 20 % stability for a small or blocked servo. Use 50 % to 60 % for a bigger servo, with about two seconds time constant. Increase the stability further if the oil is cold or has a high viscosity.
5. If high frequency oscillations are observed, the Stability can be decreased. Decreasing the Stability normally results in the possibility to further increase the Gain.
6. Check the stability over the full range by adjusting the input current between 4 mA and 20 mA in small stepwise changes.

Output Current Signal

This signal is factory calibrated. If needed, re-adjust as follows:

1. Connect a current meter to terminals 6 (+) and 7 (-). Set the input current source to 12 mA and measure the output current signal.

2. Adjust the Signal Range until the output signal is 12 mA.
3. Adjust the current source to 4 mA and 20 mA and measure the output current signal.
4. Adjust the Signal Range until both the 4 mA and 20 mA fall within $\pm 1\%$ accuracy.

The level is fixed to 0 mA.

Discrete Output Signal

The jumper setting for a NO or NC contact is shown in Figure 4-1. When an error condition is present, such as incorrect pressure or incorrect position at the internal valve, the relay will switch and the red lamp will illuminate. This major alarm has a set and reset time of two seconds. A non-resettable function of the relay can be achieved by adding an external relay circuit.

Dither

The dither can be adjusted while the prime mover is operating. Beware of unacceptable oscillations when introducing dither. It is recommended to always use some dither.

1. Turn the Dither Amplitude clockwise to increase the amplitude until oscillation of the output pressure or valve position can be observed. Decrease the amplitude slightly to prevent objectionable wear in the system.
2. If the frequency is too high for the attached servo system, reduce it by turning the Dither Frequency counterclockwise.

Due to the dynamic characteristics of the CPC, the amplitude of the pressure fluctuations will normally increase when reducing the frequency.

Finish Checkout

1. Turn off the milliamp source.
2. Remove the milliamp current source and (re)connect the plant wiring.
3. Remove additional current and/or voltmeters and (re)connect the plant wiring.
4. If applicable, remove the pressure gauge from the control output hydraulic line.
5. Re-install the cover.

The CPC is now ready for normal operation.



WARNING

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.

Chapter 5.

Repair Instructions

General

Repairs and servicing of the CPC must be performed by Woodward or its authorized service facilities.

Removal or vandalism of the nameplate is prohibited.

Return for Repair Instruction

Should the CPC need to be returned for repair, attach a tag on the unit. Include the following information on the tag:

- Customer's name and address
- The name and location where the equipment is installed
- Complete Woodward part number and serial number
- Description of the failure
- Instructions as to what type of repair is to be done

Protective Packaging

The following procedures are used for protective packaging of the CPC, if returning for repair:

1. Install shipping plates or plugs in all hydraulic connection ports or seal with tape.
2. Wrap the CPC with packaging materials that will not damage the surface of the unit.
3. Place in a double-walled packing carton.
4. Place at least 10 cm of tightly packed, industry-approved, shock-absorbing material around the unit.
5. Secure the carton with strong tape around the outside of the carton to increase the strength of the carton.

Troubleshooting

General

The following troubleshooting guide will help you isolate trouble with the control circuit board, actuator, wiring, or elsewhere. Troubleshooting beyond this level is recommended ONLY when a complete facility for control testing is available.

The wrong voltage can damage the control. When replacing a control, check the power source and wiring connections for the correct voltage.

Troubleshooting Procedure

This table is a general guide for isolating system problems. Before using the guide, make sure that the system wiring contacts and input/output connections are correct and in good working order. Complete the checks in order. Each check assumes that the preceding checks have been completed and any problems have been corrected.



WARNING

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.

Problem	Cause	Remedy
No pressure out.	Faulty power, check green lamp.	Check power connections, 24 V (dc) at pins 1 and 2 (pin 1 should be +).
	Error condition, check red lamp (= alarm = discrete output is active).	If on: Check actuator wire connection. If off: Check pressure sensor wires.
	Power supply too weak.	Change power supply. See specification.
	Power supply is limiting current.	Change limit level to maximum (≥ 5 A).
	Bad power supply.	Use Woodward recommended power supply.
Full pressure out.	Pressure sensor connected incorrectly.	Check wire connections (Table 4-1).
	Other faulty wiring.	Check wire connections (Table 4-1).
Slow dynamics.	Dynamic adjustments not optimal.	Raise Stability, and maybe Gain.
	Cold oil (viscosity too high).	Wait until normal temperature is reached or change dynamic adjustments (raise Stability).
	Tubes too small or too long.	Use bigger and/or shorter tubes.
	Water in oil.	Clean or change the oil.
High-frequency oscillation.	Servo is outside its working range.	Nothing—this is normal.
	Oil viscosity changed.	Re-adjust dynamics or reduce dither.
	Faulty valve position feedback.	Contact Woodward service.
Low-frequency oscillation.	High friction in servo.	Change dither amplitude and frequency.
	Abnormal high friction in servo.	Clean or change servo piston.
	Low CPC internal friction.	Change dither amplitude and frequency.
	High CPC internal friction.	Contact Woodward service.
Alarm not working.	Is the red lamp on?	If yes—Check the jumper. It must be set! If no—Check the pressure range. See specifications.
(4 to 20) mA output not working.	Incorrectly calibrated.	Adjust the output. See calibration.

Problem	Cause	Remedy
Occasional disturbance.	Wires broken.	Replace faulty wire(s).
	Wire protection broken.	Replace faulty wire(s).
	Wire protection broken inside the CPC.	Check pressure sensor and actuator.
	Bad contact at connectors.	Re-install all wires.
	Too high ambient or oil temperature.	Lower temperature. See specification.
Leaking inside CPC.	Pressure sensor is loose.	Fasten the pressure sensor. Check O-ring.
	Other reasons.	Contact Woodward service.
Large pressure hysteresis.	Abnormal high friction in servo.	Clean or change servo piston.
	Abnormal high internal friction.	Contact Woodward service.
Non-zero pressure at power off.	Return spring is broken.	Replace the return spring.
	Tank pressure is too high.	Reduce tank pressure.

Chapter 6. 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.

A current list of Woodward Business Partners is available by searching on "25225" or "*worldwide directory*" at:

www.woodward.com/searchpublications.aspx

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

Facility	Phone Number
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

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-0
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

Facility	Phone Number
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 contact the Woodward Customer Service Department or consult our worldwide directory (search on "**25225**" or "**worldwide directory**" at: www.woodward.com/searchpublications.aspx) for the name of your nearest Woodward distributor or service facility.

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	_____
<hr/>	
Engine/Turbine Model Number	_____
Manufacturer	_____
Number of Cylinders (if applicable)	_____
Type of Fuel (gas, gaseous, steam, etc)	_____
Rating	_____
Application	_____
<hr/>	
Control/Governor #1	
Woodward Part Number & Rev. Letter	_____
Control Description or Governor Type	_____
Serial Number	_____
<hr/>	
Control/Governor #2	
Woodward Part Number & Rev. Letter	_____
Control Description or Governor Type	_____
Serial Number	_____
<hr/>	
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.

Revision History

Changes in Revision H—

- CE compliance removed (no longer applicable)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

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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.