WOODWARD

Product Manual 26212
(Revision F, 12/2015)
Original Instructions

3055 Hydraulic Pump/Servovalve Assembly

9902-469 (LM2500) Pump/Servo Assembly
9902-458 Hydraulic Pump
9902-412 Servovalve

9902-470 (LM1600) Pump/Servo Assembly
9902-458 Hydraulic Pump
9902-413 Servovalve

9902-471 (LM2500+) Pump/Servo Assembly
9902-458 Hydraulic Pump
9902-414 Servovalve

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

www.woodward.com/publications

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

Proper Use

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

Translated Publications

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

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

Manual 26212

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Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

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

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Regulatory Compliance

The Hydraulic Pump and Servovalve is suitable for use in European Zone 2, Group II environments per compliance with EN50021, Electrical apparatus for explosive atmospheres – Type of protection ‘n’.

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking.

ATEX – Potentially Explosive Atmospheres Directive:	Declared to 94/9/EEC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. Ex nA II T4 X

Other European and International Compliance:
Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:

EMC Directive:	Not applicable to this product. Electromagnetically passive devices are excluded from the scope of the 89/336/EEC Directive.
Machinery Directive:	Compliant as a component with 98/37/EC COUNCIL DIRECTIVE of 23 July 1998 on the approximation of the laws of the Member States relating to machinery.
Pressure Equipment Directive:	Compliant as “SEP” per Article 3.3 to Pressure Equipment Directive 97/23/EC of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment.

Special Limitations for Safe Use

Wiring must be in accordance with European Zone 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field Wiring must be suitable for at least 121 °C.

Proper grounding shall be applied as part of the final installation in accordance with EN 60079-15, Clause 6.2.5 and EN 50021, Clause 7.2.5.

The final Ingress Protection of the product shall be ensured by the use of a proper mating electrical connector and is the responsibility of the user in accordance with EN 60079-15, Clause 5.1.3 and EN 50021, Clause 6.1.4.

The mating electrical connector provided at the installation must withstand a separating force of at least 15 N (1.5 kgf) or be prevented from loosening or separating in accordance with EN 60079-15, Clause 14.2 and EN50021, Clause 15.2. Do not separate the electrical connection when the product is energized.

⚠WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

⚠AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division ou Zone.

NOTICE

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figure 2-1).

Chapter 1.
General Information

Introduction

This manual describes the operation and installation of the Woodward 3055 Hydraulic Pump/Servovalve Assembly for the following part numbers:

Compliance	Turbine	Assembly	Pump	Servovalve
Non-CE	LM2500	9902-429 (P26)	9902-428 (P25)	9902-402 (P16)
	LM1600	9902-430 (P27)		9902-403 (P17)
	LM2500+	9902-431 (P28)		9902-404 (P18)
CE	LM2500	9902-439 (P29)		9902-412 (P22)
	LM1600	9902-440 (P30)		9902-413 (P23)
	LM2500+	9902-441 (P31)		9902-414 (P24)
Non-CE	LM2500	9902-459 (P33)	9902-458 (P32)	9902-402 (P16)
	LM1600	9902-460 (P34)		9902-403 (P17)
	LM2500+	9902-461 (P35)		9902-404 (P18)
CE	LM2500	9902-469 (P36)		9902-412 (P22)
	LM1600	9902-470 (P37)		9902-413 (P23)
	LM2500+	9902-471 (P38)		9902-414 (P24)

Hydraulic Pump/Servovalve Description

The hydraulic pump is a positive-displacement gear pump for use with an industrial gas turbine, supplying hydraulic pressure to the fuel metering valve/actuator (FMV/A) assembly and variable stator vane (VSV) servovalve and actuator assemblies (see manual 26213 for information on the VSV actuator assembly).

The pump is installed on the turbine gearbox and is driven by the turbine through the pump's splined drive shaft. The pump's oil supply is obtained from the turbine's lubrication oil system. The pump operates at speeds up to 6300 rpm (6000 rpm normal operating, 6300 rpm extreme* range). Discharge pressure is factory set at 5171 kPa (750 psi) nominal above supply pressure. Factory calibration is performed with US MIL-L-23699 synthetic turbine oil.

The servovalve operates with the pump and an electronic control to provide closed loop position control of the VSV actuator output shafts. These shafts are attached to the VSV hardware on the gas turbine.

Hydraulic ports on the side of the servo are marked "ROD" and "HEAD". These ports are connected to similarly marked ports on the two actuators. A third port on the servo is marked "ACC". This port may be connected to an accumulator if needed for the particular application.

Filters and screens in the system prevent contamination of essential orifices.

The servovalve has an aluminum case with through-hardened stainless steel internal parts. The specifications of this product are stated below.

*—The unit will not be operated under the extreme conditions as defined in the engine manufacturer's specification more than 2% of its total service life.

Principles of Operation

Figures 1-1 and 1-2 illustrate the operating principle of the gear pump, servovalve, and actuators.

Pump

The positive-displacement pump provides a given amount of output flow for every revolution. Except for leakage loss, this output flow remains proportional to speed and is independent of output pressure. Pump volume is provided by a drive gear and an idler gear of identical sizes. Pump rotation is clockwise when facing the pump drive shaft.

A positive pressure is required on the oil inlet side of the pump to prevent cavitation. When the pump's output flow capability exceeds output requirements, a pressure-regulating valve allows the excess oil to be bypassed back to the turbine lube oil system. When the FMV/A and VSV components are operating in a transient condition, most of the output of the pump may be required, at which time a small amount of oil will flow through the pressure-regulating valve. The pressure-regulating valve establishes the output pressure of the pump. The spring-loaded valve is adjustable, but the adjustment is set at the factory and should not be changed.

All output from the pump gears flows through an external oil filter attached to the pump housing, then back into the pump. Oil pressure taps are provided on both sides of the filter to monitor any pressure buildup which could be caused by a dirty filter. Oil to the FMV/A and to the VSV servovalve is taken from the flow of oil which has already gone through the filter.

Torque Motor and Servo

The servovalve consists of a torque-motor servovalve which uses a double nozzle and flapper to generate a differential pressure to operate the second-stage spool valve. The torque motor receives a dc current signal from the electric control and applies torque to the single-piece armature and flapper which is supported on a torsion flexure. The servo valve uses the flapper as a variable flow restriction and throttles the flow of hydraulic fluid from a nozzle on each side of the flapper. The two nozzles are supplied hydraulic fluid from the gear pump through separate, fixed orifices. The pressures controlled by the torque-motor-flapper position the second-stage valve to direct pressure oil to the two VSV actuators which are mounted on the turbine.

Pressure oil, which has been strained through the filter attached to the gear pump, is directed past a lightly loaded check valve in the servovalve to nozzles on both sides of a flapper on the torque motor. With a 20 mA control signal (null current) this flapper is centered and the second-stage valve is centered, maintaining the existing position of the actuators.

For the LM2500 Pump/Servo assembly (see Figure 1-1), if the control signal decreases below the 20 mA null current, control pressure (C2) is decreased and control pressure (C1) is increased, This causes the second-stage valve to move up from its spring centered position, sending additional pressure oil to the rod connection on the actuators and allowing the head connection to drain to the oil return. This causes the actuators to retract.

If the control signal increases above the 20 mA null current, the flapper movement results in an increase in pressure C2 and a decrease in pressure C1. This causes the second-stage valve to move down from its spring centered position, and the VSV actuators to extend.

For the LM1600 and LM2500+ Pump/Servo assemblies (see Figure 1-2), the output is reversed. If the control signal decreases below the 20 mA null current, control pressure (C2) is decreased and control pressure (C1) is increased, This causes the second-stage valve to move down from its spring centered position, sending additional pressure oil to the head connection on the actuators and allowing the rod connection to drain to the oil return. This causes the actuators to extend.

If the control signal increases above the 20 mA null current, the flapper movement results in an increase in pressure C2 and a decrease in pressure C1. This causes the second-stage valve to move up from its spring centered position, and the VSV actuators to retract.

Output flow curves for each servovalve assembly are shown in Figure 1-3.

For the LM1600 and 2500 VSV systems, the VSV actuators contain a small orifice between the Head and the Rod sides of the power piston to maintain a small bleed flow between the Rod and Head sides of the piston. This cross piston bleed flow will cause the null current of the servovalve to shift from the 20 mA null point as calibrated at the factory. Also, as the loads on the VSV actuators increase or decrease during engine operation, the null current of the servovalve may change to compensate for the increase or decrease in cross piston bleed flow.

Check Valve and Accumulator

The servo is designed for use with an optional accumulator which is filled with pressurized oil. Should the supply of pressure oil from the gear pump fail, the spring-loaded check valve in the servo will close, and the accumulator will supply enough pressure oil to move the actuators to the commanded position.

Reference Manuals

Woodward Manual 26211, *3055 Liquid Fuel Metering Valve/Actuator Assembly*
Woodward Manual 26213, *3055 VSV Actuators*

Specifications

Hydraulic Fluid	US MIL-L-23699 or MIL-L-7808
Maximum Pump Hydraulic Supply Flowrate	167 L/min (44 US gal/min)
Dry Weight	15 kg (32 lb)

	Normal Operation	**Extreme Operation***
Ambient Operating Temperature Range	–7 to +66 °C (+20 to +150 °F)	–40 to +121 °C (–40 to +250 °F)
Hydraulic Fluid Temperature Range US MIL-L-7808	–29 to +104 °C (–20 to +220 °F)	–40 to +135 °C (–40 to +275 °F)
Hydraulic Fluid Temperature Range US MIL-L-23699	–7 to +104 °C (+20 to +220 °F)	–40 to + 135 °C (–40 to +275 °F)
Maximum Pump Hydraulic Supply Pressure	58 psig (400 kPa)	125 psig (862 kPa)
Maximum Hydraulic Return Pressure (above supply)	10 psid (69 kPa)	40 psid (276 kPa)
Max. Pump Hydraulic Discharge Pressure (above return)	750 psid (5171 kPa)	1000 psid (6895 kPa)
Maximum Pump Speed	6000 rpm	6300 rpm

* The unit will not operate in the extreme range for more than 2% of its total service life.

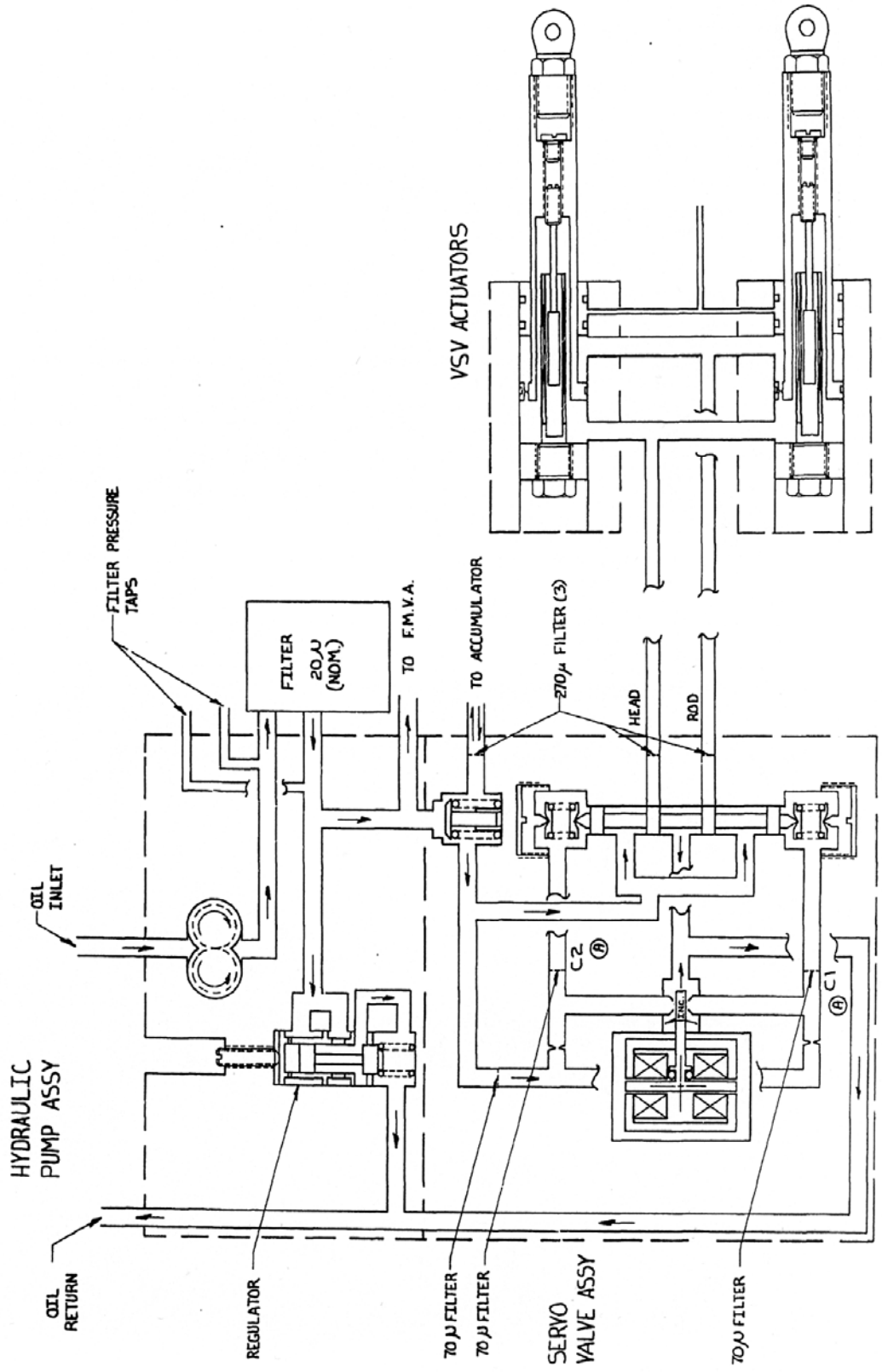


Figure 1-1. LM2500 VSV System Schematic

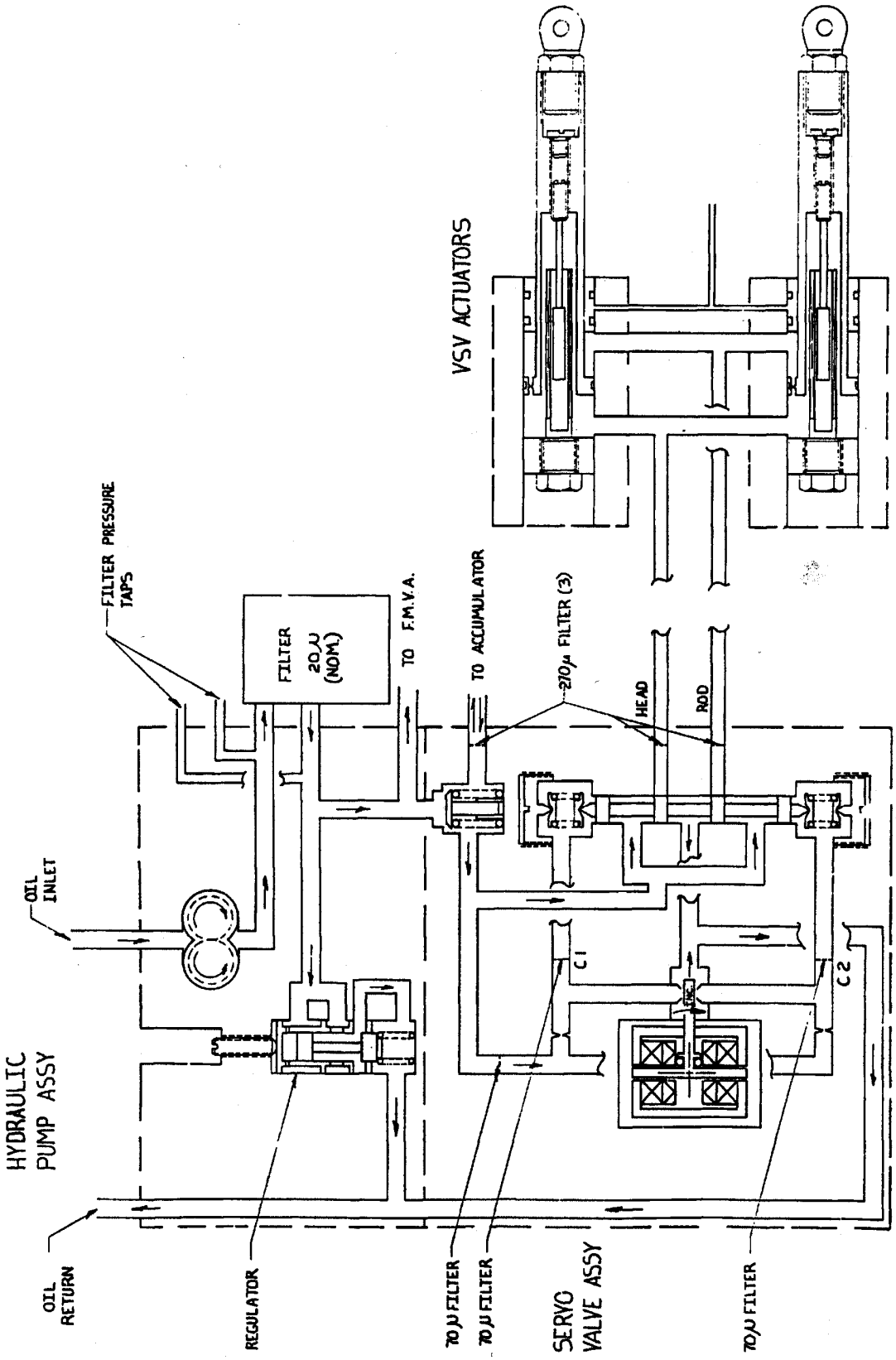


Figure 1-2. LM1600 and LM2500+ VSV System Schematic

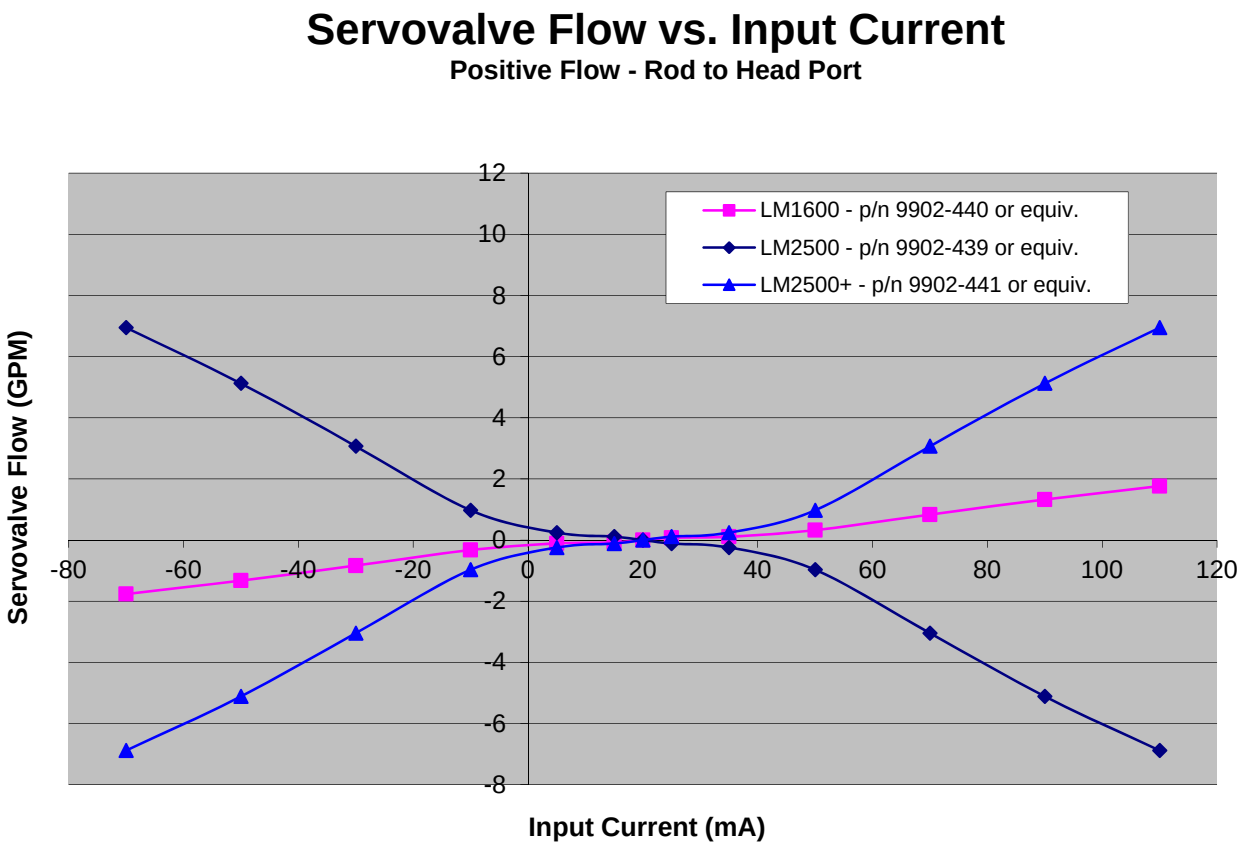


Figure 1-3. Servovalve Flow Curves

Chapter 2. Installation

Receiving

Use care while handling and installing the hydraulic pump and servovalve. Be careful to avoid striking the hydraulic ports and the electrical connectors. Abuse can damage seals, installation surfaces, and factory adjustments. Protect hydraulic connections with plastic shipping caps whenever the hydraulic pump and servovalve are not connected to the normal piping.

After factory testing and calibration, the hydraulic pump and servovalve are drained of oil. This leaves a light film of oil on internal parts to prevent rust. They are then placed in cardboard containers filled with urethane foam for delivery to the customer. The little oil left in the actuator is clean hydraulic fluid which will not contaminate a hydraulic system. Additional cleaning or calibration is not necessary before installation or operation.

Storage

Short Term Storage (Less than 1 year)
Flush the unit with a corrosion-resistant oil (US MIL-C-6529, type 3, or equivalent).

Record the date the unit was prepared and identify the oil used on two identification tags. Attach one tag to the unit and one tag to the exterior of the storage container.

Place protective closures in open ports, wrap and seal the unit in barrier material (US MIL-B-121, Type 1, Grade A, Class 1, or equivalent). Cushion the unit and place in the container.

Long Term Storage (More than 1 year)
Perform all steps outlined in the short-term storage instructions. In addition, place a proper amount of desiccant (US MIL-D-3464, Class 1, or equivalent) with the unit before wrapping it in the barrier material.

IMPORTANT **Once the unit has been properly prepared for storage, it does not require periodic flushing.**

Installation

See the outline drawings, Figures 2-1a, 2-1b, 2-1c, and 2-1d, for overall dimensions, filter location, installation hole locations, hydraulic fitting ports sizes, shaft dimensions, and electrical connections.

Filters and Screens

70 µm filters provided within the Hydraulic Pump/Servovalve protect both sides of the second-stage valve, and 270 µm screens are provided on the Head, Rod, and Accumulator outputs from the servovalve.

An external 20 µm nominal filter must to be installed to filter the hydraulic fluid as it leaves the gear pump; this filter is supplied by the turbine manufacturer. Remove the temporary cover from the oil-filter mounting pad (per Figure 2-1a or 2-1c) and install the oil filter, following the turbine manufacturer's instructions.

Attitude

The Hydraulic Pump and Servovalve can only be installed in one position, per the turbine manufacturer's instructions.

⚠WARNING

Do not attempt to hold the Hydraulic Pump and Servovalve in position and install it by yourself. It is heavy and could injure you if it falls. Either use a hoist or get a helper.

Connections

The pump/servovalve is installed on the turbine gearbox drive with a "Vee" band clamp around the flange of the pump. Radial location of the pump on the gearbox drive flange is determined by a single 0.312" (7.92 mm) diameter alignment pin, extending from the mounting surface of the pump and fitting into a location hole in the gearbox. Gaskets are not provided with the pump. However, gasket plates from the turbine manufacturer or other supplier should be used between the pump and filter.

⚠WARNING

RE-CHECK V-BAND CLAMP TENSION AFTER 50 HOURS
The V-band clamp should be tightened according to the turbine manufacturer's instructions. Pay special attention to evenly distributing the hoop stress around the entire V-band while tightening the bolt.

⚠WARNING

The alignment pin must be engaged in the corresponding alignment hole in the gearbox flange to prevent pump damage or malfunction.

Typically the pump/servovalve assembly is shipped as a complete unit. If the pump is shipped as a separate component, O-rings sealing the hydraulic supply and drain ports between the pump and servovalve should be installed when the servovalve is mounted to the pump. These Viton O-rings are supplied with the servovalve in sizes 2-121, 2-125, and 2-148. Hardware (eight 5/16-24 socket head cap screws and eight 5/16" flat washers) to mount the servo to the pump is provided with the pump. The bolt pattern at the pump/servovalve interface will permit only one radial location of the servovalve. Follow the turbine manufacturer's instructions for O-ring and fastening hardware locations.

The turbine manufacturer specifies installation of an O-ring on the pump drive shaft to prevent leakage from the spline into the gearbox; this O-ring is supplied by the turbine manufacturer. A small amount of oil leakage can be expected at the shaft seal near the pump drive spline. This minimal leakage will drain into the turbine gearbox.

The 0.562-18 (14.3+ mm) straight-thread ports on the pump housing marked "Filter In" and "Filter Out" are provided for gauges and are not used for filter connections. The pump will operate correctly with the two ports plugged.

A 0.750-16 (19.0+ mm) straight-thread port in the pump housing is provided for the oil supply connections to the FMV/A. The FMV/A return oil is directed back to the turbine lube oil system.

A 0.875-14 (22.2+ mm) straight-thread port is provided for return to the turbine lube oil system from the pump. The return plumbing should provide an unimpeded flow of oil.

A 1.062-12 (27.0– mm) straight-thread port is provided for the supply of oil to the Woodward pump. The supply line should provide a positive pressure supply of oil during all pump operating condition.

Take care during installation that dirt is not introduced into the hydraulic system, as it could seriously damage the equipment. All filters and screens must be in place during operation.

All adjustments of the pump and servovalve are made at the factory and sealed. There are no adjustments available to the user of the system.

A and B channel electrical connections are available on the servovalve. The torque motor in the valve has redundant coils, allowing the use of either channel at a given time and providing continued availability of control should one of the channels fail. Only one channel can be used at a given time.

Electrical Connections

Electrical connections to the Servovalve are made using the two 4-pin connectors as follows:

Engine	Pump & Servo Assembly	Servovalve	Connector Type
LM2500	9902-469	9902-412	MIL-DTL-5015 / MS3450KS 14S-2P
LM1600	9902-470	9902-413	MIL-DTL-5015 / MS3450KS 14S-2P
LM2500+	9902-471	9902-414	MIL-C-83723 / MS83723/83 G1404N

Figures 2-1a and 2-1c show the connector locations and plant wiring diagram.

Connect the proper cable-end connectors to the two receptacles on the Servovalve, following GE instructions.

WARNING

Unrestrained servovalve cables may result in damage to the electrical connectors, causing the control to become inoperable.

Special Limitations for Safe Use

Proper grounding shall be applied as part of the final installation in accordance with EN 60079-15, Clause 6.2.5 and EN 50021, Clause 7.2.5.

The final Ingress Protection of the product shall be ensured by the use of a proper mating electrical connector and is the responsibility of the user in accordance with EN 60079-15, Clause 5.1.3 and EN 50021, Clause 6.1.4.

The mating electrical connector provided at the installation must withstand a separating force of at least 15N (1,5 kgf) or be prevented from loosening or separating in accordance with EN 60079-15, Clause 14.2 and EN50021, Clause 15.2. Do not separate the electrical connection when the product is energized.

WARNING

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

WARNING

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.

NOTICE

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

NOTICE

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figure 2-1).

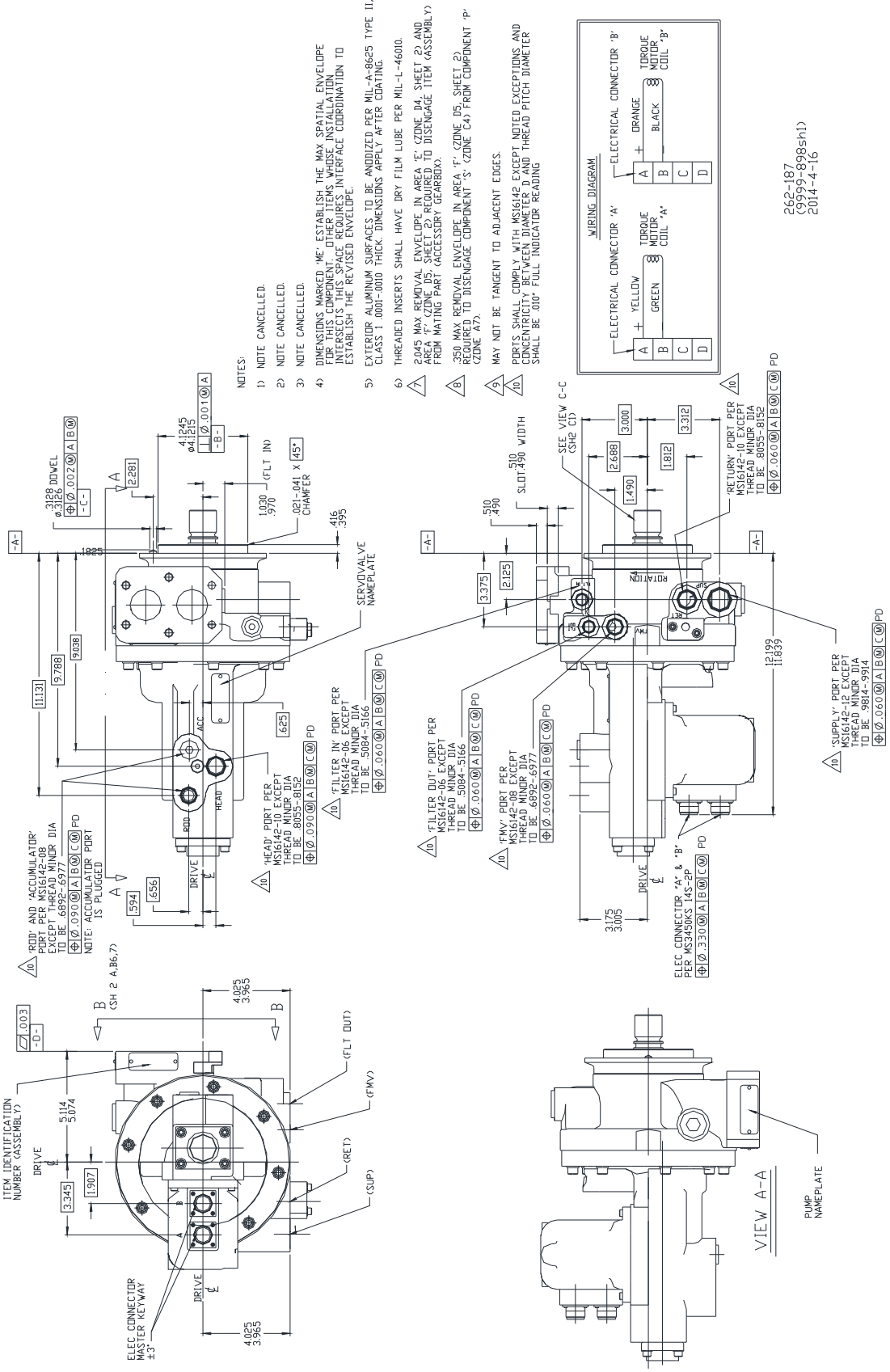
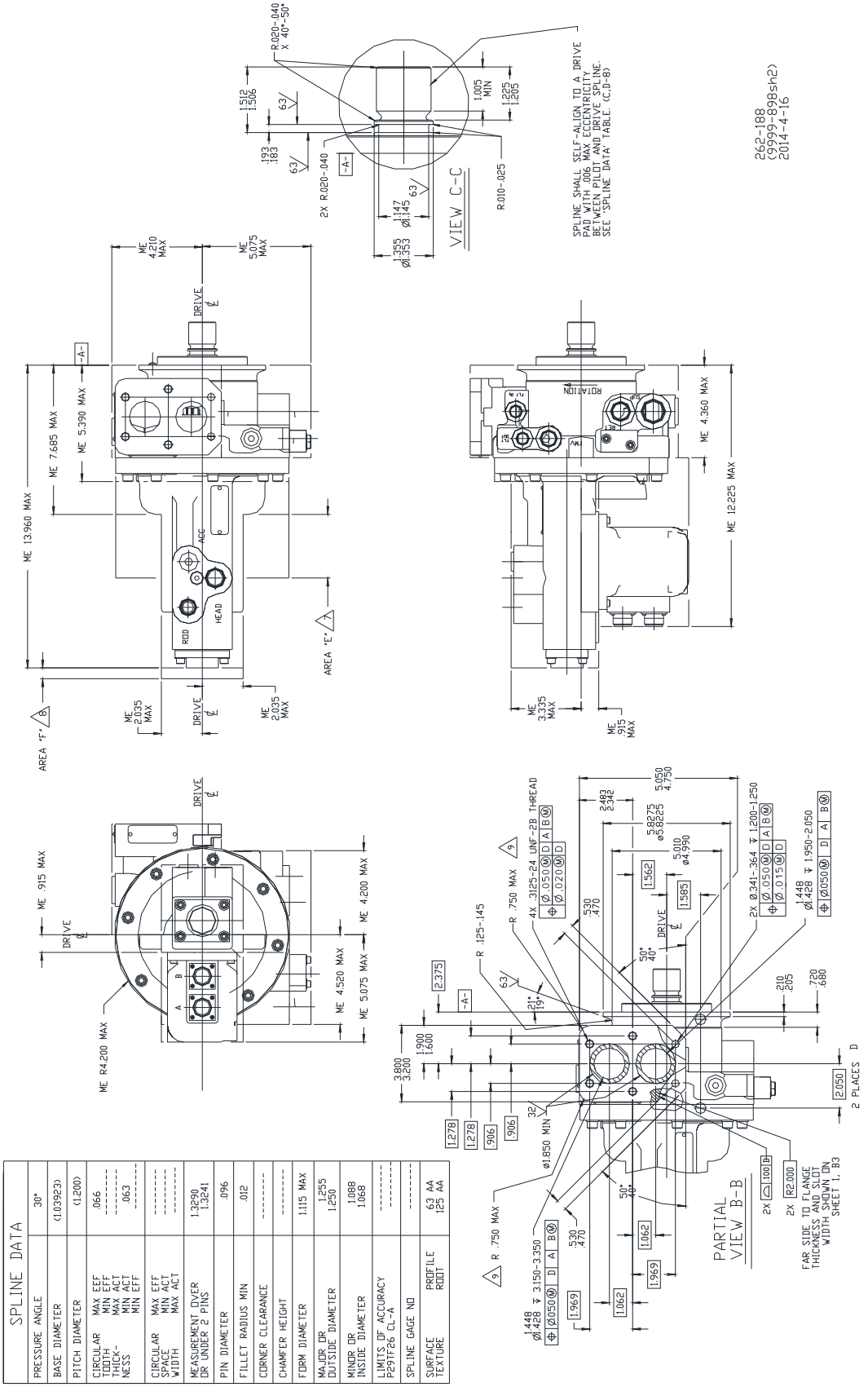


Figure 2-1a. LM1600 and LM2500 Hydraulic Pump/Servovalve Outline



SPLINE DATA	
PRESSURE ANGLE	30°
BASE DIAMETER	(1.03923)
PITCH DIAMETER	(1.200)
CIRCULAR TOOTH THICK-NESS	MAX EFF .066 MIN EFF ------- MAX ACT ------- MIN ACT .063 MIN EFF --------
CIRCULAR SPACE WIDTH	MAX EFF -------- MIN ACT -------- MAX ACT --------
MEASUREMENT OVER OR UNDER 2 PINS	1.3290 1.3241
PIN DIAMETER	.096
FILLET RADIUS MIN	.012
CORNER CLEARANCE	--------
CHAMFER HEIGHT	--------
FORM DIAMETER	1.115 MAX
MAJOR DR OUTSIDE DIAMETER	1.255 1.250
MINOR DR INSIDE DIAMETER	1.088 1.068
LIMITS OF ACCURACY P29TF26 CL-A	--------
SPLINE GAGE NO	--------
SURFACE TEXTURE	PROFILE 63 AA ROOT 125 AA

Figure 2-1b. LM1600 and LM2500 Hydraulic Pump/Servovalve Outline

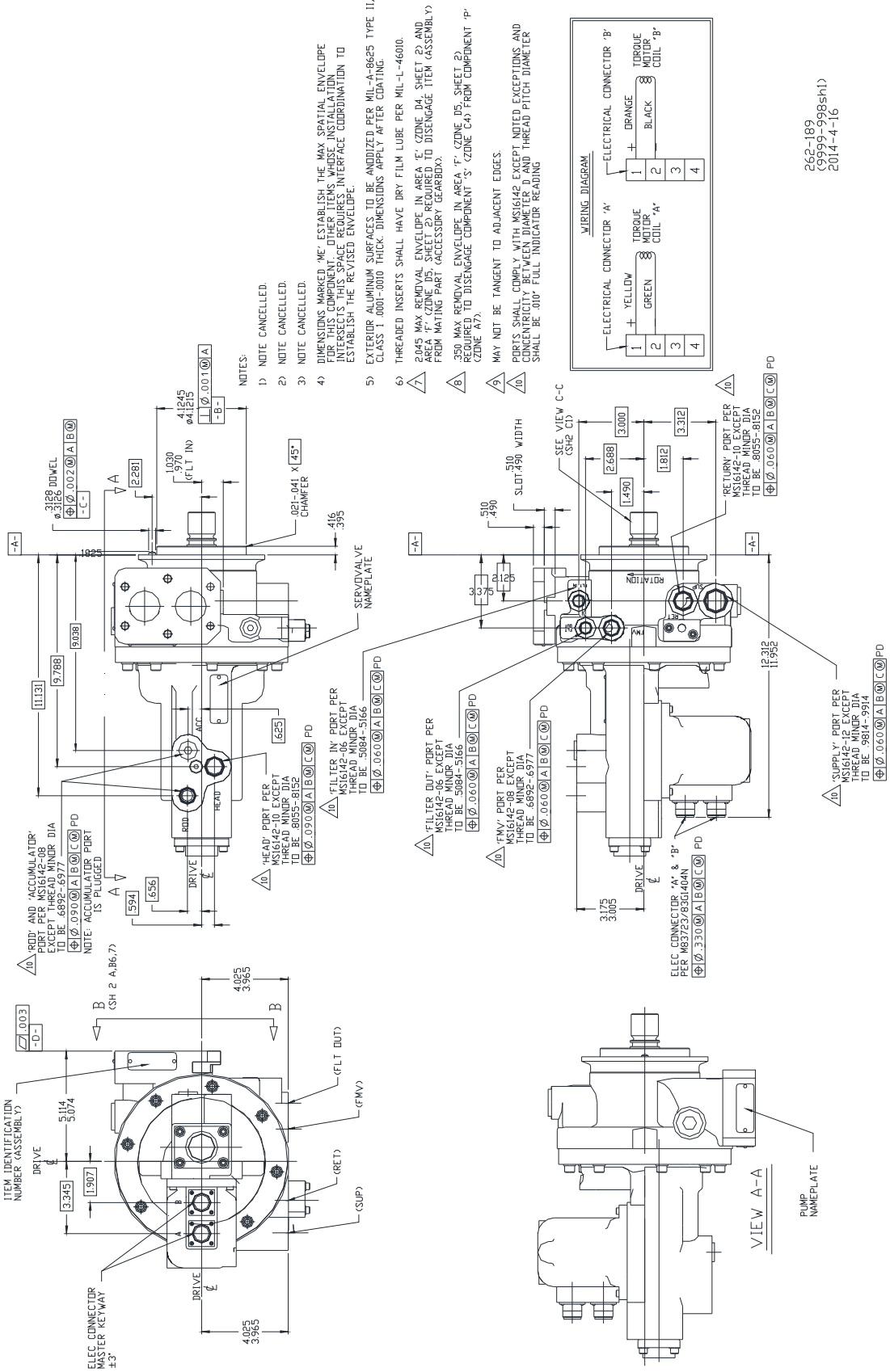


Figure 2-1c. LM2500+ Hydraulic Pump/Servovalve Outline

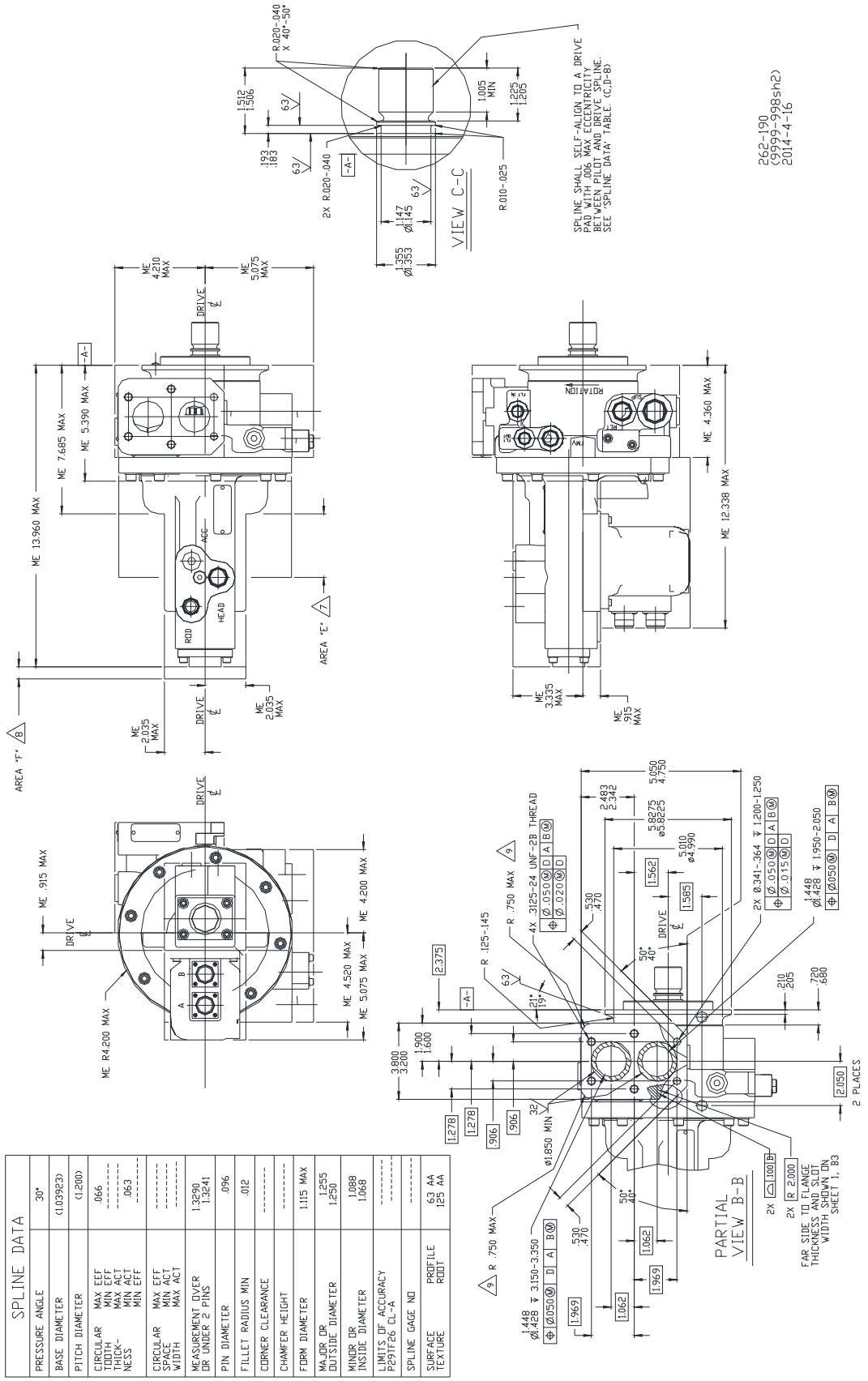


Figure 2-1d. LM2500+ Hydraulic Pump/Servovalve Outline

Chapter 3.
Initial Operation and Adjustments

Initial Operation

Before initial operation of the system, make sure that all previous installation and hookup steps are accomplished and that all linkages, electrical connections, and hydraulic fittings are secure and properly attached.

Trapped air within the hydraulic system may cause erratic behavior of the VSV actuators during the first few minutes of initial operation.

The turbine must be operated according to GE instructions, therefore, there are no operating instructions included in this manual. Use the GE instructions.

⚠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.

Adjustments

The pump is not field adjustable. The flow rate is set by design. The regulating valve pressure is factory calibrated and should not be changed.

The servovalve has been factory adjusted for a 20 mA nominal null current. All adjustments in the actuator have been sealed at the factory and cannot be changed in the field.

⚠WARNING

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

⚠WARNING

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.

⚠WARNING

To prevent possible serious personal injury, or damage to the equipment, be sure all electric power and hydraulic pressure have been removed from the HCU before beginning any maintenance.

NOTICE

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

Chapter 4.
Maintenance, Troubleshooting, and Repair

Maintenance

General Cleanliness

Take great care not to introduce contamination into the system should the connections between the servovalve and the actuators or the accumulator be removed.

Oil Filter

The 20 µm nominal filter installed on the mounting pad of the Hydraulic Pump shall be changed in accordance with the turbine manufacturer's requirements.

Rod, Head, and Accumulator Port Screens

The rod, head, and accumulator ports, shown in Figure 2-1, contain 270 µm screens. Clogged filters or screens normally slow the response of the servo.

1. Remove the hydraulic fitting from the port.
2. Remove the snap ring retainer that secures the filter screen; remove the screen.
3. Clean the screen with solvent and dry it.
4. Replace the screen in the port, and re-install the snap ring retainer.
5. Replace the hydraulic fitting and secure it following the GE instructions.

No maintenance is required for the 70 µm screens provided within the supply and control ports.

Troubleshooting

Redundant control channels are provided for both the VSV servovalve assembly and the VSV actuators. At the first sign of trouble, the control channel should be switched. If using the alternate channel cures the problem, then the system elements should be replaced as soon as possible.

If hydraulic pressures are present, and changing the control channel does not correct a problem, carefully inspect the electronic control for the source of the problem.

Should the VSV actuators not provide identical positions, inspect the hydraulic connections for blockage between the servovalve and the actuators. If the hydraulic lines appear open and clean, carefully inspect the linkage and mechanical connections that the actuators are operating.

Repair

Because assembly and calibration of the Hydraulic Pump and Servovalve requires special tools, it cannot be repaired in the field. If you suspect the unit, return it to Woodward for repair or replacement. Contact information is on the Woodward website (**www.woodward.com**) and is also stated in the following chapter. Be sure to call for a return authorization number before shipping an Hydraulic Pump and Servovalve. When shipping, include:

- Your name
- The name of your company, department or mail drop, and address
- The address where you want the unit returned (if different from above)
- The Woodward part number from the nameplate of the Hydraulic Pump and Servovalve.
- The serial number from the nameplate of the Hydraulic Pump and Servovalve
- A description of the reason the unit is being returned

Chapter 5.
Service Options

Product Service Options

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

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

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

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

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

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

www.woodward.com/directory

Woodward Factory Servicing Options

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

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

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

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

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

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

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

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

- return authorization number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (124) 4399500
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) 78954-510
India	+91 (124) 4399500
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 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

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

www.woodward.com/directory

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

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

Revision History

Changes in Revision F—

- Corrected Specifications table (page 3), Maximum Pump Hydraulic Supply Pressure.
- New Declaration of Conformity.
- Corrected ATEX statement.

Changes in Revision E—

- Updated part numbers and outline drawings
- Added two installation warnings to Chapter 2

Changes in Revision D—

- Added Alignment Pin warning on page 10
- Added new DOC and DOI

Declarations

DECLARATION OF CONFORMITY
According to EN 17050

Manufacturer's Name:	WOODWARD INC
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s)/Number(s):	Hydraulic Pump/Servo valve Assemblies: 9902-439, 9902-440, 9902-441 Servo valve: 9902-412, 9902-413, 9902-414 Pump: 9902-428
Conformance to Directive(s):	94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
Applicable Standards:	EN60079-15: 2010 Electrical apparatus for potentially explosive atmospheres - Type of protection 'n'
Marking(s):	Ex Category 3 Group II G, Ex nA II T4 X

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

C L Perl
Signature

Christopher Perkins
Full Name

Engineering Support Manager
Position

Woodward Fort Collins, CO. USA
Place

07-JAN-2016
Date

5-09-1183 Rev 8, 3/25/2011 00323-04-EU-02-02

DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

Manufacturer's Name:	WOODWARD INC	
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525	3800 N. Wilson Ave. Loveland, CO, USA 80538
Model Name(s)/Number(s):	Hydraulic Pump/Servo valve Assemblies: 9902-439, 9902-440, 9902-441 Servo valve: 9902-412, 9902-413, 9902-414 Pump: 9902-428	
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

The person authorized to compile the technical documentation:

Name: Ralf Friedrich, Group Director, Quality, EPS
Address: Woodward GmbH, Handwerkstraße 29, 70565 Stuttgart, Germany

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

The undersigned hereby declares, on behalf of Woodward Governor Company of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Directive 2006/42/EC as partly completed machinery:

MANUFACTURER

Signature

Suhail Horan
Full Name

Quality Manager
Position

Loveland, CO, USA
Place

25-MAR-2011
Date

5-09-1182 (REV. 10) 00323-04-04-EU-02-01

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26212F.

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Email and Website—www.woodward.com

**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.