WOODWARD

Product Manual 26587
(Revision C, 6/2018)
Original Instructions

MAN Actuator

MAN Diesel & Turbo

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 Out-of-date translations are marked with ⚠.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— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 26587

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Important Definitions

This is the safety alert symbol 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.

IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

Regulatory Compliance

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

EMC Directive Declared to Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC).

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

Machinery Directive: Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.

Pressure Equipment Directive: Compliant as “SEP” per Article 4.3 to Pressure Equipment Directive 2014/68/EU on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment.

Marine Compliance:
Type Approval with the following Marine Classification Societies:

ABS: 2007 Steel Vessel Rules 1-1-4/7.7.4-9-7/13.1

BV: BV Rules for the Classification of Steel Ships

CCS: Part 3, Chapter 9; Part 7, Chapter 2 of CCS "Rules for Classification of Sea-going Steel Ships" (2009) and its 2010/2011 Amendments

DNV GL Det Norske Veritas Rules for Classification of Ships, High Speed & Light Craft and Det Norske Veritas Offshore Standards

KRS: Korean Register of Shipping Pt. 6 Ch. 2 Art. 301 of the Rules for Classification, Steel Ships

LR: Lloyds Register Environmental Categories ENV1, ENV2, ENV3, and ENV4 as defined in LR Test Specification No.1: 2002

NK: Nippon Kaiji Kyokai requirements specified in Chapter 1, Part 7 of Guidance for the approval and type approval of materials and equipment for marine use and relevant Society's Rules

Special Conditions for Safe Use:

Field wiring must be suitable for at least 55 °C.

Compliance with the Machinery Directive 2006/42/EC noise measurement and mitigation requirements is the responsibility of the manufacturer of the machinery into which this product is incorporated.

Safety Symbols


Direct Current


Alternating Current


Both Alternating and Direct Current


Caution, risk of electrical shock


Caution, refer to accompanying documents


Protective conductor terminal


Frame or chassis terminal

Chapter 1.
General Information

How to Use This Manual

The following summarizes how to install a MAN Actuator into a new or existing system:

- Unpack and inspect the hardware.
- Mount and wire the hardware following the procedures and recommendations in Chapters 2–3.
- Specifications and Troubleshooting information are provided in the Appendixes.

General Description

The MAN Actuator is a mechanical hydraulic actuator used in conjunction with an external governor for controlling diesel, gas, or dual fuel engines, or steam turbines.

The MAN Actuator provides a fast-acting and high-work-output actuator, without the need for any auxiliary devices such as a start booster or oil cooler.

The MAN Actuator uses an internal, self-contained oil system operating at 1034 kPa (150 psi) internal pressure with an internal oil pump driven from the actuator's drive shaft. Oil pressure is maintained by a relief valve system with a drain to an internal oil sump.

Operational Features

The MAN Actuator terminal shaft assumes a position which is directly proportional to the (4 to 20) mA analog input signal.

Inputs / Outputs

The following inputs and outputs are available:

- Input Power (single or dual)
- Unit Healthy Status discrete output
- Analog (4 to 20) mA input controlling terminal shaft position

Available Drive Shafts

The following standard drive shafts are available:

- 0.625–36 serrated drive shaft
- 0.625 keyed drive shaft with 0.625-18 thread

Available Terminal Shafts

The following standard output terminal drive shaft is available:

- 0.750-48 serrated terminal shaft

Hydraulic Pump

The MAN Actuator is equipped with a Gerotor fixed displacement pump with a relief valve. The pump/relief valve uses oil from its self-contained sump to provide 1035 kPa (150 psi) internal operating pressure.

Two displacements are offered to cover the speed range up to 1700 grpm. The large displacement pump (22.22 mm / 0.875 inch thick) is intended to be used with actuator drive speeds from 350 to 1200 rpm. Running the large displacement pump continuously above 1200 grpm will result in excessive oil temperatures. The small displacement pump (15.88 mm / 0.625 inch thick) is designed to be used with drive speeds between 500 and 1700 rpm maximum continuous operation.

The direction of rotation is selected by pump housing alignment. The pump operates in the selected direction only. The drive uses a maximum of 335 W (0.45 hp).

Serviceability

The MAN Actuator has no field-replaceable parts.

⚠WARNING

The MAN Actuator is not equipped with an overspeed trip function. 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.

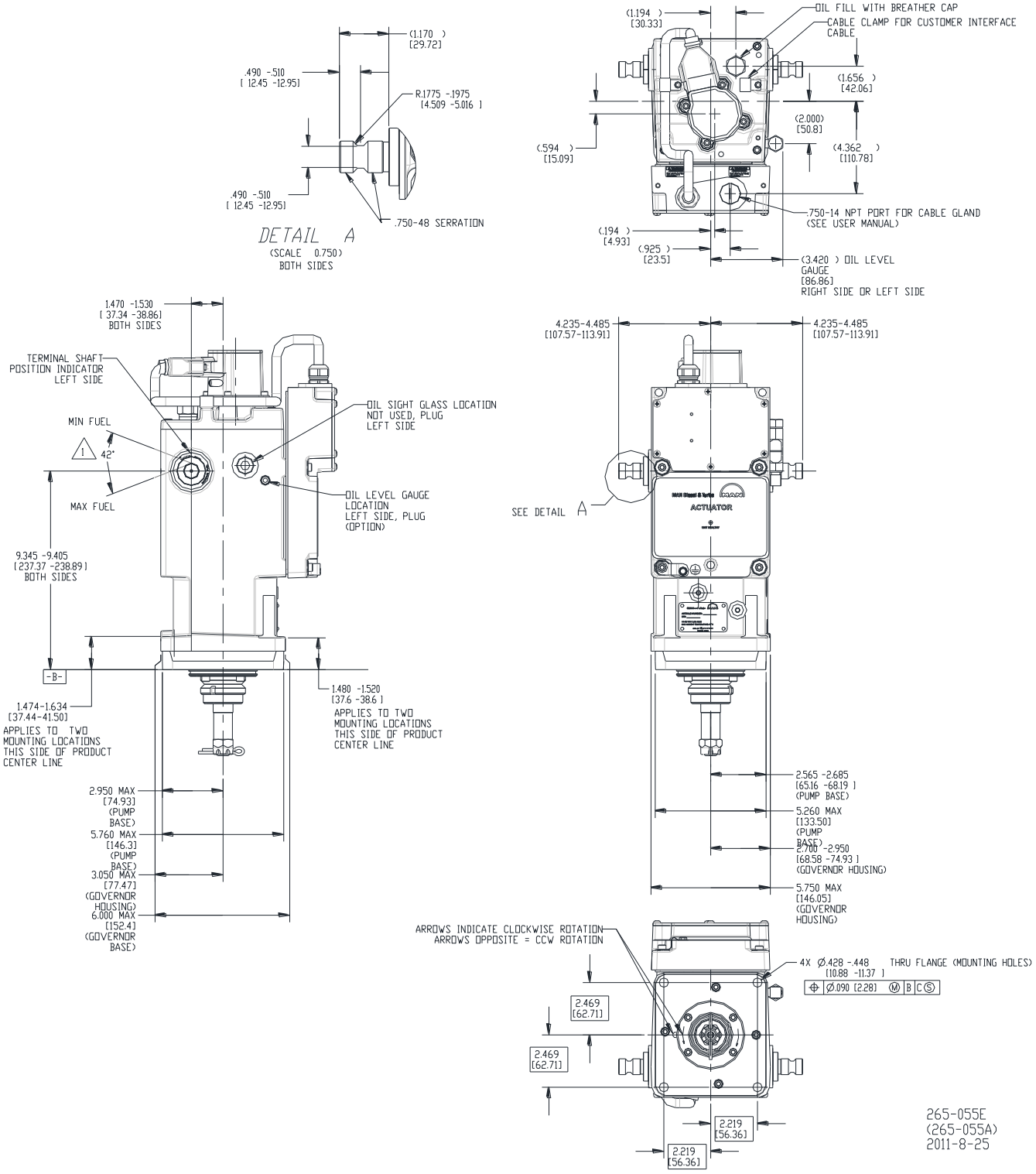


Figure 1-1a. MAN Actuator Outline Drawing

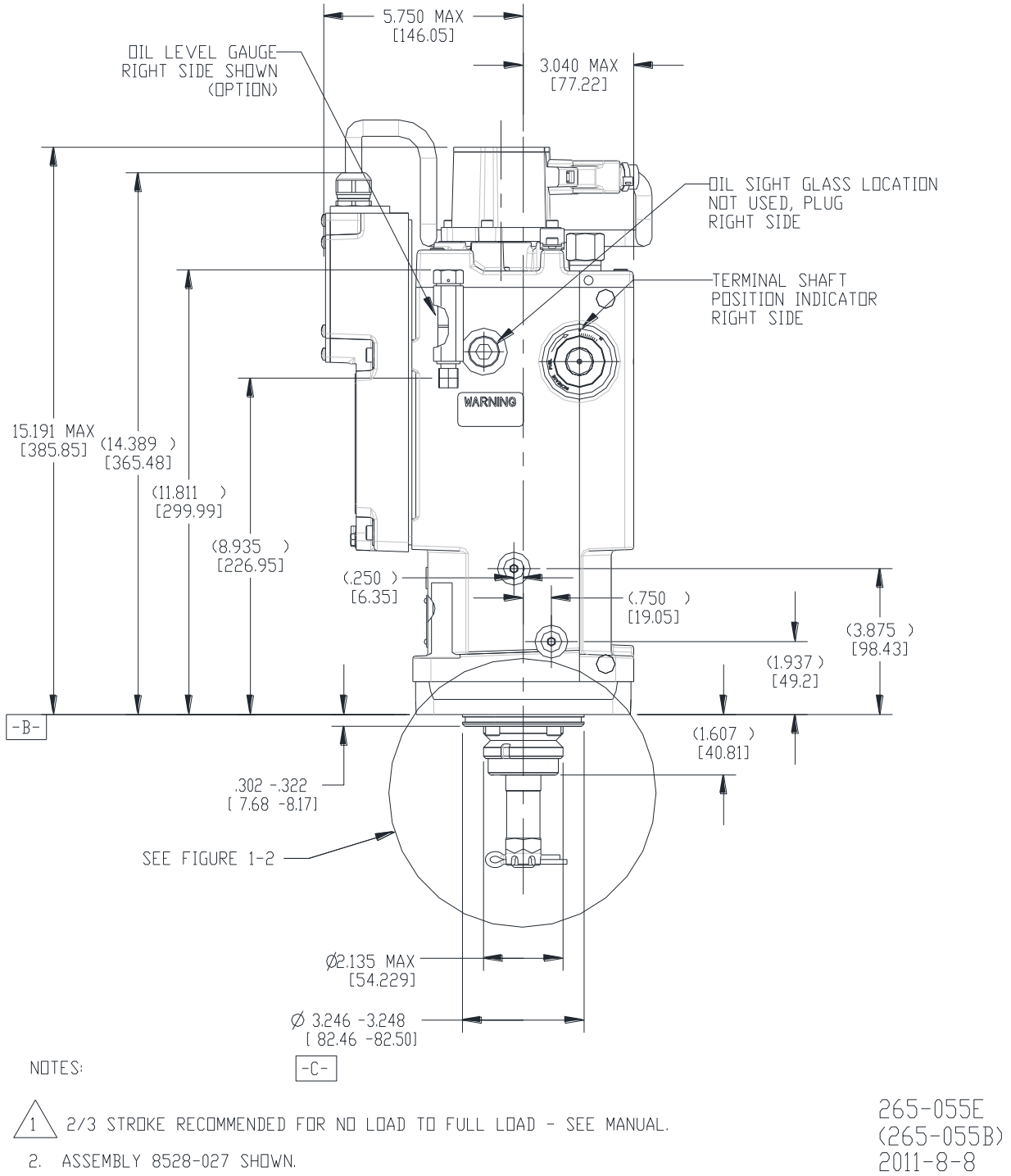


Figure 1-1b. MAN Actuator Outline Drawing

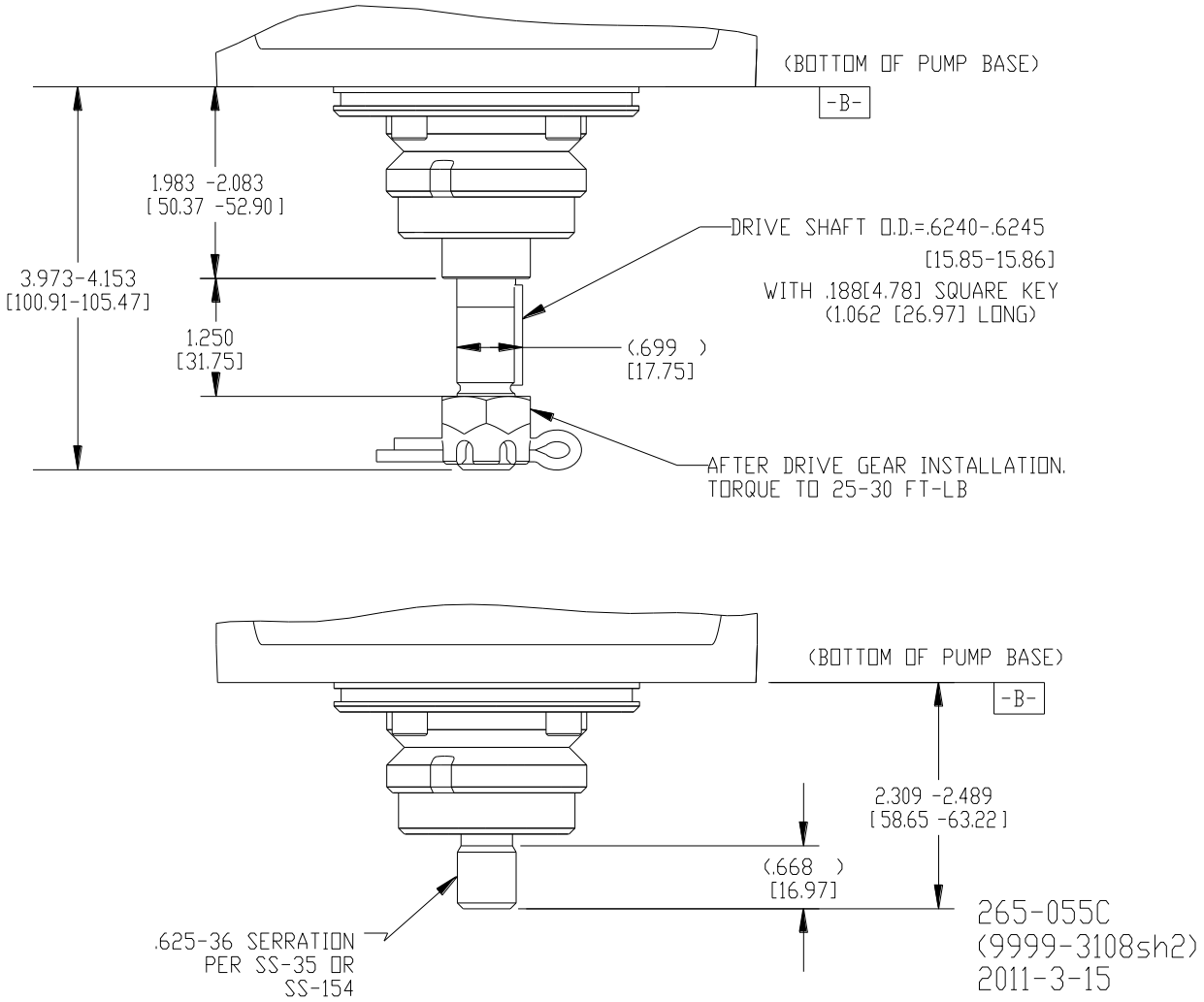


Figure 1-2. MAN Actuator Drive Shaft Configurations

Chapter 2.
Mechanical Installation

Introduction

This chapter describes receiving, storage, and installation requirements for the MAN Actuator.

⚠WARNING

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

⚠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

Use of an independent device for positive shutdown, such as a fuel shut-off valve, is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

⚠WARNING

Use of an external spring to return to minimum fuel is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

⚠WARNING

Use of a predicted minimum fuel shutdown procedure is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

NOTICE

Use care while handling and installing the MAN Actuator. Be particularly careful to avoid striking the drive shaft, terminal shaft, or the electrical connector. Abuse can damage seals, internal parts, and factory adjustments. Do not set the actuator on its drive shaft.

⚠WARNING

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.

Initial Operation

⚠WARNING

Before initial operation of the engine equipped with a MAN Actuator, read all of Chapters 2 and 3, Installation Procedures and Electrical Installation. Make sure that all installation steps have been correctly accomplished and all linkages are secured and properly attached. Carefully review the direction of rotation for the actuator oil pump.

Follow this procedure when putting a new or repaired MAN Actuator into service.

1. Check that the actuator is full of the proper type and grade of clean oil.

2. Properly adjust the linkage.

⚠WARNING

To prevent possible serious injury or loss of life, or damage to the engine, be sure to allow sufficient overtravel at each end of the terminal shaft so the actuator can shut down the engine, and also give maximum fuel when required. Misadjusted linkage could prevent the actuator from shutting down the engine.

3. Adjust the external control system to give a low Position Command signal to the MAN Actuator to achieve a low speed setting to give low engine speed at initial start-up.

⚠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.

4. Follow the engine manufacturer's instructions, and start the engine.

5. Adjust the selected speed setting of the control system to bring the engine to rated speed.

6. Obtain system stability by adjusting the control system's dynamics. (If less than the recommended actuator output stroke is used, it may cause for less than optimum engine stability or response.)

All operating adjustments of the MAN Actuator are made during factory calibration. Additional adjustment should not be needed.

Unpacking

Be careful when unpacking the unit. Check the unit for signs of damage, such as bent or dented panels, scratches, and loose or broken parts. Notify the shipper and MAN if damage is found.

Receiving

After factory testing and calibration, the MAN Actuator is drained of oil. This leaves a light film of oil on internal parts to prevent rust. External parts are painted or coated with a spray lubricant/rust inhibitor.

No internal cleaning or flushing is necessary before installation and operation. The little oil left in the actuator is clean, multi-viscosity engine oil, which will not contaminate the oil selected to operate the actuator.

Figure 2-1. MAN Actuator Overview

Storage

The MAN Actuator may be stored for short periods of time (less than a year) as received from the factory. For long-term storage (more than a year), storage in an environment with large temperature changes, humid or corrosive atmosphere, etc., or if the actuator is installed on the engine for storage, fill the actuator with oil and follow preservation packaging instructions.

Drive Shaft Rotation

The actuator drive-shaft rotation is one direction only. Rotation, as viewed from the top of the actuator, must be the same as that of the engine drive when looking down on the mounting pad.

If the actuator oil pump is rotated in the wrong direction, no oil pressure will be generated in the actuator.

NOTICE

Be sure engine mounting-pad drive and actuator-drive rotation are the same. Incorrect drive rotation will cause the actuator to become inoperative, and may cause actuator damage.

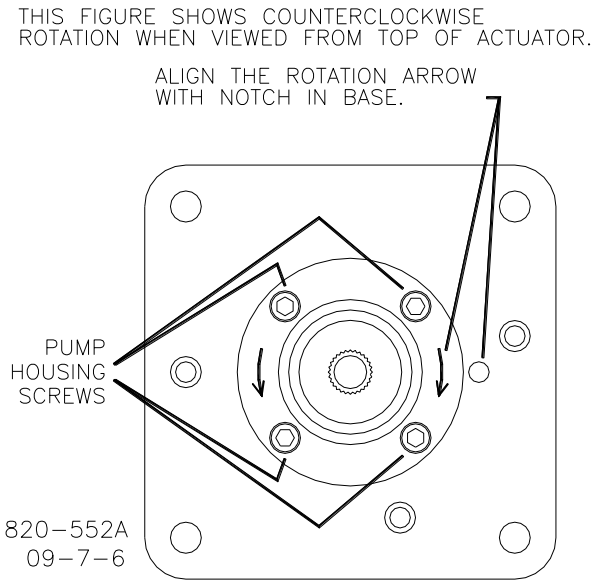


Figure 2-2. Proper Drive Shaft Rotation

Use the following procedure to change the direction of rotation:

1. Remove the four pump-housing screws located on the bottom of the MAN Actuator.
2. Index the pump plate 180 degrees to align the arrow corresponding to the direction of rotation selected with the reference notch in the base.
3. Replace the four screws, and torque the screws to 10.2 N·m (90 lb-in).
4. Make sure that the actuator drive shaft rotates freely.

Mounting Location

Locate the MAN Actuator at a distance from sources of extreme radiant heat, such as exhaust manifolds, turbochargers, or live steam lines. The ambient operating temperature range of the control is (0 to 55) °C / (32 to 131) °F (maximum allowable actuator case temperature is 100 °C / 212 °F max). In spark-ignited applications, make sure the MAN Actuator is located away from the ignition coil, and that harness wires are not routed next to the spark plug wires.

As shown in the specifications, the MAN Actuator has been designed for and validated to a given accelerated life vibration test level at the mounting surface of the actuator. The user should be aware that in any application, bracket design could significantly change the vibration levels at the actuator base. Therefore, every effort should be made to ensure the bracket is as stiff as possible so that engine vibrations are not unduly amplified, creating an even more severe environment at the actuator.

Attitude

The MAN Actuator can be installed in a vertical or near vertical position without affecting its calibration. Do not install more than 45 degrees from vertical. See the outline drawing for installation instructions and dimensions.

Mounting Dimension

When using the O-ring to seal between the MAN Actuator and actuator mounting pad on the engine, the mounting hole should have dimensions of (82.7 to 83.2) mm / (3.255 to 3.275) inches in order to provide the correct amount of squeeze on the o-ring. The mounting hole must be concentric with the drive in order to avoid side-loading the MAN Actuator drive shaft. (This O-ring part number 1355-308 can be ordered separately from Woodward.)

Lifting Method

When mounting the UG-25+ on the engine, a lifting sling can be used as shown in the photo below.

NOTICE

This lifting method should be used only for normal installation of the UG-25+. Do NOT use this method for removing the UG-25+ if the governor may be stuck in/on the engine drive. This could result in serious damage to the UG-25+.

Figure 2-3. Proper Lifting Technique

Drive Connection

Make sure the MAN Actuator drive shaft turns freely before installing the actuator. The drive gear or coupling must slip freely into the actuator drive of the engine.

In case of a keyed drive shaft, torque the nut that secures the drive gear to (34 to 41) N·m / (25 to 30) lb-ft maximum.

Do not apply external force. The drive must be free of binding, side load, or excess end-play. Improper alignment or fit between the parts can result in excessive wear or actuator-drive seizure.

Mount the MAN Actuator squarely on the mounting pad. Torque the mounting bolts evenly. There can be no movement or rocking of the actuator on the engine-mounting pad.

Control Linkage

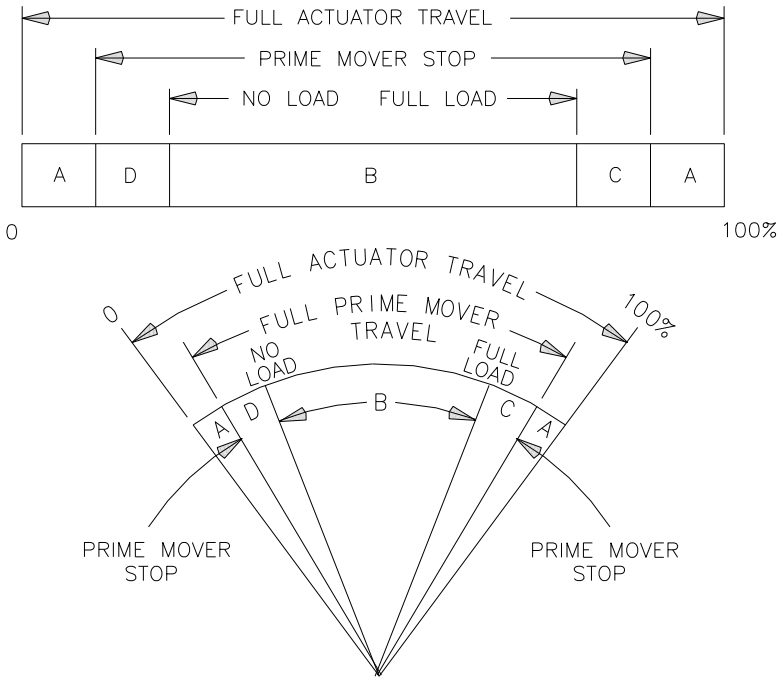
The terminal shaft has a travel of 42 degrees. Use 2/3 of the total rotation between no load and full load. The additional “overtravel” should be split and used at both ends to provide maximum fuel when required and to assure shutdown at minimum-fuel actuator position (see Figure 2-2).

WARNING

To prevent possible serious injury or loss of life, or damage to the engine, be sure to allow sufficient overtravel at each end of the terminal shaft so the actuator can shut down the engine, and also give maximum fuel when required. Misadjusted linkage could prevent the actuator from shutting down the engine.

Many control problems are related to the linkage between the actuator and the engine. Use only high-quality rod-ends for the linkage which will last under the nearly constant motion associated with precise speed control. The linkage must be stiff, not subject to engine-caused vibration. The linkage must be as light as possible and still maintain the attributes of stiffness. Linkage which is too heavy can damage the actuator as well as make it difficult to achieve steady control.

Installed linkages must operate smoothly, be free of binding, and free of lost motion due to worn parts. If there is a collapsible member in the linkage, be sure it does not yield each time the actuator moves the linkage rapidly.



A – OVERTRAVEL TO ENSURE PRIME MOVER STOPS ARE REACHED.
B – NO LOAD TO FULL LOAD TRAVEL – NORMALLY 2/3 OF FULL ACTUATOR TRAVEL IS RECOMMENDED.
C – TRAVEL REQUIRED TO ACCELERATE THE PRIME MOVER.
D – TRAVEL REQUIRED TO DECELERATE OR SHUT DOWN PRIME MOVER.

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Figure 2-4. Terminal Shaft Travel

Oil Supply

Use the information given in Figures 2-3 and 2-4 as a guide in the selection of a suitable oil. Oil grade selection is based on the operating temperature range of the actuator. Also use this information to aid in recognizing and correcting common problems associated with oil used in the actuator. Many operation and maintenance problems associated with MAN Actuators are directly related to the selection and condition of the oil in the actuator .Use care in the selection and make sure that the oil in the actuator is not contaminated.

The oil in the MAN Actuator is both a lubricating and hydraulic oil. It must have a viscosity index that allows it to perform over the operating temperature range and it must have the proper blending of additives that cause it to remain stable and predictable over this temperature range.

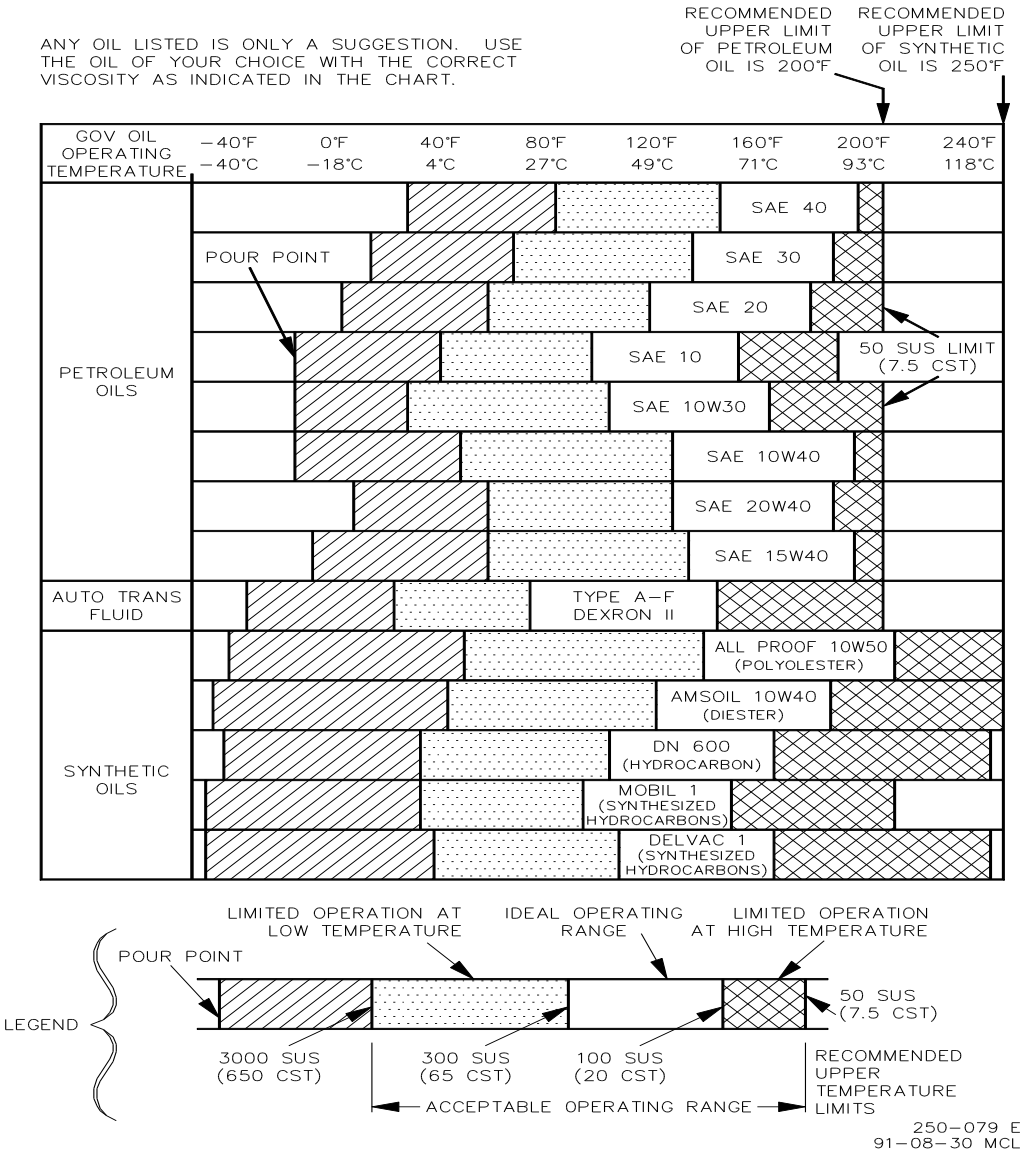


Figure 2-5. Oil Chart

Table 2-1. Viscosity Comparisons

VISCOSITY COMPARISONS

CENTISTOKES (CST, CS, OR CTS)	SAYBOLD UNIVERSAL SECOND (SUS) NOMINAL AT 100 DEGREES F	SAE MOTOR (APPROIMATE)	SAE GEAR (APPROXIMATE)	ISO
15	80	5W		15
22	106	5W		22
32	151	10W	75	32
46	214	10	75	46
68	310	20	80	68
100	463	30	80	100
150	696	40	85	150
220	1020	50	90	220
320	1483	60	115	320
460	2133	70	140	460

The MAN Actuator is designed to give stable operation with most oils, if the fluid viscosity at the operating temperature is within a 50 SUS to 3000 SUS (Saybolt Universal Seconds) range (see Figure 2-4). Poor actuator response or instability can be an indication that the oil is too thick or too thin.

Actuator oil must be compatible with seal material, that is, nitrile, polyacrylic, and fluorocarbon. Many automotive and gas engine oils, industrial lubricating oils, and other oils of mineral or synthetic origin meet these requirements.

Fill the MAN Actuator with about 2.1 liters (2.2 quarts) of oil, to a level visible in the oil sight glass. After the engine is started and the actuator is at operating temperature, add oil if necessary. Oil must be visible in the glass under all operating conditions.

Excessive component wear or seizure in the actuator indicates the possibility of:

1. Insufficient lubrication caused by:
- an oil that flows slowly when it is cold, especially during start-up;
- no oil in the actuator.

2. Contaminated oil caused by:
- dirty oil containers;
- an actuator exposed to heating and cooling cycles, which created condensation of water in the oil.

3. Oil not suitable for the operating conditions caused by:
- changes in ambient temperature;
- an improper oil level which creates foamy, aerated oil.

Operating an actuator continuously beyond the high limit temperature of the oil will result in oil oxidation. This is identified by varnish or sludge deposits on the actuator parts. To reduce oil oxidation, lower the actuator operating temperature with a heat exchanger or other means, or change to an oil more oxidation-resistant at the operating temperature.

⚠WARNING

To prevent possible serious injury or loss of life, or damage to the engine, resulting from engine overspeed or a runaway engine, be sure to use only oil that falls within the 50 SUS to 3000 SUS range. Using oils outside this range could cause the actuator to be unable to prevent a runaway engine.

Oil Maintenance

Replace the actuator oil if it is contaminated, and change it if it is suspected of contributing to instability. Drain the oil while it is still hot. Flush the actuator with a clean solvent having some lubricating quality (fuel oil or kerosene) before refilling with new oil. If drain time is insufficient for the solvent to completely drain or evaporate, flush the actuator with the same oil it is being refilled with to avoid dilution and possible contamination of the new oil.

Oil that has been carefully selected to match the operating conditions and is compatible with actuator components should give long service between oil changes. Check oil conditions regularly and change oil if any deterioration or contamination is suspected.

Regularly scheduled oil changes will extend the life of the actuator and improve actuator operation. Properly selected oil should permit annual oil changes, but more frequent changes are recommended. Too long an interval between oil changes can result in sticking of components and plugged oil passages.

Recommended Service Intervals

Carefully consider the choice of actuator oil with your oil supplier. Monitor the condition of the oil, especially the build-up of deposits, to ensure that the oil remains within the proper operating conditions.

To change oil, remove the drain plug and drain out the old oil. Flush the MAN Actuator by filling it with fuel oil, and with the prime mover running at low speed, cycle the actuator. Let the actuator hunt for a minute or two, then stop the engine and drain the MAN Actuator. Flush the actuator once again. Refill the MAN Actuator with oil (see Chapter 2, Oil Supply).

Restart the engine and reset the control system's stability.

It is recommended that the MAN Actuator be overhauled at the same interval as the engine to inspect for wear and to replace seals, bearings, etc. Units may need to be re-manufactured/overhauled before that time if there is oil leakage, parts become loose, or if the unit experiences severe operating conditions of heat or vibration.

Chapter 3.
Electrical Installation

Introduction

This chapter provides instructions for making the proper electrical connections to the MAN Actuator. Detailed wiring diagrams and recommended wiring practices are given for the electrical installation. The only input that is absolutely required is a power connection and a position command signal; all others are optional features. All wiring and accessories (wire ferrules, cable gland nuts, etc) are provided by the customer, but are shown in this chapter for ease of assembly.

The MAN Actuator has an operating voltage range of (18 to 32) V (dc). This input is protected against reverse input polarity, and consumes approximately 27 W maximum power at a peak current of 1.5 A (18 V) at 25 °C. Maximum power at the MAN Actuator is only realized if an internal fault occurs. Nominal operating current will be less than 500 mA at 24 V (dc) nominal.

The control system should be protected with a 6 A fuse in the voltage supply lines. The application should be configured to apply power to the MAN Actuator when the engine is first cranked, or slightly before.

Unit Grounding

The MAN Actuator housing must be electrically bonded to earth ground through the mechanical mounting interface in order to ensure proper EMC and Safety compliance. Do this using a 1" wide braided grounding strap with as short a length as possible. The ground strap can be tied to the ground post on the front of the actuator, directly below the user interface panel. Assure the ground strap is in contact with bare (unpainted) metal.

Figure 3-1. Location of Ground Strap

NOTICE

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 (Figures 3-2 and 3-3).

Shielded Wiring

The use of cable with individually shielded-twisted pairs is required where indicated by the control-wiring diagram (Figure 3-2). Cable shields must be terminated as indicated in the control-wiring diagram using the installation notes described below. DO NOT attempt to directly ground the shield at both ends or an undesired ground loop condition may occur. It is best to terminate the shield at the MAN Actuator, leaving the other end of the shield unterminated or electrically floating.

Installation Notes

- Wires exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches).
- The shield termination wire (or drain wire) should be kept as short as possible, not exceeding 50 mm (2 inches), and where possible the diameter should be maximized.
- Installations with severe electromagnetic interference (EMI) may require additional shielding precautions.

Failure to provide shielding can produce abnormal conditions which are difficult to diagnose. Proper shielding at the time of installation is required to assure satisfactory operation of the product.

⚠WARNING

External independent safety devices are always recommended. Fuse the Power Input +(Terminal 19) with a 6 A fuse.

⚠WARNING

This MAN Actuator does NOT provide for power-loss annunciation. It is recommended that the device that is powered by this MAN Actuator have an independent power-loss annunciation.

Electrical Connections

Prior to installation, refer to the wiring diagrams and the representative I/O interfaces schematic in this chapter. Also, review the hardware I/O specifications in Appendix B.

Use 1.3 mm² (16 AWG) stranded copper wire with insulation that meets temperature requirements in the harness design. A wiring harness stress relief within 400 mm (16 inches) of the MAN Actuator is recommended.

Contain the harness with wire loom or sheath to make it into a single bundle or a cable with an overall jacket containing the signal wires. Use grommets when passing the harness through metal panels.

Recommended Signal Wire Specifications

1.3 mm² (16 AWG), Minimum Insulation O.D. 1.96 mm (0.077 inch), –65 °C to +200 °C, 1000 V (rms), 19/29 Stranded Conductor, Teflon Insulation (TFE).

All field communications and commands enter the MAN Actuator through a threaded port in the top of the MAN Actuator User Interface panel assembly. These signal wires should be contained in a cable with an overall jacket or bundled together with an overall sheath. To maintain the IP-56 ingress protection rating, the field cable must be installed through a cable gland nut, which is threaded into the cable entry port in the top of the User Interface panel. Several suggested gland nut sizes are listed in table below, depending on the overall diameter of the field cabling used in the installation.

Remove the wiring access cover plate located on the front of the User Interface panel by removing the six M4 x 0.7, 10 mm long locking screws to access all customer field connection terminal blocks. Securely replace the wiring cover plate after completing the wiring connections to ensure the integrity of electromagnetic noise interference capabilities of the MAN Actuator.

WARNING

The MAN Actuator will not meet ingress protection requirements unless the cover is in place. See Figure 3-1 for warning label found on the inside of the cover.

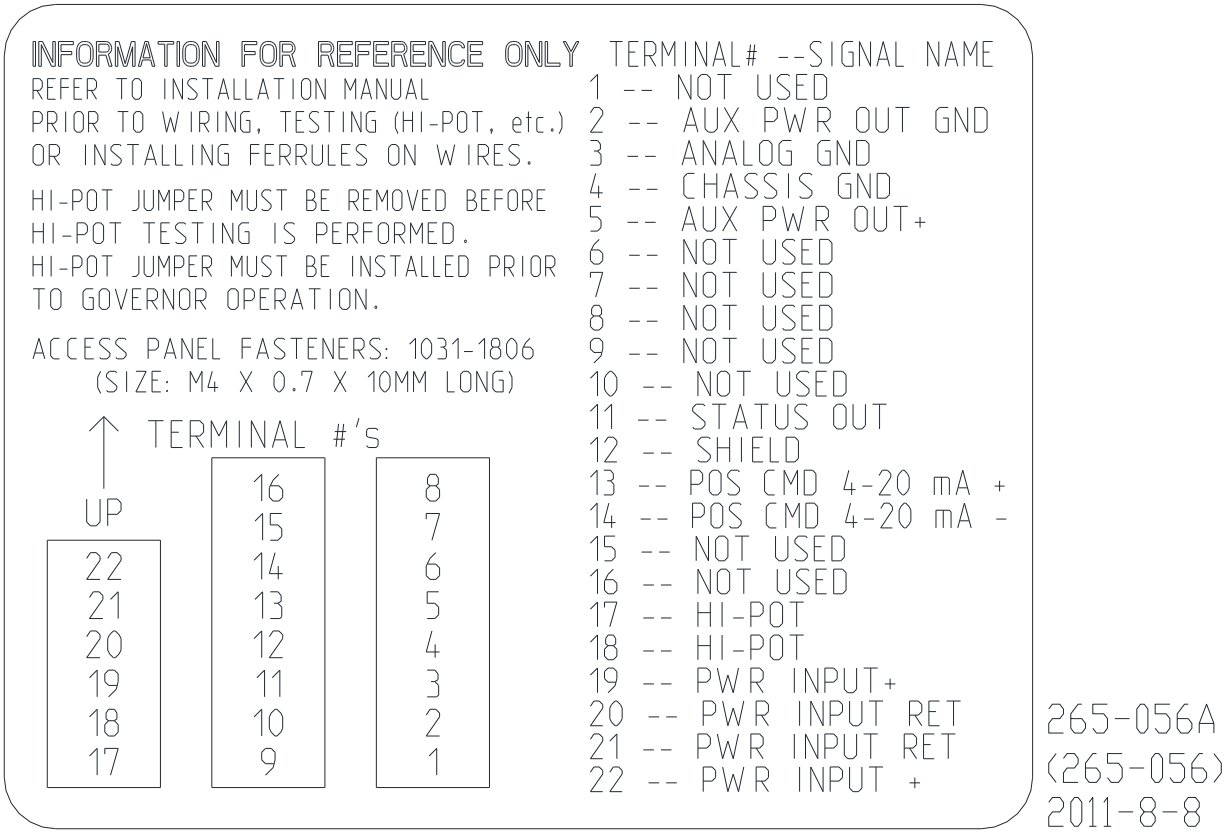


Figure 3-1. Access Cover Instruction Label

Slide the cable gland over the end of the cable with the cable gland threads toward the cable end. Select the appropriate cable gland from the chart below, depending upon the cable size.

Table 3-1. Cable Gland Reference

Heyco Part Number	Cable Diameter in mm	Mounting Hole Size
4572	9.5 to 12.5	0.750-14 (3/4" NPT)
4573	12.5 to 16	0.750-14 (3/4" NPT)
4574	16 to 20.5	0.750-14 (3/4" NPT)

Remove approximately 100 mm (4 inches) of the overall cable jacket to provide a sufficient service loop inside the User Interface panel to land the individual signal wires on the proper internal terminal.

Strip approximately 10 mm (0.4 inch) of insulation from each individual signal wire and crimp on a wire ferrule, (Phoenix part number 320043) for 16 AWG wire, to the end of each signal wire. Use the proper crimp tool, “CRIMPFOX 6H” (Phoenix part number 12 12 046) to crimp the ferrules onto the signal wires with a hexagonal crimp. The wire should extend to the end of the ferrule, but not beyond it. If the wire extends beyond the end of the ferrule, cut the excess wire off with wire cutters. The ferrule assures the signal wire does not slip out of the terminal block in high vibration environments. Tinning (soldering) the ends is not an acceptable option since the spring terminals will not grip the wires as well.

Remove the threaded plug from the customer wiring port located on the top of the User Interface panel. Insert the ferrules and wires through the threaded port far enough to hook up the wiring. Use the small terminal release tool (WAGO part number 236-332), located inside the wiring cavity of the MAN Actuator, to assist in the insertion of the ferrule on the end of each signal wire into its associated terminal location. The terminal release tool is the best way to release the spring-loaded connection clamp located in the wiring terminal block, but a thin, flat-bladed screw driver can also be used if the terminal release tool is not available.

To provide better access to the terminal blocks, install wires going into Terminals 8 through 1 first, followed by the wires going into Terminals 16 through 9 next, and then wires going to Terminals 22 through 17 next.

After installing the wires, apply thread sealant (Loctite 572 or equivalent) to the NPT threads and screw the cable gland into the customer wiring port in the top of the MAN Actuator User Interface panel assembly. Make sure that the cable's overall jacket extends slightly past the cable gland so that the rubber seal completely and tightly grips the cable jacket.

Figure 3-3. Proper Cable Orientation to Cable Gland

Tighten the NPT thread to 10 N·m (88 lb-in).

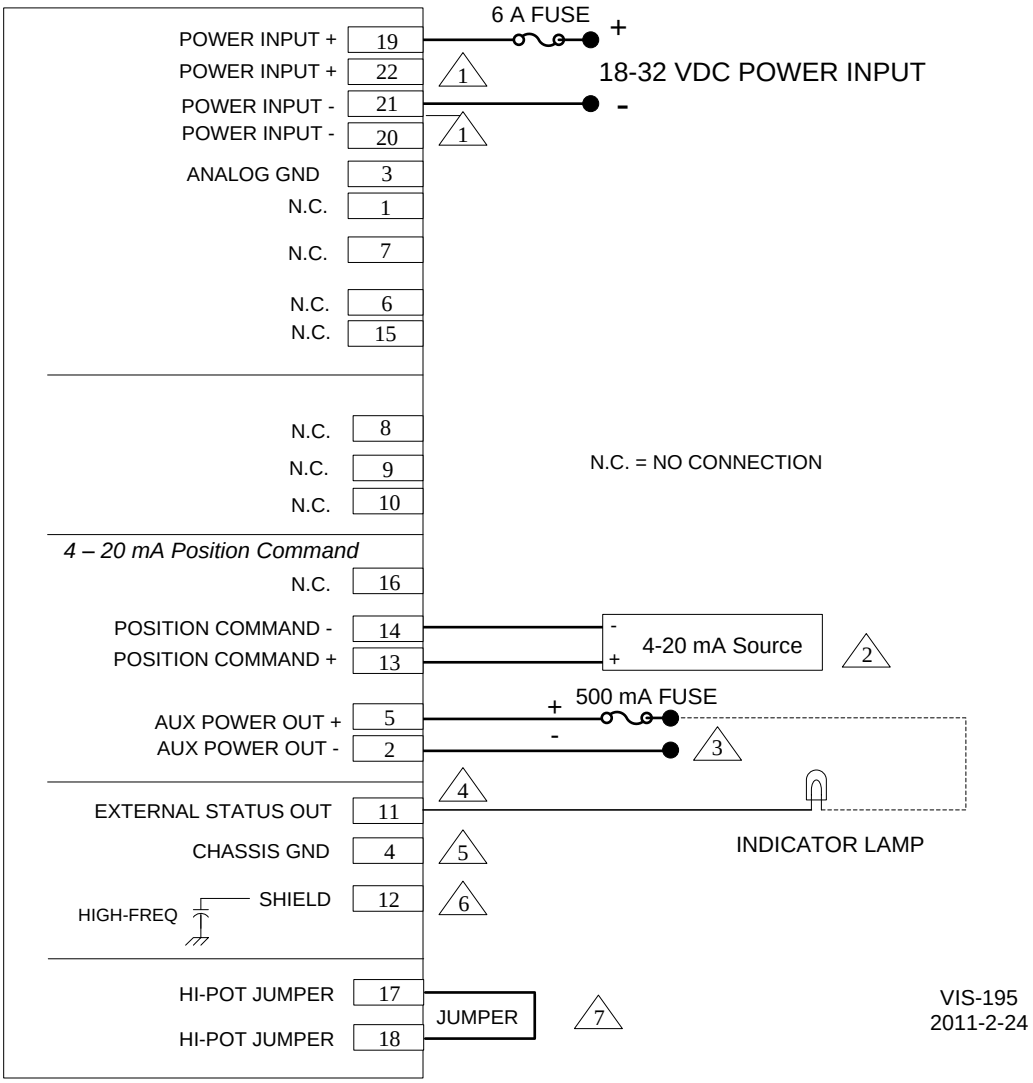
Then tighten the cable gland top dome nut securely against the rubber gland as shown below.

Figure 3-4. Correct and Incorrect Dome Nut Installation

Do not over-tighten the top dome nut. Over-tightening the top dome nut causes the rubber gland to "bulge" out the top of the dome nut, as shown below, and compromises the IP-56 ingress protection seal.

Replace the wiring access cover plate and the six M4 screws holding it to the User Interface panel. Torque all six screws to (3.4 ± 0.2) N·m / (30 ± 2) lb-in.

When routing cables, allow a sufficient service loop when routing the cable around corners. Two customer cable clamp mounting holes are located on the top, front corners of the User Interface panel and are accept M5 x 0.8, 10 mm long screws.



1. WHEN USING REDUNDANT POWER, CONNECT TO TERMINALS 22 AND 20 IN THE SAME MANNER AS TERMINALS 19 AND 21 (USING A 6 A STANDARD FUSE). OTHERWISE LEAVE THESE TERMINALS UNTERMINATED.
2. POSITION COMMAND – CONTROL SIGNAL TO THE ACTUATOR.
3. A CONDITIONED 24 V POWER SOURCE IS PROVIDED FOR POWERING THE STATUS OUTPUT. THIS IS AN ***OUTPUT*** VOLTAGE THAT FOLLOWS FROM THE POWER INPUT +. A FUSE SHOULD BE USED AS SHOWN.
4. THIS IS AN OPTIONAL HOOKUP. THIS PROVIDES FOR A REMOTE "UNIT HEALTHY" STATUS. IF AN EXTERNAL INDICATOR LAMP IS DESIRED, WIRE AS SHOWN.
5. CHASSIS GROUND IS PROVIDED, IF NEEDED.
6. SHIELDING IS NOT REQUIRED FOR EMC COMPLIANCE, HOWEVER A SHIELD TERMINATION POINT IS PROVIDED IN THE EVENT SHIELDING IS DESIRED BY THE CUSTOMER.
   NOTE: THE SHIELD TERMINATION POINT CONSISTS OF A HIGH-FREQUENCY CAPACITOR WHICH ALLOWS THE CUSTOMER TO 'HARD GROUND' THE SHIELD ON THE OPPOSITE END OF THEIR CABLE, IF DESIRED.
7. HI-POT JUMPER MUST BE INSTALLED FOR NORMAL OPERATION AND MUST BE REMOVED ONLY DURING A HI-POT TEST, THEN RE-INSTALLED FOR OPERATION.

Figure 3-5. MAN Actuator Application Wiring

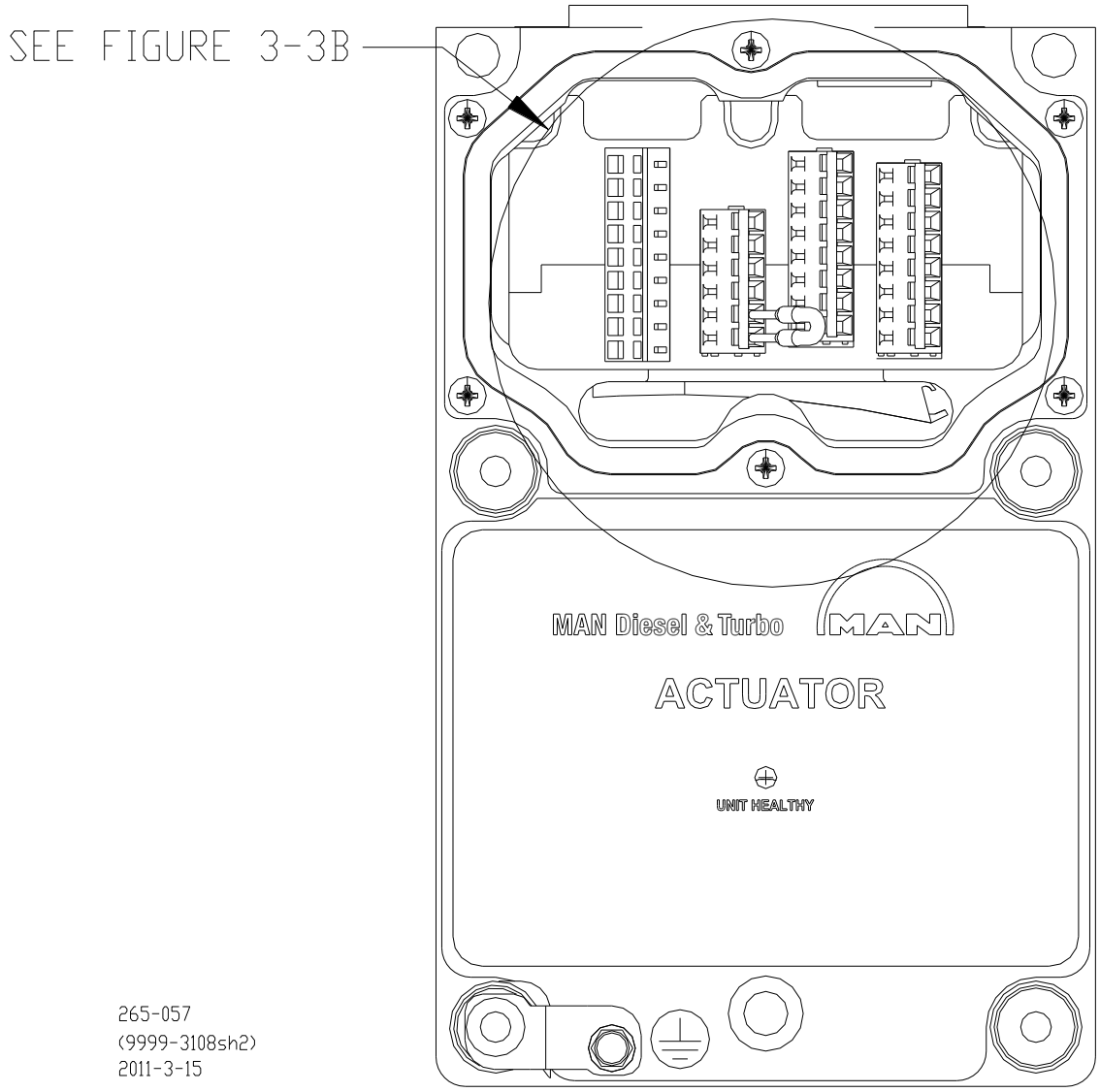


Figure 3-6a. Connector Wiring

NOTICE

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 (Figures 3-2 and 3-3).

NOTICE

The Hi-Pot jumper must be installed for normal operation, and must be removed only during a Hi-Pot test.

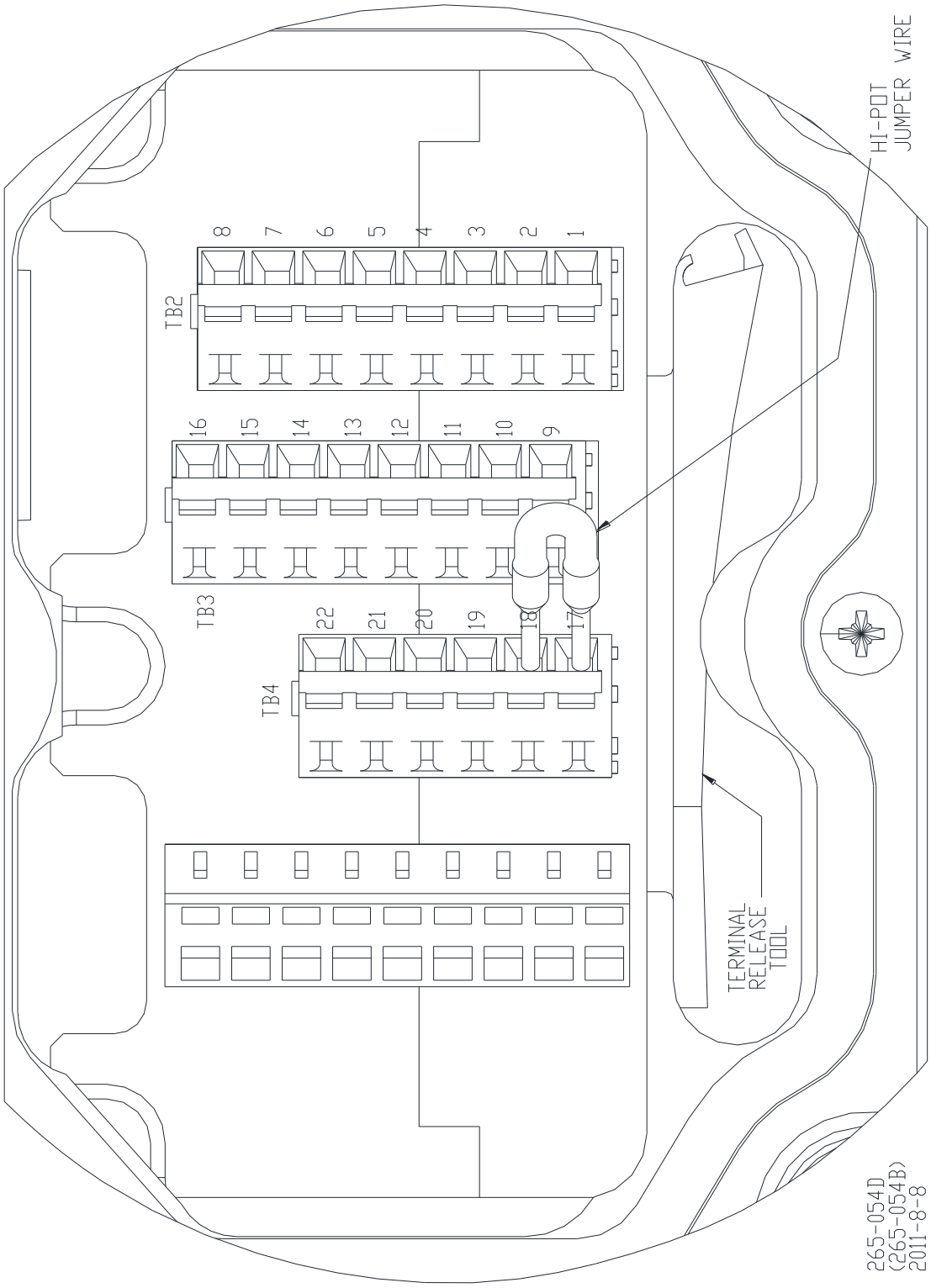


Figure 3-6b. Connector Wiring

USER PANEL			WIRING FOR MAN ACTUATOR
SIGNAL NAME	TERMINAL #	PCB REFERENCE DESIGNATOR	SIGNAL FUNCTION
NOT USED	1	TB2-1	
AUX PWR OUT GND	2	TB2-2	OPTIONAL: AUX POWER OUT GND; RETURN FOR SUPPLY POWER FOR STATUS OUT-- OUTPUT ONLY
ANALOG GND	3	TB2-3	SIGNAL GROUND
CHASSIS GND	4	TB2-4	CHASSIS GROUND
AUX PWR OUT +	5	TB2-5	OPTIONAL: AUX POWER OUT +; SUPPLY POWER + FOR STATUS OUT -- OUTPUT ONLY
NOT USED	6	TB2-6	
NOT USED	7	TB2-7	
NOT USED	8	TB2-8	
NOT USED	9	TB3-1	
NOT USED	10	TB3-2	
STATUS OUT	11	TB3-3	OPTIONAL: PROVIDES A REMOTE 'UNIT HEALTHY' STATUS
SHIELD	12	TB3-4	USE FOR TERMINATION WHEN THERE IS A SHIELDED CABLE
POS CMD 4-20 mA +	13	TB3-5	4-20 mA POSITION COMMAND SIGNAL +
POS CMD 4-20 mA -	14	TB3-6	4-20 mA POSITION COMMAND SIGNAL -
NOT USED	15	TB3-7	
NOT USED	16	TB3-8	
HI-POT	17	TB4-1	HI-POT (JUMPER FROM TERMINAL #17 TO TERMINAL #18 ALREADY INSTALLED, REMOVE FOR HI-POT TEST -- SEE MANUAL)
HI-POT	18	TB4-2	HI-POT (JUMPER FROM TERMINAL #17 TO TERMINAL #18 ALREADY INSTALLED, REMOVE FOR HI-POT TEST -- SEE MANUAL)
PWR INPUT +	19	TB4-3	POWER INPUT +
PWR INPUT RET	20	TB4-4	POWER INPUT RETURN, USE WITH REDUNDANT POWER, OTHERWISE LEAVE PIN FLOATING
PWR INPUT RET	21	TB4-5	POWER INPUT RETURN
PWR INPUT +	22	TB4-6	POWER INPUT +, USE WITH REDUNDANT POWER, OTHERWISE LEAVE PIN FLOATING

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Figure 3-6c. Connector Wiring

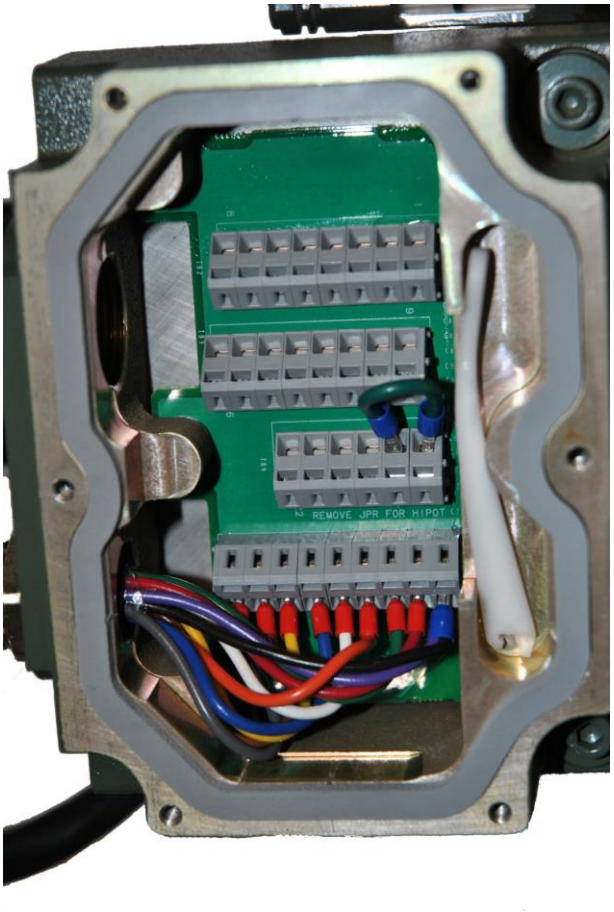


Figure 3-6d. MAN Actuator Terminals

Table 3-2. Customer I/O Terminal Position Assignment

Terminal Position	Description	Comment	Type
1 (TB2-1)	No Connection		N/A
2 (TB2-2)	Optional Power Out – (Return for 18 V to 32 V (dc) supply input)	Return for Supply Power. *Do not connect Analog Ground to this terminal.*	Output
3 (TB2-3)	Analog Ground	*Do not connect Analog Ground to Input Power (–)*	N/A
4 (TB2-4)	Chassis Ground	This terminal connects to Chassis ground through the circuit board, and then to the MAN metal housing.	N/A
5 (TB2-5)	Optional Power Out + (Supply Power, 18 V to 32 V (dc), 1.5 A max.)	This is an *output* only! Do not connect external power to this power output. This output voltage follows the Power Input(+) minus a protection diode drop.	Output
6 (TB2-6)	No Connection		N/A
7 (TB2-7)	No Connection		N/A
8 (TB2-8)	No Connection		N/A
9 (TB3-1)	No Connection		N/A
10 (TB3-2)	No Connection		N/A
11 (TB3-3)	External Status Output	This provides for a remote “Unit Healthy” status. See MAN Application Wiring Figure 3-2.	Output, open drain, low-side switch
12 (TB3-4)	Shield	This terminal is a conditioned shield tie point. (capacitively coupled to Chassis Ground)	N/A
13 (TB3-5)	Position Command +	This is the positive input of the (4 to 20) mA circuitry from the actuator's Position Command signal.	Input
14 (TB3-6)	Position Command –	This is the negative input of the (4 to 20) mA circuitry from the actuator's Position Command signal.	Input
15 (TB3-7)	No Connection		N/A
16 (TB3-8)	No Connection		N/A
17 (TB4-1)	Hi-Pot Test Jumper		Input
18 (TB4-2)	Hi-Pot Test Jumper		Input
19 (TB4-3)	Power Input +	Supply Power, (18 to 32) V (dc), 1.5 A max.	Input
20 (TB4-4)	Power Input –	Return for (18 to 32) V (dc) Supply Input.	Input
21 (TB4-5)	Power Input –	Return for (18 to 32) V (dc) Supply Input.	Input
22 (TB4-6)	Power Input +	Supply Power, (18 to 32) V (dc), 1.5 A max.	Input

Detailed Description of MAN Actuator Electrical I/O

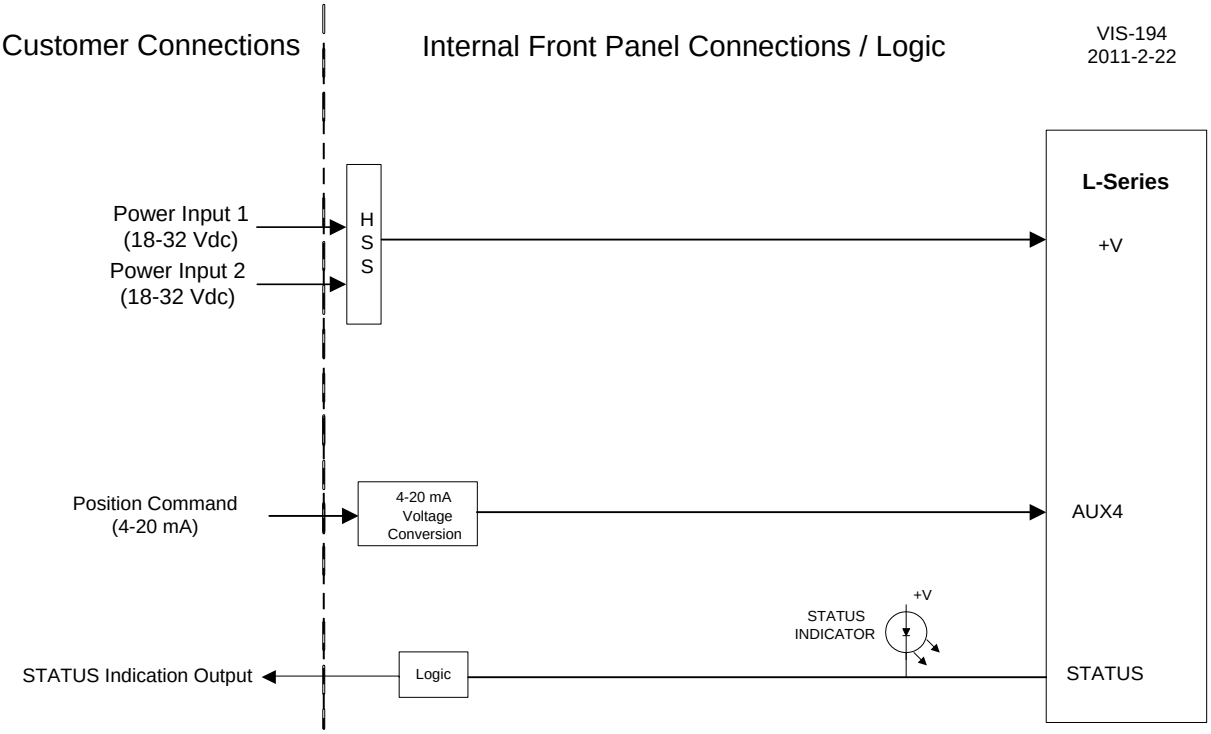


Figure 3-7. Internal Block Diagram

Power Supply Input 1 (18 V to 32 V Power Input (+) at Terminal 19, Power Input (–) at Terminal 21)
Power Supply Input 2 (18 V to 32 V Power Input (+) at Terminal 22, Power Input (–) at Terminal 20)

The two power-supply inputs are high-signal selected using diodes, so the input with the higher voltage will conduct, and other will remain in "standby" mode until the first supply's voltage drops below the "standby" supply's voltage. Both can remain connected, and there will be no electrical current flow from one power source to the other.

The MAN Actuator will handle a voltage range of 18 V to 32 V (dc), with an absolute maximum of 60 V.

The power supply terminals are reverse polarity protected, and in the case that a reverse polarity condition exists, the MAN Actuator will not power-up.

MAN recommends using a 6 A fuse on the power supply line feeding Terminals 19 and 22 of the MAN Actuator.

⚠WARNING

The input power must be fused. Failure to fuse the MAN Actuator could, under exceptional circumstances, lead to personal injury, damage to the control valve, and/or explosion.

NOTICE

If circuit ground and chassis ground are shorted together at the MAN Actuator, there is an increased risk of EMI susceptibility.

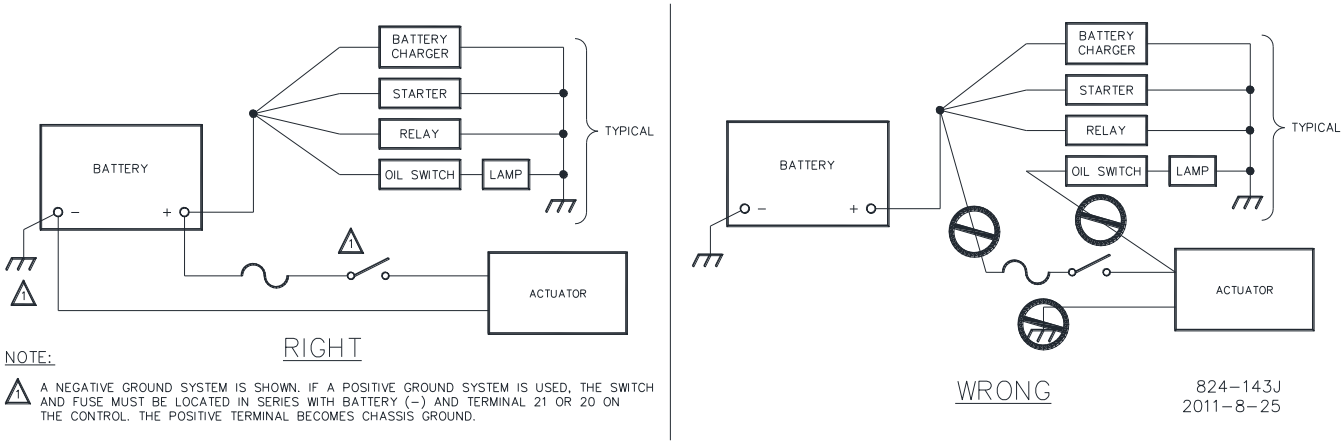


Figure 3-5. Correct and Incorrect Wiring to Power Supply

MAN recommends using a standard 6 A fuse on the (18 to 32) V (dc) input as show in Figure 3-2. ***Do NOT use a slow-blow-type fuse in this application.***

Relay Driver Output (Status/Unit Healthy)
A discrete output is provided to serve as a status indicator, mimicking the front panel Unit Healthy LED. This switchable discrete output is a closure to ground capable of sinking 500 mA maximum with an output voltage rise of less than 1.5 V, and it is available to power external relays for devices such as alarms or fuel shutoff solenoids. The circuit is protected internally against over-current and inductive spikes, so external clamping is not necessary.

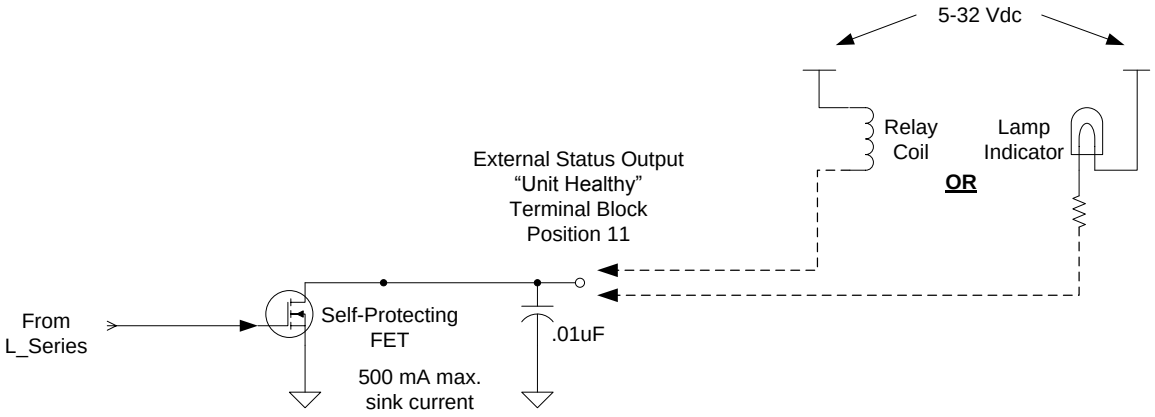


Figure 3-6. Relay Driver Output

Analog Position Command
This input accepts a 4 mA to 20 mA current input that comes from an external electronic control system's speed setpoint.

IMPORTANT

The user must provide an external means to clamp the position command input at 3 mA and 21 mA. An analog position command input below 3 mA or above 21 mA is out of the normal 4 mA to 20 mA input range and may cause the analog position command function to become disabled even though the Analog indication LED remains on.

NOTICE

To avoid EMI interference between the wire bundle and the interface panel, route the wires out of the connectors away from the panel controls. Do not allow the interface wiring to drape in front of the panel controls.

NOTICE

MAGNETIC FIELDS—During installation, avoid placing the interface panel in close proximity with any source of strong magnetic field (permanent magnet motor, magnetized tools, etc.). Strong magnetic fields can inject error into the adjustments available on the front of the interface panel.

High Potential Testing

Occasionally, marine certification requires that a high potential (HI-POT) test of the engine or prime mover be performed after the MAN Actuator is installed. The MAN Actuator is designed to accommodate this testing. Before performing any HI-POT testing, remove the small HI-POT jumper located between Terminals 17 and 18, which are found under the wiring access cover plate on the front of the User Interface panel.

The HI-POT test voltage is +755 V (dc). Repeat the test with the polarity reversed at –755 V (dc).

Apply the HI-POT voltage between all customer input and output terminals (located under the wiring access cover plate on the front of the User Interface panel) connected together and chassis ground (located on the front of the
MAN Actuator), except that Terminal 4 (chassis ground) and Terminal 12 (shield) must remain un-connected and not electrically tied to the other terminals during this test. The HI-POT test voltage ramp-up time is 5 seconds, and dwell is 60 seconds, or as specified by the certification authority.

Use the ground terminal located on the outside of the User Interface panel as the chassis ground tie point for the HI-POT test. Using Terminal 4 as the chassis ground tie point during the test does not properly check the internal chassis to circuit board connection.

NOTICE

Do not perform “AC” Hi-Pot testing on this assembly.

Securely replace the jumper between Terminals 17 and 18 after completing the HI-POT test to ensure that the electrical power surge protection on the electrical circuit board is maintained during normal operation.

NOTICE

Install the jumper between Terminals 17 and 18 for normal operation. The MAN Actuator may be damaged by power surges if this jumper is not properly installed.

Insulation Resistance Testing

Occasionally, marine certification requires that an insulation resistance test of the engine or prime mover be performed after the MAN Actuator is installed. The MAN Actuator is designed to accommodate this testing. Before performing any insulation resistance testing, remove the small HI-POT jumper located between Terminals 17 and 18, which is found under the wiring access cover plate on the front of the User Interface panel.

Connect the plus (+) probe of a multi-meter to each terminal block location in turn and the minus (–) probe to chassis ground.

NOTICE

Do not use test equipment that is powered from a power source that exceeds 64 V (dc) to perform the insulation resistance testing. It may damage the actuator electronics.

The resistance measured between each terminal block location (Terminals 1 through 3, 5 through 11, 13 through 16, and 19 through 22) and chassis ground must be greater than 830 kç.

Use the ground terminal located on the outside of the User Interface panel as the chassis ground tie point for the insulation resistance test. Using Terminal 4 as the chassis ground tie point during the test does not properly check the internal chassis to circuit board connection.

Securely replace the jumper between Terminals 17 and 18 after completing the insulation resistance test to ensure that the electrical power surge protection on the electrical circuit board is maintained during normal operation.

NOTICE

Install the jumper between Terminals 17 and 18 for normal operation. The MAN Actuator may be damaged by power surges if this jumper is not properly installed.

Chapter 4.
Description of Operation

General

The MAN Actuator receives a 4 mA to 20 mA Position Command signal from an external electronic control. This mA position command is converted into a direct proportional output position for the actuator's terminal shaft. This conversion is such that a 4 mA position command directs the terminal shaft to go to minimum position, a 20 mA position command directs the terminal shaft to go to maximum position, and a 12 mA position command directs the terminal shaft to go to mid position.

The actuator terminal shaft provides a maximum rotational travel of 42 degrees for controlling diesel, gas, or dual fuel engines, or steam turbines.

The MAN Actuator front panel provides a convenient operating interface for the user, and includes:

UNIT HEALTHY LED—This LED illuminates when there is electrical power supplied to the MAN Actuator and the L-Series electronic controller internal to the MAN Actuator is working properly. This LED turns off if supply power is removed or there is a fault in the L-Series electronics.

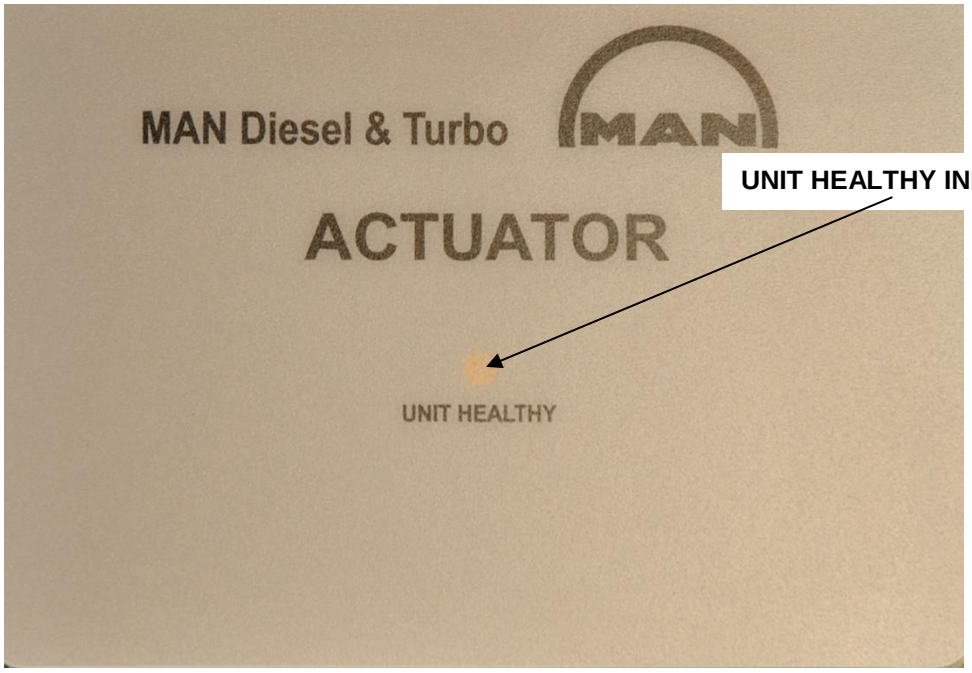


Figure 4-1. MAN Actuator Front Panel

The control has a switching power supply with excellent spike, ripple, and EMI (electromagnetic interference) rejection. Discrete inputs are capable of rejecting EMI and variable resistance in switch or relay contacts. Analog inputs are differential type with extra filtering for common-mode noise rejection.

The control provides one discrete output, which provides a Unit Healthy indication.

⚠WARNING **The MAN Actuator should not be used as the primary means of shutting down the engine.**

Principal of Operation

The MAN Actuator consists of the following three main components:

- **L-Series Controller**
  Assumes a rotary output position directly proportional to the (4 to 20) mA input current from an external control.
- **Hydraulic Amplifier**
  Amplifies the work output of L-Series control.
- **User Interface**
  Provides local Unit Healthy status. Also provides electrical connector for power and customer inputs.

The hydraulic amplifier operation is depicted in Figure 4-2, which illustrates the working relationship of the various parts. The main elements of the hydraulic amplifier are listed below:

Oil Pump
The oil pump is a Gerotor-type pump element, driven by the actuator drive-shaft to provide oil pressure for the actuator. The pump is fed oil from the self-contained sump.

Relief Valve
Set to maintain an internal operating pressure set at 1034 kPa (150 psi).

Rotary to Linear Conversion Mechanism
This mechanism converts the rotary output position of the L-Series controller into linear motion required to operate the pilot valve of the amplifier.

Return Spring
The conversion mechanism incorporates a return spring which is used to move the pilot valve to the minimum fuel position upon loss of function of the L-Series controller.

Pilot Valve Plunger
The 3-way pilot valve directs oil flow to the control side of the differential area of the power piston or towards the actuator drain.

Power Piston, Terminal Shaft Lever, and Terminal Shaft
The terminal shaft lever converts the linear motion of the differential-type power piston into a rotary motion of the terminal shaft, which in turn moves the fuel linkage. The terminal-shaft position is fed back to the pilot valve to provide the proportional control.

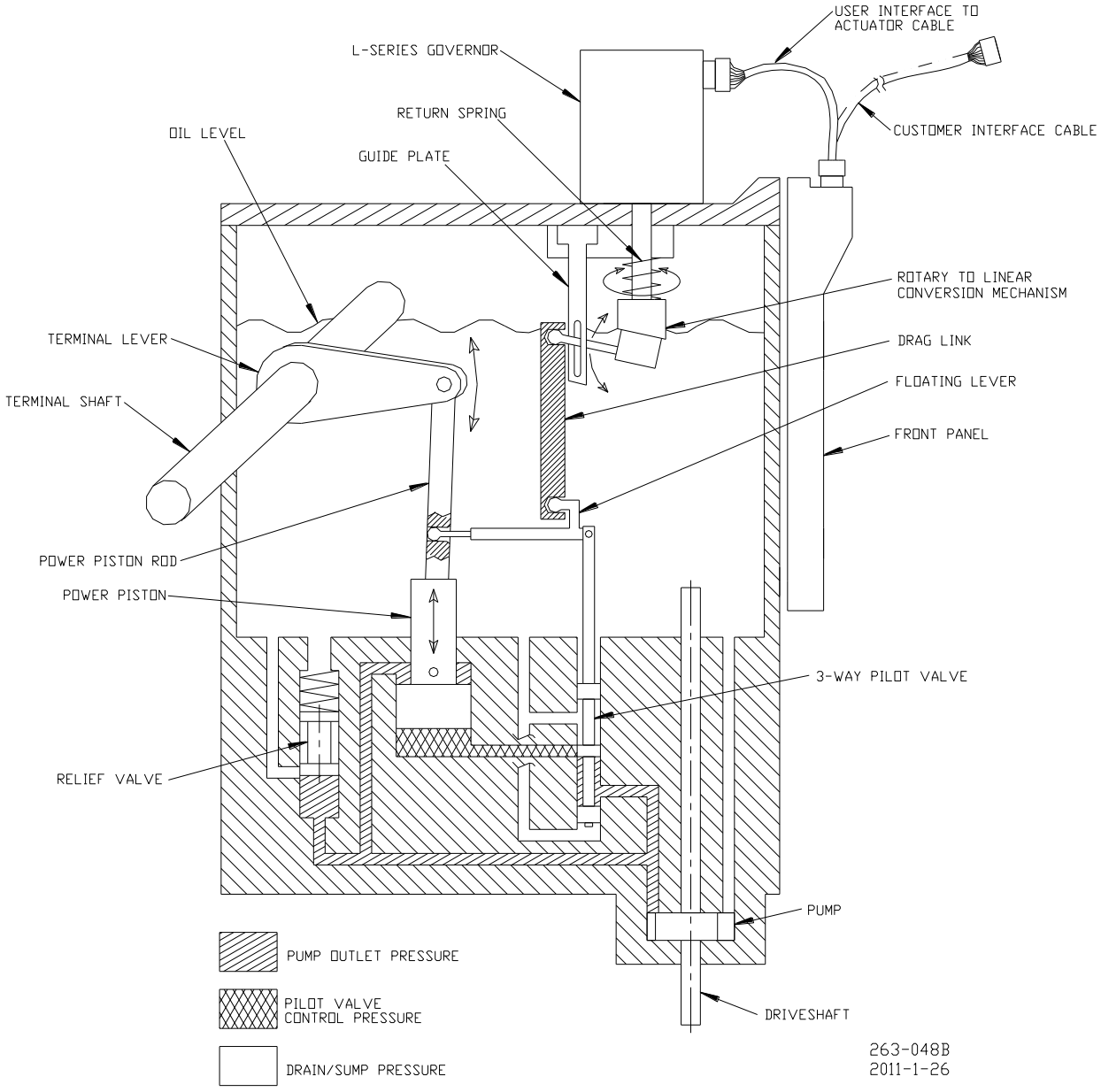


Figure 4-2. MAN Actuator Functional Overview

Increase in Position Command Signal

An increase in the externally supplied Position Command signal causes the L-Series controller output shaft to rotate CCW when viewed from the top on the MAN Actuator. This, in turn, causes the pilot valve to lift allowing control oil pressure to act on the underside of the power piston. This oil pressure underneath the power piston opposes the pump outlet oil pressure acting on the topside and causes the piston to rise, since the piston bottom has twice the area of the topside.

As the power piston rises, the power piston rod moves with it and rotates the terminal shaft, converting the output motion back to rotary. One end of the floating lever is directly connected to the power piston rod and this end rises correspondingly.

When the desired terminal shaft position is reached, the floating lever provides a mechanical feedback/restoring signal between the power piston rod and the pilot valve. During this condition, the pilot valve will be at its “null” position. Therefore, the L-Series control and the hydraulic amplifier are proportional devices with their positions a direct function of the externally supplied Position Command signal.

Decrease in Position Command Signal

A decrease in the externally supplied Position Command signal causes the L-Series controller output shaft to rotate CW. This, in turn, causes the pilot valve to lower allowing the control oil pressure acting on the underside of the power piston to flow to drain. The pump outlet oil pressure acting on the topside of the power piston will cause the piston to lower.

As the power piston lowers, the power piston rod moves with it and rotates the terminal shaft towards the minimum fuel direction. The floating lever then lowers its end coupled to the power piston rod and provides its position feedback/restoring feedback to the power piston and pilot valve.

Loss of Position Command

Upon loss of the Position Command signal, the actuator terminal shaft goes to minimum fuel, thus offering a safety feature. With loss of power supply voltage, the L-Series controller loses torque and the force of the loading or return spring causes the center adjustment to lower. The pilot valve follows, keeping the control port uncovered. Trapped oil under the power piston escapes to drain, and the servo power piston moves down until it reaches minimum fuel position.

Fault Detection and Annunciation

The MAN Actuator provides complete shutdown fault monitoring. A detected shutdown condition forces the actuator to go to the minimum fuel (0 %) position. When the shutdown condition no longer exists, the MAN Actuator is returned to a non-shutdown state. Faults are globally set as non-latching. When the condition no longer exists, the fault is automatically cleared without any reset.

Shutdown Details

Shutdown—Voltage Sense Fail
Indicates an out-of-range signal on the input power. Could indicate input power out of range or a fault in the supply voltage sense circuitry.

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Failure levels: >33 V and <6.25 V
Persistence: 650 ms

Shutdown—Temp Sense Fail
Indicates a failure of the internal on-board Temperature Sensor.

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Failure levels: >150 °C and <–45 °C
Persistence: 650 ms
Hysteresis: 5 °C (<145 °C or >–40 °C to clear)

Shutdown—OverTemp
If the on-board temperature sensor reads a temperature above 125 °C, this error will be set. The Current Limiting based on temperature will effectively make the output "limp" by reducing the drive current to zero (see Current Limiting Based on Temperature section for details).

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Failure levels: >125 °C
Persistence: 650 ms
Hysteresis: 5 °C (<120 °C to clear)

Shutdown—EEPROM Fail (internal fault)
EEPROM Fail indicates failure or corruption of the internal non-volatile memory. This is a hard-coded internal shutdown. If detected, the control output will go limp. A power cycle is required to clear this fault.

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Chapter 5. Troubleshooting

Introduction

This chapter presents several broad categories of application failures typically experienced in the field, possible causes, and some tests used to verify the causes. The exact failure experienced in the field is the product of the mechanical/electrical failure.

⚠WARNING

The actions described in this troubleshooting section are not always appropriate in every situation. Always make sure that any action taken will not result in loss of equipment, personal injury, or loss of life.

⚠WARNING

The MAN Actuator is not equipped with an overspeed trip function. 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

The MAN Actuator is used on prime movers that typically have a high noise level. Always use appropriate hearing protection while working around the MAN Actuator.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. Make these checks before contacting MAN for technical assistance.

- Is the wiring correct? Refer to wiring diagram Figure 3-2.
- Is the drive shaft rotation direction correct?
- Is the direction of the stroke correct?
- Is the direction of the failsafe shutdown correct?
- Does the output shaft move through its proper stroke smoothly?
- Does the output travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the output fully seat (close)?
- Does the output fully open?

Oil

Keep the actuator oil level to the mark on the oil sight glass with the unit operating. Dirty oil causes actuator problems. Use clean, new, or filtered oil. Oil containers used must be perfectly clean. Oil contaminated with water breaks down rapidly, causing foaming, and corrodes internal actuator parts.

Preliminary Inspection

Actuator problems are usually revealed in speed variations of the prime mover, but it does not necessarily follow that such variations are caused by the actuator. When improper speed variations appear, the following procedure should be performed:

1. Check the load to be sure the speed changes are not the result of load changes beyond the capacity of the prime mover.

2. Check engine operation to be sure all cylinders are firing properly and that the fuel injectors are in good operating condition and properly calibrated.

3. Check the linkage between the actuator and fuel racks or valve. There must be no binding or lost motion.

4. Check that the actuator oil is clean and oil level is correct at operating temperature. The source of most problems in any hydraulic actuator stems from dirty oil. Grit and other impurities can be introduced into the actuator with the oil, or form when the oil begins to break down (oxidize) or becomes sludgy.

   The internal moving parts are continually lubricated by the oil within the unit. Valves, pistons, and plungers will stick and even “freeze” in their bores, due to grit and impurities in the oil.

   When in doubt, change the oil.

   If this is the case, erratic operation and poor response can be corrected (if wear is not excessive) by flushing the unit with fuel oil or kerosene.

   The use of commercial solvents is not recommended as they may damage seals or gaskets.

   To change oil, remove the drain plug and drain out the old oil. Flush the actuator by filling it with fuel oil, and with the prime mover running at low speed, cycle the actuator. Let the actuator hunt for a minute or two, then stop the engine and drain the actuator. Flush the actuator once again. Refill the actuator with oil (see Chapter 2, Oil Supply).

   Restart the engine.

5. Check that the drive to the actuator is correctly aligned and free of roughness, side loading, and excessive backlash.

Engine/Generator Troubleshooting

Contact your local MAN service provider.

Chapter 6.
Aftermarket Services

Product Service Options

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

- Consult the troubleshooting guide in the manual.
- Contact MAN or packager of your system.
- Contact an agent appointed and trained by MAN.

MAN Servicing Options

The following factory options for servicing this product are available through your local MAN service provider or Packager of the equipment system:

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 48 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 a MAN product warranty.

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 48 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: This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work includes a service warranty of one year.

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 a product warranty of 18 months.

Returning Equipment

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 MAN 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.

Replacement Parts

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

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

How to Contact MAN

For assistance, call the 24-hour hotline:

Tel: +49 821 322-1499
Fax: +49 821 322-3838
Email: primeserv-aug@mandieselturbo.com

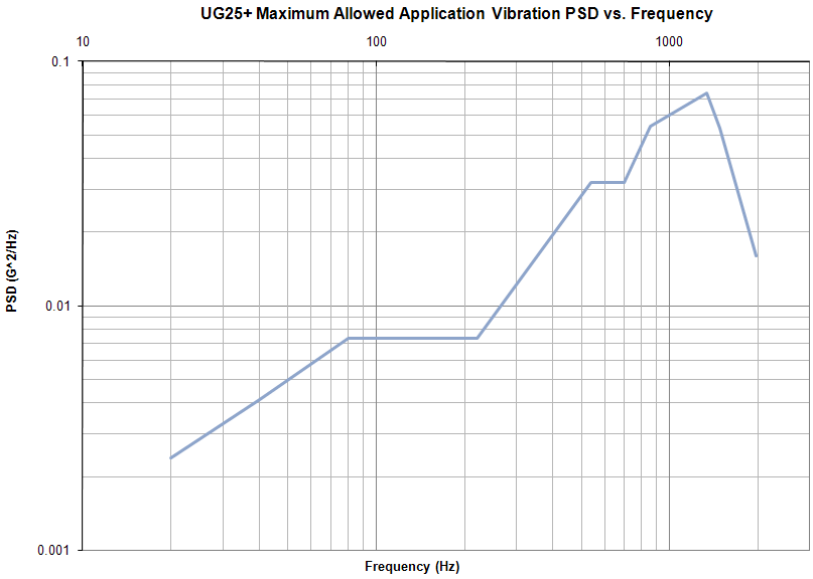
Appendix A.
Acronyms / Abbreviations

CCW	Counterclockwise
CW	Clockwise
CMRR	Common-Mode Rejection Ratio
CRC	Cyclic Redundancy Count
EMC	Electro-Magnetic Compatibility
I/O	Inputs/Outputs
L-Series	Woodward electronic engine governor that contains both a rotary governor and a controller circuit board
O.D.	Outside Diameter
OEM	Original Equipment Manufacturer
PID	Proportional/Integral/Derivative
ppm	Parts Per Million
TPS	Travel Position Sensor

Appendix B.
MAN Control Specifications

Actuator	
Power Supply:	(18 to 32) V (dc), dual inputs at 2.5 A max. each
Power Consumption:	Reverse polarity protection, 32 W max
Torque/Work Output (minimum):	
Standard Version (0.625 inch diameter terminal shaft)	45.4 N·m (33.5 lb-ft) torque; 32.9 J (24.3 ft-lb) of work over 42 degrees
Increased Output Version: (0.75 inch diameter terminal shaft)	55.5 N·m (40.9 lb-ft) torque; 40.2 J (29.6 ft-lb) of work over 42 degrees
Continuous Speed:	500 rpm to 1700 rpm (drive shaft speed) max (0.625 inch pump); 350 rpm to 1200 rpm (drive shaft speed) max (0.875 inch pump)
Hysteresis:	1.0 % or less (measured over full terminal shaft travel)
Temperature Drift:	1.0 % of full terminal shaft travel between 27 °C and 77 °C (80 °F and 170 °F)
Linearity:	2.5 % or less (measured over full terminal shaft travel)
Slew Rate:	180 degrees/second or better at full actuator oil pressure for 34 J (25 ft-lb) of work output 145 degrees/second or better at full actuator oil pressure for 41 J (31 ft-lb) of work output **Note:** All performance specifications are valid while operating at a case temperature between 71 °C and 93 °C (160 °F to 200 °F) with an oil viscosity of 20 cSt to 65 cSt (100 to 300 SUS).
Weight:	27 kg (60 lb), dry weight
Customer Connections:	Terminal blocks located inside front access plate (field wiring enters the top of the unit through a cable gland available commercially or from MAN)
Actuator Drive / Hydraulic System	
Input Shaft Options:	0.625 keyed drive shaft with 0.625-18 threads or 0.625-36 serrated
Output:	42.2 ± 0.6 degrees rotary
Terminal Shaft:	0.750-48 serration (41 J / 31 ft-lb version)
Drive Power Requirement:	335 W (0.45 hp) max.
Internal Hydraulic Pressure:	1034 kPa (150 psi)
Oil:	Self-contained sump (2.1 L / 2.2 quart capacity).
Drive Rotation:	Pump can be configured to operate in CW or CCW direction
Environment	
Ambient Operating Temperature:	(0 to 55) °C / (32 to 131) °F
Actuator Case Temperature:	100 °C (212 °F) maximum
Storage Temperature	(–40 to +85) °C / (–40 to +185) °F, limited by electronics
EMC:	EN61000-6-4, 2007: EMC Part 6-4: Generic Standards—Emissions for Industrial Environments EN61000-6-2, 2005: EMC Part 6-2: Generic Standards—Immunity for Industrial Environments
Humidity	US MIL-STD 810E, Method 507.3, Procedure III
Shock	MS1-40G 11 ms sawtooth

Vibration Validation — Power Spectral Density (PSD) must not exceed the level or frequency as shown in the curve while the governor is running on a loaded engine, as measured at governor base.



Frequency (Hz)	Allowed PSD Level (G^2/Hz)
20	0.00240
40	0.00414
80	0.00736
220	0.00736
540	0.03197
700	0.03197
860	0.05453
1340	0.07452
1480	0.05339
1960	0.01595

Thermal Shock: SAE J1455, Paragraph 4.1.3.2

Ingress Protection: IP45 for entire unit. IP56 for User Interface per EN60529 and only if proper cable glands are used as described in this manual.

Functions

I/O: (4 to 20) mA analog Position Command control signal
Unit Healthy discrete out

Front Panel Indications: Unit Healthy status indication

I/O Specifications

Table B-1. Power Input (1 and 2)

Parameter	Value
Range	(18 to 32) V (dc)
Power Consumption	Nominal consumption is less than 500 mA. If internal failures occur, the device can draw 32 W maximum. (18 V @ 1.8 A)
Protection	Reverse-polarity protected
Isolation	None

Table B-2. Status (Unit Health) Output

Parameter	Value
Output Type	Low-side output driver
Max Contact Voltage (Open)	32 V
Max Current	0.5 A
Max Contact Voltage at 0.5 A (Closed)	1.5 V
Max Delay Time for Opening Contact	6.5 ms
Default at Power Up	On (conducting), if there are no faults
During Error Condition	Off
Driving Inductive Loads	Yes, internally protected low-side switch
Protection	Utilizes circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed

Table B-3. Position Command

Parameter	Value
Input Type	(4 to 20) mA
Input Scaling	4 mA is minimum position signal 20 mA is maximum position signal
Max Input (Full Scale)	0 mA to 25 mA
Input type	Differential
3 db Circuit Bandwidth	30 Hz
Input Impedance	200 Ω
Anti-Aliasing Filter	1 anti-aliasing pole at 0.47 ms (338 Hz)
Resolution	10 bits
Accuracy	±0.8 % of full scale at 25 °C
Drift	80 ppm/°C
I/O Latency	6.5 ms
CMRR	60 dB
Common-Mode Range	45 V (dc)

Revision History

Changes in Revision C—

- Updated Regulatory Compliance directives
- Updated Recommended Service Intervals (Chapter 2)
- Added new Declaration of Conformity and Declaration of Incorporation

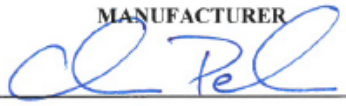
Declarations

DECLARATION OF CONFORMITY

EU DoC No.:	00332-04-EU-02-01
Manufacturer's Name:	WOODWARD, INC.
Manufacturer's Contact Address:	Building A, Ditiantai Industrial Park, Huaihedao, Beichen High-Tech Industrial Park, Tianjin, China
Model Name(s)/Number(s):	UG25+ Governor/UG25+ Actuator
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (EMC)
Applicable Standards:	EN61000-6-4, 2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments

This declaration of conformity is issued under the sole responsibility of the manufacturer.
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER



Signature

Christopher Perkins
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

09-AUG-2016
Date

5-09-1183 Rev 28

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

Manufacturer's Name:	WOODWARD, INC
Manufacturer's Address:	Building A ,Ditiantai Industrial Park, Huaihedao, Beichen High-Tech Industrial Park, Tianjin, China
Model Names:	UG25+ Governor/UG25+ Actuator/UG25+
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.

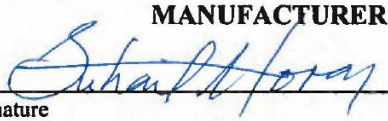
The person authorized to compile the technical documentation:

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

Fort Collins, CO, USA
Place

24-May-2012
Date

5-09-1182 (REV. 10) 00332-04-EU-MD-02-01

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We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26587.

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