WOODWARD

Product Manual 26731
(Revision E, 7/2022)
Original Instructions

EM35MR1/3171A Gas Valve

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 Out-of-date translations are marked with ⚠.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 26731

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

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, as 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, connectors, or 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. After removing the old PCB from the control cabinet, immediately place it in the antistatic protective bag.

Regulatory Compliance

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

ATEX – Potentially Explosive Atmospheres Directive (Actuator & Resolver): Directive 2014/34/EU on the harmonisation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.
SIRA 13ATEX1188X Zone 1, Ex d IIB T3 Gb

IMPORTANT

3171A Gas Valve/EM35MR1 Actuator assemblies incorporating the minimum position switch are not suitable for use in an ATEX environment.

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 2014/30/EU Directive.

Machinery Directive: Compliant as a component with 2006/42/EC COUNCIL DIRECTIVE of 17 May 2006 on the approximation of the laws of the Member States relating to 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 concerning pressure equipment.

ATEX (Valve): Exempt from the non-electrical portion of the ATEX Directive 2014/34/EU due to no potential ignition sources per EN 13463-1. Suitable for installation in a Zone 1, Group IIB environment.

North American Compliance:
Suitability for use in North American Hazardous Locations is the result of compliance of the individual components:

Actuator & Resolver: CSA Certified for Class I, Division 1, Groups C & D, Class I, Division 2, Groups B, C, D, T3 at 93 °C Ambient. For use in Canada and the United States. Certificate 1006295

Minimum Position Switch: CSA Certified for Class I, Division 1, Groups C & D. For use in Canada. LR57324 UL Listed for Class I, Division 1, Groups C & D. For use in the United States. E14274

Special Conditions for Safe Use

Wiring must be in accordance with North American Class I, Division 1 or 2, or European Zone 1 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Ambient Temperature: (–40 to +93) °C / (–40 to +200) °F

Fuel Temperature: (–40 to +149) °C / (–40 to +300) °F

Use supply wires suitable for a maximum ambient temperature of +93 °C.

For ATEX Zone 1 and Zone 2 Applications: A conduit seal must be installed within 50 mm (2 inches) of the conduit entries when the EM35MR1 Actuator and EM Resolvers are used in a Zone 1 or a Zone 2 ATEX classified explosive atmosphere. These are Category 2, flameproof, type 'd' products.

For Class I, Division 1 or Class I, Zone 1 North American Applications: A conduit seal must be installed within 45 cm (18 inches) of the conduit entry when the EM35MR1 Actuator or EM Resolvers are used in a Class I, Division 1 or Class I, Zone 1 hazardous atmosphere.

The surface of the gas valve is dependent upon the temperature of the fuel. Refer to the burn hazard warning statement below for safe handling. Fuel temperature effects on valve surface temperature must be taken into consideration when this product is used in an explosive atmosphere.

⚠WARNING

It should be noted that the following flame paths have a maximum constructional gap that is smaller than IEC 60079-1 requires.

Flame Path	Max Gap, ic (mm) Comment
Actuator Cover to Housing	Per drawing 9989-4011. The max gap permitted on this flat joint is 0.099 mm / 0.0039 inch.
Actuator Adaptor Plate to Housing	Per drawing 9989-4011. The max gap permitted on this flat joint is 0.099 mm / 0.0039 inch.
Resolver Cover to Housing	Per drawing 9989-4013. The max gap permitted on this flat joint is 0.102 mm / 0.004 inch.
Resolver Shaft	Per drawing 9989-4013. The max gap permitted on this cylindrical joint is 0.152 mm / 0.006 inch.
Actuator Shaft	Per drawing 9989-4011. The max gap permitted on this cylindrical joint is 0.152 mm / 0.006 inch.

⚠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 1 or 2 or Zone 1 or 2 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 1 ou 2 ou Zone 1 ou 2.

⚠CAUTION

The surface of this product can become hot 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

GENERAL CONDITIONS FOR SAFE USE—Turbine control system alarms, faults, or shutdowns that are initiated by the valve or valve driver should not be ignored. These alarms, faults, and shutdowns are intended to alert equipment operators of a potentially unsafe condition and to protect against personal injury, loss of life, or property damage. Valve position error alarm and shutdown thresholds should be set to values that prevent improper fuel metering flow rates during turbine light-off. Equipment operators should strictly follow turbine OEM start procedures, including purging of the gas turbine after failed start attempts.

Chapter 1.
General Information

Introduction

The EM35MR1/3171A gas valve is designed for metering gaseous fuel to industrial gas turbine engines. The EM35MR1 electric actuator is used to drive a 3171A gas valve, closed loop to position demand. Position feedback is provided by a resolver connected to the valve metering sleeve. Closed loop position control is accomplished through an EM 24 V digital driver. Feedback on the valve allows the motor assembly to be repaired or changed in the field without the loss of valve calibration.

3171A Gas Valve

The 3171A gas valve is a stainless steel valve capable of metering gas flow between 25 and 20 000 pph (11 and 9072 kg/h). The valve is designed to bolt into a 1 inch (25.4 mm) line by means of 0.625-11 UNC 2B tapped holes. The valve inlet and outlet flanges are class 600 per ANSI B16.5. The valve design is a rotary metering sleeve and a shoe-type throttling valve. The valve shoe is spring and pressure loaded against the metering port to minimize leakage and to self-clean the metering port. The metering port area is determined by input shaft positioning from the actuator. The valve has an internal spring to return the valve to the minimum fuel position in the event of a power loss to the actuator.

The 3171A valve has redundant seals on all dynamic sealing surfaces. Between these two seals is an overboard vent which vents any gasses that may leak past the first seal to a safe vent location. The use of an inner-seal vent prevents the second dynamic seal from seeing any differential pressure and thus offers protection against the leakage of gasses from the valve into the surrounding ambient atmosphere.

The valve design incorporates an inlet guide tube to condition the inlet flow and to direct any gas contaminants through the metering port, minimizing any accumulation in the valve housing. The metering sleeve support bearings are positively sealed from the gas. Internal valve parts are made of through-hardened stainless steel.

NOTICE

The valve has mechanical stop screws installed in the valve flange. These stops must not be adjusted by the customer. If these stops interfere with the valve operating region or the electrical stops, it will cause the EM 24 V digital driver to trip out on overcurrent.

EM35MR1 Actuator

The EM35MR1 actuator is an all-electric actuator designed for use in industrial gas turbine control applications. The EM35MR1 actuator consists of a high performance brushless servomotor and a precision planetary gearbox with two resolver-type shaft position sensors. All stator windings are completely sealed. The use of a high efficiency gearbox facilitates high servo system bandwidth. The motor has its own resolver providing motor rotor position feedback, and the other resolver(s) provides accurate output shaft position feedback. The actuator also has a slip clutch to allow full speed impact into optional external rigid mechanical stops.

The motor assembly is housed in a cast aluminum explosion proof housing. A thermal potting compound is used to transfer waste heat generated by the motor to the cast, explosion proof housing and out to the ambient environment. Wiring to the motor is accomplished through two 0.750-14 NPT conduit connections or two M25 x 1.5 conduit connections into a wiring compartment integral to the housing. One conduit is for the motor power wires, the other is for the motor resolver wires. The motor output shaft is directly coupled to the valve input shaft through the use of a stainless steel torsional coupling.

Resolver

Position feedback is accomplished using a highly accurate brushless resolver(s). The resolver is directly coupled to the valve metering shaft through use of stainless steel bellows and is housed in an explosion-proof enclosure. The resolver receives its excitation from the EM driver. The EM driver uses a resolver-to-digital converter to determine valve position using the output voltages from the resolver's two secondary windings. Resolver accuracy is ±0.05°. Wiring to the resolver is accomplished through two 0.750-14 NPT conduit connections or two M25 x 1.5 conduit connections.

Chapter 2.
Installation

Unpacking

Take caution when unpacking the EM 24 V digital driver and EM35MR1 actuator / 3171A gas valve. Check the devices for signs of damage such as bent or dented case and loose or broken parts. If damage is found, notify the shipper immediately. The devices may be stored in their original shipping containers until they are ready for installation. Protect the devices from weather and extreme humidity or temperature fluctuations during storage.

⚠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.

⚠CAUTION

The EM35MR1/3171A assembly weight is approximately 44 kg (98 lb). To prevent injury, a lifting strap or other means of lifting assistance should be used when handling this product.

⚠CAUTION

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the 3171 gas valve assembly.

⚠CAUTION

The surface of this product can become hot 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.

Power Requirements

The EM35MR1 actuator receives all power from the EM driver. The full actuator operating range of the actuator is 18–32 VDC. The maximum steady state driver input current is 15 A continuous with peaks of 37 A for 50 ms.

⚠WARNING

EXPLOSION HAZARD—For Zone 1 / Division 1 products: Proper torque is very important to ensure that the unit is sealed properly.
Actuator cover bolt torque is:
0.250-28 socket head cap screw = 9.2 N•m (81 lb-in)
M6 x 1 socket head cap screw = 8.0 N•m (71 lb-in)
Resolver cover bolt torque is 9.2 N•m (81 lb-in).

EM Actuator/3171 Gas Valve Installation

For most applications, the valve/actuator assembly can be supported by the 25.4 mm (1 inch) flanges when bolted into the system piping. For applications where this is not practical or where additional support is required, the assembly can be bolted to a supporting structure by the four 0.625-11 UNC-2B tapped holes in the valve base.

See Figures 2-2 and 2-3 for overall dimensions, installation hole locations, and any fitting or plumbing connections. Installation attitude does not affect valve/actuator performance.

Make sure that adequate room is allowed for required wiring and that the wiring and valve/actuator are accessible for service.

There is an overboard drain port on the 3171A valve (see Figures 2-2 and 2-3). The drain must be plumbed to an area outside the turbine enclosure. The drain vents the cavities between the inner and outer seals on both ends of the valve shaft.

NOTICE

DO NOT plug the drain port. This can cause pressure to build up in the vent cavity and potentially damage the valve.

WARNING

EXPLOSION HAZARD—The overboard drain port vents process fuel to the atmosphere. Vent the drain ports to a safe location away from the turbine enclosure or any hazardous location / explosive atmosphere. Protect the vent line from obstruction, physical damage, condensation, or corrosion.

WARNING

EXPLOSION HAZARD—The overboard drain gas volume increases as temperatures drop below 0 °C (32 °F). Plan the vent system, taking temperature affects into consideration.

IMPORTANT

It is recommended that the end of the drain line (outside the enclosure) be placed in a small container of clean, lightweight oil to check for gas leakage. This will also prevent a corrosive or salt air atmosphere from corroding the shaft bearings which are in the cavity between the shaft seals.

Electrical Connections

Shielded Wiring

1. All shielded cable must be twisted conductor pairs with either a foil or a braided shield.
2. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment.
3. Connect the shields as shown in the plant wiring diagram (Figure 2-5). Wire exposed beyond the shield must not exceed 50 mm (2 inches). The other end of the shield must be left open and insulated from any other conductor.
4. Do not run shielded signal wires with other wires carrying large currents.
5. See manual 50532, *EMI Control in Electronic Governing Systems*, for more information.

Installations with severe electromagnetic interference (EMI) may require shielded cable run in conduit, double shielded wire, or other precautions. Contact Woodward for more information.

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

Take care not to damage the cover seal, cover surface, threads, or actuator or resolver surface while removing or replacing the cover.

IMPORTANT

The EM35MR1 actuator and EM resolvers are certified as type 'd' (flameproof enclosure) ATEX Category 2 equipment, suitable for use in a Zone 1 explosive atmosphere. Wiring methods must comply with this Zone 1-Category 2 method of protection when installed in either a Zone 1 or a Zone 2 classified atmosphere. Conduit seals are required. Refer to the Special Conditions for Safe Use stated on page v.

WARNING

EXPLOSION HAZARD—For Zone 1 / Division 1 products: Proper torque is very important to ensure that the unit is sealed properly. Actuator cover bolt torque is:

0.250-28 socket head cap screw = 9.2 N•m (81 lb-in)

M6 x 1 socket head cap screw = 8.0 N•m (71 lb-in)

Resolver cover bolt torque is 9.2 N•m (81 lb-in).

Plant Wiring

WARNING

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

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 diagram (Figure 2-5).

Figure 2-5 is the plant wiring diagrams for the EM driver, EM35MR1 actuator/3171A gas valve when conduit is used for all wire runs.

Consult the EM driver manual (26159) for specific wiring requirements and procedures.

1. Do not leave extra power wiring between the motor and the driver. Any extra motor wire in the installation should be cut off and discarded, not coiled.

IMPORTANT **Coiled wire will cause an inductance which could be greater than that of the motor.**

2. The metering valve is not shipped with any field wiring attached (such as pigtails) but rather is provided with internal terminal blocks for field wiring. These terminal blocks are located under the explosion-proof covers on the actuator and resolver housings.
3. The non-metric actuator housing has two 0.750-14 NPT taps, and the resolver housing has two 0.750-14 NPT taps. The metric actuator housing has two M25 x 1.5 taps, and the resolver housing has two M25 x 1.5 taps.
4. The resolver wires need to be run through the wiring connection in front of the 10-pole WAGO terminal block. The actuator power wires should go through the other wiring connection.

The terminal blocks provided for the motor resolver wires and the position resolver are WAGO 264 series. These terminal blocks are top-load terminal blocks and are actuated by inserting a DIN 5264 screwdriver into the opening behind the wire slot. Once the cage clamp has been opened, the wire can be inserted, and the screwdriver removed (see the illustration and instructions below).

1. Insert the screwdriver into the operating slot up to the stop.

2. The screwdriver blade holds the clamping spring open automatically so that the conductor can be introduced into the clamping unit.

3. Withdraw the screwdriver. The conductor is automatically clamped.

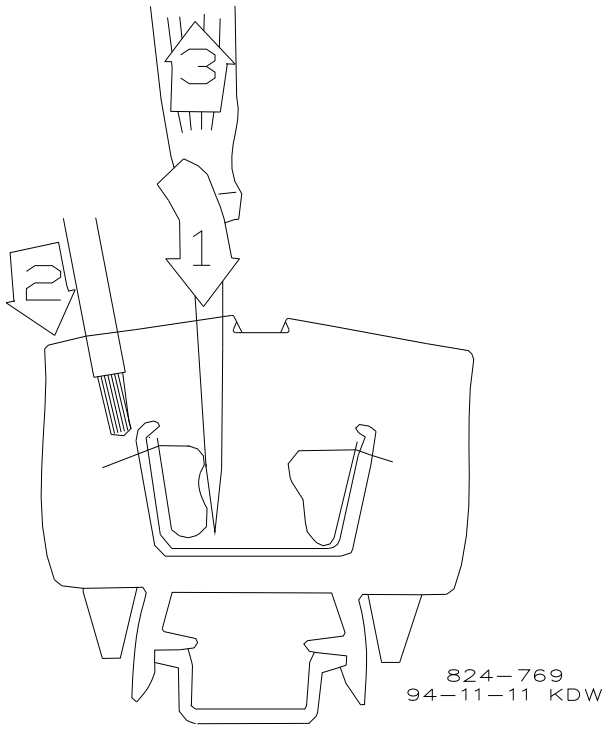


Figure 2-1. WAGO 264 Series Terminal Block

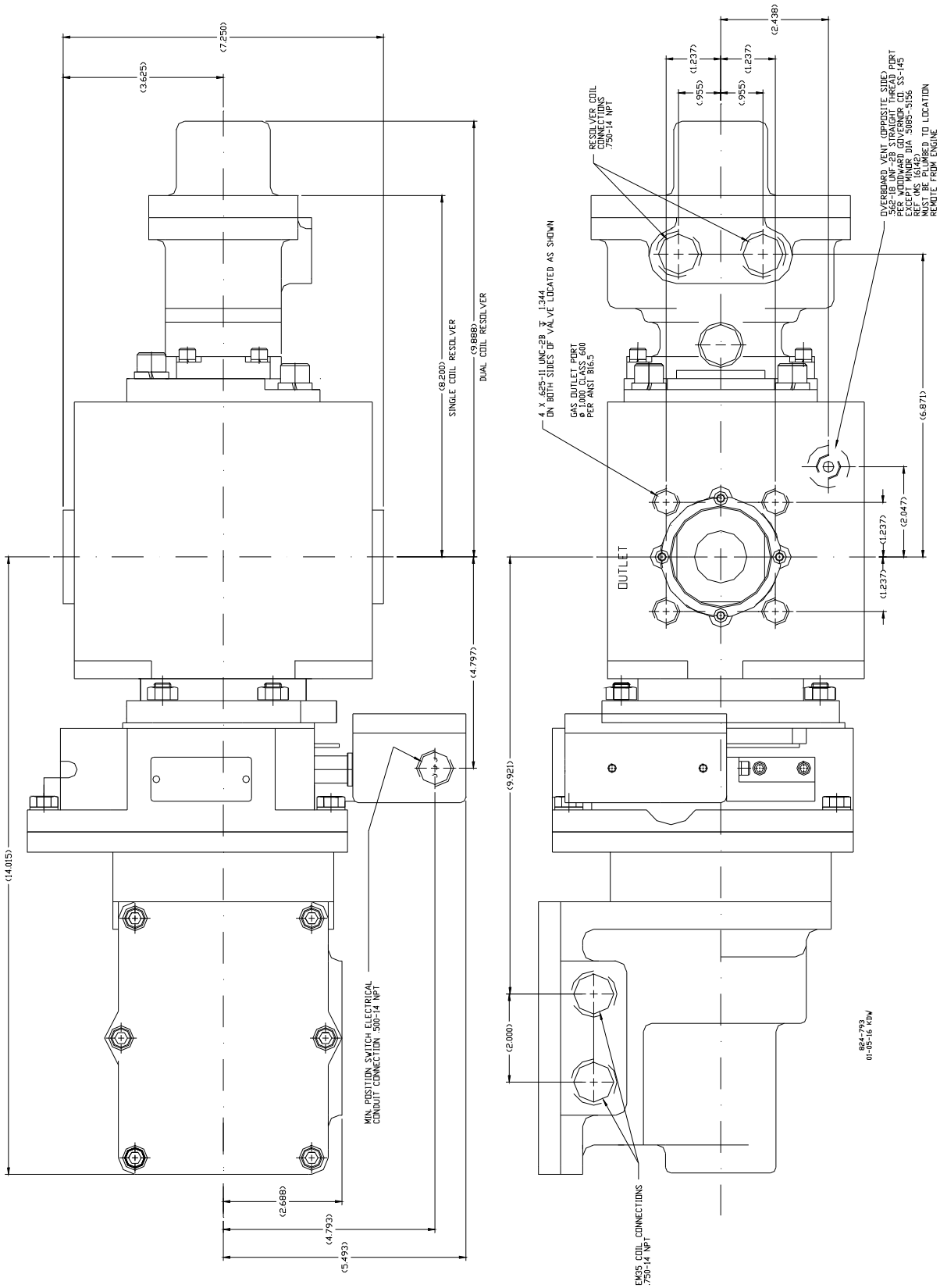


Figure 2-2a. EM35MR1 Actuator/3171A Gas Valve/Resolver
(NPT electrical conduit entries)

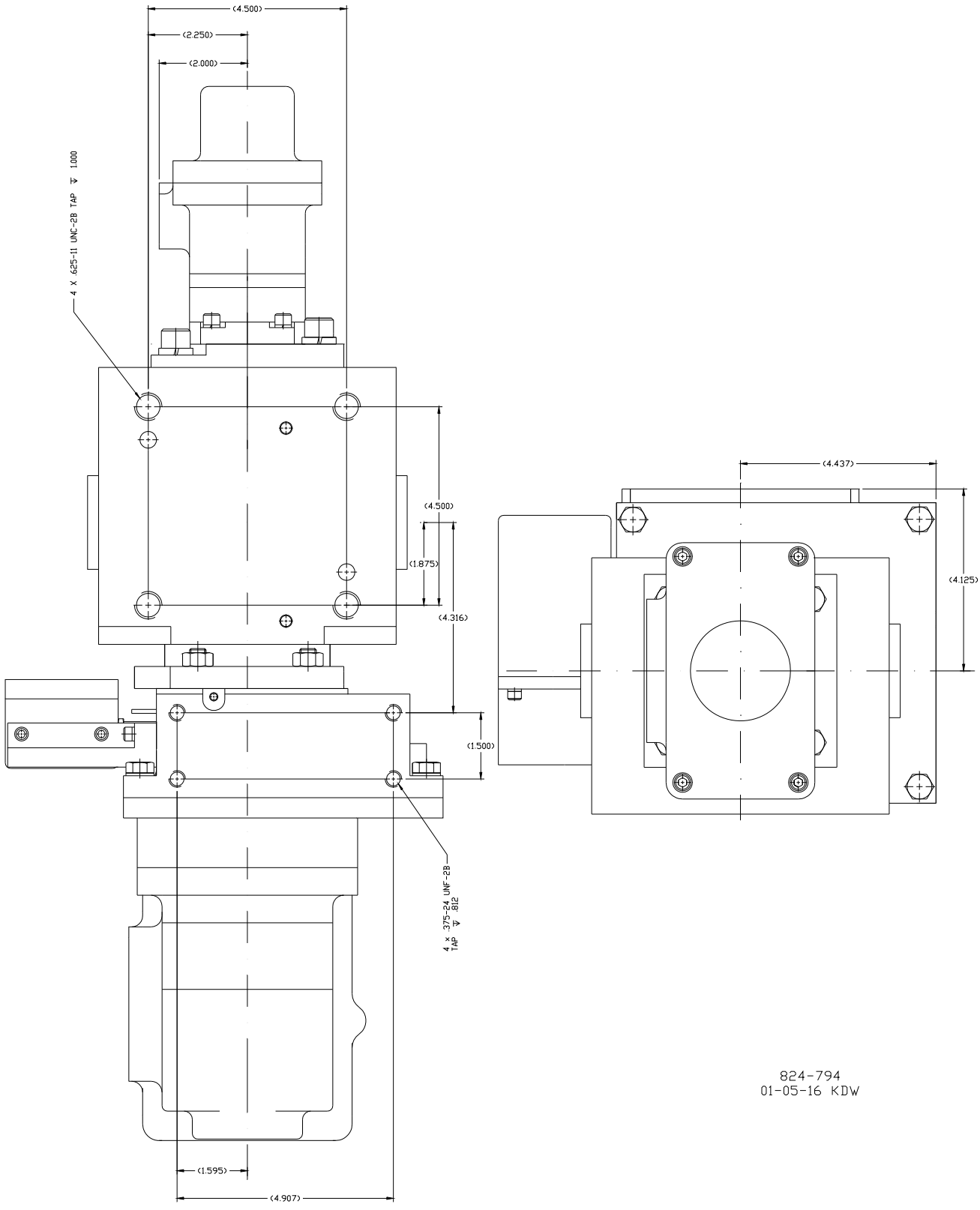


Figure 2-2b. EM35MR1 Actuator/3171A Gas Valve/Resolver
(NPT electrical conduit entries)

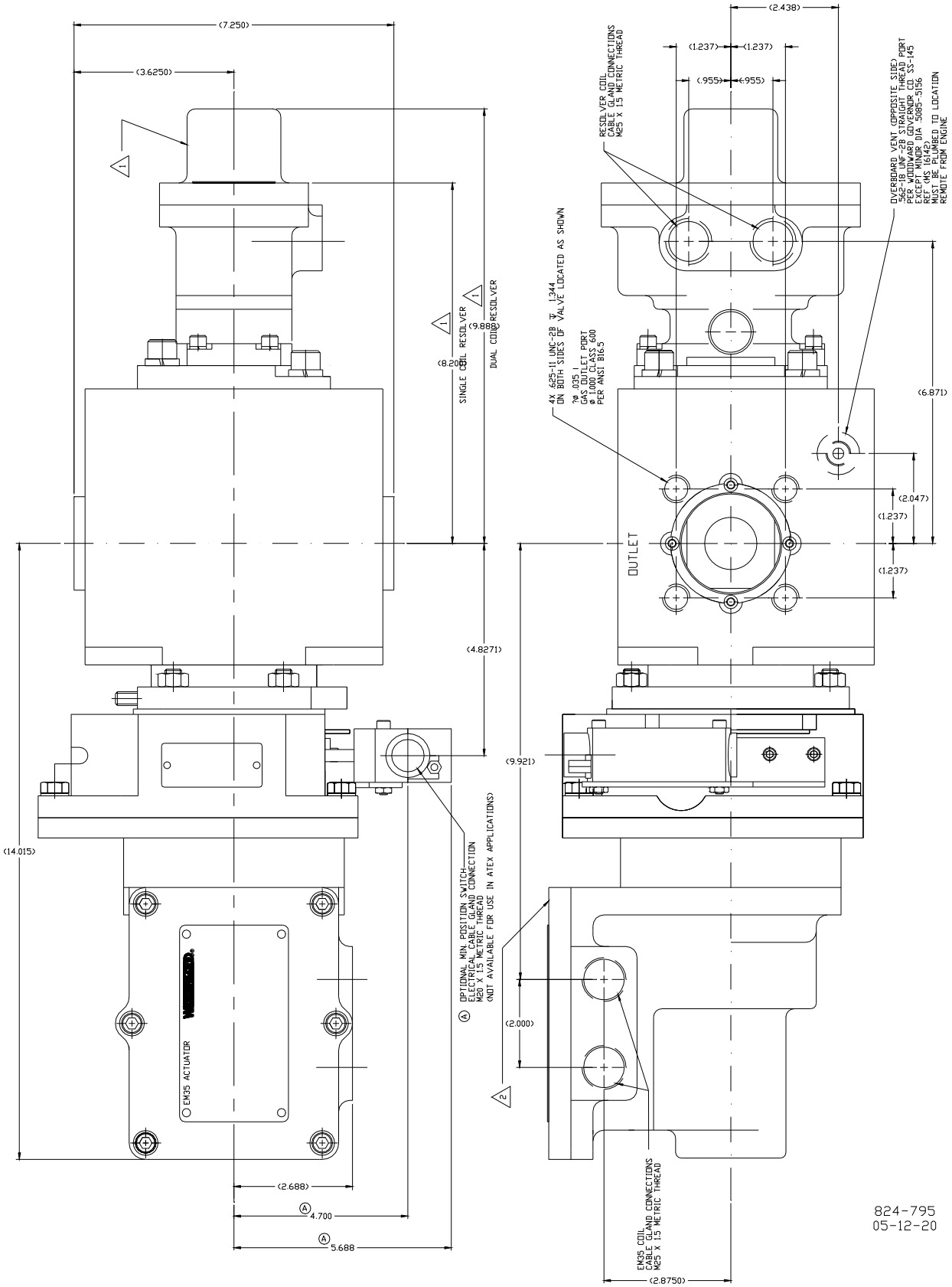


Figure 2-3a. EM35MR1 Actuator/3171A Gas Valve Position Switch/Resolver (metric electrical conduit entries)

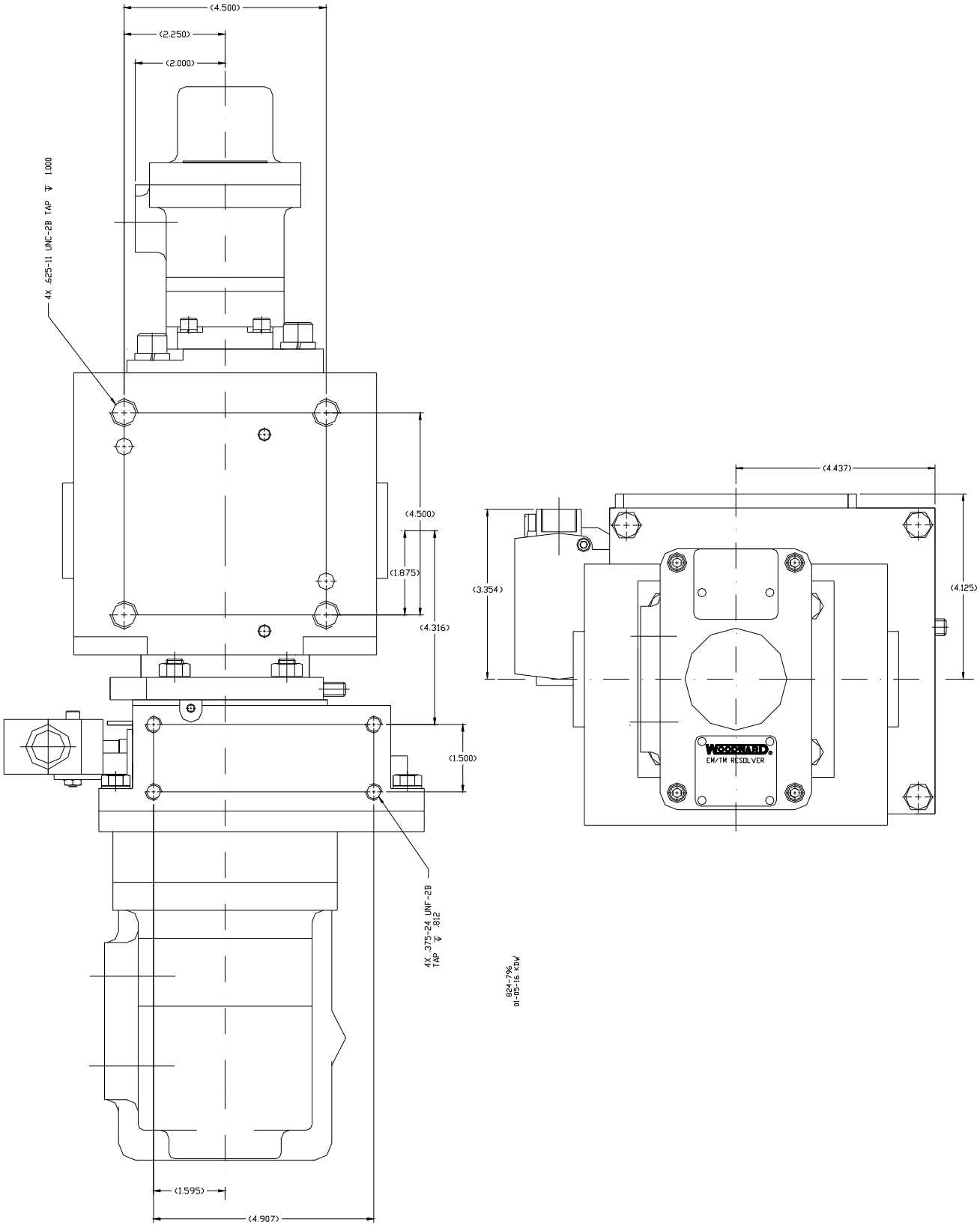


Figure 2-3b. EM35MR1 Actuator/3171A Gas Valve Position Switch/Resolver (metric electrical conduit entries)

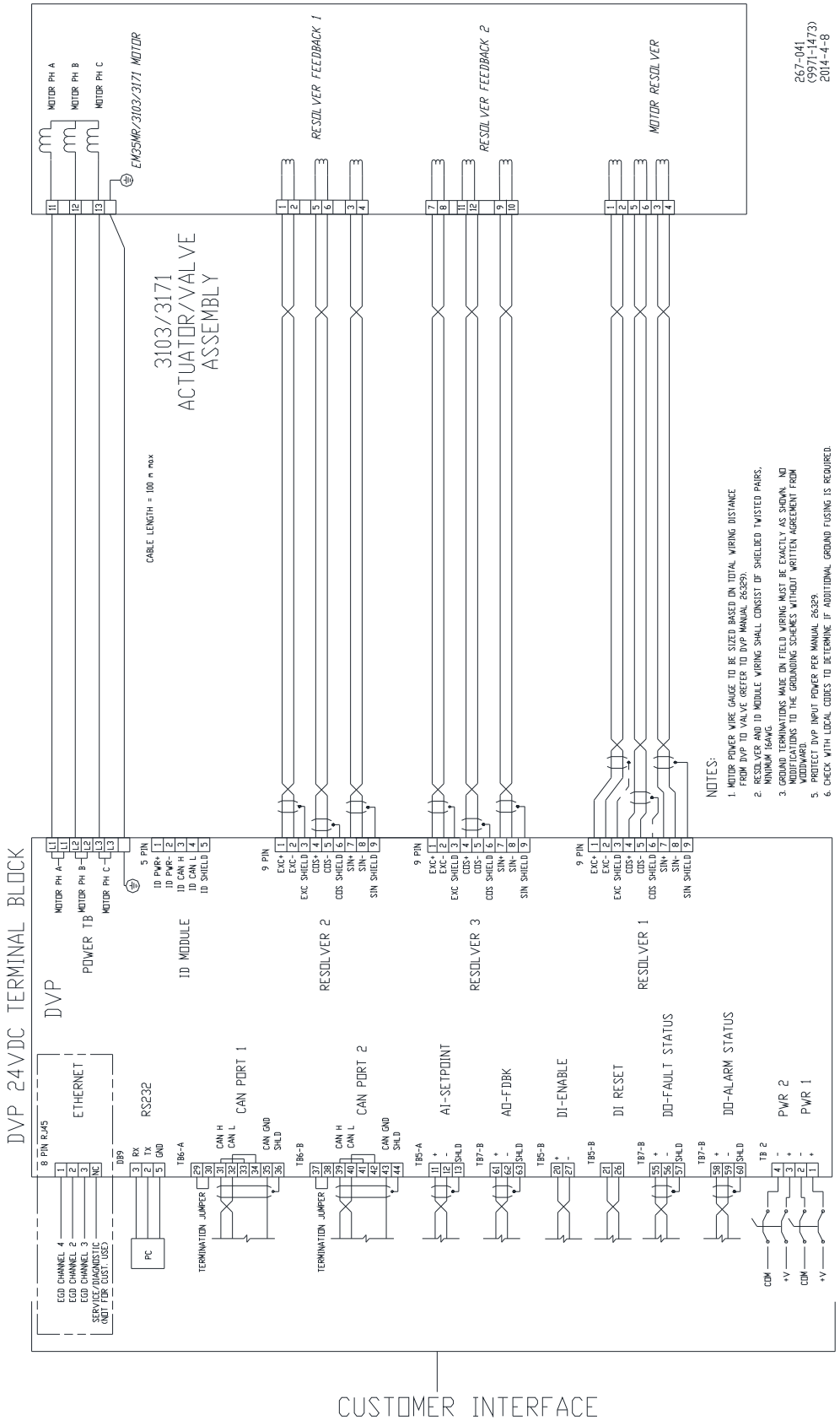


Figure 2-4. DVP Driver Drawing

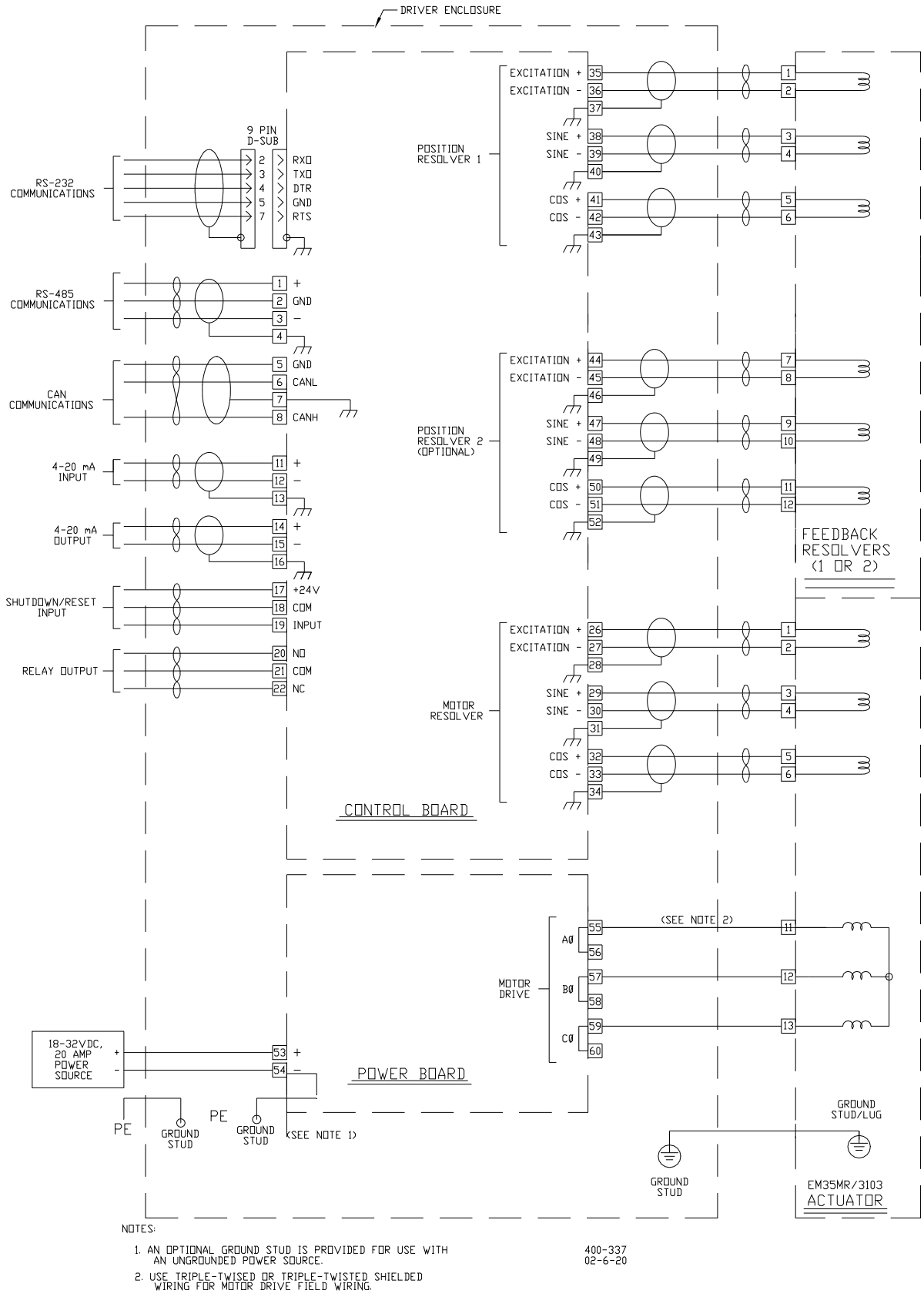


Figure 2-5. Plant Wiring Diagram

Chapter 3.
Description of Operation

EM35MR1 Actuator

The EM35MR1 electric actuator is comprised of a brushless dc motor, clutch assembly, gearhead assembly, and explosion-proof housing. The brushless dc motor uses Samarium Cobalt permanent magnets bonded and sleeved to the rotor. The high-speed motor output shaft is clutched before the gearbox assembly. This clutch prevents damage to the motor shaft and gearbox should an external force suddenly stop the rotation of the gearbox output shaft. The clutch slips at 1.5 times the maximum output force of the motor/gearbox assembly. The motor gearbox is a planetary gearbox and is used to reduce the output speed and increase the output torque.

The control signals for the motor come from an external motor driver. The motor driver handles motor commutation as well as closed-loop position control. The position feedback comes from a precision resolver directly coupled to the valve metering sleeve. This arrangement prevents any errors in sensing the desired valve position through linkages and geartrains and results in precise position control. Having the feedback on the valve also allows for the motor to be repaired or replaced in the field without any loss of calibration. The entire motor assembly is installed in a cast explosion-proof housing. The motor is heat sunk to this external housing to allow heat generated by the motor to be effectively transferred to the ambient environment. The output shaft of the geartrain is supported by two roller bearings. To minimize side load to the motor, the output shaft is directly coupled to the valve using stainless steel torsional coupling. The torsional coupling efficiently transmits the motor torque to the valve with very little lost motion and is key to achieving the desired position control of the valve.

3171A Gas Valve

Actuator output shaft movement positions the gas valve metering sleeve and resolver. Gas flow is metered at the valve through a ported rotary sleeve. Gas enters the inlet port (P1) where it is directed through the inlet guide tube to the rotary metering port. A spring and pressure-loaded, sharp edged shoe seals against the metering sleeve. Metered fuel is discharged at the outlet pressure. Metered fuel is determined by valve position, inlet pressure (P1), outlet pressure (P2), gas temperature, and gas composition.

Water Ingress Protection

NOTICE

The EM35MR1/3171A valve assembly does not carry an Ingress Protection rating and can be damaged by water exposure. Follow the water protection considerations to prevent motor damage.

The following are considerations for protecting the EM35MR actuator from water damage:

1. **Turbine Water Wash Process**—Some customers perform a water wash of the turbine compressor section which can result in incidental water spray directed onto the actuator. The EM35MR1/3171A valve assembly should be properly protected from this water spray.

2. **Conduit Fittings**—Woodward recommends that rigid or flexible conduit be used to route the actuator wiring. Woodward also recommends that water-tight conduit fittings be used when installing the wiring to the actuator.

3. **Conduit Plug**—If one of the actuator conduit ports remains unused, the supplied steel plug should be securely installed with a non-hardening pipe thread sealant. Do not over-tighten.

4. **Power Wash**—The valve and actuator assembly should NOT be pressure / power washed. If there is other equipment in the vicinity that is being pressure washed, the EM35MR1/3171A assembly should be adequately protected from incidental water spray.

Figure 3-1. Conduit Plug (M25 Shown) & Warning Label

Chapter 4.
Actuator/Valve Calibration

EM35MR1 Actuator/3171 Gas Valve with Driver

For calibration details, see manual 40142 *Dry Low Emissions, Fuel Metering Valves: Warnings, Calibration, and Installation*.

The EM35MR1 actuator/gas valves used with the digital driver is typically for applications that require extremely high accuracy, such as dry low emissions (DLE) control. For that reason, all calibration of the actuator/valve assembly is performed at the factory.

The mechanical stops on the valve limit valve travel and prevent damage caused by driving it beyond its normal range. Flow calibration is achieved using the digital resolver feedback and a valve characterization table. The flow vs. angle data is determined for each valve during the flow testing and is recorded on a floppy disk.

No field rigging is required to calibrate the valve. There is a warning tag on the valve and a warning message on the operator panel stating that the table identification (serial number and date code) must match the valve identification.

⚠WARNING

For DLE systems, significant turbine damage, high emissions levels, release of high-temperature gas, fire, damage to nearby equipment, injury to personnel, or death may result from incorrect fuel valve calibration. To correctly operate the fuel metering valve(s), the NetCon or MicroNet controller must be programmed with the correct valve characterization curve for the specific valve being used. Woodward provides the programming information to the valve purchaser in the form of a data file specifically identified by the valve serial number and date. The supplier of the application program must incorporate the valve characterization data file into the application program by following the procedure described in this manual. Failure to follow the procedure herein, or any non-Woodward alteration (including attempt to repair), or damage to the valve, may result in a change of characteristics leading to the same potential hazards.

⚠WARNING

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

Chapter 5. Troubleshooting

General

Faults in the governing system are usually revealed as speed variations of the prime mover, but it does not necessarily follow that such speed variations indicate governing system faults. Therefore, when improper speed variations appear, check all components including the prime mover for proper operation.

Problems with the EM/valve assembly will usually show up as faults in the driver. Refer to the EM 24 V driver manual (26159) for detailed fault information.

Overcurrent trips experienced by the driver can be a result of driving the valve into (or operating too close to) the mechanical stops. These stop screws are used for calibration purposes only and are backed out of the valve operating range before shipment to the customer.

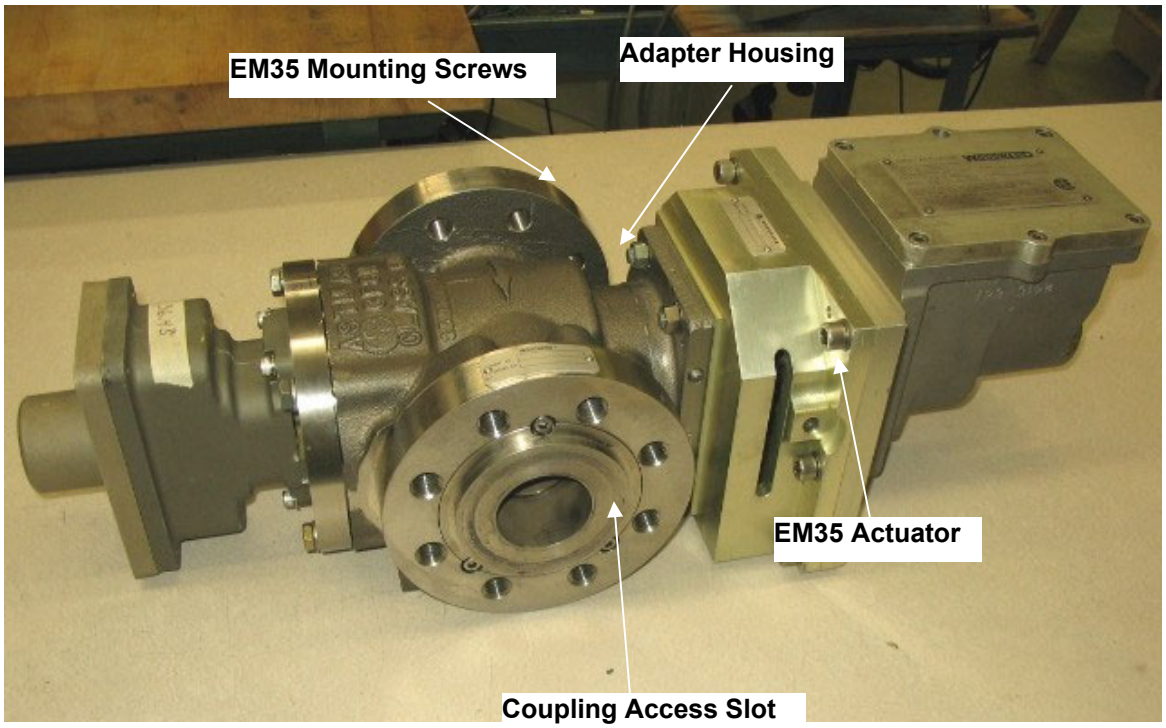
Procedure for EM35 Actuator Field Replacement

The EM35 actuator may be replaced in the field without affecting the calibration of the valve/actuator assembly. This procedure describes the steps necessary to perform an actuator replacement in the field.

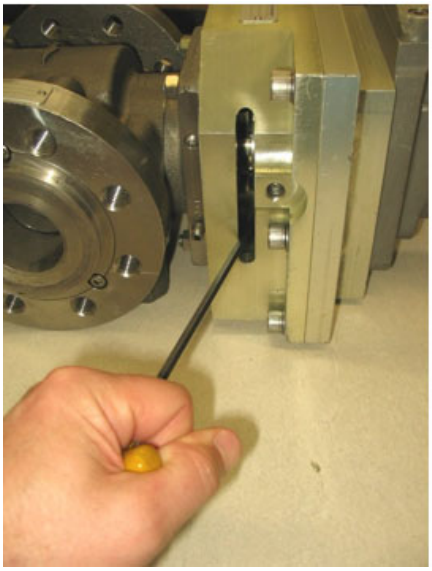
Required Tools:
- 3/16” ball hex driver, 6” long, 3/8” drive
- 5/16” ball hex driver, 6” long, 3/8” drive
- 3/8” drive ratchet
- 5/16” hex Allen wrench
- 3/8” drive torque wrench, capable of 33.2 N•m (24.5 lb-ft)

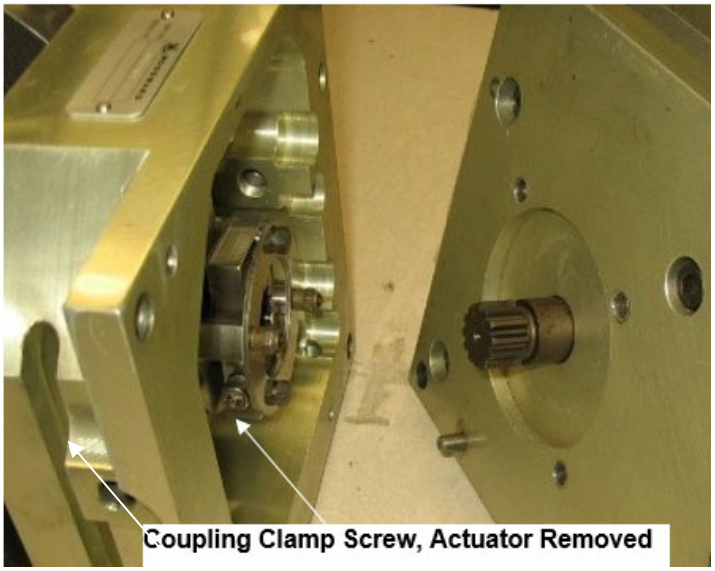
Procedure

1. Locate the coupling assembly between the 3171A gas valve and the EM35 actuator; it can be viewed through the long vertical slot in the adapter housing.



2. Using the 3/16” ball hex driver, loosen the socket head cap screw that clamps the coupling assembly to the EM35 output shaft. Do not loosen the clamp screw that mounts the coupling assembly to the valve shaft.





3. Using the 5/16” Allen wrench, remove the five socket head cap screws and lock washers that mount the EM35 actuator to the adapter housing. Remove the EM35 actuator from the assembly.

4. Before installing the new EM35 actuator, properly orient the unit so the two lining pins for the actuator match up with the corresponding holes in the adapter housing. If necessary, rotate the shaft of the EM35 motor by hand to properly orient the splines up with those of the coupling assembly.

   When everything is in position, first slip the actuator shaft into the coupling assembly, then line up the pins of the actuator with the adjacent holes in the adapter housing. The actuator should mate up without any binding or use of significant force.

5. Once the actuator is in proper position, re-install the five socket head cap screws and lock washers removed in step 3. Torque the bolts to 33.2 N•m (24.5 lb-ft).

6. Using the 3/16” long ball hex driver and torque wrench, tighten the socket head cap screw on the coupling at the EM35 output shaft. Torque to 9.3 N•m (82 lb-in).

7. Reconnect field wiring to EM35 actuator terminal blocks.

8. Perform valve-stroking procedure, verifying the valve can be stroked from the minimum to maximum stop.

Chapter 6.
Valve Sizing—Non-DLE Applications

Determination of Effective Area

To choose the proper size of valve for an application, the *effective area* required to meet your maximum flow requirement must first be determined. The effective area is determined using the following equations.

$$R7(K) = \left(\frac{2}{1+K}\right)^{\frac{K}{K-1}}$$

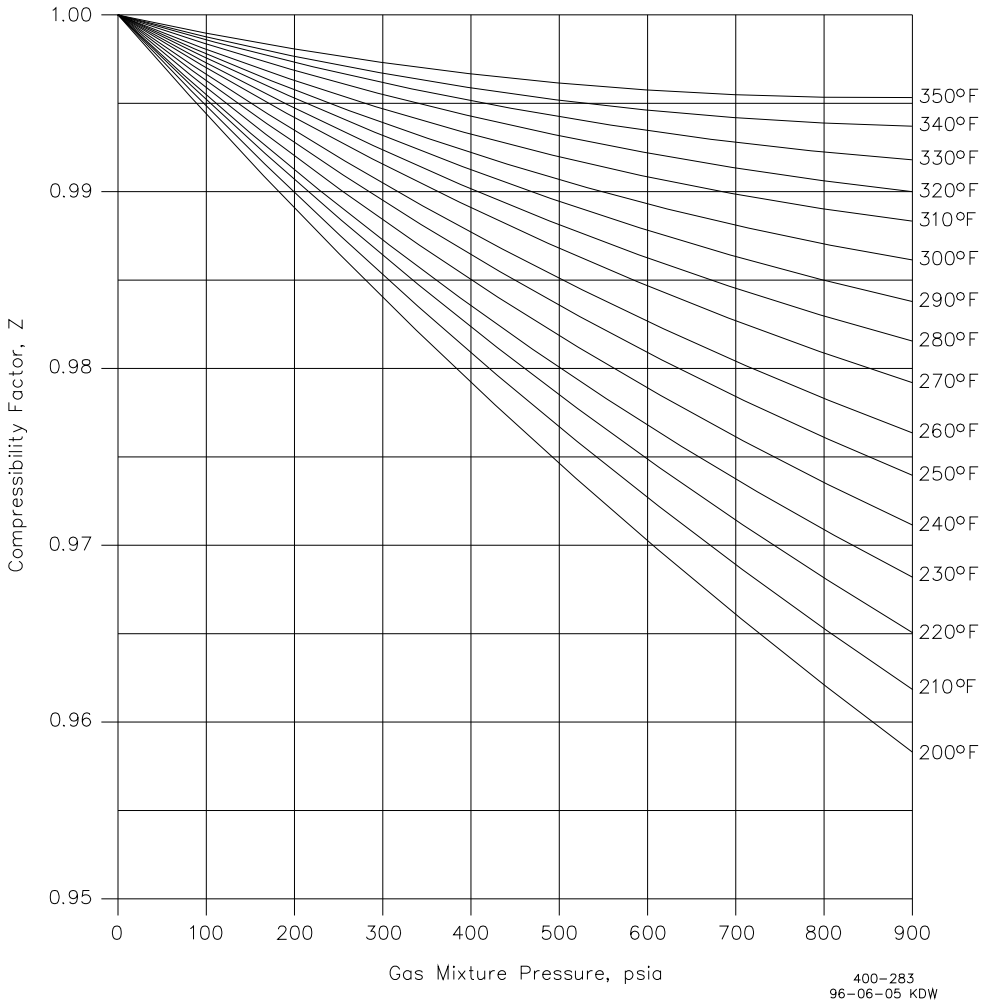
$$\text{If} \quad \frac{P2}{P1} \geq R7 \qquad \text{Effective\_Area} = \frac{FLOW}{\left[3955.289 \cdot P1 \cdot \sqrt{\left[\frac{K \cdot Sg}{(K-1) \cdot T \cdot Z}\right] \cdot \left[\left(\frac{P2}{P1}\right)^{\frac{2}{K}} - \left(\frac{P2}{P1}\right)^{\frac{1+K}{K}}\right]}\right]}$$

$$\text{If} \quad \frac{P2}{P1} < R7 \qquad \text{Effective\_Area} = \frac{FLOW}{\left[3955.289 \cdot P1 \cdot \sqrt{\left[\frac{K \cdot Sg}{(K-1) \cdot T \cdot Z}\right] \cdot \left(R7^{\frac{2}{K}} - R7^{\frac{1+K}{K}}\right)}\right]}$$

Where:

- P1 = Valve inlet pressure (psia)
- P2 = Valve discharge pressure (psia)
- K = Ratio of specific heats for the gas
  (1.300 typical for standard natural gas at 60 °F)
- Sg = Specific gravity relative to air for the gas
  (0.60 typical for standard natural gas)
- Flow = Valve metered flow (lb/h)
- T = Temperature of the gas (Deg Rankine)
  (Deg R = Deg F + 459.7)
- Z = Gas Compressibility Factor
  (essentially 1 for most applications—see the following graph)

IMPORTANT **The valve size selected should be sized to be adequate for worst-case flow conditions. This would be minimum P1, maximum P2, maximum flow, and maximum temperature.**



Valve Sizing and the Effective Area Tables

Once the effective area has been determined, move to the effective area tables later in this chapter. The effective area table has % valve travel, demand mA, and valve angle listed in the first three columns. The following ten columns list the valve effective area for pressure ratios (P2/P1) from 0.05 to 0.95 respectively. To pick the proper size valve for an application, move to the sheet that has a value for effective area greater than or equal to that determined above in the 100 percent travel row for the applicable pressure ratio column.

IMPORTANT

Woodward recommends that no less than 60% valve travel be used for the full control range. Using less than that could cause instability problems as the system attempts to control at very low increments of travel.

Determining the Demand Required to Achieve Specific Flows

Determining demand values necessary to achieve a specific flow at end or intermediate points once the valve size is set is a very similar process to sizing the valve. First, determine the necessary valve effective area for the flow point. Interpolate between pressure ratios and demand columns to determine at what percent/mA/valve angle the flow will be achieved.

Notes on the Valve Sizing and Application Program

The algorithm used for sizing and demand value determination used in the standard valve application programs available for the 3171A is essentially the same as that described above. However, the program makes use of a valve inlet pressure compensation algorithm that enhances the accuracy of the calculation. This compensation scheme is not easily implemented in a manual system as described here. Therefore, the demand values determined using the methods described here will be slightly different from those determined using the application programs. Since this difference is small, the use of the application program is not absolutely necessary for the sizing/application of standard valves.

Table 6-1. Effective Area Table (0.45 port)

% Travel	Driver mA	Valve Angle	Pressure Ratio (P2/P1) 0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
2.22	4.36	1	0.000229	0.000223	0.000222	0.000225	0.000229	0.000226	0.000230	0.000232	0.000231	0.000197
6.67	5.07	3	0.001875	0.001869	0.001872	0.001865	0.001837	0.001775	0.001721	0.001677	0.001640	0.001579
11.11	5.78	5	0.005285	0.005270	0.005258	0.005229	0.005156	0.004990	0.004832	0.004721	0.004637	0.004528
15.56	6.49	7	0.010537	0.010489	0.010456	0.010395	0.010235	0.009893	0.009588	0.009372	0.009197	0.009032
20.00	7.20	9	0.017432	0.017408	0.017362	0.017259	0.017002	0.016447	0.015918	0.015528	0.015182	0.014904
24.44	7.91	11	0.025954	0.025933	0.025888	0.025763	0.025399	0.024611	0.023860	0.023300	0.022938	0.022542
28.89	8.62	13	0.036183	0.036147	0.036078	0.035920	0.035515	0.034516	0.033553	0.032883	0.032446	0.031871
33.33	9.33	15	0.048787	0.048787	0.048368	0.048144	0.047767	0.046659	0.045347	0.044240	0.043590	0.042985
37.78	10.04	17	0.062435	0.062435	0.062371	0.061836	0.061301	0.059990	0.058865	0.058280	0.056579	0.056051
42.22	10.76	19	0.077651	0.077651	0.077387	0.076922	0.076424	0.075020	0.073929	0.072893	0.072379	0.070978
46.67	11.47	21	0.094680	0.094680	0.094488	0.093706	0.092399	0.092150	0.090652	0.090042	0.089633	0.088293
51.11	12.18	23	0.112763	0.112763	0.112763	0.113240	0.112285	0.109713	0.109392	0.108721	0.108380	0.108864
55.56	12.89	25	0.133094	0.133094	0.133094	0.132659	0.131963	0.129670	0.128738	0.128946	0.128520	0.129995
60.00	13.60	27	0.154584	0.154584	0.154584	0.153889	0.153911	0.151566	0.149995	0.149207	0.149297	0.150635
64.44	14.31	29	0.178065	0.178065	0.178065	0.177566	0.176445	0.173847	0.172562	0.171867	0.172051	0.172530
68.89	15.02	31	0.200942	0.200942	0.200942	0.200942	0.200599	0.198966	0.197009	0.195823	0.195508	0.199157
73.33	15.73	33	0.227444	0.227444	0.227444	0.227444	0.226616	0.224725	0.222349	0.221850	0.221843	0.225184
77.78	16.44	35	0.255442	0.255442	0.255442	0.255442	0.254331	0.251887	0.250449	0.249719	0.250291	0.255755
82.22	17.16	37	0.284425	0.284425	0.284425	0.284425	0.284425	0.281631	0.279959	0.280850	0.282375	0.286134
86.67	17.87	39	0.315929	0.315929	0.315929	0.315929	0.315929	0.312620	0.312357	0.313831	0.317176	0.323685
91.11	18.58	41	0.344793	0.344793	0.344793	0.344793	0.344793	0.344793	0.345974	0.349147	0.354705	0.365706
95.56	19.29	43	0.381113	0.381113	0.381113	0.381113	0.381113	0.381113	0.383051	0.388496	0.397124	0.411842
100.00	20.00	45	0.419587	0.419587	0.419587	0.419587	0.419587	0.419587	0.419587	0.432397	0.443849	0.462109

Valve angle = Resolver Feedback Angle – Resolve Offset Angle
Resolver Offset Angle = ~20 degrees
4 mA = 0° valve angle = 0 % valve position = ~20° resolver angle
min stop = –2 degrees valve angle
max stop = 47 degrees valve angle

Table 6-2. Effective Area Table (0.56 port)

% Travel	Driver mA	Valve Angle	Pressure Ratio (P2/P1)										
			0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
2.22	4.36	1	0.000340	0.000340	0.000340	0.000340	0.000340	0.000331	0.000323	0.000318	0.000314	0.000310
6.67	5.07	3	0.002410	0.002451	0.002462	0.002462	0.002441	0.002381	0.002328	0.002305	0.002280	0.002249
11.11	5.78	5	0.006576	0.006550	0.006550	0.006531	0.006412	0.006297	0.006112	0.005984	0.005802	0.005703
15.56	6.49	7	0.013062	0.013114	0.013070	0.013007	0.012794	0.012346	0.011951	0.011671	0.011443	0.011194
20.00	7.20	9	0.021966	0.022016	0.021777	0.021643	0.021288	0.020551	0.019886	0.019347	0.019032	0.018662
24.44	7.91	11	0.032670	0.032866	0.032811	0.032632	0.032145	0.031091	0.030072	0.029238	0.028796	0.028136
28.89	8.62	13	0.045808	0.045808	0.045994	0.045799	0.044958	0.043634	0.042273	0.041157	0.040530	0.039957
33.33	9.33	15	0.061408	0.061408	0.061080	0.060669	0.060330	0.058537	0.056713	0.055484	0.054779	0.054149
37.78	10.04	17	0.078515	0.078515	0.078421	0.077907	0.077192	0.075399	0.073338	0.072188	0.071236	0.070728
42.22	10.76	19	0.098062	0.098062	0.097738	0.097697	0.096853	0.094875	0.092763	0.091721	0.091419	0.089625
46.67	11.47	21	0.119900	0.119900	0.119900	0.119872	0.118845	0.116488	0.114171	0.114509	0.114398	0.113719
51.11	12.18	23	0.143813	0.143813	0.143813	0.143071	0.142550	0.139447	0.138697	0.138446	0.138990	0.138690
55.56	12.89	25	0.169449	0.169449	0.169449	0.168313	0.167743	0.164815	0.165074	0.165541	0.165411	0.167690
60.00	13.60	27	0.196374	0.196374	0.196374	0.196374	0.194597	0.192875	0.193634	0.194556	0.194645	0.196853
64.44	14.31	29	0.226344	0.226344	0.226344	0.226344	0.223891	0.222085	0.224023	0.224218	0.226397	0.229857
68.89	15.02	31	0.257915	0.257915	0.257915	0.257915	0.256055	0.253273	0.255976	0.257355	0.259127	0.264236
73.33	15.73	33	0.288893	0.288893	0.288893	0.288893	0.288893	0.286747	0.288915	0.292843	0.295360	0.304574
77.78	16.44	35	0.324405	0.324405	0.324405	0.324405	0.324405	0.323881	0.325043	0.331615	0.337278	0.352703
82.22	17.16	37	0.363388	0.363388	0.363388	0.363388	0.363388	0.363388	0.366373	0.373116	0.381959	0.402301
86.67	17.87	39	0.406746	0.406746	0.406746	0.406746	0.406746	0.406746	0.410352	0.422136	0.435759	0.461875
91.11	18.58	41	0.454544	0.454544	0.454544	0.454544	0.454544	0.454544	0.454544	0.472314	0.492225	0.529226
95.56	19.29	43	0.505518	0.505518	0.505518	0.505518	0.505518	0.505518	0.505518	0.529134	0.556913	0.598571
100.00	20.00	45	0.589023	0.589023	0.589023	0.589023	0.589023	0.589023	0.589023	0.589023	0.629651	0.679971

Valve angle = Resolver Feedback Angle – Resolve Offset Angle
Resolver Offset Angle = ~20 degrees
4 mA = 0° valve angle = 0 % valve position = ~20° resolver angle
min stop = –2 degrees valve angle
max stop = 47 degrees valve angle

Table 6-3. Effective Area Table (0.80 port)

% Travel	Driver mA	Valve Angle	Pressure Ratio (P2/P1)										
			0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
2.22	4.36	1	0.001268	0.001268	0.001268	0.001259	0.001240	0.001178	0.001174	0.001130	0.001118	0.001098
6.67	5.07	3	0.007104	0.007104	0.007097	0.007047	0.006915	0.006664	0.006419	0.006235	0.006094	0.005994
11.11	5.78	5	0.013164	0.013164	0.013123	0.012975	0.012674	0.012163	0.011663	0.011261	0.010921	0.010601
15.56	6.49	7	0.020476	0.020476	0.020489	0.020313	0.019914	0.019132	0.018417	0.017871	0.017435	0.016984
20.00	7.20	9	0.031493	0.031493	0.031462	0.031293	0.030746	0.029664	0.028625	0.027895	0.027404	0.026858
24.44	7.91	11	0.046439	0.046439	0.047144	0.046844	0.045797	0.043606	0.042195	0.041121	0.040273	0.039714
28.89	8.62	13	0.064134	0.064134	0.064032	0.063844	0.063401	0.061785	0.059564	0.058264	0.057145	0.056213
33.33	9.33	15	0.084614	0.084614	0.084418	0.084504	0.083775	0.081571	0.079180	0.077576	0.076727	0.076499
37.78	10.04	17	0.108130	0.108130	0.107064	0.107385	0.106905	0.104499	0.102432	0.101102	0.100227	0.099891
42.22	10.76	19	0.133135	0.133135	0.133135	0.133355	0.132112	0.130222	0.127515	0.126490	0.125698	0.124748
46.67	11.47	21	0.163205	0.163205	0.163205	0.161529	0.161990	0.158794	0.157151	0.156008	0.157555	0.158241
51.11	12.18	23	0.194867	0.194867	0.194867	0.194867	0.192081	0.190876	0.190011	0.189020	0.191609	0.194386
55.56	12.89	25	0.227775	0.227775	0.227775	0.227775	0.226682	0.225527	0.223845	0.228674	0.231551	0.237357
60.00	13.60	27	0.265077	0.265077	0.265077	0.265077	0.265077	0.262624	0.264426	0.270081	0.273840	0.282968
64.44	14.31	29	0.305461	0.305461	0.305461	0.305461	0.305461	0.299181	0.307252	0.315207	0.323542	0.335320
68.89	15.02	31	0.343460	0.343460	0.343460	0.343460	0.343460	0.343460	0.352959	0.362608	0.373934	0.389487
73.33	15.73	33	0.389337	0.389337	0.389337	0.389337	0.389337	0.389337	0.400309	0.411596	0.425662	0.445432
77.78	16.44	35	0.446380	0.446380	0.446380	0.446380	0.446380	0.446380	0.446380	0.462247	0.479492	0.505635
82.22	17.16	37	0.493362	0.493362	0.493362	0.493362	0.493362	0.493362	0.493362	0.515399	0.536750	0.572877
86.67	17.87	39	0.570578	0.570578	0.570578	0.570578	0.570578	0.570578	0.570578	0.570578	0.604271	0.644578
91.11	18.58	41	0.637356	0.637356	0.637356	0.637356	0.637356	0.637356	0.637356	0.637356	0.666604	0.719300
95.56	19.29	43	0.734476	0.734476	0.734476	0.734476	0.734476	0.734476	0.734476	0.734476	0.734476	0.791275
100.00	20.00	45	0.804711	0.804711	0.804711	0.804711	0.804711	0.804711	0.804711	0.804711	0.804711	0.865144

Valve angle = Resolver Feedback Angle – Resolve Offset Angle
Resolver Offset Angle = ~20 degrees
4 mA = 0° valve angle = 0 % valve position = ~20° resolver angle
min stop = –2 degrees valve angle
max stop = 47 degrees valve angle

Chapter 7. Maintenance

There are no critical maintenance items in the EM35MR1/3171A gas valve assemblies, such as filters that should be changed, etc. The valve assembly should be visually inspected, in accordance with your specific maintenance schedule. Each site must determine the appropriate schedule based on the severity of the service conditions. Inspect for dirt, grease, dust, or other buildup in the areas of moving parts or joints. Clean environmentally originated buildup from the unit. If cleaning solution is used, verify that it is compatible with the Viton and Teflon valve seal materials. If any buildup appears to have originated from within the valve, return the valve to Woodward for service (see Chapter 8).

Chapter 8.
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 the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at www.woodward.com, which also contains the most current product support and contact information.

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

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany:	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

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.

EM35MR1/3171A Specifications

The EM35MR1 electric actuator was designed to position Woodward gas and liquid valves equipped with resolver feedback. The actuator requires a final driver for driving the motor and for closed-loop control.

The EM35MR1 actuator uses a brushless dc motor with a 137:1 reducing planetary gearhead. The motor is designed with Samarium Cobalt permanent magnets bonded to the rotor element, and all stator windings are completely sealed. Rotor position sensing is performed by the resolver unit integral with the motor. This inductive device requires excitation and demodulation within the electronic motor controller.

Mechanical	
Output shaft rotation	45° (rotation limited by valve stops)
Actuator/valve coupling	Direct coupling
Torque constant	1.8 N•m/A (16 lb-in/A)
Continuous output torque	±25 N•m (±220 lb-in) maximum
Peak output torque	±62 N•m (±552 lb-in) minimum
Clutch breakaway torque	±68 N•m (±600 lb-in)
Valve gas connection	1" 600# ANSI B16.5 (25 mm, 2669 N)
Gas flow	11 to 9070 kg/h (25 to 20 000 pph) natural gas
Gas pressure	0 to 6205 kPa (0 to 900 psia)
Electrical	
Motor Voltage	28 VDC nominal, 18–32 VDC operating
Motor Current	15 A continuous 37 A peak current for 50 ms
System Accuracy	
Using 485 or CAN for control:	
Accuracy:	± 6 arc min RSS (root sum squared)
Using 4–20 mA for control:	
Initial Accuracy:	± 0.22°
Accuracy Over Temperature:	± 1.372°
4–20 mA Position Readback:	
Initial Accuracy:	± 0.24°
Accuracy Over Temperature:	± 0.49°

System Performance

Slew Time Performance—Less than 100 ms to open and close the valve at a line voltage of 24 VDC. This slew rate shall be measured using the speed achieved between the 10% and 90% points. The rated stroke of the 3171A gas valve is 45°

System bandwidth is nominally greater than 31.4 rad/s (5.0 Hz). The frequency response mimics a 2-pole linear system, with the bandwidth corresponding to –6 dB gain. The damping factor is set to 1.

Equivalent dead time does not exceed 40 ms, which includes all effects such as the communications, processing time, mechanical times, etc.

Environmental	
Ambient Temperature	
Valve, Actuator, & Resolver:	–40 to +93 °C (–40 to +200 °F)
Fuel Temperature:	–40 to +149 °C (–40 to +300 °F)
Vibration:	US MIL-STD-810C Method 514.2, Category b.1, Table 514.2-II, Figure 514.2 curve j (5 g)

Shock: US MIL-STD-810C, Method 516.2, Figure 516.2-1, 20g 11ms sawtooth

Revision History

Changes in Revision E—
- Replaced all Declarations

Changes in Revision D—
- Compliance Updates
- Updated Declarations

Changes in Revision C—
- Added DVP Driver drawing (Figure 2-4)

Changes in Revision B—
- Added Effective Area tables for 0.45, 0.56, and 0.80 ports at the end of Chapter 6.

Changes in Revision A—
- Updated Regulatory Compliance information and Declarations
- Added Water Ingress Protection information (page 13)

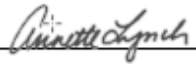
Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00111-04-CE-02-02
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	EM35MR1 Actuators
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/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 equipment and protective systems intended for use in potentially explosive atmospheres
Markings in addition to CE marking:	Ex II 2 G, Ex db IIB T3 Gb
Applicable Standards ATEX:	EN IEC 60079-0:2018 Electrical apparatus for potentially explosive atmospheres - General Requirements (A review against EN IEC 60079-0:2018, which is harmonized, shows no significant changes relevant to this equipment so EN 60079-0:2012 continues to represent "State of the Art") EN 60079-1:2014 Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure 'd' (A review against EN60079-1:2014, which is harmonized, shows no significant changes relevant to this equipment so EN60079-1:2007 continues to represent "State of the Art")
Third Party Certification:	Sira 13ATEX1188X CSA Group Netherlands B.V. Ultrechseweg 310, 6812 AR, Arnhem, Netherlands
Conformity Assessment:	ATEX Annex IV - Production Quality Assessment, 01 220 113542 TUV Rheinland Industrie Service GmbH (0035) Am Grauen Stein, D51105 Cologne

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

Annette Lynch
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

June 15, 2022
Date

Page 1 of 1

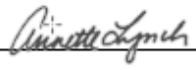
5-09-1183 Rev 37

EU DECLARATION OF CONFORMITY

EU DoC No.:	00144-04-CE-02-02
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	EM/TM Resolver 9907-106, 9907-965 thru 9907-970, 9907-2332
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/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 equipment and protective systems intended for use in potentially explosive atmospheres
Markings in addition to CE marking:	Ⓔx II 2 G, Ex db IIB T3 Gb
Applicable Standards:	
ATEX:	EN IEC 60079-0:2018 Electrical apparatus for potentially explosive atmospheres - General Requirements (A review against EN IEC 60079-0:2018, which is harmonized, shows no significant changes relevant to this equipment so EN 60079-0:2012 continues to represent "State of the Art") EN 60079-1:2014 Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure 'd' (A review against EN60079-1:2014, which is harmonized, shows no significant changes relevant to this equipment so EN60079-1:2007 continues to represent "State of the Art")
Third Party Certification:	Sira 13ATEX1188X CSA Group Netherlands B.V. Ultrechseweg 310, 6812 AR, Arnhem, Netherlands
Conformity Assessment:	ATEX Annex IV - Production Quality Assessment, 01 220 113542 TUV Rheinland Industrie Service GmbH (0035) Am Grauen Stein, D51105 Cologne

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

Annette Lynch
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

06/15/2022
Date

Page 1 of 1

5-09-1183 Rev 37

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

File name:	00111-04-CE-02-01
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Names:	EM35MR1 Actuator
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 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: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

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 Inc. 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

Annette Lynch
Full Name

Engineering Manager
Position

Woodward Inc., Fort Collins, CO, USA
Place

06/15/2022
Date

Document: 5-09-1182 (rev. 21) **PAGE** 1 of 1

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

File name: 00144-04-CE-02-01
Manufacturer's Name: WOODWARD INC.
Manufacturer's Address: 1041 Woodward Way
Fort Collins, CO 80524 USA
Model Names: EM/TM Resolver
This product complies, where applicable, with the following Essential Requirements of Annex I: 1.1, 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: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

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 Inc. 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

Annette Lynch
Full Name

Engineering Manager
Position

Woodward Inc., Fort Collins, CO, USA
Place

06/15/2022
Date

Document: 5-09-1182 (rev. 21) **PAGE** 1 of 1

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

File name: 00211-04-EU-02-01
Manufacturer's Name: WOODWARD INC.

Manufacturer's Address: 1041 Woodward Way
Fort Collins, CO 80524 USA

Model Names: 3171A Gas Valve

This product complies, where applicable, with the following Essential Requirements of Annex I: 1.1, 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.

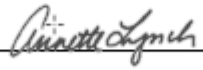
The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

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 Inc. 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

Annette Lynch
Full Name

Engineering Manager
Position

Woodward Inc., Fort Collins, CO, USA
Place

06/15/2022
Date

Document: 5-09-1182 (rev. 21) **PAGE** 1 of 1

Released

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26731.

B 2 6 7 3 1 : E

PO Box 1519, Fort Collins CO 80522-1519, USA
1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

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.