WOODWARD

Product Manual 26159
(Revision L, 4/2014)
Original Instructions

EM and LQ Digital Driver

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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, 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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, 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 Out-of-date translations are marked with ⚠.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 26159

Contents

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.

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

Regulatory Compliance

These listings are limited only to those units bearing the CE Marking.

European Compliance for CE Mark

EMC Directive:	Declared to 2004/108/EC COUNCIL DIRECTIVE of 15 Dec 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility.
Low Voltage Directive:	Declared to 2006/95/EC COUNCIL DIRECTIVE of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.
ATEX – Potentially Explosive Atmospheres Directive:	Declared to 94/9/EC COUNCIL Directive of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. Zone 2, Category 3, Group II G, Ex nA IIC T4 Gc

Other European Compliance:

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.

North American Compliance

UL:	UL Listed for Class I, Division 2, Groups A, B, C, & D, T3C at 68 °C ambient. For use in Canada and the United States. UL File E156028.

Special Conditions for Safe Use

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D, or Non-Hazardous Locations only.

Wiring must be in accordance with North American Class I, Division 2, or European Zone 2, Category 3 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field Wiring must be suitable for at least 68 °C.

Connect ground terminal to earth ground.

⚠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 2 and Zone 2.

⚠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, Division 2 et Zone 2.

⚠WARNING

HIGH VOLTAGE—High voltage may be present even after power is removed. Measure the voltage across the input power terminals to confirm that internal capacitors are fully discharged.

Chapter 1.
General Information

Introduction

The EM and LQ drivers and the EM/LQ actuator/valve provide rugged and reliable all-electric actuation systems for various prime mover control applications. The systems provide high bandwidth and high accuracy for the most demanding applications such as gas valves, water valves, flow control valves, and variable geometry steam valves. The EM and LQ drivers control an EM actuator or LQ valve position proportional to a position demand signal received from a controlling device.

The EM and LQ drivers are digital controls using advanced, model-based control algorithms for robust control over a wide range of actuator load inertias and friction levels. The Driver Interface Program (DIP) is provided as a configuration tool. It connects from a PC to the EM/LQ drivers for setup and system monitoring. The drivers may also be configured using RS-485 and a MicroNet™ control system.

Variations of the EM and LQ drivers are used to control several Woodward all-electric actuators. The EM and LQ drivers provide extensive fault monitoring. Some faults trip an alarm, while more serious faults both trip an alarm and execute a user defined shutdown action.

Acronyms and Definitions

The following acronyms and definitions are used throughout the remainder of this manual:

ESD	Electrostatic Discharge
Servlink	Proprietary Woodward serial communications software for an RS-232 connection between a PC and the EM/LQ driver
PE	Protective Earth (ground)
EBV	Electric Bleed Valve

For convenience, the EM and LQ driver will be referred to as the EM/LQ driver and similarly, the EM actuator and LQ valve will be referred to as the EM/LQ actuator.

Driver Communications

WARNING

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

The EM/LQ digital drivers offer a variety of interfaces to use for control and configuration:

- 4–20 mA position demand and feedback interface (control only).
- RS-485 interface for control, setup, and configuration. This interface works with a NetCon® or MicroNet™ control with the Real Time Serial I/O (input/output) module.
- RS-232 interface to a PC, using the Servlink protocol. A PC-based program provides setup and configuration features.

	RS-232	RS-485	4-20 mA	Discrete I/O
Setup/Configure	X	X		
Fault Indication	X	X		X
Reset Driver	X	X		X
Position Demand		X	X	
Position Feedback	X	X	X	

Table 1-1. Interfaces for Control and Configuration

Chapter 2.
EM/LQ Driver Installation

⚠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.

Unpacking

Check the shipping container for evidence of mishandling during shipping. Carefully remove the EM/LQ driver from the shipping container. Check the hardware for evidence of damage during shipping. Notify the shipper and Woodward if shipping damage is found.

EM/LQ Driver Mounting

The driver must be mounted on a vertical (or nearly vertical) surface such that the wires exit out of the driver in an upward or (preferably) downward direction. See the direction indication in Figure 2-2.

NOTICE

The EM/LQ driver must be mounted vertically (or nearly vertically) with at least 25 mm or 1 inch clearance above and below the EM/LQ driver to allow free convection air flow past the enclosure cooling fins. Without clearance between adjacent hardware above and below, convection-cooling air will be prevented from reaching the cooling fins, and the EM/LQ driver may overheat. Clearance must also be provided for wire cable exit.

Do not mount the EM/LQ driver near sources of excessive radiant heat such as exhaust manifolds or other excessively hot engine components.

Considerations for EM/LQ driver mounting location:

- Vertical mounting
- Specified environmental limits
  - ✓ Temperature
  - ✓ Vibration
- Cable length to (refer to tables in this chapter for detailed requirements)
  - ✓ Power supply
  - ✓ EM actuator
  - ✓ Controlling device
  - ✓ Monitoring device
- Cooling air flow
- Away from high voltage or high current devices or high electromagnetic radiation (EMC) sources
- Clearance for gland plate removal and cables
- Clearance for removal of EM/LQ driver cover

Mount the EM/LQ driver using the bolt pattern shown in Figure 2-1. The bolt pattern is a standard 19-inch (483 mm) rack mounting and is for an off-engine mounted location.

Wiring Requirements

General

The ground terminals on the EM/LQ driver enclosure and EM/LQ actuator must be connected to Protective Earth (PE) ground. The input power supply should be referenced to PE ground for safety and to enable ground fault detection.

⚠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 diagrams in individual valve/actuator sections of this manual.

PE The PE terminal is for Protective Earth. The terminal uses green and yellow earth ground wire, which is routed to the EM/LQ driver with the input power. This terminal must be connected directly to Protective Earth.

The circled ground symbol identifies the earth wire running from the EM/LQ actuator to the EM/LQ driver. In the event of a fault in the actuator, this terminal may be used to carry fault currents through the chassis of the EM/LQ driver and out the PE terminal to earth.

This symbol identifies functional or EMC earth. These terminals are to be used for cable shield or for connecting the cable gland plates to the chassis.

To maintain compliance with CE marking requirements, the EMC directive requires that all shields be connected to the terminals provided in the EM/LQ driver according to the wiring diagram for the appropriate actuator type.

The I/O (input/output) must only be connected to CLASS III circuits.

All terminal block screws should be tightened to 0.56—0.79 N·m (5.0—7.0 lb-in).

Shielded and Ground Wiring

All shielded cable must be twisted pairs with either a foil or a braided shield. All signal lines should be shielded to prevent picking up stray signals from nearby equipment. Connect the shields as shown in the plant-wiring diagram for the appropriate actuator type. Wire exposed beyond the shield must be as short as possible.

NOTICE

All wiring shields in the driver are connected to earth ground. For best noise immunity, connect the other end of all shields to earth ground through a capacitor (0.001 µF, 1000 V).

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 in individual valve/actuator sections of this manual.

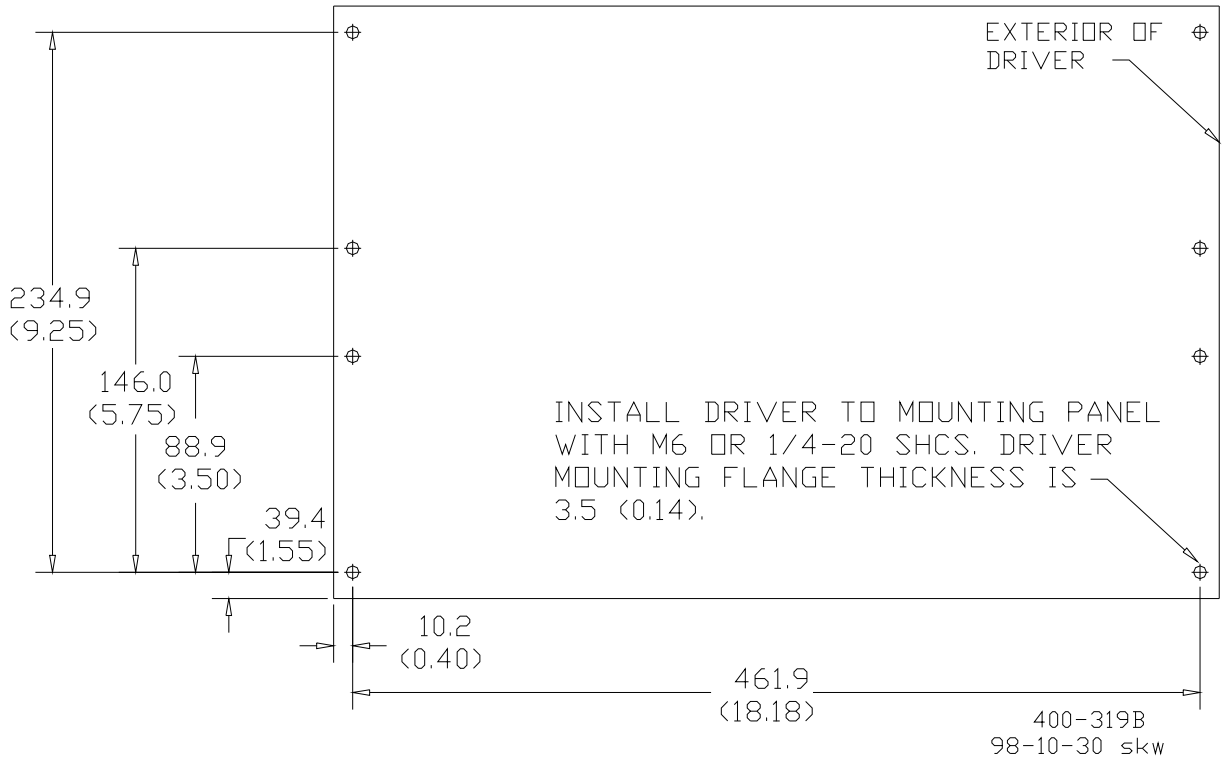


Figure 2-1. EM/LQ Driver Mounting Bolt Pattern

Resolver excitation, sine, and cosine wiring should be three individually-shielded twisted pairs or three overall-shielded twisted pairs. In order to meet positioning accuracy, the maximum capacitance of the resolver wires should be 180 pF/m (55 pF/ft) or less.

For best noise immunity, the actuator power cables should be run in separate cable trays or conduits from the resolver cables. Similarly, the power input cables should be run in separate cable trays or conduits from the I/O cables.

The EM/LQ driver chassis must be connected to PE ground using one of the grounding lugs on the back inside surface of the EM/LQ driver enclosure. The wire used for PE ground must be the same size used for the input wires.

The EM/LQ actuator motor ground wire must be connected to the EM/LQ driver chassis using one of the grounding lugs on the back inside surface of the EM/LQ driver enclosure. The wire for this connection must be the same size used for the motor drive wires.

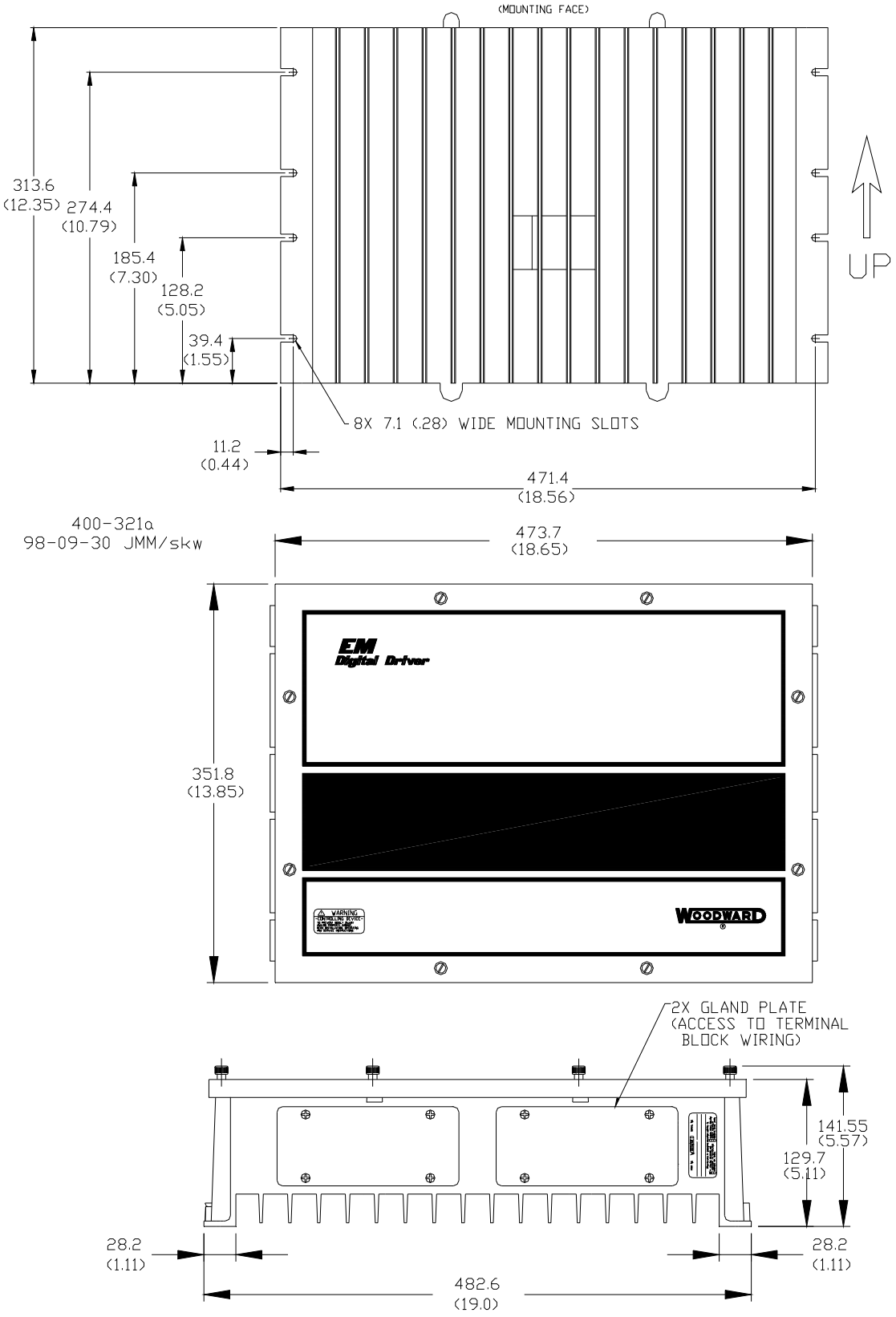


Figure 2-2. EM/LQ Driver Outline Drawing

EM/LQ Driver Electrical Connections and Pin Functionality

Two gland plates are provided on the driver to allow the user to drill through-holes for appropriate wire connections. It is assumed that the user will mount circular connectors, armored cable glands, or conduit connections for passing wires though the gland plates. The wire feedthroughs must be water tight so that water does not enter the IP56 sealed EM/LQ driver even when the driver enclosure exterior is pressure washed. The gland plates cover two rectangular openings that are each approximately 50 mm (2 inch) tall by 127 mm (5 inch) wide.

Remove the main EM/LQ driver cover.

Remove, modify, and replace one or both gland plates to provide watertight wire feedthrough. Use agency-approved conduit hubs when installing in hazardous or ordinary locations. Gland plate fasteners must be well tightened (1.8 N·m or 16 lb-in) for proper sealing.

NOTICE **Follow all ESD cautionary instructions at the beginning of this manual while the EM/LQ driver cover is removed.**

Connect all wires as shown in the plant-wiring diagram for the appropriate actuator type.

- Refer to Chapter 7 for the EML100 actuator.
- Refer to Chapter 8 for the EM35MR/EBV 63 and 100.
- Refer to Chapter 9 for the EM35MR/3103 and 3171A gas valves.
- Refer to Chapter 10 for the LQ25, LQ25T, and LQ Bypass liquid fuel valves.
- Refer to Chapter 11 for the EM70 and EM140 actuators.
- Refer to Chapter 12 for the EGV and ESV actuators.

The cable between the valve and driver must be no longer than 100 m (328 ft) in order to ensure position accuracy and slew time.

The actuator must also be connected to Protective Earth (PE) via a green and yellow wire, as shown on the wiring diagram. This wire must not be smaller than the power wires, by code. This wire may be run directly to Protective Earth, or to the terminal provided in the driver chassis and marked with the circled ground symbol.

Resolver excitation and secondary wiring should be three individually-shielded twisted pairs or three overall-shielded twisted pairs.

For best noise immunity, the valve power cables should be run in separate cable trays or conduits from the resolver cables.

IMPORTANT **The EM/LQ driver will not operate if these resolver connectors are connected to the wrong resolver.**

Cables should conform to the following requirements:

- Code and regulatory requirements applicable to the site location
- EM/LQ driver cable size for the installed length to the power source
- EM/LQ driver cable size for the installed length to the actuator
- Maximum cable length to controlling device
- Shielded wiring with shields grounded as shown in the wiring diagram for the appropriate actuator type
- Resolver feedback wires isolated from motor power wires
- Wire rated for the maximum expected ambient temperature

Woodward can supply all mating connectors needed as component parts for wiring the motor and resolvers.

The functions of the terminals on the EM/LQ driver are described in the following paragraphs.

RS-232 Port

Connector J4 is a 9-pin serial port (DSUB) that connects to a PC computer COM port through a null modem cable. The wiring must meet the requirements of EIA RS-232. This standard states a maximum cable length of 16 m (50 ft) with a total capacitance less than 2500 pF and a data rate not exceeding 56 kbps. The driver's RS-232 port configuration is fixed at 38.4 kbps, no parity, 8 bits, and 1 stop bit. Do not leave the RS-232 null modem cable attached to the driver if its other end is removed from the PC. This reduces the possibility of EMC noise being introduced to the EM/LQ driver.

To enable this connection, it is necessary to use the two software programs supplied with the EM/LQ driver. These programs are WGC_DIP.exe and Servlink.exe. The software must be installed on a Pentium 166 MHz or faster PC with 32 MB of RAM, running Windows® 95 or 98, or Windows NT®.

The following functions are provided though this interface:

- Driver setup, configuration and tuning
- Alarm and fault indication
- Driver shutdown and reset
- Position feedback

The Driver Interface Program cannot configure the driver if the NetCon® unit is being used to control the driver over the RS-485 interface. However, the Driver Interface Program is able to monitor the condition and parameters on the driver while simultaneously communicating over RS-485.

⚠WARNING

If the driver is controlled via the RS-485 interface from a NetCon or a MicroNet™ control, the Backup Demand selected should be Analog. If the Driver Interface Program is used simultaneously with the RS-485, the driver may cause periodic RS-485 network faults resulting in switching to the Analog backup demand source. For real time control over RS-485 when using Analog backup demand, it is recommended that you do NOT use the Driver Interface Program except when setting up or configuring the driver.

Due to the low priority and low speed of RS-232 communications on the PC, this protocol is not robust enough to support demand input control. Time-out errors may also interrupt the supported communications functions over RS-232.

Top Board Terminal Blocks

All inputs and outputs on the top board of the EM/LQ driver are made through screwless “CageClamp” style terminal blocks. The spring clamp can be actuated by using a standard 3 mm or 1/8 inch flat bladed screwdriver or a snap-on thumb lever (Figure 2-3). Two snap-on levers are provided with the EM/LQ driver. The EM/LQ driver terminal blocks accept wires from 0.08 to 2.5 mm² (28 to 12 AWG). Wires for these terminal blocks should be stripped about 8 mm (about 1/3 inch) from the end.

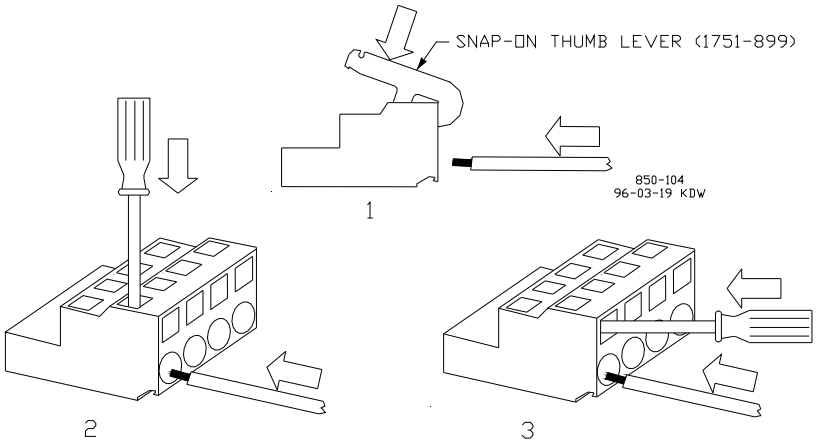


Figure 2-3. CageClamp Terminals

The EM/LQ driver’s terminal blocks on the top board are designed to be removed by hand. After the EM/LQ driver’s input power is disconnected, the terminal blocks can be removed one at a time by prying them off using the fingertips. When removing the terminal block, never pull on the wires connected to the terminal block.

RS-485 Port

Pins 1 through 4 are for the RS-485 interface. The wiring must be one continuous cable between nodes and must meet the requirements of EIA RS-485 for 500 kbps excepting that one-half of the cable length limit is recommended due to harsh environments typical of prime mover installations as follows.

Maximum cable lengths:

- Standard shielded twisted-pair cable 30 m (100 ft)
- 120 m (400 ft), 0.3 mm² (22 AWG) low-capacitance cable (36 pf/m or 11 pF/ft)
- Over 150 m (500 ft), use fiber optic cable with optical repeaters

This interface allows control of the EM/LQ driver using a proprietary Woodward protocol with 5 ms updates when connected to one of the following Woodward controls:

- MicroNet with a real time SIO module
- NetCon with a real time SIO module

The following functions are provided though this interface:

- Alarm and fault indication
- Driver shutdown and reset
- Position command (demand)
- Position feedback

The EM/LQ driver supports RS-485 at speeds of 38.4, 57.6, and 417 kbaud. The real time SIO module communicates at 417 kbaud. To enable this option, the user must select RS-485 from the Driver Interface Program Tune page for the communications demand setting. The RS-485 demand input may be specified as the primary demand input or a redundant input to be used after a failure of the primary demand input.

To initiate communications, connect the EM/LQ driver to the Real Time SIO module and select Reset from the MicroNet or NetCon control. The MicroNet or NetCon control will provide all configuration/RUN information to the EM/LQ driver, according to the Graphical Application Program (GAP™).

The RS-485 connection has two jumpers for the termination resistor. From the factory, the termination resistor jumpers are in the “OUT” position. If this driver is at the end of the RS-485 network, move the jumpers to the “IN” position.

The drivers have address switches (S1 and S2) on the control circuit board, as shown in Figure 2-5. S1 sets the tens digit, and S2 sets the ones digit for the driver address. Although these switches allow up to 20 drivers on the network, the Real Time SIO can only support one driver per channel.

During initialization, the driver reads the position of the switches which then becomes its address. It responds to data to this address, and sends data with this driver address. The MicroNet or NetCon GAP application has an input field for address, which should be configured by the customer or application engineer to match the driver address switches.

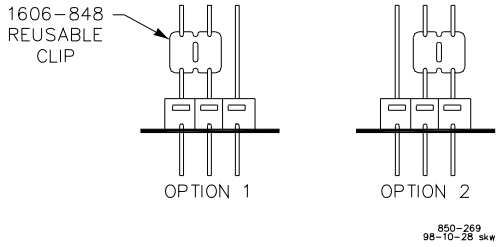


Figure 2-4. Jumper Configurations

Analog Input

Pins 11 and 12 allow input of a 4 to 20 mA position command (demand) signal. Pin 13 is a shield terminal for this cable. A 4 mA input will position the EM/LQ actuator to the 0% position. A 20 mA input will position the EM/LQ actuator to the 100% position.

An overtravel setting may be enabled to allow an additional 2% travel at both ends of the stroke to drive into optional external mechanical stops. This allows 3.68 mA to provide –2% position and 20.32 mA to provide 102% travel. The EM/LQ driver will shut down due to a demand error if the 4 to 20 mA input drops below 2 mA or exceeds 22 mA, or if the polarity is reversed. If this feature is used, verify that your Position Error Alarm and Shutdown set points are set to greater than 2% to avoid false trips. See Chapter 4 on how to change these set points using the Driver Interface Program.

The 4–20 mA position command is less accurate than using the RS-485 digital interface for position command.

If the 4–20 mA analog input is used for position command, we recommend that the 4–20 mA analog output be used to monitor position as a means of verifying correct driver operation.

If using the Servlink interface, the user must verify that Analog is selected for Demand Input on the Driver Interface Program's Tune page to ensure that the 4 to 20 mA input will control the actuator's position. The analog demand input may be specified as the primary demand input or a redundant input to be used after a failure of the primary demand input. If the RS-485 interface is used, demand and backup demand can be configured through the GAP block.

Analog Output

Pins 14 and 15 provide an isolated 4 to 20 mA output signal from the driver that is proportional to the EM/LQ actuator shaft position feedback sensor output. Pin 16 is a shield terminal for this cable. A 4 mA output occurs when the EM/LQ actuator is at the 0% position. A 20 mA output occurs when the EM/LQ actuator is at the 100% position.

If the analog output is not going to be used, it is suggested that it be terminated with a resistor (10 600 Ω) between pins 14 and 15 to prevent an analog output alarm indication.

The 4–20 mA position feedback is less accurate than using the RS-485 digital interface for position feedback.

Discrete Input

Pins 17 through 19 provide an isolated shutdown and reset discrete input to the driver. Use pins 17 and 19 with an external contact or use pins 18 and 19 with an external contact in series with an external power supply.

The operation of the discrete input is as follows:

Open the external contact to shut down the driver. Close the external contact to reset the driver and clear any latched driver fault alarms. Keep the external contact closed while the driver is running. Keep this external contact open when initially applying power to the EM/LQ driver.

We recommend that a safe position command (fully open or fully closed, depending on the application) be used in addition to a shutdown in order to improve shutdown reliability.

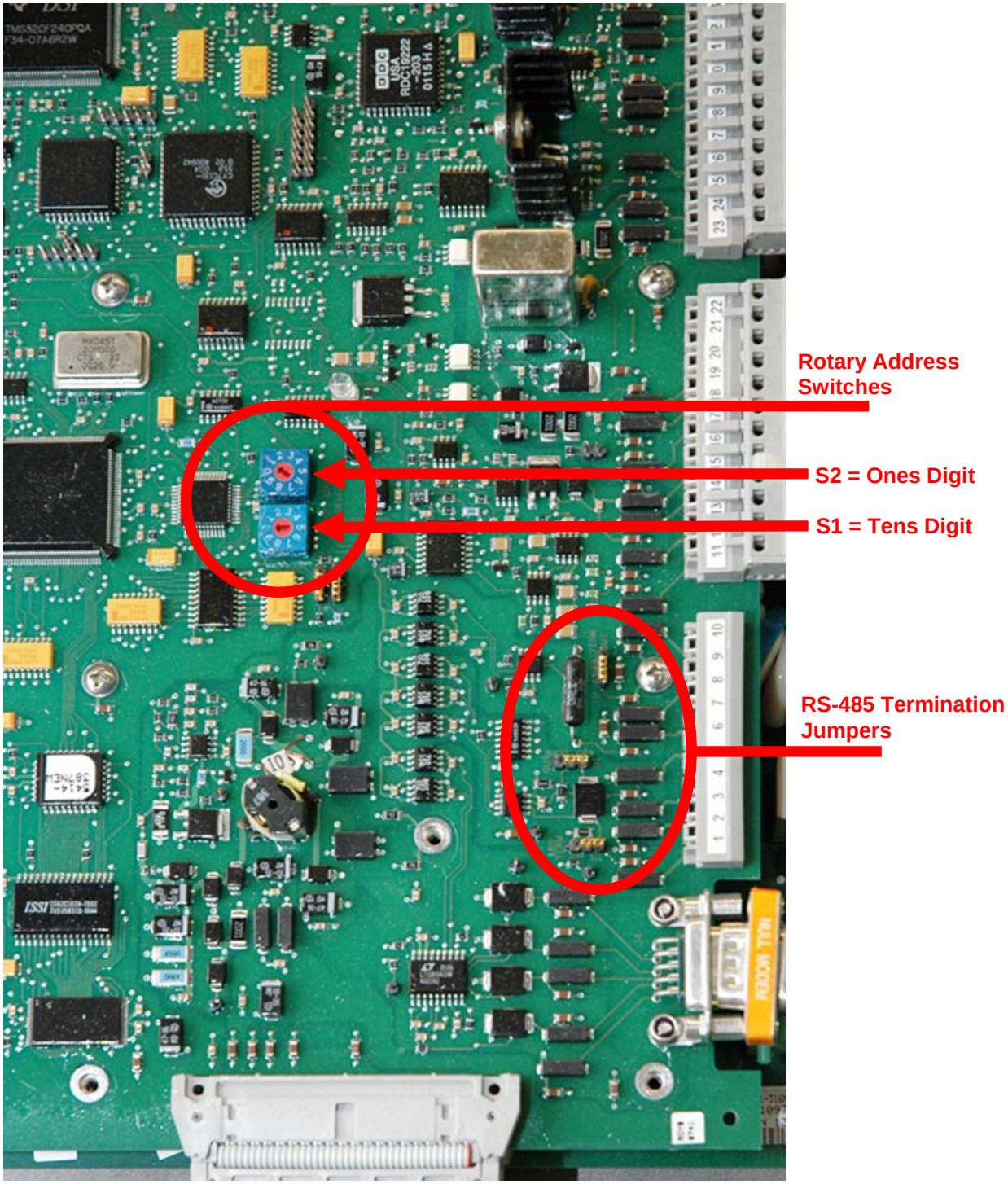


Figure 2-5. Jumper Locations

Discrete Output

Pins 20 through 22 provide a relay output. Pin 20 to pin 21 is a normally open output contact. The contact is closed (energized) when the EM/LQ driver is operating properly. Pin 21 to pin 22 is a normally close output contact. In the case of a power shutdown by fault or loss of power, pins 20 and 21 open and pins 21 and 22 close.

Motor Overtemperature Discrete Input

(only with EM70 and EM140 Actuators)

Pins 23 through 25 are to be used for a thermal switch input. The EM70 or EM140 Actuators have internal thermal switches to prevent overheating of the motor. Use pins 23 and 24 to connect to the switch. Pin 25 is the shield terminal for this cable.

This switch will open if the motor temperature rises above 177 °C (350 °F) and toggles an alarm within the EM120V driver. It will not cause a shutdown but will warn that the ambient temperature is too high. It could also be that the thermal conductivity of the mounting pad is too low or that a problem exists in the actuator.

Motor Resolver

Pins 26 through 34 connect to the motor rotor shaft resolver (per actuator plant wiring diagram). This resolver provides motor shaft position feedback that is required to allow brushless commutation of the motor. Cables to the resolver should be properly shielded from the motor power connections and other EMC sources to avoid problems due to induced noise that may distort the feedback signal. The LQ valves do not have a motor resolver.

Position Resolver #1

Pins 35 through 43 connect to the actuator output shaft resolver (see actuator plant wiring diagram). This resolver provides actuator position feedback and allows the EM/LQ actuator to position with high accuracy. Cables to the resolver should be properly shielded from the motor power connections and other EMC sources to avoid problems due to induced noise that may distort the feedback signal. In order to meet positioning accuracy, the maximum capacitance of the resolver wires should be 180 pF/m (55 pF/ft) or less.

If only one resolver is available to measure shaft position, we recommend that mass flow be monitored at the system level in order to detect a problem in the position feedback.

Position Resolver #2

Pins 44 through 52 connect to the actuator output shaft resolver (see actuator plant wiring diagram). This optional redundant resolver provides a second actuator position feedback signal. Some units do not offer this redundant resolver. Cables to the resolver should be properly shielded from the motor power connections and other EMC sources to avoid problems due to induced noise that may distort the feedback signal. In order to meet positioning accuracy, the maximum capacitance of the resolver wires should be 180 pF/m (55 pF/ft) or less.

Bottom Board Terminal Blocks

All terminal block screws should be tightened to 0.56—0.79 N·m (5.0—7.0 lb-in).

Input Power

Pins 53(+) and 54(–) connect the EM/LQ driver to input power from an external power source. Refer to Table 5-1 for input voltage recommendations. The input power must meet overvoltage category III. The voltage between either pin 53 or 54 and the EM/LQ driver enclosure must not exceed the maximum specified for each model (Table 5-1). The input power source should be referenced to PE ground for safety and to enable ground fault detection. The power source may be negative-grounded, positive-grounded, or middle-grounded.

NOTICE

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

The EM/LQ driver is not equipped with input power switches. For this reason, some means of switching input power must be provided for installation and servicing. Do not use a fuse as a switch. A circuit breaker meeting the above requirements or a separate switch with appropriate ratings may be used for this purpose. See Table 5-1 for appropriate fusing specifications. The fuse or circuit breaker must have appropriate dc voltage ratings.

Branch circuit fuses, breakers, and wiring must have applicable safety approval and be selected according to applicable codes and area classifications. The system disconnect must be in easy reach of the operator and marked as a disconnect device. Use only the wire sizes specified below or equivalent metric sizes which meet local code requirements.

Also note that the wire gauge must comply with local code requirements and be of sufficient size such that the power supply voltage minus the IR loss in the two lead wires to the EM/LQ driver does not drop below minimum voltage specification (Table 5-1) when the current draw is 20 A.

The following voltage drops are calculated at maximum ambient temperature.

Wire Gauge (AWG)	Voltage Drop Per Meter At 20 A Round-Trip (V)	Voltage Drop Per Foot At 20 A Round-Trip (V)
8	0.100	0.031
10	0.165	0.050
12	0.262	0.080

Table 2-1. Voltage Drop Using American Wire Gauge (AWG)

Example calculation: 10 AWG wires will drop 0.050 V/ft at 20 A. Using 100 feet between the EM/LQ driver and the power supply would provide a voltage drop of 100 x 0.05 = 5.0 V. Thus the power supply must always provide between 23 and 32 Vdc or between 95 V and 150 V depending on the driver input power specification.

Wire Area (mm²)	Voltage Drop Per Meter At 20 A Round-Trip (V)	Voltage Drop Per Foot At 20 A Round-Trip (V)
10	0.087	0.026
6	0.144	0.044
4	0.216	0.066

Table 2-2. Voltage Drop Using Wire Area (mm²)

Example calculation: 6 mm² wires will drop 0.144 volts per meter at 20 A. Using 50 meters between the EM/LQ driver and the power supply would provide a voltage drop of 50 x .144 = 7.2 V. Thus the power supply must always provide between 25.2 and 32 Vdc or 97.2 V and 150 V depending on the driver input power specification.

Heavier wires than those listed above will not fit into EM/LQ driver terminals 53 and 54.

Motor Drive Output

Pins 55 through 60 connect the output power from the EM/LQ driver to the motor coil power windings. Follow the indications and recommendations on wire gauge and pins used for each desired cable length in Table 2-3. If two parallel wires are used for each of the three motor phases, the wires must be spliced as close as possible to the EM/LQ actuator such that only a single wire is soldered into the non-agency listed EM/LQ actuator connector or connected to the single flying lead wire used with the agency listed EM/LQ actuator.

IMPORTANT

If wires larger than 12 AWG or 2.5 mm² are required, the larger wires given below must be spliced as close as possible to the actuator using a junction box. From the junction box, 12 AWG or 2.5 mm² need to be used to the actuator.

Maximum Cable Length Meters	Maximum Cable Length Feet	Terminal Pins 55, 57, 59	Terminal Pins 56, 58, 60	American Wire Gauge (AWG)	Metric Wire (mm²)
12	40	X		14	2.5
24	79	X	X	14	2.5
19	62	X		12	4
39	128	X	X	12	4
30	98	X		10	6
60	197	X	X	10	6
50	164	X		8	10
100	328	X	X	8	10

Table 2-3. Cable Lengths

In order to meet the specified slew time, the wiring practices for the input and motor drive must be followed. Larger wire diameters can be used to further minimize the voltage drop in the wire.

Example calculation: Suppose the cable length between actuator and driver is 50 m (164 ft). Single 10 mm or 8 AWG wires (total of 3 wires) or double 6 mm or 10 AWG wires (total of 6 wires) may be used.

For best noise immunity, the actuator power cables should be run in separate cable trays or conduits from the resolver cables.

NOTICE

The EM/LQ driver will not operate properly if the motor phases are wired incorrectly. Verify connections before operation.

Chapter 3.
Control Using the RS-485 Interface

Introduction

This chapter describes using a Real Time SIO module in a MicroNet™ or NetCon® control to configure and control the driver over the RS-485 port. If you are using the Driver Interface Program to monitor the driver via RS-232 with an analog input controlling position, refer to Chapter 4.

A more detailed description of the Real Time SIO module can be found in the MicroNet manual.

A Graphical Application Program (GAP™) must be made for each installation using a Real Time SIO module (usually in combination with other MicroNet or NetCon modules) to control EM/LQ systems. The GAP HELP program contains all the information to control and calibrate the EM/LQ system.

IMPORTANT **For calibration of DLE systems, please refer to Woodward manual 40142.**

Up to 15 drivers may be monitored on each RS-485 channel. RS-485 termination jumpers should be moved to the “IN” position on the units on the ends of the network (see Chapter 2 for illustration).

After the MicroNet or NetCon control is reset and the EM/LQ driver is reset, the Comm faults can be cleared and the EM/LQ system(s) should be ready to control actuator position(s).

The RS-485 interface provides all necessary information to the EM/LQ digital driver.

IMPORTANT **Verify that fuel pressure is not present to actuators that may open due to actuator motion.**

Applying Power

1. Verify that the power source is set within the input voltage range, taking into consideration the cable IR loss.
2. Verify that all EM/LQ driver connections listed in Chapter 2 are properly made, including earth and motor ground cables and cable shield grounding terminations.
3. Verify that the EM/LQ driver cover is installed and all cover fasteners are tightened.
4. Verify that fuel pressure is not present to valves that may open due to actuator motion.
5. If a brake is present, turn on the power supply to the brake.
6. Verify that the pin 17 to 19 external contact is open to prevent the driver from running.
7. Apply power to the NetCon or MicroNet system and wait for all modules to initialize.
8. Verify that the input command is between 0% and 100% for RS-485.

9. Apply power to the EM/LQ driver and wait for the driver(s) to initialize (approximately 5 seconds).
10. Reset COMM Faults on all EM/LQ systems (method of reset can differ depending on GAP application).
11. Close contact from pin 17 to 19 and make sure that actuator(s) drive to commanded position.

GAP and the EM/LQ Driver and EM Actuator

For questions about the operation of the particular GAP application program, contact the responsible application engineer or refer to the reference documentation provided with your application.

Chapter 4.
Configuration Using the Driver Interface Program

Introduction

Purpose

The Driver Interface Program is a configuration tool for the EM/LQ driver. The following functions are provided through this interface:

- Driver setup, configuration, and tuning
  - ✓ Calibrate the actuator stroke
  - ✓ Set the Alarm and Shutdown set points
  - ✓ Set Shutdown action
- Set source for demand signal
- Fault indication
  - ✓ Monitor Alarms
  - ✓ Monitor Shutdowns
- Reset driver Alarms and Shutdowns
- Monitor actuator position
- Monitor actuator current

System Requirements

The recommended PC is a 166 MHz or faster Pentium with at least 32 MB RAM running Windows® 95 or 98, or Windows NT®. A 9-pin null-modem RS-232 cable is required to connect to the driver. The Driver Interface Program requires the Servlink Server, version 1.54 or later. Servlink is included in the installation package and will automatically install and configure itself.

⚠WARNING **An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.**

Limitations

The Driver Interface Program is a configuration tool and is not designed to provide permanent remote monitoring capabilities.

The Driver Interface Program cannot reset or configure the driver if any other serial communications port, such as RS-485, is being used to control the driver. However, if this protocol is used, the Driver Interface Program is still able to monitor the condition and parameters on the driver while simultaneously communicating over RS-485.

The driver's RS-232 port configuration is fixed at 38.4 kbps, no parity, 8 bits, and 1 stop bit. This chapter describes using the Driver Interface Program to configure the driver over the RS-232 port. If a Real Time SIO module (usually in combination with other NetCon® or MicroNet™ modules) is being used to control and configure over RS-485, refer to Chapter 3.

IMPORTANT

If the driver is controlled via the RS-485 interface from a NetCon or a MicroNet control, the Backup Demand selected should be Analog. If the Driver Interface Program is used simultaneously with the RS-485, the driver may cause periodic RS-485 network faults resulting in switching to the Analog backup demand source. For real time control over RS-485 when using Analog backup demand, it is recommended that you do NOT use the Driver Interface Program except when setting up or configuring the driver.

Installing and Configuring the Driver Interface Program

The Woodward Driver Interface Program is supplied on one diskette. Find and run the application SETUP on this diskette. Follow the instructions on the screen to install the Servlink protocol server and the Driver Interface Program. After installation is complete, reboot the computer so that changes to the Windows registry will take effect.

IMPORTANT

Verify that fuel pressure is not present to actuators that may open due to actuator motion.

Applying Power

1. Verify that the power source is set between the input voltage range, taking into consideration the cable IR loss.
2. Verify that all EM/LQ driver connections are properly made, including earth and motor ground cables and cable shield grounding terminations.
3. Verify that the EM/LQ driver cover is installed and all cover fasteners are tightened.
4. Verify that the pin 17 to 19 external contact is open to prevent the driver from running.
5. If a brake is present, turn on the power supply to the brake.
6. Verify that the input command is between 4 and 20 mA for analog control or between 0% and 100% for RS-485 control.
7. Apply power to the EM/LQ driver and wait for driver(s) to initialize (approximately 5 seconds).
8. Close the contact from pin 17 to 19 and make sure that actuator(s) drive to commanded position.

If the Servlink server has not been configured on the PC used to run the Driver Interface Software, it should be configured at this time.

Loading the Servlink Server

The Servlink server handles all serial communications tasks between the PC and the driver. It is a common application that is used for several Woodward products.

1. Connect the PC to the driver using a null modem RS-232 cable. (The EM/LQ driver only requires pins 2, 3, and 5 on a standard 9-pin RS-232 connector.) Use a male connector on one end and a female connector on the other for normal PC configurations. It is recommended that in actual use this cable be kept as short as is practical. From the Start menu, go to Programs => Servlink => Servlink server, and run the program.
2. From the Servlink File menu, select New. Servlink will display a communications dialog box. Verify that the correct serial port is selected (either COM1 or COM2), and that it is set for Point-to-Point communications at 38.4 kbps, then select OK. Servlink will now communicate with the driver and compile the information the PC needs to interface with the driver. Compiling this information will take ten to fifteen seconds.
3. After this process is complete, select Save As from the Servlink File menu. Save the file as WGC.NET. This file contains information about the program that runs the driver, as well as PC setup information such as baud rate, port number, etc.
4. Close the Servlink program. The above process of creating the WGC.NET file only needs to be completed once for any PC and driver combination. However, if a different PC is used with this driver, or a different driver with this PC, a new WGC.NET file must be created at that time.

Driver Interface Program Conventions

Green LEDs indicate a desired state. Red LEDs indicate warning, error, and wait states. LEDs that are gray indicate an item that is not used for the selected actuator type.

If the page being opened has a Ready Light on it, wait for the light to turn green before pressing any buttons on that page. The Ready Light indicates that the control is in the desired mode and is ready to accept new data or commands from the Driver Interface Program.

The Shutdown button can be pressed at any time and will result in the driver reverting to its shutdown state. The Reset button will not work if the driver is not in RS-232 Configuration mode. This mode is set on the Tune page.

The Alarm/Shutdown Monitor LEDs at the bottom of the screen will latch ON (red) when an error occurs. When an error is indicated, refer to the Alarm or Shutdown pages to identify the problem. The Status Relay LED follows the status of the fault relay output. When “Shutdown Input Trips Fault Relay Output” on the Tune page is True, it causes the fault relay output to trip when any shutdown occurs. When it is False, the fault relay will not indicate a trip state when the shutdown comes from, and only from, the Shutdown/Reset discrete input. All other shutdowns will cause the relay to trip.

Starting Up the Driver Interface Program

IMPORTANT

For Servlink and Driver Interface Program usage:

If either error message “The control did not reply to the last request” or “The last message received was garbled” is seen, shut down both the Driver Interface Program and the Servlink server. After verifying that the driver has been powered up for a minimum of 5 seconds, restart the program. This will clear any existing Servlink server communications problems with the driver.

1. Start the Driver Interface Program on the PC to configure the EM/LQ driver.
2. Wait for the Driver Interface Program to stop displaying Initializing in the Driver Detected box.
3. Go to the Tune page.
4. Under Configuration, select RS-232.
5. Under Demand, select the interface which will be used to provide position demands to the driver. Analog represents the 4–20 mA interface, and is the usual choice.
6. Under Backup, select None.
7. Verify that the desired shutdown action is set.
8. Verify that the communications values are properly configured.
   - Configuration Set to RS-232
   - Demand Analog or RS-485
   - Backup None, Analog, or RS-485
9. Go to the Configure page.
10. Under Driver Type, select the actuator/valve type that is being used.

Screen Images and Descriptions

Run Page

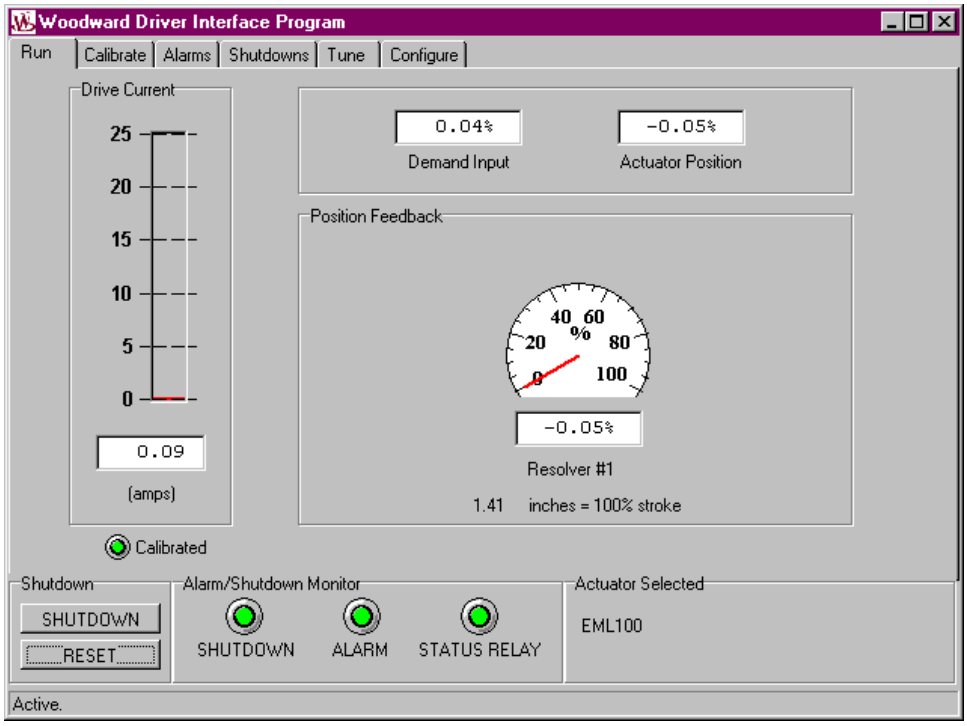


Figure 4-1. Run Page

Figure 4-1 shows the first screen that will be displayed when the Driver Interface Program is first started.

Bottom of Window

Shutdown Box

Shutdown Button

This shuts down the EM/LQ driver and opens the Discrete Output (opens pins 20 and 21 and closes pins 21 and 22).

Reset Button

This resets Alarms and Shutdowns and will attempt to restart the EM/LQ driver.

Alarm/Shutdown Monitor Box

Shutdown LED

Turns red when the EM/LQ driver is shut down. Go to the Shutdowns page for more information.

Alarm LED

Turns red when an Alarm occurred. Go to the Alarms page for more information.

Status Relay LED

Turns red when the discrete output status relay is de- energized.

Actuator Selected Box

After initialization, this box displays the type of actuator that has been configured. The setting must be correct for proper operation. Wait until initialization is complete before using the Driver Interface Program. This setting can be modified on the Configure page.

Top of Window

Demand Input

This shows the demand input from the controlling device, where 0% is the minimum actuator position demand and 100% is the maximum actuator position demand. The controlling device is selected on the Tune page. If this source has failed, it will follow the input from the Backup demand source if a Backup has been selected.

Actuator Position

The Actuator Position box will be identical to the Resolver #1 display. 0% represents the minimum actuator position and 100% represents the maximum actuator position, using the same scaling as Demand Input, above.

Drive Current

This represents the quadrature (torque) current sent to the actuator.

Calibrated LED

The Calibrated LED should always be on during normal operation, thus indicating that the control has been through Calibration at least once. Note that the calibrated LED is not reset if the Calibration mode has been aborted or if it failed for any reason. The control simply returns to the previous set of Calibration values. The LED will not be on when the control is initially delivered from the factory.

Calibration Using the Driver Interface Program

- Refer to Chapter 7 for calibrating the EML100 and EML100/3151A using the RS-232 Interface.
- Refer to Chapter 8 for calibrating the EM35MR/EBV 63 and 100 using the RS-232 Interface.
- Refer to Chapter 9 for calibrating the EM35MR/3103 and 3171A Gas Valves using the RS-232 Interface.
- Refer to Chapter 10 for calibrating the LQ25, LQ25T, and LQ Bypass Liquid Valves using the RS-232 Interface.
- Refer to Chapter 11 for calibrating the EM70 and EM140 actuators using the RS-232 Interface.
- Refer to Chapter 12 for calibrating the EGV actuator using the RS-232 interface.

Verifying Calibration

1. Go to the Run page.
2. Move the input demand to 4 mA for analog control or 0% for RS-485 and verify that the actuator moves to its minimum position and that Position Feedback, Analog Input, and Actuator Position are all 0%.
3. Move the input demand to 20 mA for analog control or 100% for RS-485, and verify that the actuator moves to its maximum position and that Position Feedback, Analog Input, and Actuator Position are all 100%.
4. Move the input demand to 12 mA for analog control or 50% for RS-485, and hit the Shutdown button at the bottom of the window to verify that the correct shutdown action occurs.
5. The EM/LQ driver is now calibrated. The Driver Interface Program should be left running during initial engine operation to monitor for fault indications.
6. The null modem RS-232 cable may now be removed from the EM/LQ driver, or may be left in place to allow future use of the Driver Interface Program. The Driver Interface Program should not be left running for long-term monitoring of the driver. If the cable is left connected to the driver it should also stay connected at the PC end to avoid possible stray EMC emissions.

Troubleshooting Calibration

Actuator Calibration Verification Procedure—Go to the Configure page and select the Shutdown Configuration box. Select Drive to Minimum. Go to the Run page. Press the Shutdown button at the bottom of the page to shut down the control. The actuator should go to its minimum (4 mA) position. Go to the Configure page and select the Shutdown Configuration box. Select Drive to Maximum. Go to the Run page. Press the Shutdown button at the bottom of the page to shut down the control. The actuator should go to its maximum (20 mA) position. If this procedure works as described, then the actuator is calibrated correctly. After performing this test, return the Shutdown Configuration to the desired setting.

Run Page–Note—The Calibrated LED on the Run page should always be on, indicating that the control has been through Calibration at least once. Note that the Calibrated LED is not reset if the Calibration mode has been aborted or if it has failed for any reason, because the control simply returns to the previous set of calibration values. The LED will not be on when the control is initially delivered from the factory. This LED is a safety precaution to ensure that the user calibrates the actuator/control before the actuator is allowed to move.

Other Things to Check—Does the 4 mA input approximate the 0% Analog Input reading on the Run page? Does the 20 mA input approximate the 100% Analog Input reading on the Run page? If yes, then the Analog Input circuitry is calibrated correctly.

On the Tune page, in the Communications box, Configuration should be set to RS-232, Demand should be set to Analog, and Backup should be set to None. This does not apply for RS-485 (NetCon or MicroNet) controlled drivers.

Note on Servlink and Driver Interface Program Usage—If either error message "The control did not reply to the last request" or "The last message received was garbled" is seen, shut down both the Driver Interface Program and the Servlink server. After verifying that the driver has been powered up for a minimum of 5 seconds, restart the program. This will clear any existing Servlink server communications problems with the driver.

Applying Power to a Calibrated EM/LQ driver—If the EM/LQ driver has been calibrated, the Driver Interface Program and Servlink software do not need to be started, and the PC and null modem RS-232 cable do not need to be installed.

Apply power to the EM/LQ driver.

Wait approximately 5 seconds for the driver to initialize.

Alarms and Shutdowns

The EM/LQ driver continuously monitors its own operation and detects many types of problems with the EM/LQ driver, the actuator, or the interconnecting wiring. The alarm and shutdown faults are described later in this chapter. The EM/LQ driver notifies the user of the nature of the problem in the Driver Interface Program or the RS-485 interface. For faults resulting in shutdown, the condition is indicated by the discrete output contact and the user can select the appropriate shutdown action from the Tune page.

Possible shutdown actions:

- Turn off power
- Drive to minimum (4 mA or 0%) position
- Drive to maximum (20 mA or 100%) position

⚠WARNING

The above settings must be verified before operating a turbine with the driver. Failing to do so could cause damage to the turbine due to overspeed conditions if the actuator shuts down in the wrong direction.

If there is a motor or resolver wire fault (shorted or open wire), the actuator WILL NOT go the designated shutdown position for the obvious reason of lack of control via the connections.

For faults resulting only in an alarm and not a shutdown, the user is warned that a situation exists which, if it worsens, may result in a shutdown fault.

Alarms and shutdown fault indications may be reset through the Driver Interface Program. Opening and closing the discrete input contact may also reset the EM/LQ driver, but this will shut down the EM/LQ driver while the discrete input is open, and is not recommended while the engine is running.

The Driver Interface Program and RS-485 interface may each shut down the driver at any time. As long as the source of the shutdown is active, no other source can Reset the driver. For example, if the driver is being controlled by a NetCon or MicroNet over RS-485 and the Shutdown button is pressed from the Driver Interface Program, a Reset command from the NetCon or MicroNet will not clear the shutdown condition. Either the Reset has to come from the Driver Interface Program itself (set to RS-232 Configuration on the Tune page), or the RS-232 cable should be disconnected from the PC for 15 seconds before a Reset command from a NetCon or MicroNet will clear the Shutdown condition.

⚠WARNING

The discrete output relay is de-energized when a shutdown fault is detected by the EM/LQ driver. Emergency shutdown valves and other safety devices necessary to avoid damage or injury should be set to activate anytime a shutdown fault is detected by the EM/LQ driver.

Alarms Page

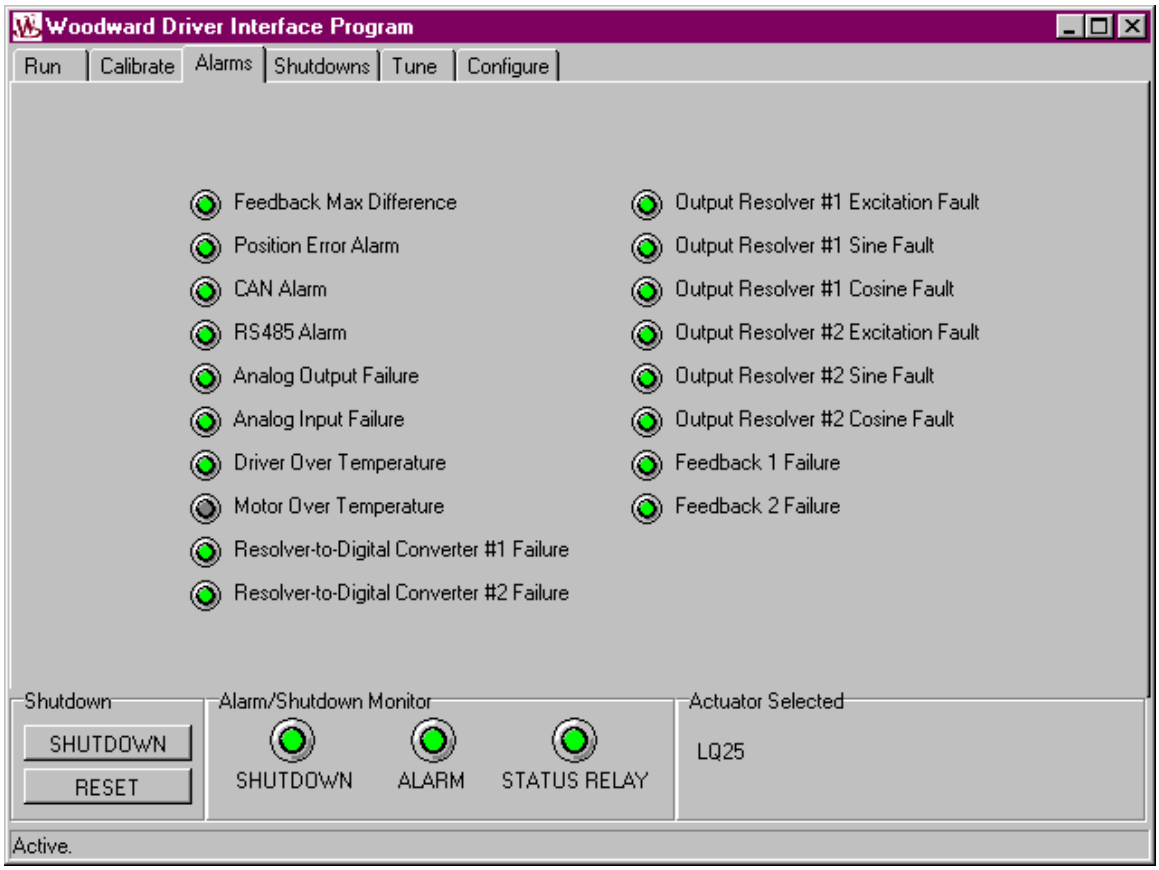


Figure 4-2. Alarms Page

The LEDs on the Alarms page indicate the current status of the alarms. If any LEDs are gray, that alarm does not apply to the selected actuator type. A red LED indicates a fault status, while for normal operation all LEDs are green. If the Alarm LED at the bottom of the page is Red and no alarms are showing on the page, the alarm condition does not exist anymore. Many of the set points that drive these alarms are set from the Tune page, Figure 4-4.

Feedback Max Difference
If the difference between the two position resolvers exceeds the Redundant Feedback Fail Alarm % setting on the Tune page for longer than the allowed delay, an alarm is generated. The difference between the resolver readings is averaged when the spread value is under this alarm setting. This indication should only happen if one of the resolvers comes loose from its mounting and moves from its calibrated position. If a wire fault occurs on either resolver, this alarm is meaningless.

Position Error Alarm
Turns red if the difference between the actuator position and demand is greater than the Tune page alarm amplitude and duration setting.

Controller Area Network (CAN) Alarm
This LED should not be annunciated because CAN is not supported in this version of the driver.

RS-485 Alarm
An RS-485 communication error was detected or the Configure page time-out limit was exceeded.

Analog Output Failure
Turns red if the actual analog output current is not within 1% of full scale (25 mA) of the internal current readback. This failure will occur if the analog output is un-terminated. If the analog output is unused it should be terminated with a resistor in the range of 10 to 600 Ω.

Analog Input Failure
Turns red if analog input is selected for demand and is not between 2 and 22 mA, or if polarity is reversed. Also occurs if redundant demand inputs are selected and the difference between the two demand signals is greater than the Tune page alarm amplitude and duration settings.

Driver Over Temperature
Turns red if the temperature sensors in the EM/LQ driver exceed 80 °C (176 °F).

Motor Over Temperature
Turns red if the motor's on-board temperature monitoring switch opens. This fault is illuminated only when the driver is used with the EM70 or EM140 actuator.

This switch will open if the motor temperature rises above 180 °C (356 °F). It could also be that the thermal conductivity of the mounting pad is too low or that a problem exists in the actuator.

Resolver-to-Digital Converter #1 Failure
Turns red to show the actuator output position feedback resolver #1 circuit has failed.

Resolver-to-Digital Converter #2 Failure
Turns red to show the actuator output position feedback resolver #2 circuit has failed.

Output Resolver #1 Excitation Fault
Indicates a fault with the Resolver #1 Excitation circuitry or wiring. If this circuit opens, it will trip a position error depending on the position of the actuator.

Output Resolver #1 Sine Fault
Indicates a fault with the Resolver #1 Sine circuitry or wiring. If this circuit opens, it will trip a position error depending on the position of the actuator.

Output Resolver #1 Cosine Fault
Indicates a fault with the Resolver #1 Cosine circuitry or wiring. If this circuit opens, it will trip a position error depending on the position of the actuator.

Output Resolver #2 Excitation Fault
Indicates a fault with the Resolver #2 Excitation circuitry or wiring. If this circuit opens, it will trip a position error depending on the position of the actuator.

Output Resolver #2 Sine Fault
Indicates a fault with the Resolver #2 Sine circuitry or wiring. If this circuit opens, it will trip a position error depending on the position of the actuator.

Output Resolver #2 Cosine Fault
Indicates a fault with the Resolver #2 Cosine circuitry or wiring. If this circuit opens, it will trip a position error depending on the position of the actuator.

Feedback 1 Failure
Turns red to show the actuator output position feedback resolver #1 circuit has failed. This alarm may also indicate that one of the sine, cosine, or excitation wires for resolver #1 is shorted. If a shorted wire is detected and Reset is received, the driver must see a change in Demand and a corresponding change in the resolver feedback before the alarm is actually cleared.

Feedback 2 Failure
Turns red to show the actuator output position feedback resolver #2 circuit has failed. This alarm may also indicate that one of the sine, cosine, or excitation wires for resolver #2 is shorted. If a shorted wire is detected and Reset is received, the driver must see a change in Demand and a corresponding change in the resolver feedback before the alarm is actually cleared.

Shutdowns Page

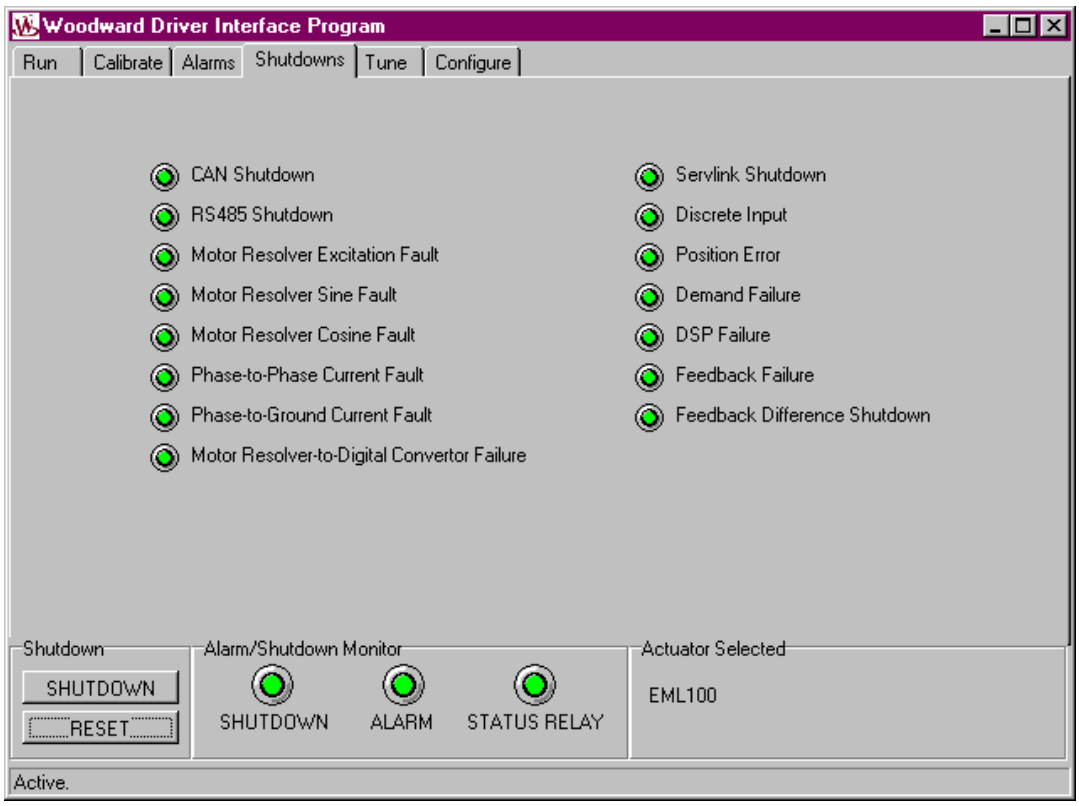


Figure 4-3. Shutdown Page

The LEDs on the Shutdown page indicate the condition that caused the shutdown. If any LEDs are gray, that shutdown does not apply to the selected actuator type. A red LED indicates a fault status, while for normal operation all LEDs are green. Many of the set points that drive these shutdowns are set from the Tune page, shown in Figure 4-4.

CAN Shutdown
This LED should not be annunciated because CAN is not supported in this version of the driver.

RS-485 Shutdown
Turns red if a Shutdown was received across RS-485, or a protocol or wiring error occurred while RS-485 was controlling the position of the actuator.

Motor Resolver-to-Digital Converter Failure
Turns red to show the actuator motor resolver circuit has failed or if actuator motor resolver feedback circuit opens or shorts.

Motor Resolver Excitation Fault
Turns red to show actuator motor resolver excitation circuit opens or shorts.

Motor Resolver Sine Fault
Turns red to show actuator motor resolver sine circuit opens or shorts.

Motor Resolver Cosine Fault
Turns red to show actuator motor resolver cosine circuit opens or shorts.

Phase-to-Phase Current Fault
Turns red if a short exists between two of the motor phases.

Phase-to-Ground Current Fault
Turns red if a short exists between a motor phase and PE ground, or from a motor phase to positive input supply (terminal block 53 +).

Discrete Input
Turns red if a shutdown came from the discrete input (opened).

Position Error
Turns red if the difference between the actuator position and demand is greater than the Tune tab page alarm amplitude and duration setting.

Demand Failure
Turns red if analog input is selected for demand and it is not between 2 and 22 mA. Also turns red if RS-485 is selected and the time-out limit is exceeded or the input is not between 0% and 100% (–2% and +102% if Extend Travel by 2% is selected). This input may be redundant such that failure of the primary demand signal will only produce an alarm when the controlling demand input switches to the backup demand signal.

DSP Failure
Turns red if the DSP processor inside the EM/LQ driver has a fault. Cycling power to the EM/LQ driver may correct the Feedback Failure.

Feedback Failure
Turns red to show the actuator output shaft position resolver circuit has failed.

Feedback Difference Shutdown
If the difference between the two position resolvers exceeds the Redundant Feedback Fail Shutdown % setting on the Tune page for longer than the allowed delay, a shutdown is generated. The difference between the resolver readings is averaged when the spread value is under this setting. This indication should only occur if one of the resolvers comes loose from its mounting and moves from its calibrated position. If a wire fault occurs on either resolver, this alarm is meaningless.

Tune Page

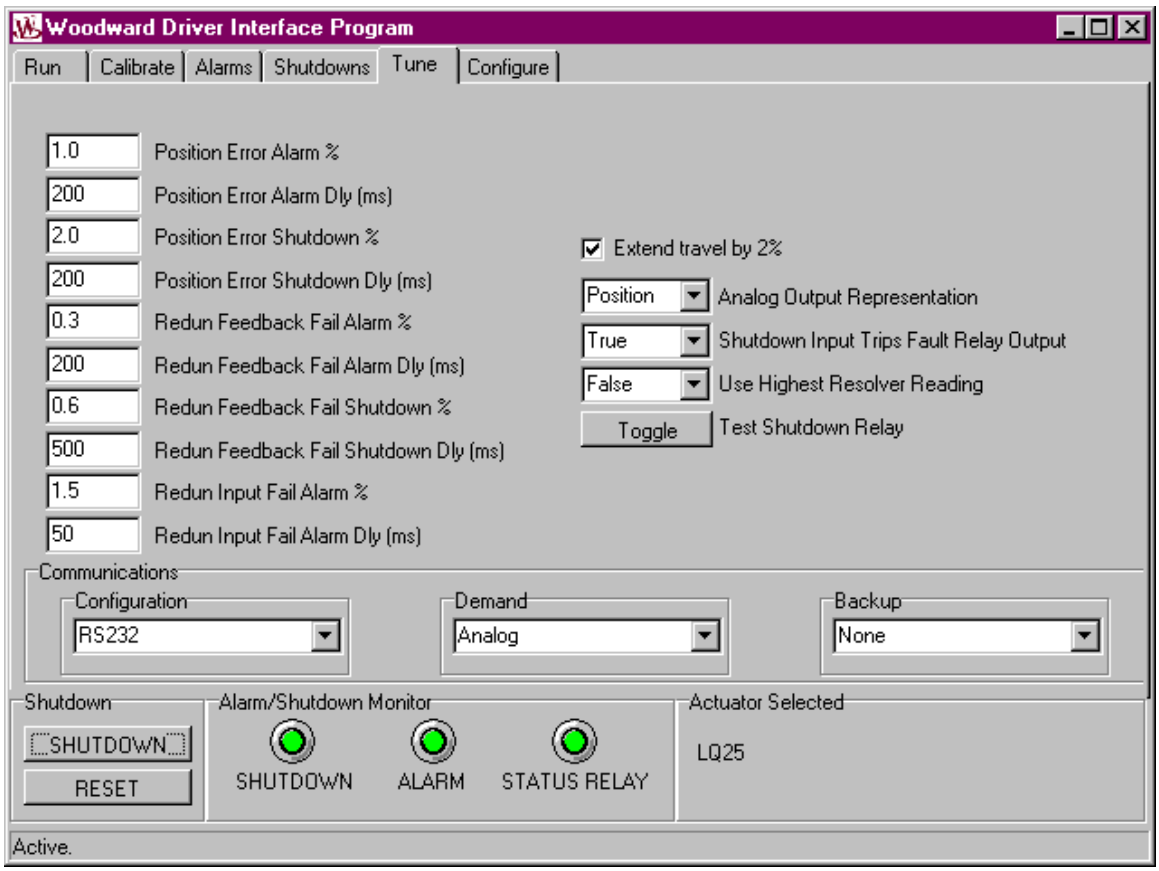


Figure 4-4. Tune Page

The Tune page contains items that can be modified while the driver is controlling a valve or actuator.

Position Error Alarm %, Position Error Alarm Delay
This is the difference allowed between the position resolver and the demand without generating an alarm. If the set percentage is exceeded for longer than the set delay time, an alarm is generated. Setting the magnitude to 100% effectively disables the alarm.

Position Error Shutdown %, Position Error Shutdown Delay
This is the difference allowed between the position resolver and the demand without generating a shutdown. If the set percentage is exceeded for longer than the set delay time, a shutdown is generated. Setting the magnitude to 100% effectively disables the shutdown.

Redundant Feedback Fail Alarm %, Redundant Feedback Fail Alarm Delay
This is the difference allowed between the two position resolvers without generating an alarm. If the set percentage is exceeded for longer than the set delay time, an alarm is generated. To clear the alarm, a reset must be asserted and the resolvers must be within the spread alarm percentage. The difference between the resolver readings is averaged when the spread value is under this alarm setting. When this alarm is reached, and no wire faults exist, the feedback switches to the lowest or highest resolver reading, as indicated by the Use Highest Resolver Reading setting.

Redundant Feedback Fail Shutdown %, Redundant Feedback Fail Shutdown Delay
This is the difference allowed between the two position resolvers without generating a shutdown. If the set percentage is exceeded for longer than the set delay time, a shutdown is generated. To clear the shutdown, a reset must be asserted and the resolvers must be within the spread percentage. The difference between the resolver readings is averaged when the spread value is under this shutdown setting. If this shutdown occurs, the unit will default to the highest or lowest resolver reading as determined by the setting of the Use Highest Resolver Reading box on the Tune page. Setting the delay to 0 ms disables the shutdown.

Redundant Input Fail Alarm %, Redundant Input Fail Alarm Delay.
This is the difference allowed between the two redundant inputs without generating an alarm. If the set percentage is exceeded for longer than the set delay time, an alarm is generated. To clear the alarm, a reset must be asserted and the inputs must be within the alarm percentage.

Extend Travel by 2%
Allows a 3.68 mA input to provide a –2% position, and a 20.32 mA input to provide 102% of travel. This feature can be used to drive the actuator past the calibrated 0% to 100% positions.

Analog Output Representation
Sets the analog output to be proportional to actuator position or actuator motor current. If it is set to actuator position, then it is equivalent to actual actuator position (4 mA = 0 % and 20 mA = 100%). If it is set to motor current, then 0 mA = –25 A and 25 mA = +25A.

Shutdown Input Trips Fault Relay Output
If this is true, then opening the discrete input will also open the fault relay, and therefore the fault relay will provide EM/LQ driver status. If this is false, the fault relay will open for all shutdown conditions except the opening of the discrete input, and therefore the fault relay no longer provides true EM/LQ driver status, and the Status Relay LED may differ from the shutdown LED.

Use Highest Resolver Reading
This value only results in an action if redundant position resolvers are used, no wire faults have been detected, and the Feedback Max Difference Alarm exists. If the Use Highest Resolver Reading value is True, the actuator position will be controlled using the resolver that gives the highest position. If False, the actuator position will be controlled using the resolver that gives the lowest position.

Test Shutdown Relay
Pressing this button activates the Shutdown relay (Fault relay) for one second. This feature is used to validate the external alarm connection, such as a flashing light or bell.

Communications
Configuration—This must be set to RS-232 for the Driver Interface Program to be able to configure, calibrate, or reset alarms and shutdowns.
Demand—This is the source for the position demand signal. This value will usually be set to Analog.
Backup—This is for the backup source for the position demand signal. If the Demand input fails, the control will default to the Backup demand input.

Configure Page

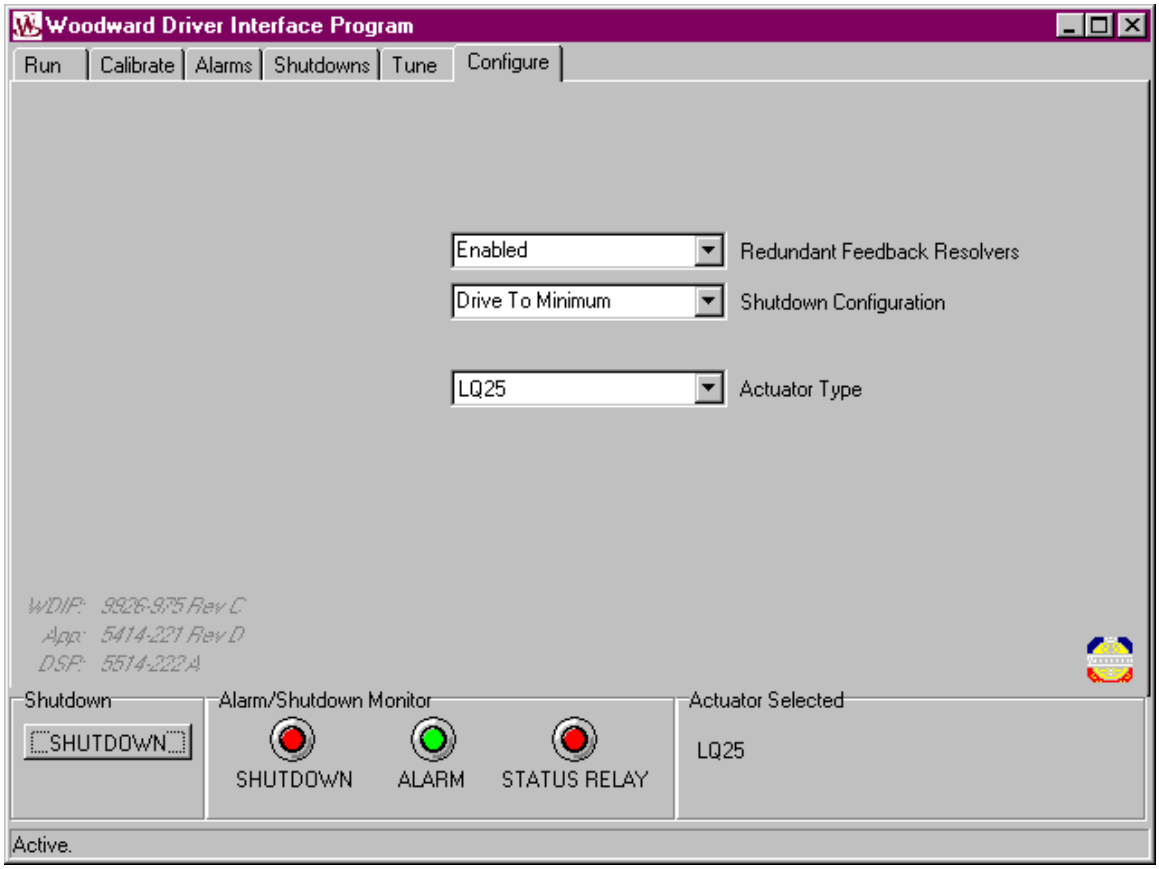


Figure 4-5. Configure Page

IMPORTANT **The numbers indicating software module revision levels are for example only and may not apply to your driver.**

⚠WARNING **Entering the Configure page will shut down the driver. DO NOT enter the Configure page of the Driver Interface Program unless you have taken precautions to prevent a shutdown from damaging your system.**

⚠WARNING **An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.**

The Configure page is used to modify values that cannot be changed while the driver is controlling an actuator.

Redundant Feedback Resolvers
Set to False if only one resolver is on the actuator.

Actuator Type
Changing the Actuator Type will reload the parameters that control the actuator, requiring recalibration. It is recommended that after changing this setting, the driver be power-cycled, then the calibration procedure be performed. The Actuator Type would only be changed if the driver were moved from its initial actuator to an entirely different type of actuator.

Shutdown Configuration
Sets action taken after a shutdown fault:

- Turn off power
- Drive to minimum (4 mA or 0%) position
- Drive to maximum (20 mA or 100%) position

⚠WARNING

If there is a motor or resolver wire fault (shorted or open wire), the actuator WILL NOT go the designated shutdown position for the obvious reason of lack of actuator control via the connections.

Chapter 5.
EM/LQ Driver Detailed Specifications

EM/LQ Driver Specifications

Environmental Specifications

Operating Temperature
–20 to +68 °C (–4 to +154 °F), uncirculated air, no external heat loads
Lloyds: Tested to ENV 4

Storage Temperature
–40 to +85 °C (–40 to +185 °F)
Component life is adversely affected by high temperature, high humidity environments. Room temperature storage is recommended for equipment longevity.

Humidity
Lloyd's environment 4 humidity test 1 (2 cycles 20–55 °C at 95% RH non-condensing, over 48 hours)
EN 50178 (96 hours @ 93 +2 -3 % RH @ 40°C 104 °F)

Vibration
Lloyd's environment 4 vibration test 2 (5-25 Hz @ ± 1.6 mm; 25–100 Hz @ 4.0 g, 10 sweeps per axis at 1 octave/minute)
EN 50178 vibration test 1 (10-57 Hz @ 0.075 mm amplitude and 57–150 Hz @ 1 g, 10 sweeps per axis at 1 octave/minute)

Shock
US MIL-STD 810C Method 516.3, Procedure I
(30 G, 11 ms half-sine waveform)

Installation Overvoltage Category
Category III

Air Quality
Pollution degree 2

Ingress Protection
Certified under IEC/EN 60079-15 and IEC/EN 60079-0 to the requirements of IP54 as defined in IEC 60529

EM/LQ Driver Weight
11 kg (24 lbs)

Dielectric Withstand
707 Vdc from power input and motor drive outputs to PE, for 24 Vdc and 28 Vdc nominal drivers
1838 Vdc from power input and motor drive outputs to PE, for 120 Vdc nominal drivers

Electrical Specifications

IMPORTANT **Power supply to be a Class III (SELV) for the 24 V version drivers (EM 24V and LQ 24V). Also power input is at the input terminals of the driver.**

	EM 24V Digital Driver		EM 120V Digital Driver	LQ 24V Digital Driver
Nominal Input Voltage	28 Vdc		120 Vdc	24 Vdc
Nominal Input Voltage Range	18–32 Vdc		90–152 Vdc	18–32 Vdc
Power Consumption	3.3 A continuous	5.5 A continuous	1.1 A continuous	2.4 A continuous
Max Power	20 A transient up 0.2 s depending on the stroke of the output shaft		20 A transient up 1.8 s depending on the stroke of the output shaft	18 A transient up 0.1 s depending on the stroke of the output shaft
Fusing	12 A time delay, min I^2T rating of 1200 A2s or circuit breaker		8 A time delay, min I^2T rating of 440 A2s or circuit breaker	12 A time delay, min I^2T rating of 1200 A2s or circuit breaker
Ambient Operating Temperature	–20 to +68 °C (–4 to +154 °F)			

Table 5-1. Electrical Specifications

4-20 mA Input

Number Of Channels	1
Input Type	4–20 mA, 0–25 mA maximum
Isolation	0 Vrms, –60 dB CMRR, 200 Vdc common mode voltage
Input Impedance	200 Ω
Anti-Aliasing filter	2 poles at 5 ms
Resolution	16 bits
Accuracy	±0.02 mA at 25 °C
Temp Drift	±6.7 µA/°C, maximum

4-20 mA Output

Number Of Channels	1
Output Type	4–20 mA, 0–25 mA maximum
Current Output	4–20 mA
Isolation	0 Vrms
Min Load Resistance	10 Ω
Max Load Resistance	600 Ω
Current Readback	10 bits
Resolution	12 bits
Accuracy	±0.064 mA @ 25 °C
Temperature Drift	±1.5 µA/°C, maximum

Discrete Input
Three terminals are provided for this input: +24V, Input, and Common. Either a dry contact or an externally powered circuit may be used. Connect a dry contact between +24V and Input. The internal power supply will conduct approximately 4 mA through the contact. When using an externally powered circuit, connect the Common terminal to the external voltage common, and connect the Input terminal to a voltage source.

Number Of Channels	1
Input Type	Optically isolated discrete input
Input Thresholds	< 8 Vdc = “OFF”
	> 16 Vdc = “ON”
Input Current	3 mA @ 24 Vdc
External Input Voltage Range	18–32 Vdc

Isolated 24 Vdc supply may be used to power contacts, 20 mA maximum

This input is isolated from all other I/O at 500 Vdc. It is not isolated from the other Discrete Input.

Relay Output
This is a dry contact output providing simplified driver and actuator status information. A form-C relay contact (NC, Com, and NO terminals) is available. If any fault is present in the driver or actuator, this relay will be de-energized (Com and NC connected). If no faults are present, this contact will be energized (Com and NO connected). The relay specifications are as follows:

UL recognized contact ratings
5 A at 28 Vdc; resistive load
0.5 A at 115 Vac; resistive load

This coil is isolated from all other I/O at 500 Vdc.

Position Resolver(s): Resolver/Digital Converter

Type:	ratiometric
Bandwidth:	300 Hz
Resolution:	0.33 arc min
Accuracy:	< 6 arc min (over temperature range)

Motor Resolver: Resolver/Digital Converter

Type:	ratiometric
Bandwidth:	1200 Hz
Resolution:	5.3 arc min
Accuracy:	< 11 arc min (over temperature range)

Communications Ports
The communications ports are isolated from all other I/O and each other to 500 Vdc.

Driver Overtemp Sensor
When the internal temperature reaches 80 °C (176 °F), a signal will be sent to the Driver Interface Program which will cause an Alarm condition. This alarm will be seen on the Driver Interface Program’s Alarm page and over the RS-485 interface.

Chapter 6.
EM/LQ Driver Troubleshooting

Introduction

A clear understanding of the function of the EM/LQ driver and the EM/LQ actuator is important for troubleshooting. Please read this manual to become familiar with the hardware prior to troubleshooting.

⚠WARNING

For safe turbine operation in fault situations, valves must be used in conjunction with an additional high-speed shutoff valve. Also, the driver fault relay should be tied into the engine protection system.

⚠WARNING

Before attempting any troubleshooting action, verify that the prime mover is shut down and that fuel pressure is not present to valves that may open due to actuator motion.

The following list contains suggestions for quick troubleshooting of the EM/LQ Digital Driver. If a problem is found, correct the problem and then reset the driver either by toggling the shutdown/reset switch or by cycling power off and on.

- Is the correct input power applied? (Verify correct voltage present between terminals 53 [+] and 54 [–].) Refer to Table 5-1.
- Is the appropriate voltage (18–32 V) present at pin 19 referenced to pin 18 (either from pin 17 or from an external supply)?
- If the driver is not communicating via RS-232, follow the procedure on setting up the Servlink Server file again. Refer to Chapter 4.
- If the driver is configured to accept analog (4–20 mA) demand signal, is a 4–20 mA signal present between terminals 11 (+) and 12 (–)? (If analog demand is selected, the driver will shut down if this signal is < 2 mA or > 22 mA, unless a backup is configured.)
- If the driver is configured to accept RS-485 demand signal, is the driver properly connected to an RS-485 device such as a MicroNet™ system Real Time SIO module? Are the address switches and termination jumpers in the correct position?
- Are any of the power wires from the driver terminals 55–60 to the actuator shorted to each other or to earth ground? Are they connected to the actuator? Are they phased correctly?
- Are all wires of the appropriate size, length, and shielded with properly grounded shields?

EM/LQ Driver Faults

If a fault condition exists in the EM/LQ driver consider the following actions:

- Read Chapter 4 of this manual under the Alarms or the Shutdowns sections and take the recommended actions listed.
- Turn off the power to the EM/LQ driver for at least 10 seconds, then turn the EM/LQ driver power back on.

The Driver Interface Program Fails to Run Properly—If the Driver Interface Program fails to run, consider the following actions:

- Verify that the EM/LQ driver is running
- Verify that the RS-232 cable is properly connected to the EM/LQ driver and the PC
- Exit the Driver Interface Program
- If Servlink is still running on the PC, exit Servlink
- Shutdown and restart the PC
- Start the Driver Interface Program
- Verify that Servlink is running
- Wait until the Driver Interface Program finishes initialization

Calibration Problems

Actuator/Valve Calibration Verification Procedure

Go to the Tune page and select the Shutdown Configuration box. Press the Shutdown button at the bottom of the page to shutdown the control. Select Drive to Minimum. The actuator should go to its minimum (4 mA) position. Select Drive to Maximum. The actuator should go to its maximum (20 mA) position. If this procedure works as described, then the actuator is calibrated correctly. After performing this test, return the Shutdown Configuration to its previous setting.

EM Calibration Page—Understanding What Is Happening

When a user opens the Calibration page and accepts the warning message, the Driver Interface Program puts the control in Calibration mode. The calibration procedure may be initiated at either the maximum or the minimum position. Pressing any Up arrow moves the actuator in the minimum-position-to-maximum-position direction, as selected by the CW/CCW Actuator Direction setting. If the actuator is at the minimum position and pressing the Up arrow moves it towards the minimum stop, then the Actuator Direction setting is incorrect and needs to be changed to the other direction. If, on the other hand, the actuator is at its maximum position, pressing the Down arrow should move it towards its minimum position.

IMPORTANT

Both the Set Maximum and Set Minimum buttons must have been pressed at least once during the Calibration procedure, or else pressing the Accept button merely reverts the control to its previously saved Calibration values.

Exiting the Calibration page in any form exits the control from Calibration mode and returns it to normal operation. If the RS-232 connection is broken during Calibration, the control will return to an uncalibrated state in approximately 5 seconds.

Run Page—Note

The Calibrated LED on the Run page should always be lit, thus indicating that the control has been through Calibration at least once. Note that the calibrated LED is not reset if the Calibration mode has been aborted or if it failed for any reason, because the control simply returns to the previous set of Calibration values. The LED will not be lit when the control is initially delivered from the factory. This LED is a safety precaution to ensure that the user Calibrates the actuator/control before the actuator is allowed to move.

Calibration Testing
For testing purposes, go to the Tune page and set Shutdown Configuration to Turn Off Power. Go to the Calibration page. Press the Shutdown button. Press the Set Minimum Position button. Move the actuator toward the maximum position. Press the Set Maximum Position button, followed by the Accept button. Perform the Actuator Calibration Verification Procedure above. Verify that the actuator moves. If it does not, something may be wrong with the control and this procedure should be performed on the backup unit. After this test, recalibrate the actuator to its original settings and return Shutdown Configuration to its previous state.

Other Things to Check
Does the 4 mA input approximate the 0% Analog Input reading on the Run page? Does the 20 mA input approximate the 100% Analog Input reading on the Run page? If yes, then the Analog Input circuitry is calibrated correctly.

On the Tune page, in the Communications box, Configuration should be set to RS-232, Demand should be set to Analog, and Backup should be set to None. This does not apply for RS-485 controlled drivers.

On the Run page, press the Shutdown button. Move the actuator. Is the movement somewhat related to the identical movement of the Resolver #1 and the Actuator Position box? If yes, then the actuator resolver is working. If no, there may be a wiring problem or a problem with the actuator.

WARNING

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

IMPORTANT

For Servlink and Driver Interface Program usage:

If either error message "The control did not reply to the last request" or "The last message received was garbled" is seen, shut down both the Driver Interface Program and the Servlink Server. After verifying that the driver has been powered up for a minimum of 5 seconds, restart the program. This will clear any existing Servlink Server communications problems with the driver.

Using Analog Demand

New Installation

This section assumes that the driver has never controlled an actuator at this location.

Driver does not control the actuator
- Check Alarms & Shutdowns.
- Check Wiring. If sine and cosine resolver wiring is switched, or '+' is switched with '–', the driver is unable to move the actuator. A Short or Open condition does not exist, therefore the driver does not detect a wiring fault. All Alarms and Shutdowns could be cleared but the driver is still not able to move the actuator if the wiring is not correct.

- Check for blinking LEDs. The LEDs on the PCB of an operational driver will be off. Blinking LEDs usually indicate a hardware problem on the driver. Reset the driver (turn power off, then back on). If the blinking LEDs still exist, the driver has a problem and most likely will need to be returned to Woodward for repair or replacement.
- If Shutdown Configuration is set to Turn Off Power and you are having trouble clearing the Position Error Alarm and Shutdown conditions, keep in mind that external forces may move the actuator beyond the Position Error Alarm and Shutdown settings (Tune page). For example, if a return-to-minimum spring is used, the actuator's physical minimum position, or hard stop, is 0 degrees, the Minimum Position (or Offset) is set to 30 degrees, and the Position Error Shutdown setting is 10 degrees, a Reset will not be able to clear the Position Error Shutdown because a 30-degree difference exists between the desired position (assuming a 0% demand) and the current position. If Turn Off Power is used, it is mandatory that your Position Error Shutdown setting be greater than the difference between your Minimum Hard Stop and your Minimum Position settings.

Driver moves the actuator backwards or always drives into a hard stop

- Check Wiring. If the excitation resolver wiring is reversed, the actuator moves in the opposite direction from what is expected. The driver is unable to detect reversed resolver wiring.

Existing Installation

Driver does not control the actuator

- Check all conditions under New Installation, but you can assume the wiring is OK if it has not been modified since it last ran successfully.

Driver moves the actuator backwards or always drives into a hard stop

- Check Calibration. Verify that the hard stop numbers are outside of the Min/Max numbers. For example, if Hard Stop Min is 100, Min Position is 110, Max Position is 190, and Hard Stop Max is 200 degrees, the Hard Stop Min number is outside the Min/Max span for a clockwise direction, but is inside the Min/Max span (and therefore incorrect) for a counterclockwise direction. The driver cannot make an intelligent decision about what the user wants to do. For most installations, the Hard Stop Min and Hard Stop Max numbers should be taken directly from numbers marked on the actuator housing.

Using the NetCon® or MicroNet™ Control

New Installation

Driver does not control the actuator

- Review all items under Using Analog Demand. If any LEDs are blinking, this could be caused by a rare case of first-time initialization from a NetCon or MicroNet. Reset the driver (turn power off, then back on). If the blinking LEDs still exist, the driver has a problem and most likely will need to be returned to Woodward for repair or replacement.
- Check the Degree Span field of the GAP™ block. It is an integer (in hundredths of a degree) that represents the degree difference of the between the Minimum and Maximum stops. If this is Zero or some other number which does not make sense for the specific application, check the calibration numbers.

- Check your address switches. The driver always receives the Demand input, but if its address is different from what is configured in the GAP block, it won't respond to the NetCon or MicroNet controls. The highest recognized address is 63.
- For a new driver shipped from Woodward, it takes four reset commands from the NetCon or MicroNet control to fully initialize and calibrate the driver. The first reset puts it in RS-485 Configuration mode. The second sends a regular reset. The third calibrates the driver. Finally, the fourth gets the driver running, assuming all faults have been cleared.

General Guidelines

- Don't run the Driver Interface Program while the driver is controlling an actuator from a NetCon or MicroNet control, especially if using a 5 ms rate group. While COMM_FAULTs are rare, the additional processing required by the incoming RS-232 data does modify the RS-485 interrupt timing. This causes an occasional RS-485 fault when the driver takes more than a few hundred microseconds to respond to the request from the NetCon or MicroNet control.
- If using RS-485 (NetCon or MicroNet), don't configure the Analog Input as the primary demand source. The digital data is more accurate and should always be configured as the primary demand source when it is available. The Analog Input can be used as the backup demand source.
- If the NetCon or MicroNet control modifies the driver configuration (any Reset command) and the Driver Interface Program is also being used to monitor the driver, some fields on the Driver Interface Program will not reflect the changes from the NetCon or MicroNet until a page change or the Driver Interface Program is restarted.
- When the NetCon or MicroNet is rebooted or receives a full system reset, the driver will report a Feedback Fail alarm (#1 or #2) until the Demand is stepped any small amount and the driver can tell for certain that a resolver wire short does not exist.
- Since calibration information is sent on every Reset command from the NetCon or MicroNet control to the driver, the driver only performs the calibration task when the calibration information has changed. Consequently, there can be cases where the NetCon or MicroNet control tries to calibrate the driver and it does not calibrate because the stored data is identical to the sent data. The work-around is to slightly bump any Feedback Offset or Minimum/Maximum stop number, send a Reset, then return the variable to its original value.

Actuator/Valve Problems

Refer to the applicable actuator/valve manual.

Driver Failure

If all of the previous troubleshooting techniques have been tried and the driver still does not work, try power-cycling the driver. If the driver still does not work, try the following:

1. Remove power from the driver.
2. Remove the top cover.
3. Remove the RS-232 cable to assure that the PC does not try to communicate with the driver during the initialization sequence.
4. Restore power to the driver.

WARNING

HIGH VOLTAGE—Keep clear of the electrical connections while the driver boards are exposed!

5. If either diagnostic LED is flashing, a non-recoverable hardware error has occurred with one of the boards inside the driver. The driver should be returned to Woodward to be repaired or replaced.

Chapter 7.
EML100 Actuator and EML100/3151A Water Valve

Introduction

The EM24 Digital Driver and the EML100 actuator provide a rugged and reliable all-electric actuation system for various prime mover control applications. The system provides high bandwidth and high accuracy for the most demanding applications for water valves, flow control valves, and variable geometry steam valves. The EM24 Digital Driver controls the EML100 actuator position proportional to a position demand signal received from a controlling device.

The EML100 actuator consists of a high performance brushless servomotor and a precision planetary gearbox with two resolver type shaft position sensors. The use of a high efficiency gearbox facilitates high servo system bandwidth. One resolver provides 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.

IMPORTANT **For detailed specifications on the EML100 Actuator or the 3151 Water Valve / EML100, please refer to the appropriate manual.**

System Accuracy

EML100 Actuator Position Hysteresis	±0.010 inch/0.25 mm (±0.67% of 1.5 inch/38 mm stroke)
EML100 Actuator Position Threshold	±0.002 inch/0.05 mm (±0.13% of 1.5 inch/38 mm stroke)
Using RS-485 for control:	
Initial Accuracy:	±0.0125 inch/0.318 mm
Accuracy over temperature:	±0.0127 inch/0.323 mm
Using 4–20 mA for control:	
Initial Accuracy:	±0.0125 inch/0.318 mm
Accuracy over temperature:	±0.042 inch/1.07 mm
4–20 mA Position Readback	
Initial Accuracy:	±0.4% of stroke + 0.0075 inch/0.19 mm
Accuracy Over Temperature:	±0.81% of stroke + 0.0075 in./0.19 mm

System Performance

Slew Time (10-90% stroke)	0.150 seconds max for 1.5 inch/38 mm travel at 445 N (100 lbs force) within rated temperature range at 28 Vdc input voltage to the driver.

System bandwidth is nominally greater than 18.85 rad/s (3 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 20 ms, which includes all effects such as the communications, processing time, mechanical times, etc.

Valve Installation to the Driver

Making Electrical Connections

Refer to the general wiring instructions (wire gauge, wire type, and length) in Chapter 2. Detailed descriptions of the terminal blocks and connectors are also found there.

The cable between the valve and driver must be no longer than 100 m (328 ft) in order to ensure position accuracy and slew time.

The actuator must also be connected to Protective Earth (PE) via a green and yellow wire, as shown on the wiring diagram. This wire must not be smaller than the power wires, by code. This wire may be run directly to Protective Earth, or to the terminal provided in the driver chassis and marked with the circled ground symbol.

Resolver excitation and secondary wiring should be three individually shielded twisted pairs or three overall shielded twisted pairs.

For best noise immunity, the valve power cables should be run in separate cable trays or conduits from the resolver cables.

The EM24 Digital Driver will not operate if these resolver connectors are attached to the wrong resolver.

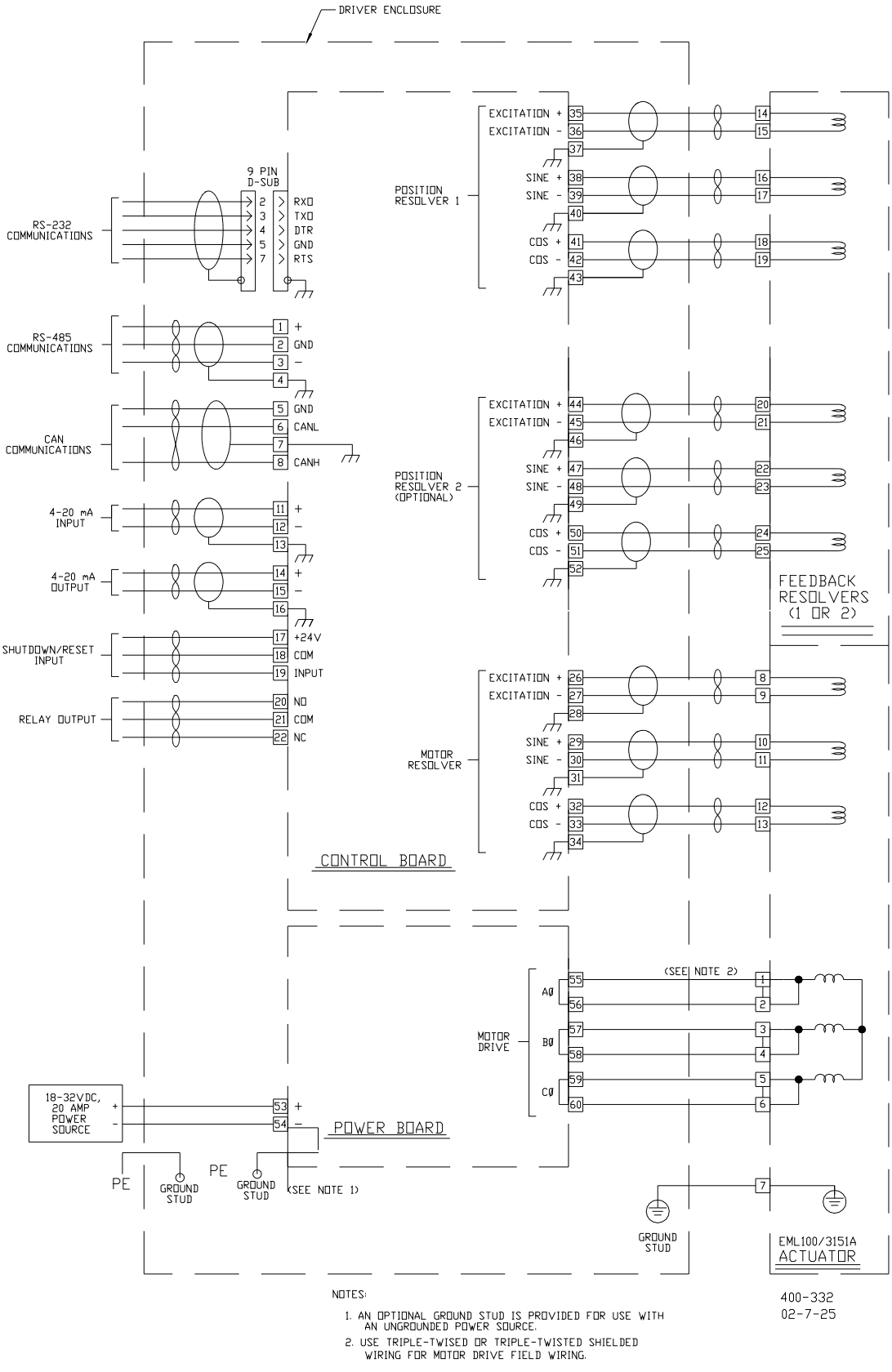


Figure 7-1. EM 24V Digital Driver/EML 100 Plant Wiring Diagram

Calibration Using the RS-232 Interface

Refer to Chapter 4 for installation and operation of the Driver Interface Program.

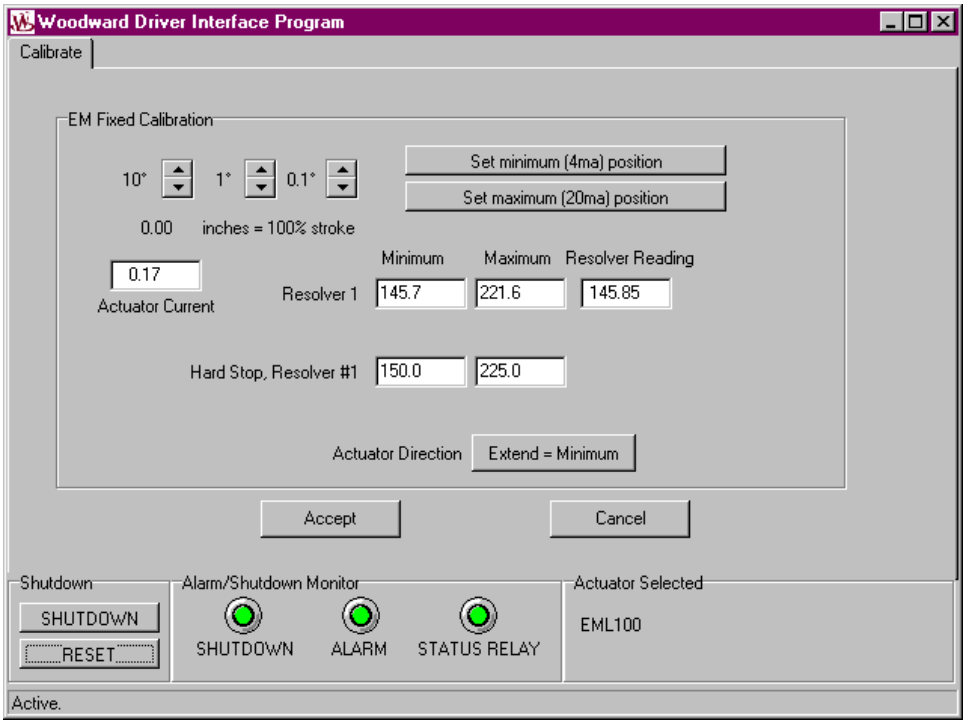


Figure 7-2. EML 100 Calibrate Page

Calibrating the Actuator with the Driver

The value next to the “inches = 100% stroke” label indicates the approximate stroke of the actuator when the Accept button is pressed and the calibration values are saved.

WARNING

If the RS-232 connection is lost, or the Driver Interface Program is interrupted while the Calibrate page is displayed, the control will revert to an uncalibrated state within 5 seconds. Power will be removed from the actuator, and it may move due to external forces (such as return spring). Take precautions to ensure that actuator movement will not cause damage to your system. DO NOT enter the Calibrate page of the Driver Interface Program unless the prime mover is stopped and fuel is not available.

10°, 1°, 0.1°
These buttons move the actuator the specified angle to allow the actuator stroke to be set. The Up arrow means the actuator will travel in the Minimum (0%) to Maximum (100%) direction. The Down arrow means the actuator will travel from the Maximum to the Minimum direction. The direction is set in the Actuator Direction box, described below.

Set Minimum (4 mA) Position
Press this button when the actuator is positioned at the desired minimum stroke (4 mA or 0% demand).

Set Maximum (20 mA) Position
Press this button when the actuator is positioned at the desired maximum stroke (20 mA or 100% demand).

Actuator Current
This is the same as Actuator Current on the Run page.

Resolver Minimum, Maximum and Resolver Reading boxes
When the Set Minimum button is pressed, the resolver value, as displayed in the Resolver Reading box, is copied into the Minimum box. When the Set Maximum button is pressed, the resolver value is copied into the Maximum box. The Minimum and Maximum boxes are also input fields. If your actuator was previously calibrated with a driver and the Minimum/Maximum numbers were written down in a log book, those numbers can be entered in the boxes in lieu of moving the actuator with the Up/Down arrows and pressing the Set Minimum and Set Maximum buttons.

Hard Stop, Resolver #1—Minimum and Maximum
If these boxes appear on the Calibrate page, they must be filled-in correctly to avoid improper direction of actuator travel during a shutdown or a reset. A hard stop is a mechanical restriction of actuator movement. These values should be stamped on the side of the actuator.

Actuator Direction—Retract or Extend
The direction of output shaft travel is from the 0% to 100% position. Selecting Retract means that the actuator shaft will retract into the actuator body on increasing demand signals (the actuator is fully extended at minimum position). Selecting Extend means that the actuator shaft will extend away from the actuator body on increasing demand signals (the actuator is fully retracted at minimum position). If your actuator is delivered from Woodward attached to a valve (such as a 3151A valve), the actuator direction is preset and this box will not be shown.

Accept
This saves the changes made in the Calibrate page and returns the user to the Run page. The changes are not saved if both the Set Minimum and the Set Maximum buttons were not pressed while on this page. The Set Minimum and the Set Maximum buttons can be pressed in any order and any number of times before the Accept button is pressed.

Cancel
Returns the user to the Run page without saving any changes made in the Calibrate page.

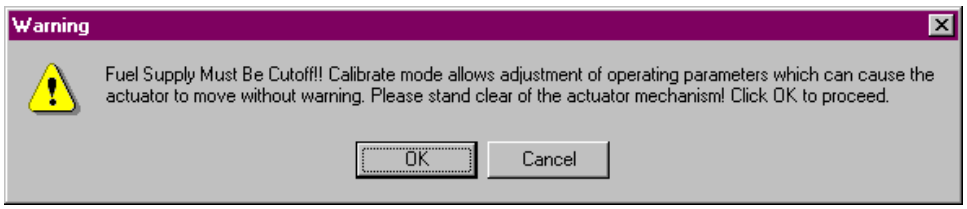


Figure 7-3. Calibration Warning Message

While in Calibration Mode, the driver ignores any Demand change requests from Analog Input, or RS-485. It is not capable of controlling an engine while in this mode. Exiting the Calibrate page will return to allowing Demand changes from the normal sources. This change may result in a sudden change of the actuator's position.

Setting the Endpoints of Actuator Travel

The EML100 actuator has programmable stroke length. Endpoints must be set to match the requirements of the actuator and the prime mover.

IMPORTANT

The best endpoint settings for electric actuators differ from the best settings for hydraulic actuators. Read this section carefully before setting endpoints.

⚠WARNING

The actuator will change position during this procedure. In Calibration mode, all position control from 4–20 mA and digital interfaces is disabled. DO NOT enter the Calibrate page of the Driver Interface Program unless the prime mover is stopped and fuel is not available.

The EML100 actuator is available with one- or two-position resolvers. The minimum and maximum hard stop positions are stamped into the nameplate attached to each actuator. Each actuator has unique minimum and maximum angles that must be configured with the driver. The driver and the actuator are not calibrated together at the factory. The resolver minimum and maximum angles(s) must be entered before the driver will accurately control the actuator's position.

Setting the Resolver Minimum and Maximum Angle Values

1. Go to the Calibrate page.
2. At any point during this process, pressing Cancel will stop the calibration procedure and restore the previous resolver minimum and maximum settings.
3. Enter Resolver #1 and Resolver #2 minimum and maximum values. If the actuator was shipped attached to a Woodward valve (such as a 3151A valve), these values will be found on the nameplate attached to the actuator motor, or on the Test Specification Procedure (TSP) sheet shipped with each actuator.

OR

Using the Up/Down arrows, move the actuator to the desired Minimum position. Press the Set Minimum button. Move the actuator to the desired Maximum position. Press the Set Maximum button. Note: If the actuator reaches a hard stop when you are positioning it using this method, the value in the Actuator Current box will reach a steady-state level of 7 to 10 A. The stored minimum and maximum positions should not be against a hard stop.

4. Enter Resolver #1 and Resolver #2 minimum and maximum hard stop values. These values will be found on the nameplate attached to the actuator motor, or on the Test Specification Procedure (TSP) sheet shipped with each actuator.
5. Press Accept to save the new resolver settings and return to Run mode.
6. Apply input commands from 4 mA to 20 mA to the analog input, and observe the resolver readings on the Run page. If you have dual resolvers, their readings should be very closely aligned. If the endpoint settings are not correct, repeat the above procedure to correct the settings.

Checking Alarm and Shutdown Set Points

It is recommended that the Alarm and Shutdown set points be checked at this point to avoid invalid alarms or shutdowns. Factory Settings are:

Position Error Alarm %	7%
Position Error Alarm Delay (ms)	100 ms
Position Error Shutdown %	10%
Position Error Shutdown Delay (ms)	100 ms
Redundant Feedback Fail Alarm %	0.4%
Redundant Feedback Fail Alarm Delay (ms)	50 ms
Redundant Feedback Fail Shutdown %	1.0%
Redundant Feedback Fail Shutdown Delay (ms)	100 ms
Redundant Input Alarm %	1.5%
Redundant Input Alarm Delay (ms)	50 ms

IMPORTANT **These settings may change with different applications. Please note the correct settings for your application and retain them for reference.**

In addition to the normal functions, the shorted resolver wire detection algorithm uses the Redundant Feedback Fail Alarm values. Modifying these values determines how quickly the algorithm can detect the shorted wire and how far the resolver reading drifts before the error is detected and the resolver removed from the position calculations. Using smaller values than the defaults can result in premature or invalid error detection.

When an EML100 or EML100/3151 is calibrated with a 1.5 inch/38 mm stroke, the Redundant Feedback Fail numbers can be as low as indicated below to minimize actuator movement when resolver wires are shorted:

Redundant Feedback Fail Alarm %	0.1
Redundant Feedback Fail Alarm Delay	50

When using an EM35MR/3103 or an EML100 or EML100/3151 with a 0.5 inch/13 mm stroke, the Redundant Feedback Fail numbers can be as low as indicated below to minimize actuator movement when resolver wires are shorted:

Redundant Feedback Fail Alarm %	0.4
Redundant Feedback Fail Alarm Delay	50

Under no circumstances should your configuration use numbers less than those indicated above. These numbers can be increased to make an alarm or shutdown condition less likely to occur, but only at the expense of actuator movement when a resolver wire is shorted. In general, most turbine applications will use the above numbers. Most reciprocating engine applications can afford to increase these numbers. These are installation-dependent values.

Chapter 8.
EM35MR/EBV63 and EM35MR/EBV100

Introduction

The EM/LQ driver with the EM35MR actuator and the Electric Bleed Valves (EBV) provide a rugged and reliable all electric actuation system for various prime mover control applications. The system provides high bandwidth and high accuracy for the most demanding applications for gas turbine airflow metering. The EM/LQ driver controls the EM35MR actuator position proportional to a position demand signal received from a controlling device.

The EM35MR actuators consist of a high performance brushless servomotor and a precision planetary gearbox with two resolver type shaft position sensors. The use of a high efficiency gearbox facilitates high servo system bandwidth. One resolver provides motor rotor position feedback, and the other resolver provides accurate output shaft position feedback. The actuator also has a slip clutch to allow full speed impact into optional external rigid mechanical stops.

IMPORTANT **For detailed specifications on the EBV63/100/EM35MR, please refer to the appropriate manual.**

System Accuracy

Using RS-485 for control:

Initial Accuracy:	±0.3° (18 arc-minutes)
Accuracy Over Temperature:	±0.323° (19.4 arc-minutes)

Using 4–20 mA for control:

Initial Accuracy:	±0.3° + 0.125% of stroke
Accuracy Over Temperature:	±0.323° + 2.00% of stroke

4–20 mA Position Readback

Initial Accuracy:	±0.4% of stroke
Accuracy Over Temperature:	±0.81% of stroke

System Performance

Slew Time is 250 ms at a stroke of 90° at a nominal line voltage of 28 Vdc to the driver. This slew rate must be measured using the speed achieved between the 10% and 90% points.

System bandwidth is nominally greater than 34 rad/s (5.5 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 20 ms, which includes all effects such as the communications, processing time, mechanical times, etc.

Wiring Installation to the Driver

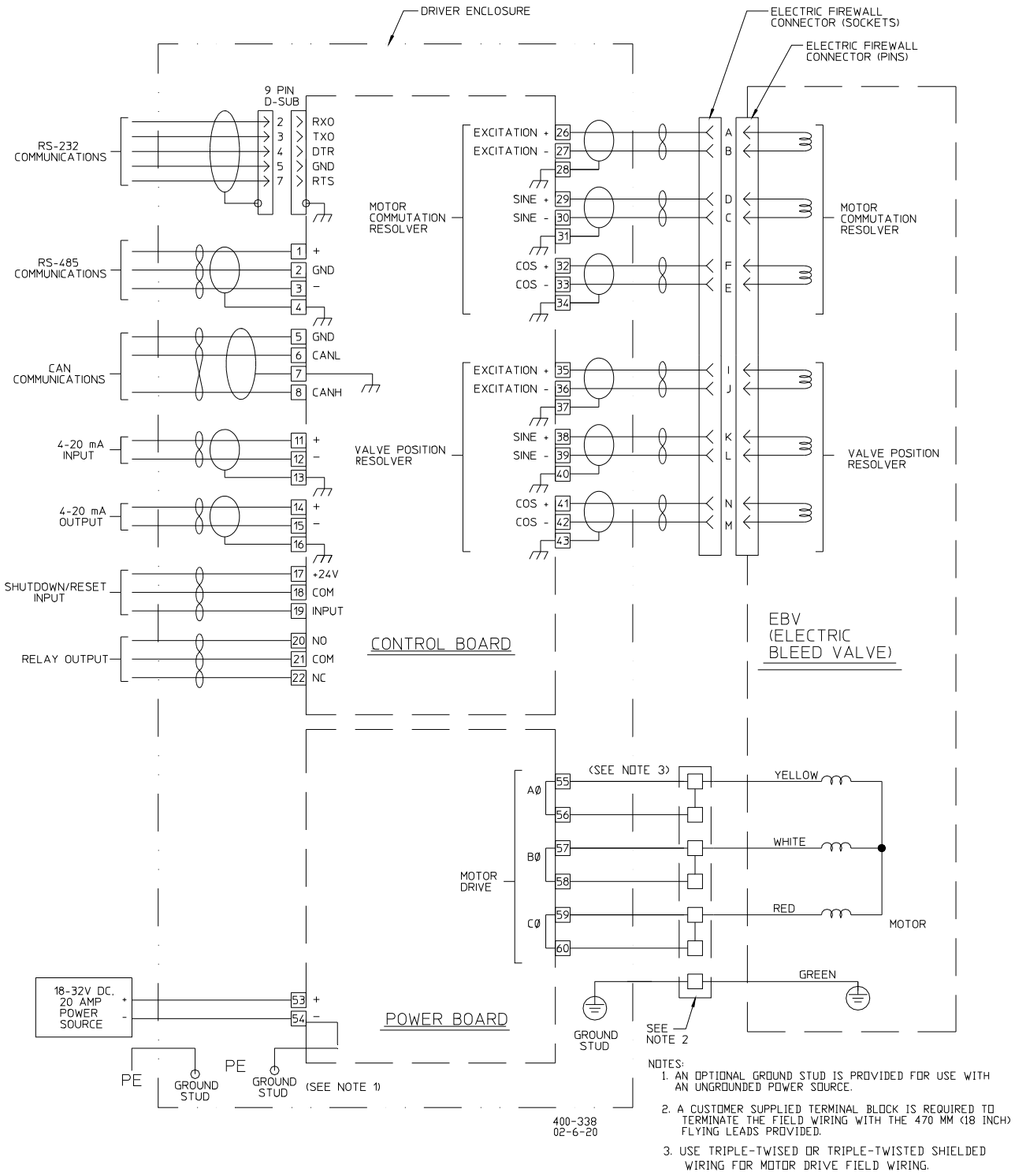


Figure 8-1. EM 24V Digital Driver with EM35MR and EBV63/100 Plant Wiring Diagram

Calibration Using the RS-232 Interface

Refer to Chapter 4 for installation and operation of the Driver Interface Program.

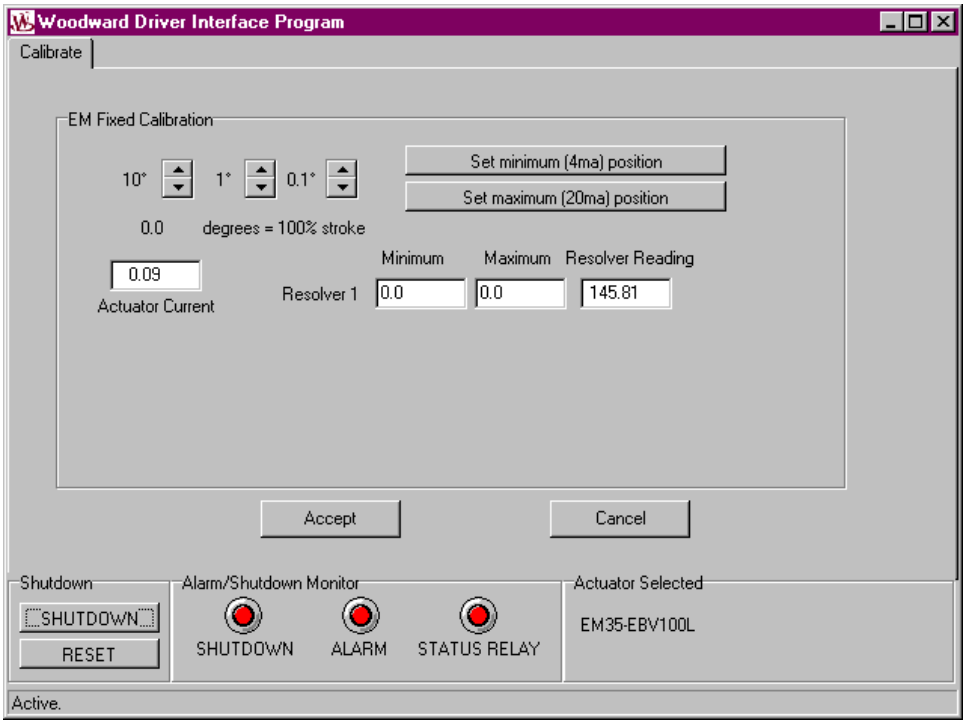


Figure 8-2. Calibrate Page

Calibrating the Actuator with the Driver

The value next to the “inches = 100% stroke” label indicates the approximate stroke of the actuator when the Accept button is pressed and the calibration values are saved.

WARNING

If the RS-232 connection is lost, or the Driver Interface Program is interrupted while the Calibrate page is displayed, the control will revert to an uncalibrated state within 5 seconds. Power will be removed from the actuator, and it may move due to external forces (such as return spring). Take precautions to ensure that actuator movement will not cause damage to your system. DO NOT enter the Calibrate page of the Driver Interface Program unless the prime mover is stopped and fuel is not available.

10°, 1°, 0.1°
These buttons move the actuator the specified angle to allow the actuator stroke to be set. The Up arrow means the actuator will travel in the Minimum (0%) to Maximum (100%) direction. The Down arrow means the actuator will travel from the Maximum to the Minimum direction. The direction is set in the Actuator Direction box, described below.

Set Minimum (4 mA) Position
Press this button when the actuator is positioned at the desired minimum stroke (4 mA or 0% demand).

Set Maximum (20 mA) Position
Press this button when the actuator is positioned at the desired maximum stroke (20 mA or 100% demand).

Actuator Current
This is the same as Actuator Current on the Run page.

Resolver Minimum, Maximum and Resolver Reading boxes
When the Set Minimum button is pressed, the resolver value, as displayed in the Resolver Reading box, is copied into the Minimum box. When the Set Maximum button is pressed, the resolver value is copied into the Maximum box. The Minimum and Maximum boxes are also input fields. If your actuator was previously calibrated with a driver and the Minimum/Maximum numbers were written down in a log book, those numbers can be entered in the boxes in lieu of moving the actuator with the Up/Down arrows and pressing the Set Minimum and Set Maximum buttons.

Accept
This saves the changes made in the Calibrate page and returns the user to the Run page. The changes are not saved if both the Set Minimum and the Set Maximum buttons were not pressed while on this page. The Set Minimum and the Set Maximum buttons can be pressed in any order and any number of times before the Accept button is pressed.

Cancel
Returns the user to the Run page without saving any changes made in the Calibrate page.

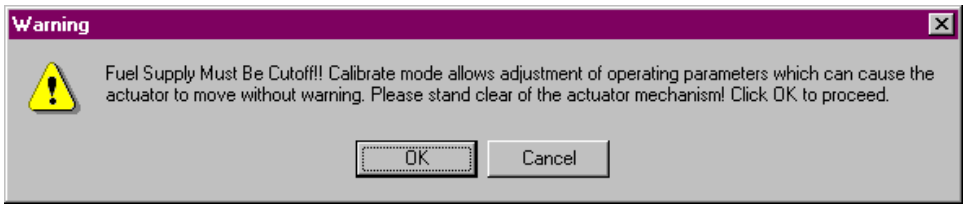


Figure 8-3. Calibration Warning Message

While in Calibration Mode, the driver ignores any Demand change requests from Analog Input or RS-485. It is not capable of controlling an engine while in this mode. Exiting the Calibrate page will return to allowing Demand changes from the normal sources. This change may result in a sudden change of the actuator's position.

Setting the Endpoints of Actuator Travel

The EM35MR/EBV actuator has programmable stroke length. Endpoints must be set to match the requirements of the actuator and the prime mover.

IMPORTANT

The best endpoint settings for electric actuators differ from the best settings for hydraulic actuators. Read this section carefully before setting endpoints.

⚠WARNING

The actuator will change position during this procedure. In Calibration mode, all position control from 4–20 mA and digital interfaces is disabled. DO NOT enter the Calibrate page of the Driver Interface Program unless the prime mover is stopped and fuel is not available.

The EM35MR/EBV actuator is available with one or two position resolvers. The minimum and maximum positions are stamped into the nameplate attached to each actuator. The driver and the actuator are not calibrated together at the factory. The resolver minimum and maximum positions must be entered before the driver will accurately control the actuator's position.

Setting the Resolver Minimum and maximum angle Values

1. Go to the Calibrate page.
2. At any point during this process, pressing Cancel will stop the calibration procedure and restore the previous resolver minimum and maximum settings.
3. Enter Resolver #1 and Resolver #2 minimum and maximum values. These values will be found on the nameplate attached to the actuator motor, or on the Test Specification Procedure (TSP) sheet shipped with each actuator.

OR

Using the Up/Down arrows, move the actuator to the desired Minimum position. Press the Set Minimum button. Move the actuator to the desired Maximum position. Press the Set Maximum button. Note: If the actuator reaches a hard stop when you are positioning it using this method, the value in the Actuator Current box will reach a steady-state level of 7 to 10 A. The stored minimum and maximum positions should not be against a hard stop.

4. Press Accept to save the new resolver settings and return to Run mode.
5. Apply input commands from 4 mA to 20 mA to the analog input, and observe the resolver readings on the Run page. If you have dual resolvers, their readings should be very closely aligned. If the endpoint settings are not correct, repeat the above procedure to correct the settings.

Checking Alarm and Shutdown Set Points

It is recommended that the Alarm and Shutdown set points be checked at this point to avoid invalid alarms or shutdowns. Factory Settings are:

Position Error Alarm %	7%
Position Error Alarm Delay (ms)	200 ms
Position Error Shutdown %	45%
Position Error Shutdown Delay (ms)	200 ms
Redundant Feedback Fail Alarm %	0.5%
Redundant Feedback Fail Alarm Delay (ms)	50 ms
Redundant Feedback Fail Shutdown %	1.5%
Redundant Feedback Fail Shutdown Delay (ms)	75 ms

IMPORTANT **These settings may change with different applications. Please note the correct settings for your application and retain them for reference.**

In addition to the normal functions, the shorted resolver wire detection algorithm uses the Redundant Feedback Fail Alarm values. Modifying these values determines how quickly the algorithm can detect the shorted wire and how far the resolver reading drifts before the error is detected and the resolver removed from the position calculations. Using smaller values than the defaults can result in premature or invalid error detection.

Chapter 9.
EM35MR/3103 and EM35MR/3171A Gas Valves

Introduction

The EM24 Digital Driver with the EM35MR actuator and the 3103 or 3171 Gas Valves provides a rugged and reliable all electric actuation system for various prime mover control applications. The system provides high bandwidth and high accuracy for the most demanding applications like DLE. The EM24 Digital Driver controls the EM35MR actuator position proportional to a position demand signal received from a controlling device.

The EM35MR actuator consists of a high performance brushless servomotor and a precision planetary gearbox with two resolver-type shaft position sensors. The use of a high efficiency gearbox facilitates high servo system bandwidth. One resolver provides 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.

IMPORTANT **Please refer to the EM35MR/3103 Gas Valve manual and to the EM35MR1/3171A Gas Valve manual for the individual detailed specifications.**

System Accuracy

Using RS-485 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 is 125 ms to open the valve and 120 ms to close the valve (internal spring adding) at a nominal line voltage of 28 Vdc. This slew rate must be measured using the speed achieved between the 10% and 90% points. The rated stroke of the 3103 Gas Valve is 60°, while for the 3171 Gas Valve it's 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.

Wiring Installation to the Driver

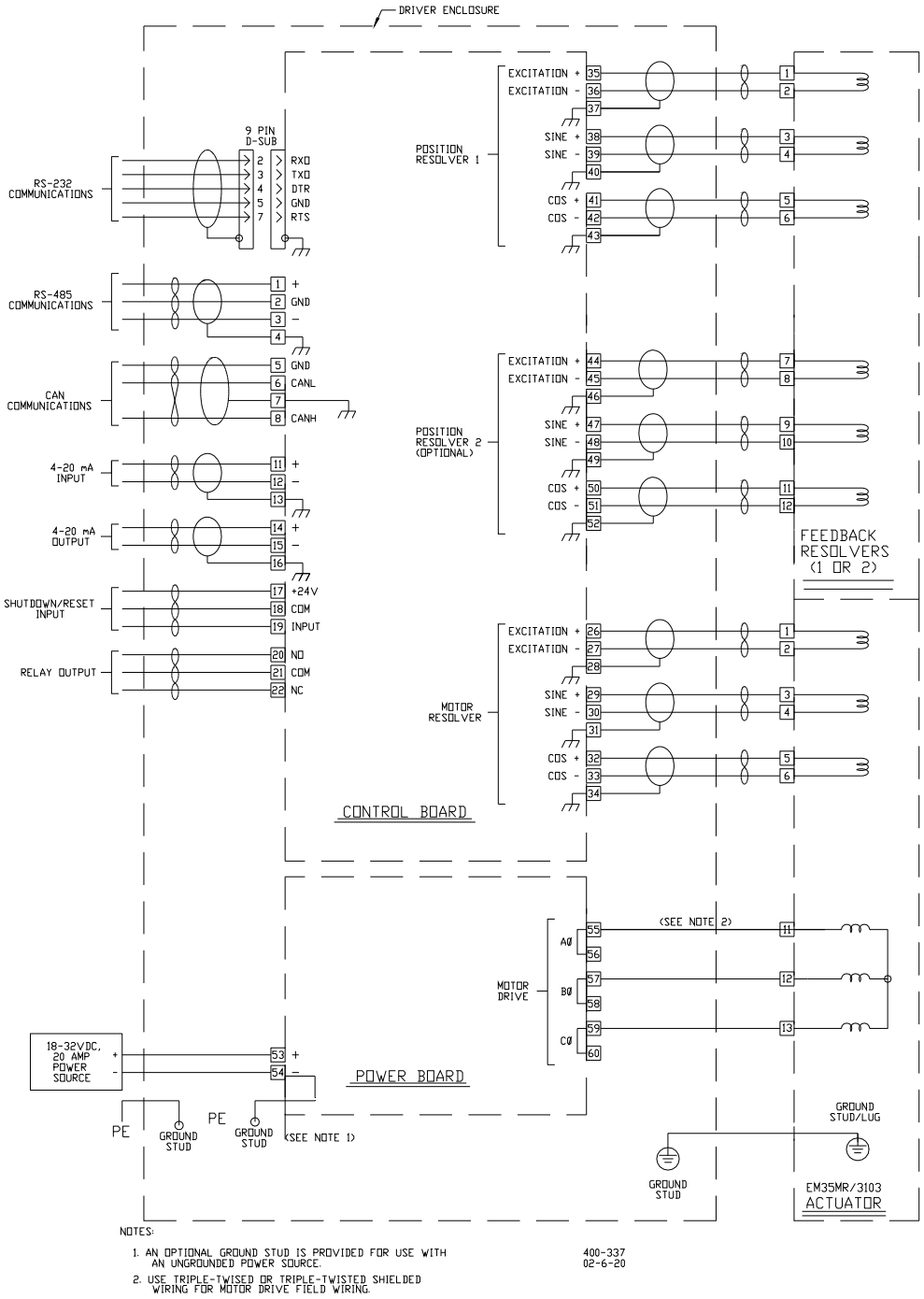


Figure 9-1. EM24 Digital Driver with EM35MR/3103 Gas Valve Plant Wiring Diagram
[This is the same for the EM35MR/3171A Gas Valve.]

Calibration Using the RS-232 Interface

Refer to Chapter 4 for installation and operation of the Driver Interface Program.

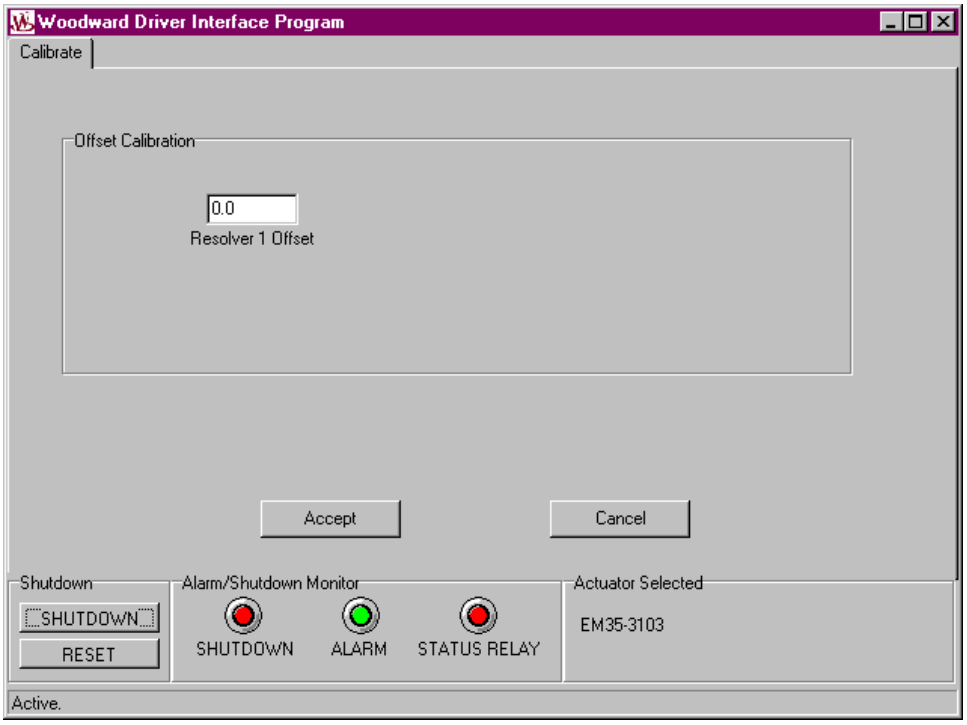


Figure 9-2. EM35MR/3103 Calibrate Page

Calibrating the Actuator with the Driver

WARNING

If the RS-232 connection is lost, or the Driver Interface Program is interrupted while the Calibrate page is displayed, the control will revert to an uncalibrated state within 5 seconds. Power will be removed from the actuator, and it may move due to external forces (such as return spring). Take precautions to ensure that actuator movement will not cause damage to your system. DO NOT enter the Calibrate page of the Driver Interface Program unless the prime mover is stopped and fuel is not available.

The following calibration procedure applies for both the EM35MR/3103 and the EM35MR/3171A Gas Valve.

Setting the Resolver Offset Values

1. Go to the Calibrate page.
2. At any point during this process, pressing Cancel will stop the calibration procedure and restore the previous resolver minimum and maximum settings.
3. Enter Resolver #1 and Resolver #2 (if using dual position resolvers) offset values. These values will be found on the nameplate attached to the actuator motor, or on the Test Specification Procedure (TSP) sheet shipped with each actuator.

4. Press Accept to save the new resolver settings and return to Run mode.
5. Apply input commands from 4 mA to 20 mA to the analog input, and observe the resolver readings on the Run page. If you have dual resolvers, their readings should be very closely aligned. If the endpoint settings are not correct, repeat the above procedure to correct the settings.

Checking Alarm and Shutdown Set Points

It is recommended that Alarm and Shutdown set points be checked at this point to avoid invalid alarms or shutdowns. Factory Settings are:

	EM35MR/ 3103	**EM35MR/ 3171A**
Position Error Alarm %	0.5%	7%
Position Error Alarm Delay (ms)	250 ms	200 ms
Position Error Shutdown %	1%	45%
Position Error Shutdown Delay (ms)	500 ms	200 ms
Redundant Feedback Fail Alarm %	0.1%	0.5%
Redundant Feedback Fail Alarm Delay (ms)	50 ms	50 ms
Redundant Feedback Fail Shutdown %	1.0%	1.5%
Redundant Feedback Fail Shutdown Delay (ms)	100 ms	0 (disabled)
Redundant Input Alarm %	1.5%	1.5%
Redundant Input Alarm Delay (ms)	100 ms	50 ms

IMPORTANT

These settings may change with different applications. Please note the correct settings for your application and retain them for reference.

In addition to the normal functions, the shorted resolver wire detection algorithm uses the Redundant Feedback Fail Alarm values. Modifying these values determines how quickly the algorithm can detect the shorted wire and how far the resolver reading drifts before the error is detected and the resolver removed from the position calculations. Using smaller values than the defaults can result in premature or invalid error detection.

Chapter 10.
LQ25, LQ25T, and LQ Bypass Liquid Valves

Introduction

The LQ25, LQ25T, or LQ bypass valve assemblies with the LQ24V Digital Driver are integrated liquid fuel metering systems which feature valve position control, all electric actuation, fuel bypass, fuel flow regulation, and fault indication. These systems may allow multiple independent metered flow paths with a single pump.

The LQ valve assemblies are brushless dc limited angle torquers which position a metering port for liquid fuel control. The LQ actuators are directly coupled to both the metering port and position feedback resolvers (single or dual). There are no intervening gears, linkages, or flex couplings. The high torque actuator and shearing action of the shoe on the rotor valve provide a high degree of contamination resistance.

IMPORTANT **For detailed specifications on the LQ25, LQ25T, and LQ bypass valve, please refer to the appropriate manual.**

System Accuracy

Using RS-485 for control:
Initial Accuracy: ±0.1° (including temp. drift)
Using 4–20 mA for control:
Initial Accuracy: ±0.1° + (0.0179 x span)

The rotary valve travel for the LQ25 is 69 degrees, giving 1.335 degrees positional accuracy. The rotary valve travel for the LQ25T and LQ25BP is 66 degrees, giving a positional accuracy of 1.281 degrees.

System Performance

System bandwidth is 40 rad/s (6.4 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 20 ms, which includes all effects, such as communications, processing time, mechanical times, etc.

Wiring Installation to the Driver

LQ 25 Wiring

The LQ25 has a green lead wire, which must be connected to earth ground. This may be connected to the terminal provided on the driver (TB1-8) or more directly to earth ground near the valve. The earth connections on both the valve and the driver must be connected to the same earth grounding system.

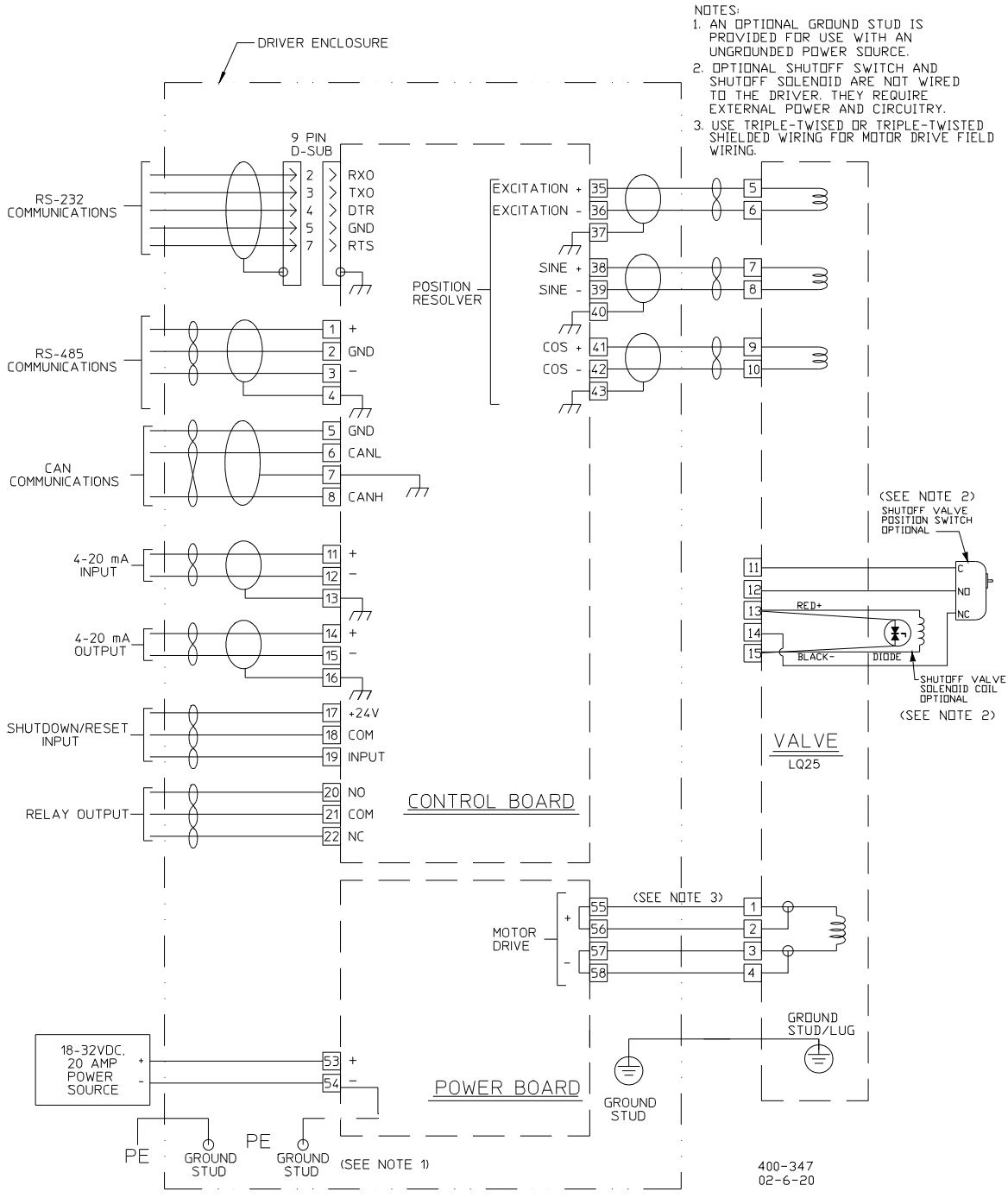


Figure 10-1. LQ24V Digital Driver with LQ25 Valve Plant Wiring Diagram

LQ 25T and LQ Bypass Wiring

The LQ25T and the LQ Bypass have green lead wires, which must be connected to earth ground. They may be connected to the terminal provided on the driver (TB1-8) or more directly to earth ground near the valve. The earth connections on both the valve and the driver must be connected to the same earth grounding system.

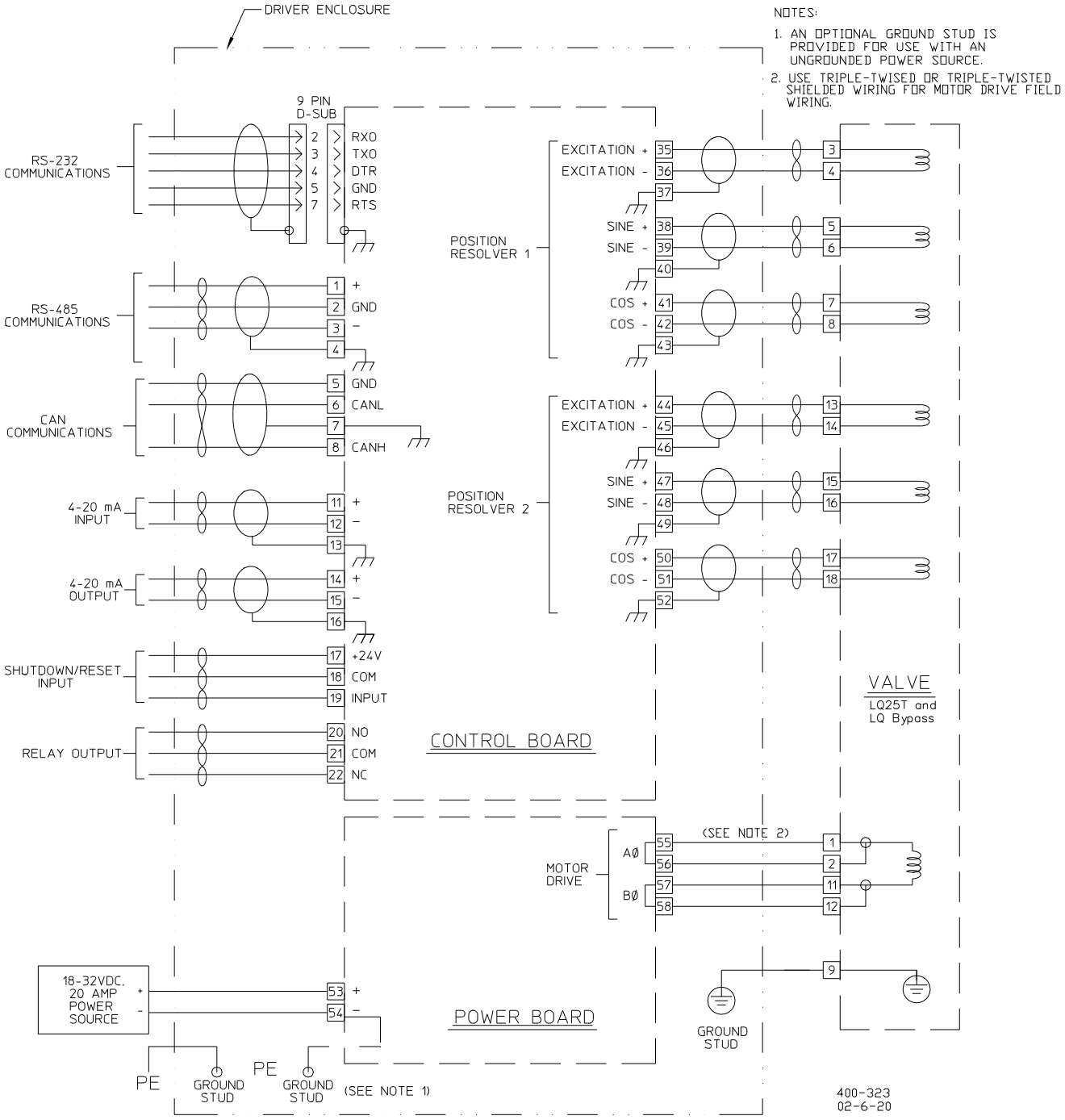


Figure 10-2. LQ24V Digital Driver with LQ25T or LQ Bypass Valve Plant Wiring Diagram

Calibration Using the RS-232 Interface

Refer to Chapter 4 for installation and operation of the Driver Interface Program.

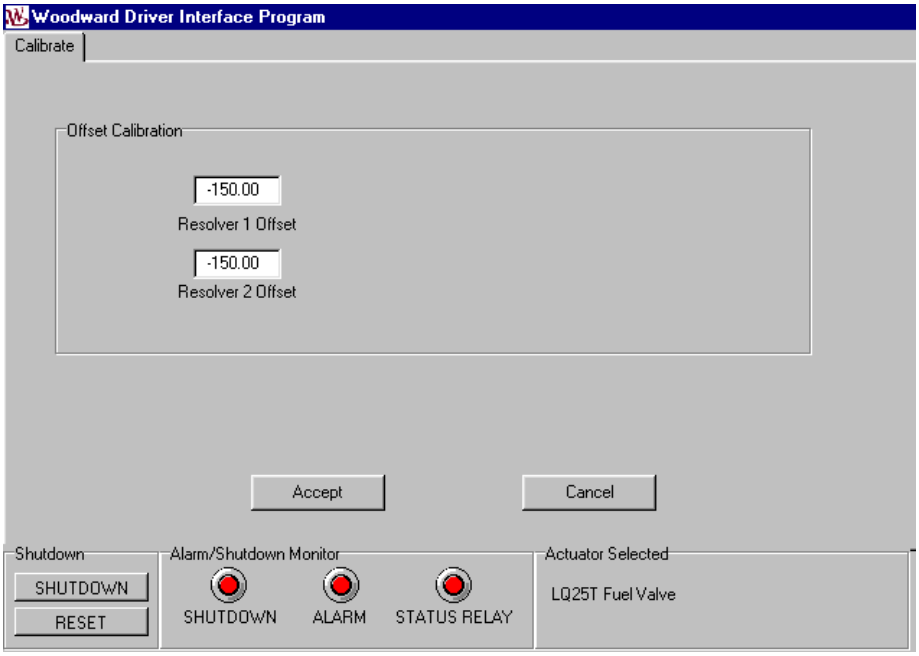


Figure 10-3. LQ Digital Driver Calibrate Page

Calibrating The Valve With The Driver

WARNING

If the RS-232 connection is lost, or the Driver Interface Program is interrupted while the Calibrate page is displayed, the control will revert to an uncalibrated state within 5 seconds. Power will be removed from the actuator, and it may move due to external forces (such as return spring). Take precautions to ensure that actuator movement will not cause damage to your system. DO NOT enter the Calibrate page of the Driver Interface Program unless the prime mover is stopped and fuel is not available.

Setting the Resolver Offset Values

1. Go to the Calibrate page.
2. At any point during this process, pressing Cancel will stop the calibration procedure and restore the previous resolver minimum and maximum settings.
3. Enter Resolver #1 and Resolver #2 (if using dual position resolvers) offset values. These values will be found on the nameplate attached to the actuator motor, or on the Test Specification Procedure (TSP) sheet shipped with each actuator.
4. Press Accept to save the new resolver settings and return to Run mode.
5. Apply input commands from 4 mA to 20 mA to the analog input, and observe the resolver readings on the Run page. If you have dual resolvers, their readings should be very closely aligned. If the endpoint settings are not correct, repeat the above procedure to correct the settings.

Checking Alarm and Shutdown Set Points

It is recommended that the Alarm and Shutdown set points be checked at this point to avoid invalid alarms or shutdowns. Factory Settings are:

	LQ25	LQ25T	LQ25BP
Position Error Alarm %	1%	1%	1%
Position Error Alarm Delay (ms)	200 ms	200 ms	200 ms
Position Error Shutdown %	2%	2%	2%
Position Error Shutdown Delay (ms)	200 ms	200 ms	200 ms
Redundant Feedback Fail Alarm %	0.3%	0.3%	2.5%
Redundant Feedback Fail Alarm Delay (ms)	200 ms	200 ms	200 ms
Redundant Feedback Fail Shutdown %	0.6%	0.6%	5.0%
Redundant Feedback Fail Shutdown Delay (ms)	500 ms	500 ms	500 ms
Redundant Input Alarm %	1.5%	1.5%	1.5%
Redundant Input Alarm Delay (ms)	50 ms	50 ms	50 ms

IMPORTANT

These settings may change with different applications. Please note the correct settings for your application and retain them for reference.

In addition to the normal functions, the shorted resolver wire detection algorithm uses the Redundant Feedback Fail Alarm values. Modifying these values determines how quickly the algorithm can detect the shorted wire and how far the resolver reading drifts before the error is detected and the resolver removed from the position calculations. Using smaller values than the defaults can result in premature or invalid error detection.

Chapter 11.
EM70 and EM140 Actuators

Introduction

The EM120V Digital Driver and the EM70 or EM140 actuator provide a rugged and reliable all electric actuation system for various prime mover control applications. The system provides high bandwidth and high accuracy for the most demanding applications for positioning engine fuel injection linkage control, flow control valves, and gas turbine variable geometry systems. The EM120V Digital Driver controls the EM70 and EM140 actuator position proportional to a position demand signal received from a controlling device.

The EM70 and EM140 actuators consist of a high performance brushless servomotor and a precision planetary gearbox with two resolver type shaft position sensors. The use of a high efficiency gearbox facilitates high servo system bandwidth. One resolver provides motor rotor position feedback, and the other resolver provides accurate output shaft position feedback. The actuators also have a slip clutch to allow full speed impact into optional external rigid mechanical stops.

IMPORTANT **For detailed specifications on the EM70 and EM140 actuators, please refer to the appropriate manual.**

System Accuracy

Total positioning accuracy depends on the calibrated stroke as follows:

Using RS-485 for control

Initial Accuracy:	±0.283° (17 arc-minutes)
Accuracy Over Temperature:	±0.31° (18.6 arc-minutes)

Using 4–20 mA for control

Initial Accuracy:	±0.283° + 0.125% of stroke
Accuracy Over Temperature:	±0.31° + 2.00 % of stroke

4–20 mA Position Readback

Initial Accuracy:	±0.4% of stroke
Accuracy Over Temperature:	±0.81% of stroke

System Performance

Slew Time for the EM70 is 0.112 seconds for 42° of travel at 84 N·m, and for the EM140 0.225 seconds for 42° of travel at 168 N·m. This slew rate must be measured using the speed achieved between the 10% and 90% points. The rated stroke of these actuators is 10° to 320° adjustable (no internal mechanical stops).

System bandwidth is nominally 34 rad/s (5.5 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 20 ms, which includes all effects such as communications, processing time, mechanical times, etc.

Wiring Installation to the Driver

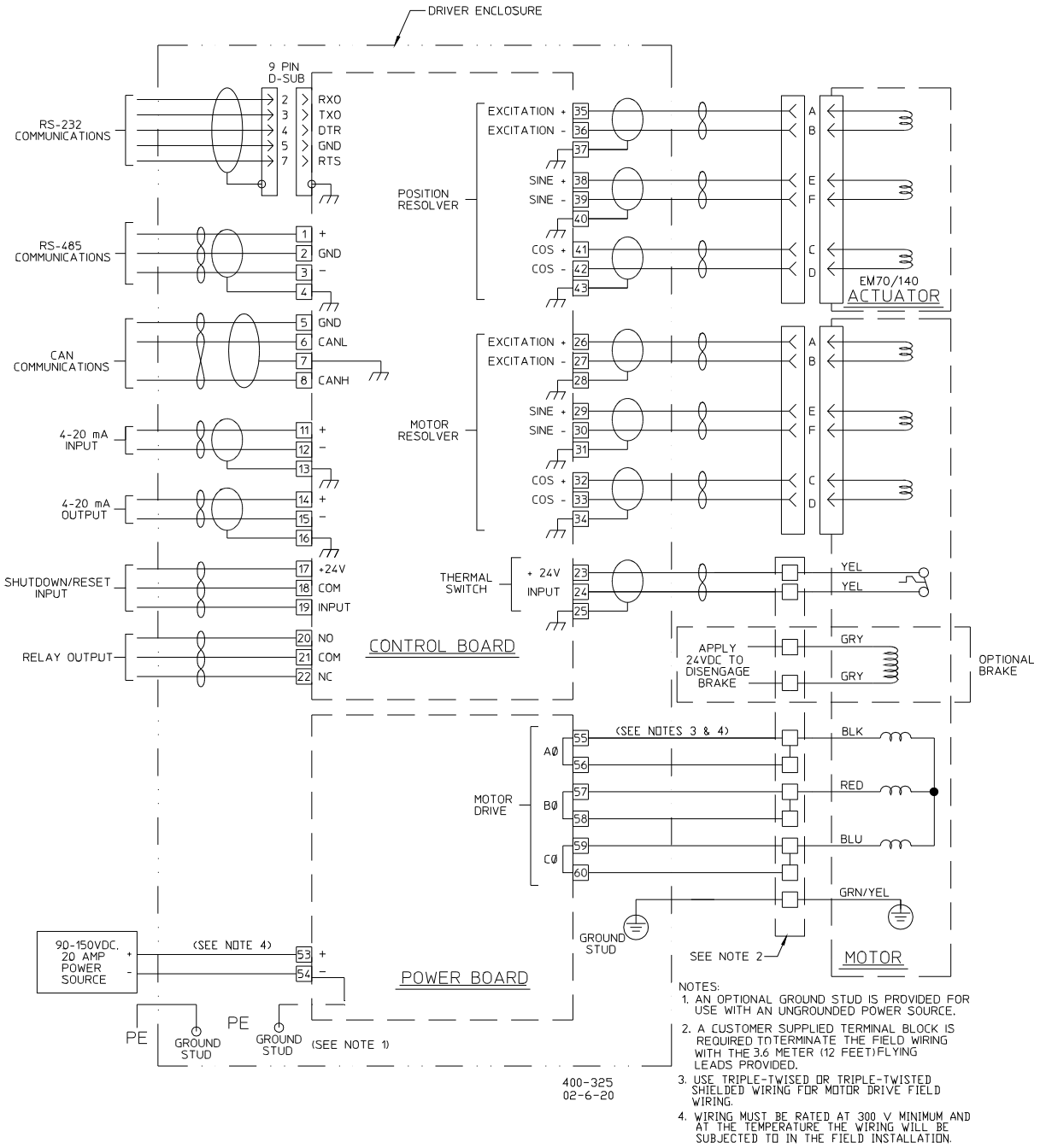


Figure 11-1. EM 120V Digital Driver w/ EM70 or EM140 Actuator Plant Wiring Diagram

Calibration Using the RS-232 Interface

Refer to Chapter 4 for installation and operation of the Driver Interface Program.

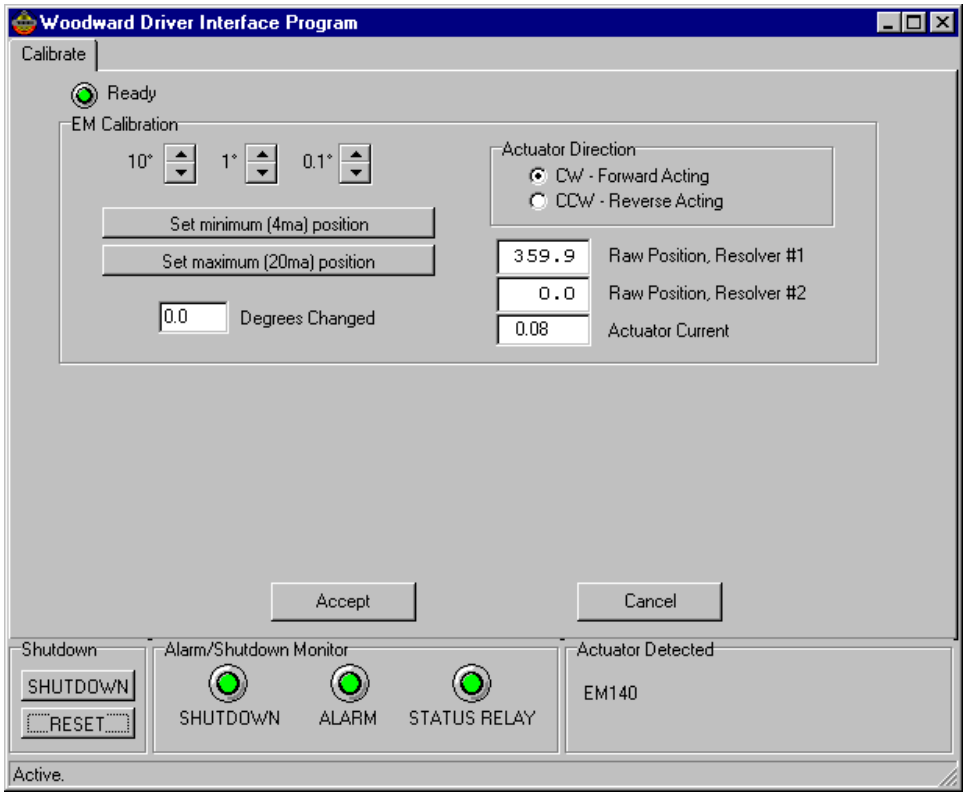


Figure 11-2. EM70 or EM140 Calibrate Page

Calibrating the Actuator with the Driver

WARNING

If the RS-232 connection is lost, or the Driver Interface Program is interrupted while the Calibrate page is displayed, the control will revert to an uncalibrated state within 5 seconds. Power will be removed from the actuator, and it may move due to external forces (such as return spring). Take precautions to ensure that actuator movement will not cause damage to your system. DO NOT enter the Calibrate page of the Driver Interface Program unless the prime mover is stopped and fuel is not available.

10°, 1°, 0.1°
These buttons move the actuator the specified angle to allow the actuator stroke to be set. The Up arrow means the actuator will travel in the Minimum (0%) to Maximum (100%) direction. The Down arrow means the actuator will travel from the Maximum to the Minimum direction. The direction is set in the Actuator Direction box, described below.

Set Minimum (4 mA) Position
Press this button when the actuator is positioned at the desired minimum stroke (4 mA or 0% demand).

Set Maximum (20 mA) Position
Press this button when the actuator is positioned at the desired maximum stroke (20 mA or 100% demand).

Actuator Current
Same as Actuator Current on the Run page.

Actuator Direction—CW or CCW
The direction of travel from 0% to 100% position as viewed by observing the output shaft of the EM70 or EM140 actuator.

Resolver Minimum, Maximum and Resolver Reading boxes
When the Set Minimum button is pressed, the resolver value, as displayed in the Resolver Reading box, is copied into the Minimum box. When the Set Maximum button is pressed, the resolver value is copied into the Maximum box. The Minimum and Maximum boxes are also input fields. If your actuator was previously calibrated with a driver and the Minimum/Maximum numbers were written down in a log book, those numbers can be entered in the boxes in lieu of moving the actuator with the Up/Down arrows and pressing the Set Minimum and Set Maximum buttons.

Actuator Direction—Retract or Extend
The direction of travel from 0% to 100% position as viewed by looking at the output shaft of the actuator. Selecting Retract means that the actuator shaft will retract into the actuator body on a 0% demanded position. Selecting Extend means that the actuator shaft will extend away from the actuator body on a 0% demanded position. If your actuator is delivered from Woodward attached to a valve (such as a 3151A valve), the actuator direction is preset and this box will not be shown.

Accept
This saves the changes made in the Calibrate page and returns the user to the Run page. The changes are not saved if both the Set Minimum and the Set Maximum buttons were not pressed while on this page. The Set Minimum and the Set Maximum buttons can be pressed in any order and any number of times before the Accept button is pressed.

Cancel
Returns the user to the Run page without saving any changes made in the Calibrate page.

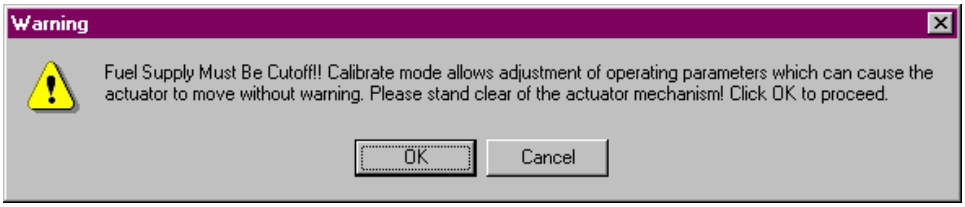


Figure 11-3. Calibration Warning Message

While in Calibration Mode, the driver ignores any Demand change requests from Analog Input or RS-485. It is not capable of controlling an engine while in this mode. Exiting the Calibrate page will return to allowing Demand changes from the normal sources. This change may result in a sudden change of the actuator's position.

Setting the Endpoints of Actuator Travel

1. With the Driver Interface Program running, select the Calibration page. A warning dialog will appear as a reminder that fuel supply to the prime mover must be OFF.
2. At any point during this process, pressing Cancel will stop the calibration procedure and restore the previous resolver minimum and maximum settings.
3. Close the pin 17-19 discrete input. Hit the Reset button on the Driver Interface Program to clear any faults or shutdowns.
4. Enter the Calibrate page. Select OK to enter the calibration procedure. Select either CW–Forward Acting, or CCW–Reverse Acting. The clockwise and counterclockwise directions are as viewed from the output shaft end of the actuator.
5. On the Calibrate page, the Up and Down arrows labeled 10, 1.0, and 0.1 move the actuator by the given angles. Use the buttons to position the actuator to the correct 4 mA position. When the correct position is set, select Set Minimum (4 mA) Position to save the position. Use the arrow buttons to position the actuator to the maximum or 20 mA position. When the correct position is set, select Set Maximum (20 mA) Position. This will save the position.
6. Press Accept to save the new resolver settings and return to Run mode.
7. Apply input commands from 4 mA to 20 mA to the analog input, and observe the resolver readings on the Run page. If the endpoint settings are not correct, repeat the above procedure to correct the settings.

Checking Alarm and Shutdown Set Points

It is recommended that the Alarm and Shutdown set points be checked at this point to avoid invalid alarms or shutdowns. Factory Settings are:

Position Error Alarm %	2%
Position Error Alarm Delay (ms)	250 ms
Position Error Shutdown %	3%
Position Error Shutdown Delay (ms)	350 ms
Redundant Feedback Fail Alarm %	0.5%
Redundant Feedback Fail Alarm Delay (ms)	50 ms
Redundant Feedback Fail Shutdown %	1.5%
Redundant Feedback Fail Shutdown Delay (ms)	0 (disabled)
Redundant Input Alarm %	1.5%
Redundant Input Alarm Delay (ms)	50 ms

IMPORTANT **These settings may change with different applications. Please note the correct settings for your application and retain them for reference.**

In addition to the normal functions, the shorted resolver wire detection algorithm uses the Redundant Feedback Fail Alarm values. Modifying these values determines how quickly the algorithm can detect the shorted wire and how far the resolver reading drifts before the error is detected and the resolver removed from the position calculations. Using smaller values than the defaults can result in premature or invalid error detection.

Chapter 12.
EGV and ESV Actuators

Introduction

The EM120V Digital Driver with the EGV (Electric Globe Valve) or the ESV (Electric SonicFlo™ Valve) actuators provide a rugged and reliable all electric actuation system for various prime mover control applications. The system provides high bandwidth and high accuracy for the most demanding applications for positioning turbine engine gas fuel flow control valves. The EM120V Digital Driver controls the EGV or ESV actuator position proportional to a position demand signal received from a controlling device.

The EGV and ESV actuators consist of a high performance brushless servomotor, resolver, precision ball screw assembly, fail safe return spring, and soft stop spring. The use of a high efficiency ball screw facilitates high servo system bandwidth. One resolver provides motor rotor position feedback, and provides accurate output shaft position feedback. The actuator's soft stop spring allows the actuator to close unpowered via the soft stop spring into the closed position without damaging the actuator.

IMPORTANT **For detailed specifications on the EGV and ESV actuators, please refer to the appropriate manual.**

System Accuracy

Accuracy Definition—Accuracy is a function of a 3-sigma tolerance analysis. The equation is as follows:

%F.S. = Percent of full scale travel (unit)
%open = Percent of full scale open
ΔT = Temperature change in °C from 25 °C
%P = Position in percent of full scale
ΔP = Change in position due to temperature and position

$$\Delta P = \Delta T * 0.00303\ (\%F.S./°C) + \Delta T * \%P * 0.0000812\ (\%F.S./(°C * \%open))$$

Example: 10% open and 65 °C change from 25 °C

$$\Delta P = 65\ °C * 0.00303\ (\%F.S./°C) + 65\ °C * 10\%open * 0.0000812\ (\%F.S./(°C * \%open))$$

$$\Delta P = 0.197\%F.S. + 0.0528\%F.S.$$

$$\underline{\Delta P = 0.25\%F.S.}$$

Total positioning accuracy depends on the calibrated stroke as follows:

Using RS-485 for control	
Initial Accuracy:	±0.001 inch/0.03 mm (±0.1% of stroke)
Using 4–20 mA for control	
Initial Accuracy:	±0.00125 inch/0.0318 mm (±0.125% of stroke) @ 25 °C
Accuracy Over Temperature:	0.00042 inch/0.0107 mm (±0.042% of stroke) per °C change from 25 °C
4–20 mA Position Feedback	
Initial Accuracy:	±0.001 inch/0.03 mm (±0.1% of stroke) @ 25 °C
Accuracy Over Temperature:	±0.000094 inch/0.00239 mm (±0.0094% of stroke) per °C change from 25 °C

System Performance

Slew Time for the EGV or ESV is 12 to 10 inches per second, or 25% to 75% in 0.130 seconds regardless of load. This slew rate must be measured using the speed achieved between the 40% and 60% points. The rated stroke of these actuators is 1.00” (internal mechanical stops at –0.380”/–9.65 mm and at 1.180”/29.97 mm from closed position).

System bandwidth is nominally 10 Hz at ±0.050 amplitude for the EGV, with –4 dB gain and 140° phase lag.

Equivalent dead time does not exceed 10 ms, which includes all effects such as communications, processing time, mechanical times, etc.

Actuator Load Capability

Both actuators are capable of producing 1779 N (400 lb force) continuously. The force will include frictional load, return spring load, and aero loads. The total aero loads allowed are 890 N (200 lb force).

Calibration

No calibration is required for either the EGV or ESV with the EM120 Digital Driver.

Wiring Installation to the Driver

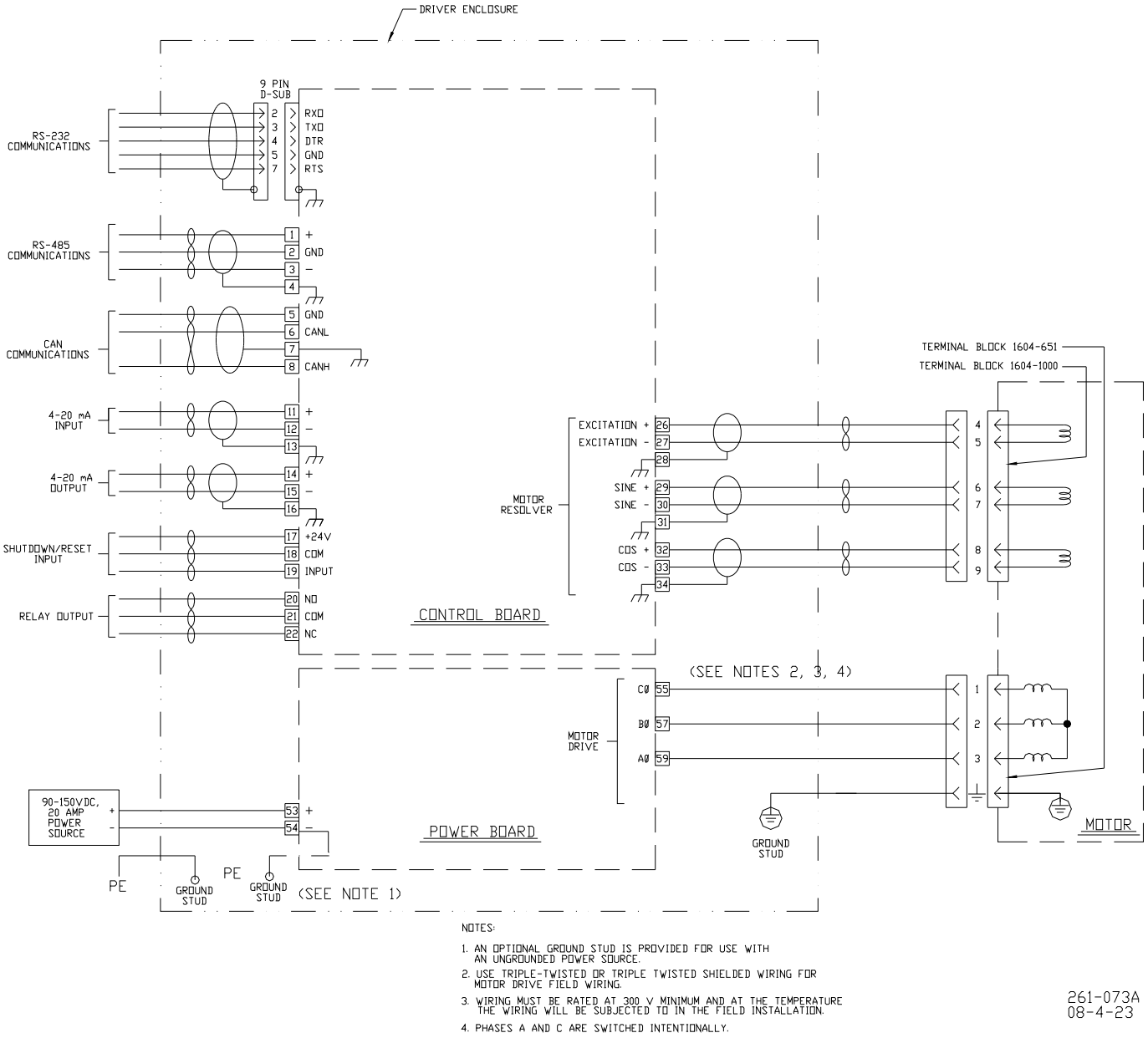


Figure 12-1. EM 120V Digital Driver/EGV Actuator Plant Wiring Diagram

Checking Alarm and Shutdown Set Points

It is recommended that the Alarm and Shutdown set points be checked at this point to avoid invalid alarms or shutdowns. Factory Settings are:

Position Error Alarm %	2%
Position Error Alarm Delay (ms)	500 ms
Position Error Shutdown %	20%
Position Error Shutdown Delay (ms)	20 ms
Redundant Feedback Fail Alarm %	0.5%
Redundant Feedback Fail Alarm Delay (ms)	50 ms
Redundant Feedback Fail Shutdown %	1.5%
Redundant Feedback Fail Shutdown Delay (ms)	75 ms
Redundant Input Alarm %	1.5%
Redundant Input Alarm Delay (ms)	50 ms

IMPORTANT

These settings may change with different applications. Please note the correct settings for your application and retain them for reference.

In addition to the normal functions, the shorted resolver wire detection algorithm uses the Redundant Feedback Fail Alarm values. Modifying these values determines how quickly the algorithm can detect the shorted wire and how far the resolver reading drifts before the error is detected and the resolver removed from the position calculations. Using smaller values than the defaults can result in premature or invalid error detection.

Chapter 13.
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:

http://www.woodward.com/directory

Woodward Factory Servicing Options

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

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

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

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

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

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

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

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

How to Contact Woodward

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

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

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

http://www.woodward.com/directory

Technical Assistance

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

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

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

Appendix.
Product Support Statement

Introduction

This product support statement provides information about the support of the Woodward EBV actuator and associated EM drivers.

EBV Compatibility with EM Digital Driver

Due to component obsolescence, Woodward has discontinued the production of the EBV (Electric Bleed Valve) actuator.

All EBV applications should use the 8200-319 EM digital driver. this is currently the only driver that is compatible with the EBV application.

Although some EBV applications originally used the 8200-177 driver, all were upgraded to the 8200-319 EM digital driver in the field to provide better functionality. Current revisions of the 8200-177 EM digital driver are not compatible with the EBV and should not be used.

Revision History

Changes in Revision L—

- Updated Ingresss Protection information (page 34)

Changes in Revision K—

- Updated Regulatory Compliance information
- Added updated Declaration

Changes in Revision J—

- Updated UL temperature code from T4 to T3C

Changes in Revision H—

- Updated Regulatory Compliance information
- Added updated Declarations

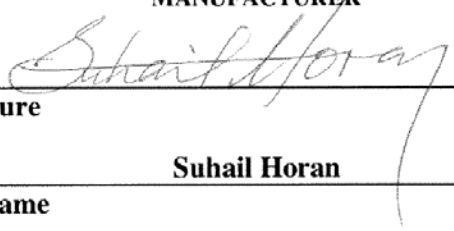
Declarations

DECLARATION OF CONFORMITY

DoC No.:	00153-04-CE-02-08.DOCX
Manufacturer's Name:	WOODWARD INC
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s)/Number(s):	EM120V Driver
Conformance to Directive(s):	2004/108/EC COUNCIL DIRECTIVE of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and all applicable amendments 2006/95/EC COUNCIL DIRECTIVE of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits
The object of the declaration described above is in conformity with the following Directives of the European Parliament and of the Council:	
Applicable Standards:	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 EN50178, 1997: Electronic Equipment for Use in Power Installations

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

Suhail Horan

Full Name

Quality Manager

Position

Woodward, Fort Collins, CO, USA

Place

26-Apr-2012

Date

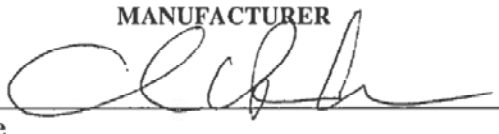
5-09-1183 Rev 18, 3-Feb-2012

DECLARATION OF CONFORMITY

DoC No.:	00153-04-CE-02-09
Manufacturer's Name:	WOODWARD INC
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s)/Number(s):	EM 24V Driver, LQ24V Driver, and GS/LQ Driver
Conformance to Directive(s): **The object of the declaration described above is in conformity with the following Directives of the European Parliament and of the Council:**	94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres 2004/108/EC COUNCIL DIRECTIVE of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and all applicable amendments
Marking(s):	Ex Category 3, Group II G, Ex nA IIC T4 X Gc,
Applicable Standards:	EN60079-15 :2010 Electrical apparatus for potentially explosive atmospheres - Type of protection 'n' 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
Special Conditions of Safe Use:	Product must be installed into an enclosure that provides a minimum of IP54 or better protection against the ingress of dust and moisture.

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

04 - Nov - 2013
Date

5-09-1183 Rev 18, 3-Feb-2012

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

Manufacturer's Name:	WOODWARD GOVERNOR COMPANY (WGC)	
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525	3800 N. Wilson Ave. Loveland, CO, USA 80538
Model Names:	EM and GS/LQ Drivers	
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 1.2, 1.3, 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.

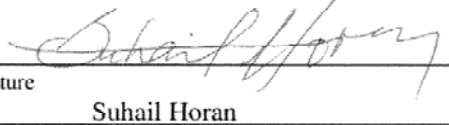
The person authorized to compile the technical documentation:

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

WGC, Fort Collins, CO, USA

Place

26-Apr-2012

Date

5-09-1182 (REV. 10) 00153-04-EU-02-01

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26159L.

B26159:L

WOODWARD

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

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.