WOODWARD

Product Manual 40161
(Revision D)
Original Instructions

EM-35 Digital Driver (Single and Dual Feedback)

Installation and Operation Manual

IMPORTANT

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

DEFINITIONS

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

WARNING

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

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

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the *publications page* on the Woodward website:

www.woodward.com/publications

The current revision and distribution restriction of all publications are shown in manual *26311*.

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.

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

NOTICE

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

NOTICE

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

Revisions—Text changes are indicated by a black line alongside the text.

Contents

Illustrations and Tables

Regulatory Compliance

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

Wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

Connect the 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 applications.**

⚠AVERTISSEMENT	**RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.** **La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division 2.**

Electrostatic Discharge Awareness

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

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

    - Do not touch any part of the PCB except the edges.

    - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.

    - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

NOTICE

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

Chapter 1.
General Information

Description

This manual describes the installation, calibration and operation of the EM-35 digital driver. The EM (electric motor) 35 driver is an electric actuator driver for use with a three-phase, brushless, dc motor. The electric motor/actuator operates a rotary fuel metering valve. The EM-35 digital driver is designed primarily for use with dry low emissions (DLE) systems, or other applications where high accuracy and dynamic performance are required.

The EM-35 digital driver is housed in a watertight, corrosion resistant, sheet metal enclosure.

EM-35 Driver Operation

See Figure 1-1 for the EM-35 functional block diagram. The EM-35 digital driver system consists of a position controller module and the driver. The position controller module, which resides in the NetCon® system control, contains a digital position controller which receives a demand signal from the system CPU and redundant feedback signals from a resolver/digital converter in the remote driver. The position controller output is sent to a brushless dc motor driver in the remote driver. The position controller module and the digital driver exchange information over serial communication lines. The digital form of the data preserves the 16 bit feedback resolution needed to meet the system accuracy requirements.

The digital position controller in the position controller module closes a position loop, independent of the system processor. A 16-bit demand signal is sent to this module via the VME bus. The time interval for the demand signal is determined by the rate group in which the IACT_EM MOE block is operating. The demand is compared to one of the 16-bit position feedback signals, received every 1.66 ms from the R/D converter in the remote driver. The difference is processed by a digital control algorithm. The position controller module monitors both feedback signals, selects the appropriate one to use in the control algorithm and communicates any error in the feedback signals.

The position controller module is configured during the system initialization with data selected off-line by the Menu Oriented Editor (MOE™) or Graphical Application Program (GAP™). Controller, driver, and feedback status is provided by the IACT_EM software block.

The remote driver contains the brushless dc motor driver, an analog velocity controller and a resolver/digital converter, and must be located within 30 m (100 ft) of the actuator/valve assembly in order to maintain a high quality sensing signal. A brushless, three-phase, position sensor (field director) provides feedback to the motor driver. Velocity feedback is provided by a tachometer mounted on the electric motor/actuator shaft before the gearbox. The R/D converter feedback is provided by a dual brushless resolver (rotary position transducer) mounted directly on the input shaft of the fuel metering valve. They are excited with separate 1 kHz signals and their output is modulated by the rotation of the valve. The resolver outputs are demodulated by the R/D converters in the EM-35 driver which produce 16-bit feedback signals.

IMPORTANT

Because of the accuracy required (±6 arc min), the resolver feedback cable needs to be low capacitance (46 pF/m or 14 pF/ft) and equal to or less than 30 m (100 ft) in length.

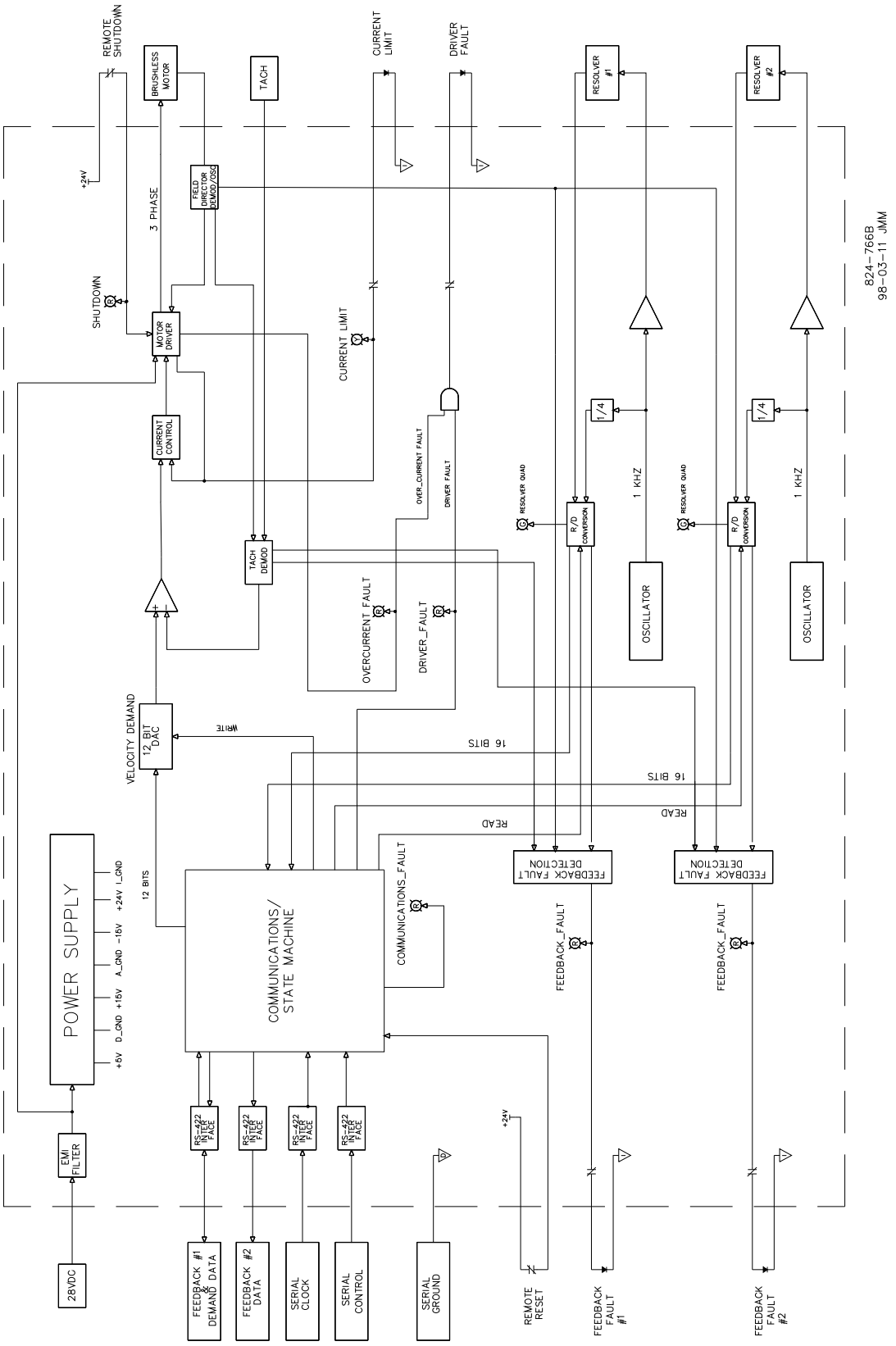


Figure 1-1. EM-35 Digital Driver Functional Block Diagram

Chapter 2. Installation

Unpacking

Be careful when unpacking the EM-35 driver. Check the devices for signs of damage such as bent or dented case and loose or broken parts. If damage is found, notify the shipper immediately. The devices may be stored in their original shipping containers until they are ready for installation. Protect the devices from weather and from extreme humidity or temperature fluctuations during storage.

Power Requirements

The EM-35 driver requires a 28 Vdc, 25 A input power supply. The maximum steady state driver input current is 4.5 A continuous with 25 A peak for 50 ms.

Location Considerations

Carefully study this chapter before choosing a location for the EM-35 driver. Wiring and grounding considerations may influence the selection of a location for the device.
Consider the following general requirements when selecting the location:

- Adequate ventilation for cooling
- A location that will provide an operating temperature range of –20 to +60 °C (–4 to +140 °F)
- Space for servicing
- Protection from direct exposure to sunlight, water, or to a condensation prone environment
- Protection from high-voltage or high-current devices which produce electromagnetic interference
- Avoidance of vibration

See Figure 2-1 for the overall dimensions and mounting hole locations for the EM-35 driver enclosure.

⚠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 applications.**

⚠AVERTISSEMENT	**RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.** **La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division 2.**

Electrical Connections

Shielded Wiring

All shielded cable must be twisted conductor with either a foil or a braided shield and should not exceed 164 pF/m (50 pF/ft) rating. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields as shown in the Plant Wiring Diagram (Figures 2-2 and 2-3). Wire exposed beyond the shield must not exceed two inches. The other end of the shield must be left open and insulated from any other conductor. Do not run shielded signal wires with other wires carrying large currents. See manual 50532, *EMI Control for Electronic Governing Systems*, for more information.

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

Plant Wiring

Figures 2-2 and 2-3 are the plant wiring diagrams for the EM-35 driver when conduit is used for all wire runs. If conduit is not used, the eight single wires from the driver to the FTM must use 2-4 conductor, shielded wires to prevent EMI interference. The shields from all of the wires (with the exception of the motor shield) must be connected to the ground studs in the bottom of the driver chassis. The wiring between the EM-35 driver and the EM actuator and resolver must be limited to 100 feet and must be low capacitance (46 pF/m or 14 pF/ft) cable. Communication wire from the FTM to the driver must also use low capacitance wire and must not exceed 305 m (1000 ft).

Power wiring between the motor and the driver must be three conductor 5.0 mm^2 (10 AWG), shielded wire to prevent EMI emissions. The shields must be terminated to the ground screw in the motor wiring cavity and to the terminal block in the driver chassis. This wiring must not exceed 30 m (100 ft) maximum length, to minimize voltage drop. Any extra motor wire in the installation should be cut off and discarded, not coiled.

Coiled wire will cause an inductance which could be greater than that of the motor and interfere with motor operation.

To maintain the IP56 Rating of the enclosure, conduit hubs shall be installed in gland plates and shall be CSA or UL certified as Type 4 or IP56.

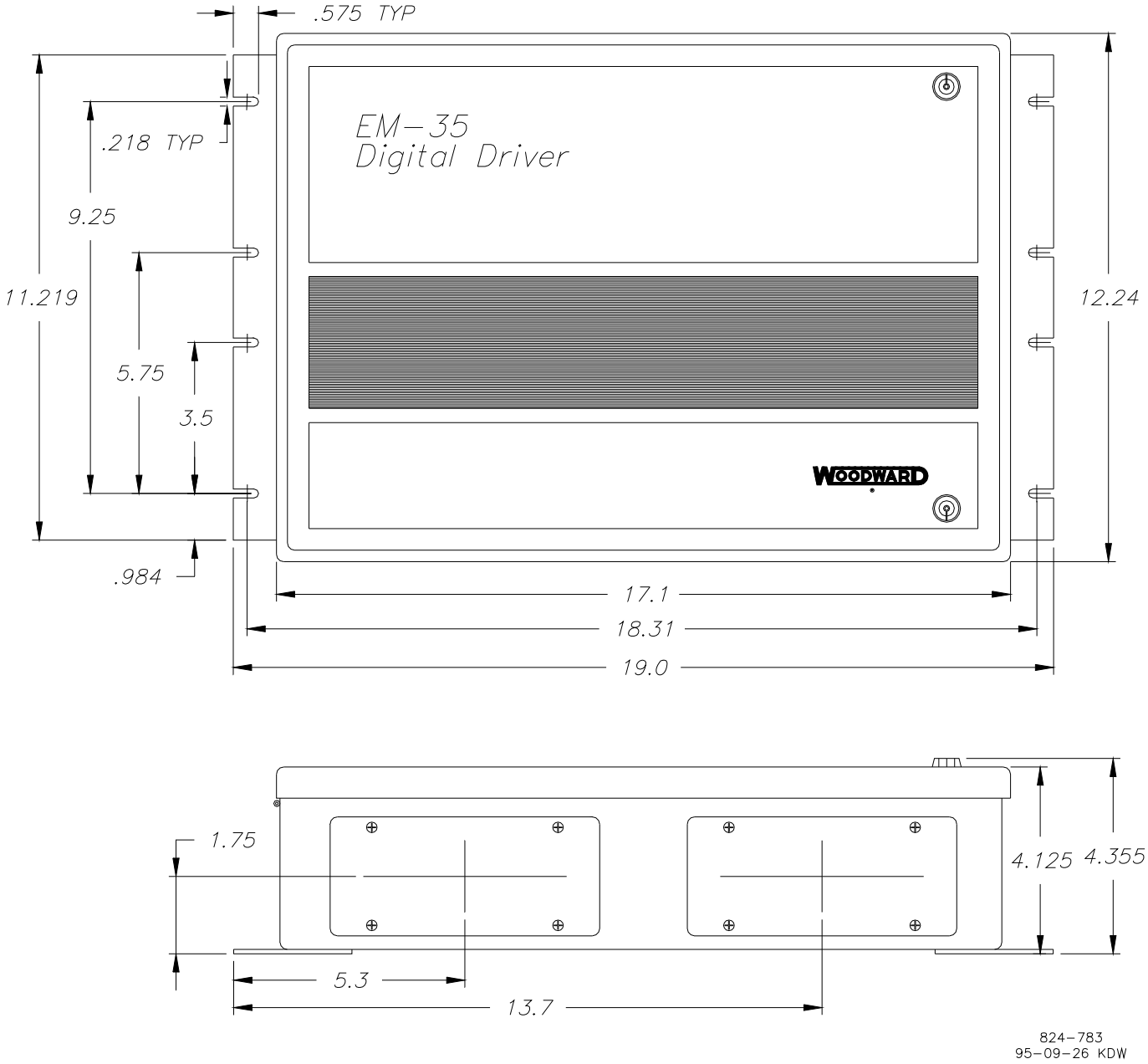
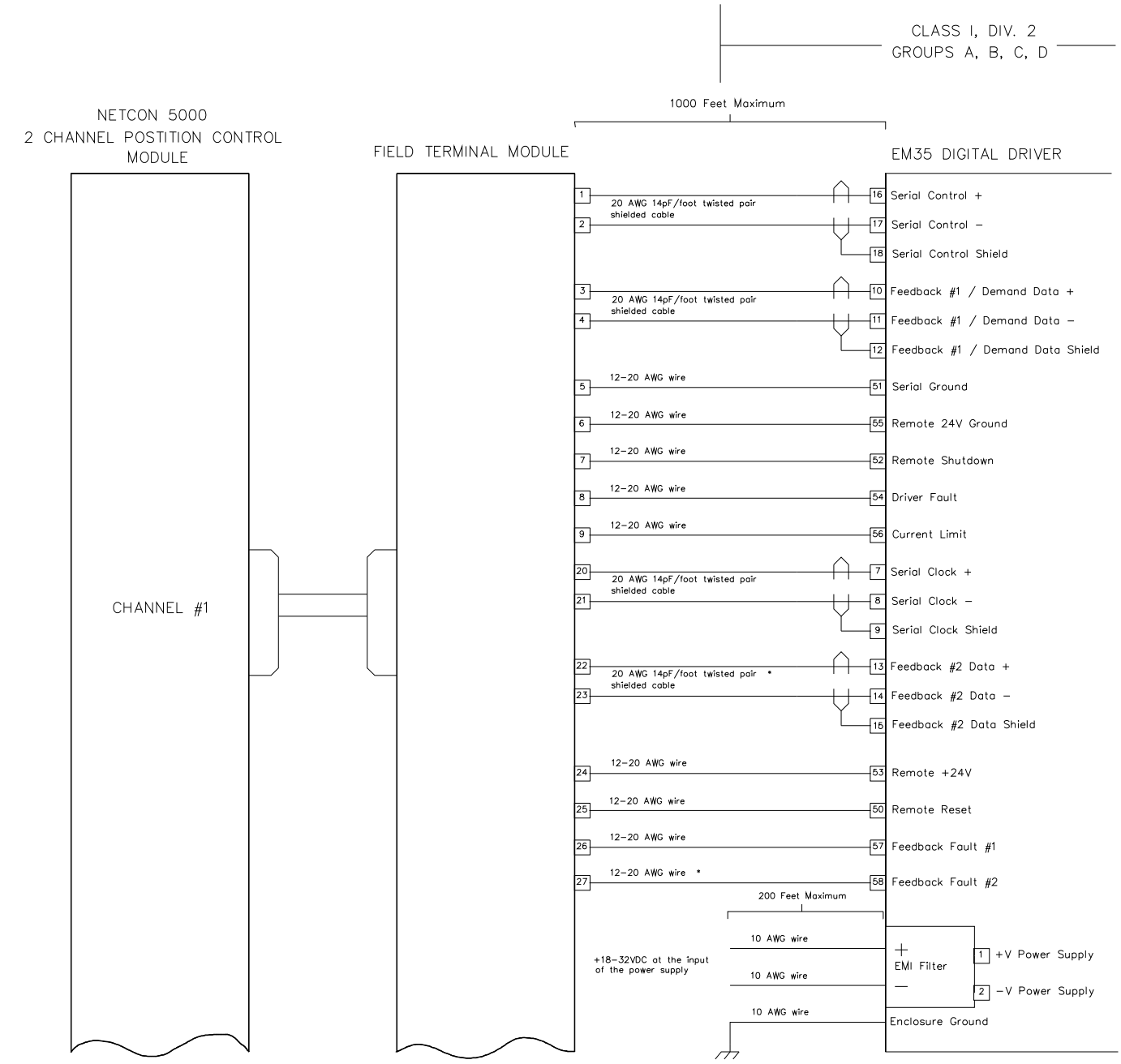


Figure 2-1. EM-35 Digital Driver Outline Drawing



20 AWG 14pF/foot twisted pair shilded cable: Belden Part Number: 89207 or equivalent

824–767B
98–03–11 JMM

* NOT NEEDED FOR SINGLE FEEDBACK

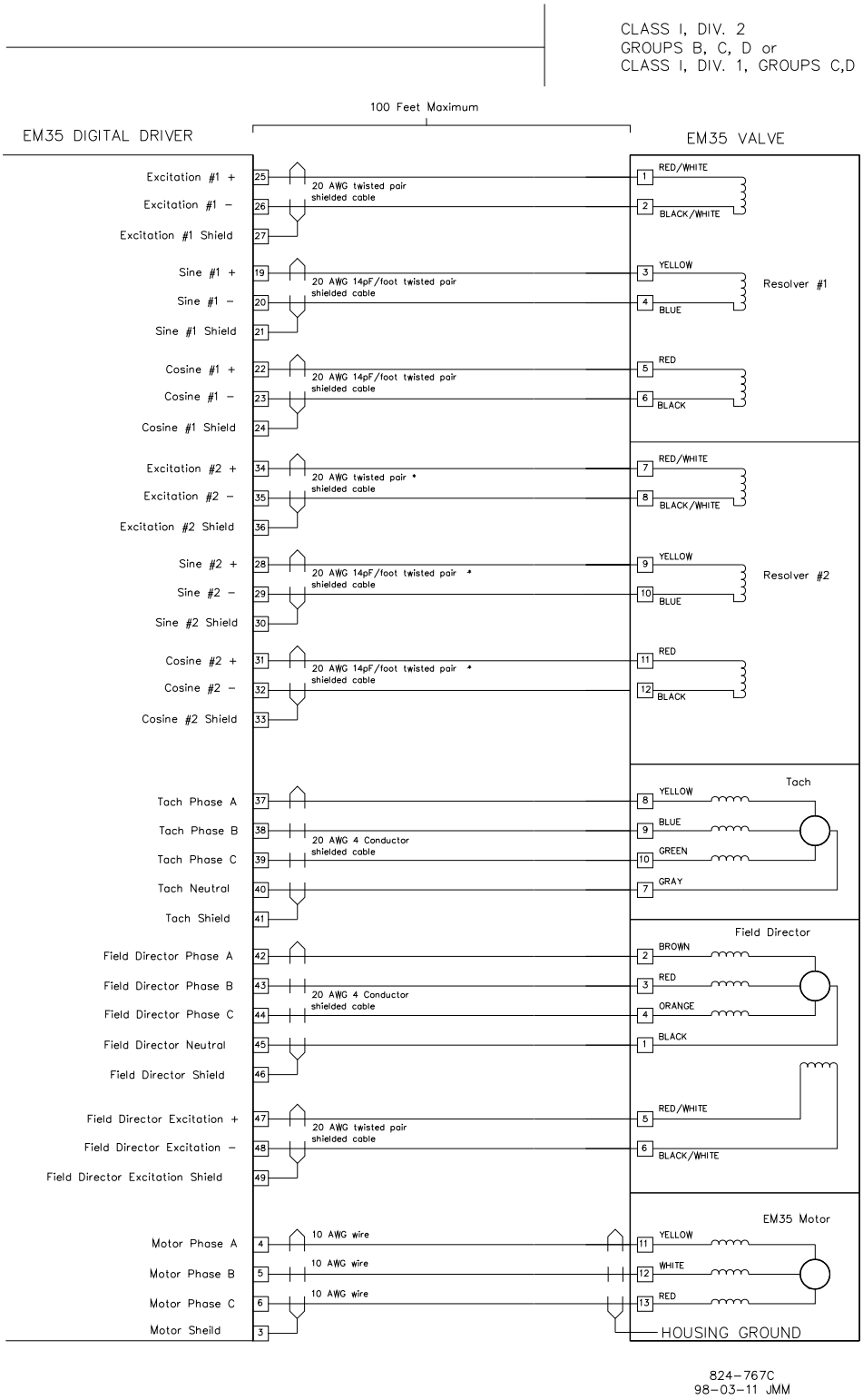
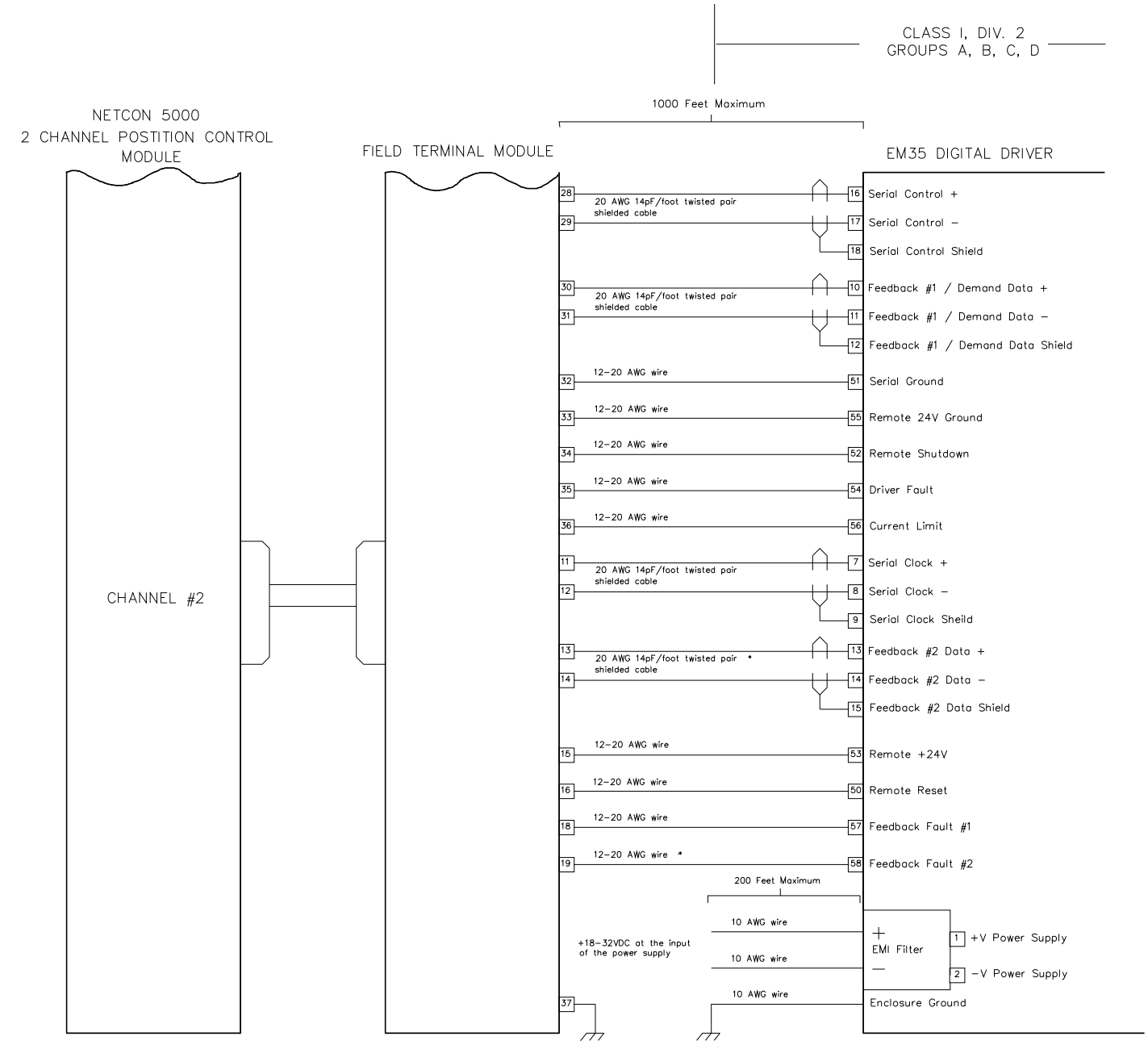


Figure 2-2. Plant Wiring Diagram, Position Control Module Channel #1 with Dual Feedback



20 AWG 14pF/foot twisted pair shilded cable: Belden Part Number: 89207 or equivalent

824–768B
98–03–11 JMM

* NOT NEEDED FOR SINGLE FEEDBACK

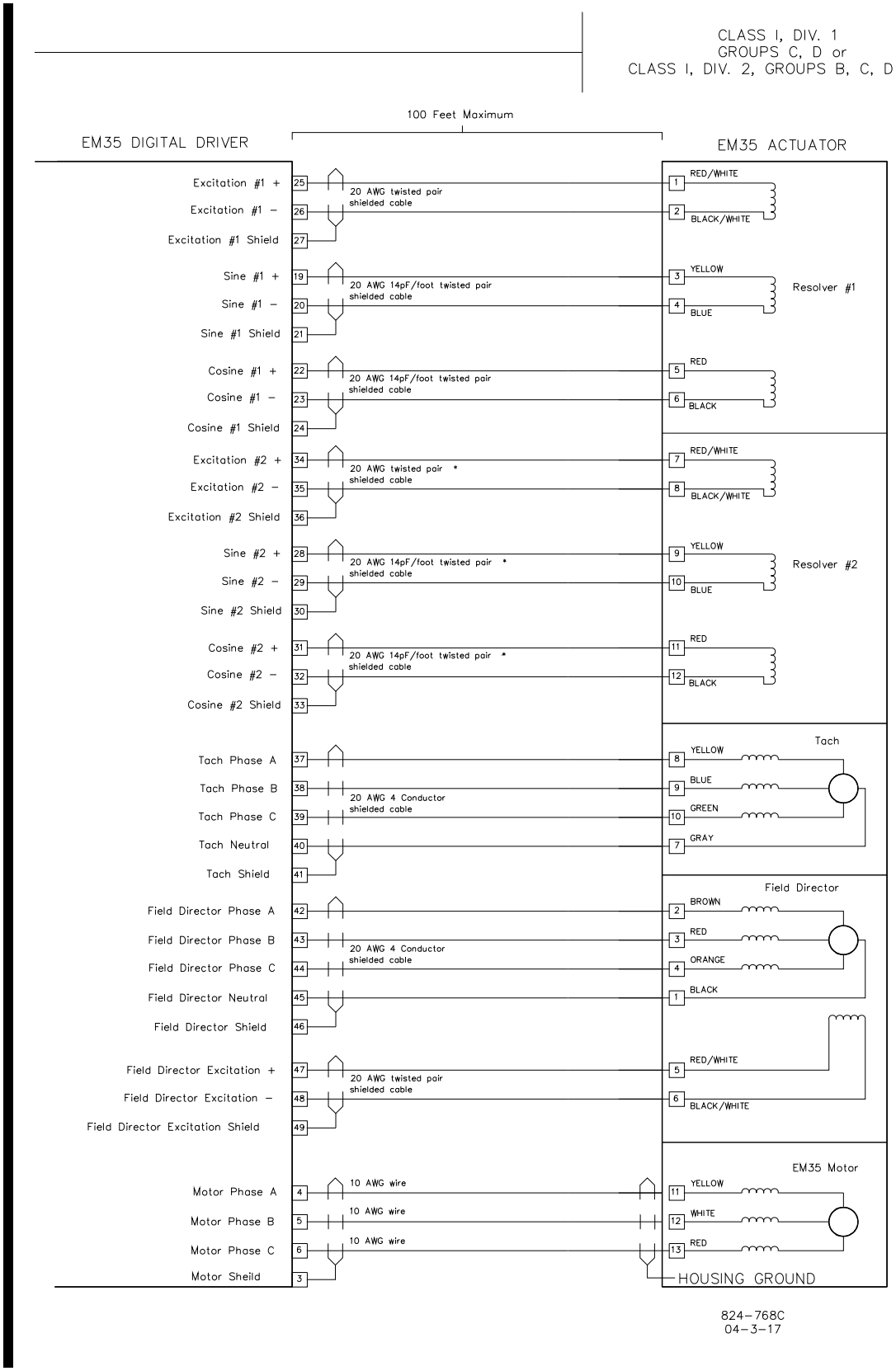


Figure 2-3. Plant Wiring Diagram, Position Control Module Channel #2 with Dual Feedback

Chapter 3. Troubleshooting

General

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

Faults

Problems with the EM-35/valve assembly will usually show up as faults in the valve driver or the NetCon control. The type of fault is indicated by LEDs on the driver circuit board.

⚠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 applications.**
⚠AVERTISSEMENT	**RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.** **La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division 2.**

Starting Up the EM-35/Valve

After power has been applied to the driver, the following conditions should exist, otherwise see the troubleshooting guide.

These LEDs should be ON in the driver for startup:

- Driver Fault
- Shutdown
- Resolver Quad #1
- Resolver Quad #2

These status indicators in the NetCon MOE block (IACT_EM) for this specific driver should be TRUE for start-up:

- DRVR FLT
- FDBK_FAIL 1
- FDBK_FAIL 2

If all of the above conditions are true, make sure that RES_FDBK #1 and #2 in the IACT_EM block read the same value ±0.25° as the valve calibration offset. If they are not the same value, consult the troubleshooting guide. If the problem still cannot be resolved, consult Woodward. The driver can now be RESET through the NetCon control. If a position error (POS_ERR) occurs at reset, see the troubleshooting guide. If the problem still cannot be resolve, check all of the wiring.

EM-35/Valve Troubleshooting Guide

The following faults can be present before start-up or after the driver has been running.

Status LEDs inside the driver	**Status of faults inside the NetCon position control module MOE block**	**Description**
Resolver Quad(s) OFF Shutdown ON Driver Fault ON	DRVR_FLT TRUE FDBK_FAIL(s) TRUE	The Resolver has moved and is not in the correct quadrant and the calibration of the valve is incorrect. Call Woodward. **Do not try to adjust the resolver.** The driver will not reset and run.
Resolver Quad LED(s) may be ON or OFF Shutdown ON Driver Fault ON Feedback Fault(s)ON The Feedback Fault LED(s) may be ON or OFF momentarily if a wire is intermittent.	DRVR_FLT TRUE FDBK_FAIL(s) TRUE	Check all wiring for the resolver, tachometer, and the field director. One of the wires is broken or disconnected. The driver may reset if one of the two avail able feedback circuits is working. If FDBK_FAIL #1 is TRUE, check the wiring for resolver #1, if FDBK_FAIL #2 is TRUE, check the wiring for resolver #2.
Resolver Quad(s) ON Communication Fault ON Shutdown ON Driver Fault ON The Comm. Fault LED may be ON or OFF momentarily if a wire is intermittent.	DRVR_FLT TRUE FDBK_FAIL(s) TRUE	Check the Serial Clock and Serial Ground wiring. One of the wires is broken or disconnected. The driver will not reset until this problem is fixed.
Resolver Quad(s) ON Communication Fault ON Shutdown ON Driver Fault ON The Comm. Fault LED may be ON or OFF momentarily if a wire is intermittent.	DRVR_FLT TRUE PARITY_FLT TRUE FDBK_FAIL(s) TRUE This PARITY_FLT may be TRUE or FALSE momentarily if the wire is intermittent.	Check the clock and the serial ground wiring. One of the wires is broken or disconnected. The driver will not reset until this problem is fixed.
Resolver Quad(s) ON Communication Fault ON Shutdown ON Driver Fault ON The Comm. Fault LED may be ON or OFF momentarily if a wire is intermittent.	DRVR FLT TRUE PARITY FLT TRUE This PARITY_FLT may be TRUE or FALSE momentarily if the wire is intermittent.	Check the DEMAND_DATA/ FEEDBACK_DATA and the serial ground wiring. One of the wires is broken or disconnected. The driver will not reset until this problem is fixed.

Status LEDs inside the driver	**Status of faults inside the NetCon position control module MOE block**	**Description**
Resolver Quad(s) ON Shutdown ON Driver Fault ON	DRVR_FLT TRUE	Check all of the wiring from the field terminal module to the driver (e.g. Remote Reset, Remote +24 V, Remote Shut down, and Driver Fault). One of the wires is broken or disconnected. The driver will not reset until this problem is fixed.
Resolver Quad(s) ON Shutdown ON Driver Fault ON	DRVR_FLT TRUE FDBK_FAIL(s) TRUE CURR_LIM TRUE	Check the wiring for the remote +24 V Ground. The wire is bro ken or disconnected. The driver will not reset until this problem is fixed.
Resolver Quad(s) ON Shutdown ON Driver Fault ON	DRVR FLT TRUE FDBK_FAIL(s) TRUE	Check the feedback fault wire to the field terminal module. The wire is broken or disconnected. The driver will not reset until this problem is fixed.
Resolver Quad(s) ON Shutdown ON Driver Fault ON	CURR_LIM TRUE DRVR_FLT TRUE POS_ERR can be TRUE if driver is commanded to a different position and it can not over come the obstacle inside of the valve.	Check the current limit wiring, the valve is being commanded into a mechanical stop or an obstacle inside the valve. The driver will shutdown and will not control until the problem is fixed.
Overcurrent ON Shutdown ON Driver Fault ON Resolver Quad ON	DRVR_FLT TRUE	A short exists from one of the 3 motor windings to earth ground, battery + or -. A problem exists with the wiring or inside of the motor. The driver will not reset until this problem is fixed.
Resolver Quad(s) ON Shutdown ON Driver Fault ON	FAULT TRUE	Re-seat the position control module inside of the NetCon control. If driver still cannot be reset, the position control module needs to be replaced.

The POS_ERR is an alarm condition and its set points are adjustable inside of the NetCon (in the IACT_EM MOE block). There is a set point for PE_DELAY (Position Error Delay) and PE_THRSH (Position Error Threshold). The Position Error is application dependent. It can be made to shut down the driver in the NetCon control.

IACT_EM MOE BLOCK

All of the adjustments for the EM-35 digital driver are made in the NetCon control, via the IACT_EM block.

Dither Adjustment

The maximum dither adjustment (degrees of movement of motor shaft) depends on the valve which is connected to the EM-35 driver. The adjustment is made inside of the NetCon control (in the IACT_EM MOE block). These maximum dither adjustments should not be the default setting. The adjustment should be made so the dither can be barely felt on the pointing device on the valve and then backed off until it cannot be felt any more. The following chart shows the maximum adjustment for each valve type:

Valve	Maximum Dither Adjustment
1907 Liquid	0.9
3171 Gas	1.55
3103 Gas	2.21

Dynamic Adjustments

The dynamic adjustment for the EM system is made inside of the NetCon control (inside the IACT_EM MOE block). The natural frequency (NAT_FREQ) of the system sets the bandwidth of the system in radians/second. It is typically set to 40 and is adjustable from 35 to 50. The damping ratio (DAMP_FACT) adjusts the over and undershoot of the system. It is typically set to 1 and is adjustable from 0.5 to 1.

Additional Inputs and Outputs

Following is a detailed description of the other inputs and outputs of the IACT_EM MOE block. These are provided for information purposes only, because all values are pre-set at the factory.

- The input (IN) is an analog value between -10 and 110%.
- Maximum valve angle (MAX_VLVANG) represents maximum valve angle (degrees) at 100% input. Minimum valve angle is set to 0.
- Resolver offset input in degrees (RES_OFFSET #1 and #2) This input is subtracted from resolver read back output to get actual valve angle.
- Position error delay (PE_DLY) in milliseconds. This value is the amount of time that a position error must exist before the POS_ERR output goes true.
- Position error threshold (PE_THRSH) in degrees. A position error exists if the difference between the position demand and the measured position exceeds this threshold.
- Shutdown input (SD) when this input is true the current to the electric motor is interrupted.
- Alarm reset input (ALM_RESET) this input is used to clear all fault outputs, and to reset the remote driver to an operation condition.
- Valve demand (VLV_DEMAND) output in degrees. This output is the valve position demand. This output is created based on the 0-100% input demand and the maximum value angle defined by MAX_VLVANG.
- Valve read back (VLV_RDBK) output in degrees, this output represents the true valve angle as defined by RES_RDBK - RES_OFFSET. Valve percent output (VLV_PERCT) is VLV_RDBK converted to percent using MAX_VLVANG.
- Resolver read back (RES_RDBK #1 and #2) output in degrees. This output represents the valve angle of the resolver.
- Controller output in radians/sec (CONTRL_OUT) this output represents the velocity command being sent to the remote driver.

- Driver fault output (DRVR_FLT) this output goes true anytime a fault has occurred that forces the remote driver to be shutdown.
- Current limit output (CURR_LIM) this output is true if the motor current exceeds 25 amps for CUR_LIMDLY milliseconds + 500 ms.
- Position error output (POS_ERR) This output is true if the difference between the position demand and the measured position exceeds the PE_THRSH value for longer than PE_DLY. This output is non-latching.
- Feedback failure output (FDBK_FAIL #1 and #2) This output goes true if an open resolver wire is detected or a R/D converter fault has occurred or if the resolver angle is outside of its normal 0 to 90 degree range or one filed director, or tachometer wires opens.
- Parity fault output (PARITY_FLT) this output goes true after the incorrect parity has been detected in either resolver data four times in a row.
- Card watchdog failure (FAULT) this output goes true if the system determines that the card is no longer executing its control program properly, or any time the card is not present in the system.
- Maximum electrical stop input (DEG_MAXLIM) is in degrees. It is set between the maximum operating point and the maximum mechanical stop.
- Minimum electrical stop input (DEG_MINLIM) is in degrees. It is set between the minimum operating point and the minimum mechanical stop.
- Feedback maximum difference exceeded alarm (FB_MAX_DIFF) output goes true when the difference between RES_RDBK_1 and RES_RDBK_2 exceeds the FDBK_S_TOL limit. It latches true until the difference drops below the limit and ALM_RST is taken true.
- Feedback spread tolerance (FDBK_S_TOL) is the maximum amount in degrees that the two resolver angles can differ before causing FB_MAX_DIF to go true and selecting the proper resolver as feedback. (see FDBK_SEL)
- Feedback select on failure (FDBK_SEL) determines whether the higher or lower of RES_RDBK_1 and RES_RDBK_2 is used when the difference between the two exceeds the FDBK_S_TOL limit.

Chapter 4.
Product Support and Service Options

Product Support Options

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

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or 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 current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

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.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic 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.

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. 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 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's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- 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.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor 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 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 one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

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

Products Used In Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
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

Products Used In 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

Products Used In Industrial Turbomachinery 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

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

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

Symptoms

Description _____

_____

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. Specifications

Electrical

Digital Position Controller

Bandwidth:	> 5 Hz @ 3 deg p-p input
Sample time:	1.66 ms
Dynamics:	tunable (MOE block)
Data format:	8-bit integer, 24-bit fraction
Processor status:	watchdog timer
Controller status:	fault = position error >threshold for delay time threshold range = 0–90 degrees delay time range = 0–10 000 ms

Serial Transmitter/Receiver

Data rate:	200 k bits/s
Error detection:	odd parity
Interface:	RS-485
Isolation:	500 Vrms

Brushless dc Motor Driver

Bandwidth:	> 1000 Hz
Input voltage:	±10 V (+ = CW viewed from the motor shaft end)
PWM frequency:	50 ±5 kHz

Velocity Controller

Bandwidth:	> 100Hz
Input D/A:	12-bit resolution
Feedback voltage:	2.15 Vrms ±12% @ 66 rpm, 25 °C
Feedback linearity:	±5%
Feedback ripple:	5% rms
Dither:	tunable (MOE Block)

Resolver Exciter

Voltage:	7.07 Vrms ±1%
Current:	30 mA rms max
Frequency:	1 kHz ±50 Hz
Waveform:	sinusoidal with < 1% harmonic distortion

Resolver/Digital Converter

Type:	ratiometric
Bandwidth:	> 100 Hz
Resolution:	.33 arc min
Accuracy:	< 2 arc min (over temperature range)
Cable sensitivity:	< 3 arc min @ 30 m (100 ft), 46 pF/m (14 pF/ft)

System Performance

Position range:	60 degrees
Position accuracy:	±6 arc min RSS (Root Sum Squared)
Slew rate (50 deg):	150 ms open, 80 ms close at 28 V (100 ms close for 137:1 gear ratio) where slew time = valve travel ÷ max slew rate

IMPORTANT

Slew rates apply only if the power input voltage at the driver terminals is maintained greater than 28 Vdc.

System Installation

Power input:	28 Vdc nominal, 18–32 Vdc operating 4.5 A continuous 25 A peak for 50 ms
Power cable:	5.0 mm² (10 AWG), 60 m (200 ft) max, 3.0 mm² (12 AWG), 30 m (100 ft) max
Motor cable:	Shielded, 3 conductor #10 AWG, 30 m (100 ft) max, 3.0 mm² (12 AWG), 15 m (50 ft) max
Tachometer cable:	4 conductor shielded, 30 m (100 ft) max
Field director cable:	4 conductor shielded & 2 conductor shielded, 30 m (100 ft) max
Resolver cables(3):	2 conductor shielded, 0.5 mm² (20 AWG), 46 pF/m (14 pF/ft), 30 m (100 ft) max
Serial cables(3):	2 conductor shielded, 0.5 mm² (20 AWG), 46 pF/m (14 pf/ft), 300 m (1000 ft) max
Wire termination:	5.0 mm² (10 AWG) max—power & motor wiring 3.0 mm² (12 AWG) max—all control wiring
Discrete wiring:	Must use 4 conductor, shielded, 0.5 mm² (20 AWG) wire, if conduit is not used

System EMC

Radiated susceptibility:	IEC 801-3, Level 3 10 V/m, 26-1000 MHz
Conducted susceptibility:	IEC 801-6, Level 3 10 V, .15–100 MHz, all leads
Radiated emissions:	EN 55011, Class A
Conducted emissions:	EN 55011, Class A
ESD susceptibility:	IEC 801-2, Level 3 8 kV air, 4 kV contact
Fast transients:	IEC 801-4, Level 3 2 kV direct to power leads 2 kV capacitive to I/O leads
Surge:	IEC 801-5, DC input 500 V common mode 500 V differential mode

Environmental

Temperature range:	–20 to +60 °C operating –40 to +85 °C storage
Humidity:	US MIL-STD-810D, Method 507.2, Procedure II
Shock:	US MIL-STD-810D, Method 516.3, Procedure I
Vibration:	US MIL-STD-167, Type 1

Enclosure

Corrosion resistant:	To retain corrosion resistance, use stainless steel (SST) or non-metallic bushings.
Ingress protection:	IP56
Dimensions (HxLxW):	104.78 x 482.60 x 310.9 mm (4.125 x 19.00 x 12.24 inches) nominal
Cable entry:	2 gland plates (see IP rating requirement note in the installation section)

North American Hazardous Locations

CSA Listed for Class I, Division 2, Groups A, B, C, and D, T4 (LR79726-39)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 40161D.

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Email and Website—www.woodward.com

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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.

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