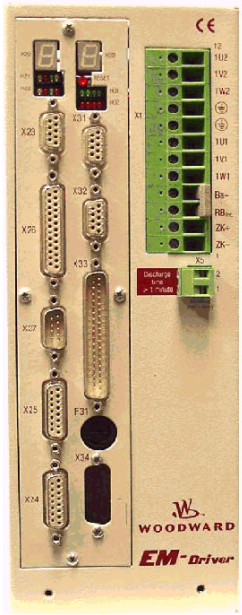
WOODWARD

Product Manual 36173
(Revision G, 12/2013)
Original Instructions



EM-80/EM-300 Actuator

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 Out-of-date translations are marked with ⚠.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 36173

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

European Compliance for CE Mark: Baumüller

Low Voltage Directive: Declared to 2006/95/EC COUNCIL DIRECTIVE of 12 December 2006 on the harmonized laws of the Member States relating to electrical equipment designed for use within certain voltage limits.

North American Compliance:

UL: Baumüller:
UL Listed for Ordinary Locations for use in Canada and the United States. UL File E179860

Other Compliance

When installed as instructed, the EM-80/EM-300 system will meet the component EMC requirements for “Restricted Second Environments” as described in EN61800-3.

The EM-80/-300 system is certified to the following standards. A compliance mark is applied to each unit.

Name	Mark
Low Voltage Directive 2006/95/EC	CE

Marine Type Approval Compliance

American Bureau of Shipping (ABS):
EM-80 Actuator 8256-XXX
EM-80 Driver 3522-XXXX
EM-300 Actuator 8256-XXX
EM-300 Driver 3522-XXXX
EMC Class I, Environmental Class A
2013 Steel Vessel Rules 1-1-4/7.7, 1-1-Appendix 3, 4-2-1/7.3, 4-9-2/11.7, 4-9-3/17, 4-9-4/23, 4-9-7/Table 9 & 10.

Bureau Veritas (BV):
Certified under BV Rules for the Classification of Steel Ships.
EM-80 Driver 3522-xxxx
EM-300 Driver 3522-xxxx
EM-80 Actuators 8256-108, -110
EM-300 Actuator 8256-109

Det Norske Veritas (DNV):
Drivers 3522-1004 through 3522-1012
EM-80 Actuators 8256-108, -110
EM-300 Actuator 8256-019
Certified for Marine Applications
Temperature: Actuator Class B, Driver Class A
Humidity: Actuator and Driver Class B
Vibration: Actuator Class B, Driver Class A
EMC: Actuator and Driver Class A
Enclosure: Actuator Class C, Driver Class A

Lloyd’s Register: Type Approval Certification Pending

Russian Maritime:	Electric Actuator and Driver of type EM-80/EM-300 Part XV, Rules for the Classification and Construction of Sea-Going Ships, 2012; Section 12, Part IV Rules for the Technical Supervision During Construction of Ships and Manufacture of Materials and Products for Ships, 2012.

General Installation and Operation Notes and Requirements

- Field wiring must be suitable for at least 90 °C.
- Grounding is required by the input PE terminal.

Chapter 1.
General Information

WARNING

READY FOR USE RELAY—The NO contact of the Ready for Use Relay on TB-X26 of the EM-80/-300 driver must be integrated into the Emergency Shutdown system of the prime mover.

Introduction

This manual covers components of the EM-80/-300 Actuator system and does not include operating instructions for the prime mover or the driven devices or processes. For information about other Woodward products used in conjunction with the EM-80/-300, please refer to the specific Woodward documentation supplied with each product.

For specific operating information such as start-up, shutdown, and the prime mover's response to signals from the Woodward control, refer to the prime mover manufacturer's manual.

Description of Components

The EM-80/-300 provides an all-electric actuation system for various prime mover control applications.

The system is intended for use on large diesel, gas, and gasoline engines, and on all types of turbines, to control the position of the engine fuel racks, turbine fuel racks, turbine and turbocharger variable geometry, and to perform timing control.

The EM Driver controls the EM-80/-300 Actuator position proportional to a position demand signal received from a controlling device. The EM-80/-300 Actuator consists of a high-performance three-phase brushless ac motor that drives a precision planetary gearbox.

WARNING

Use of this equipment by untrained or unqualified personnel could result in damage to the control or the installation's equipment and possible loss of life or personal injury. Make sure personnel using or working on this equipment are correctly trained.

A complete system consists of:

- An actuator (Woodward-supplied)
- A TT Type EMI Filter (Woodward-supplied)
- A driver (Woodward-supplied)
- A resolver cable (Woodward-supplied)
- Shielded power cables
- Shielded motor drive cables
- Metal cabinet enclosure
- 15- and 25-pin filter pin D-sub connector adapters (Woodward-supplied)
- Protected 24 Vdc power source
- ICL Module

For a low-leakage application, substitute the TT type filter with following filter:

- IT Type EMI Filter (Woodward-supplied upon request)

The actuator is available in two versions: the EM-80 and the EM-300. Both consist of a high-performance, three-phase brushless AC motor that drives a precision planetary gearbox. A resolver on the motor provides a position feedback signal.

The EM-driver controls the EM-80/-300 actuator position and consists of a power board and a controller in one housing. The driver is programmable to accommodate custom requirements. PC/Windows based software facilitates customization.

A customer-supplied standard three-phase cable, including a ground wire, is required to connect the Power board of the Driver to the Actuator. The maximum cable length that should be used is 100 m (328 ft).

The resolver cable is a dedicated cable to ensure correct feedback of the resolver signal. The maximum cable length that should be used is 100 m (328 ft).

Identification plates are installed on the side of the actuator and on the driver. They contain the part numbers and serial numbers which should be provided in any correspondence with Woodward.

IMPORTANT

Installation of other electronic equipment inside the cabinet that encloses the EM-80/EM-300 requires that the cabling for this equipment meet the same requirements that the cabling for the EM-80/EM-300 meets. See Appendix A for further details.

General Safety Precautions

⚠WARNING

Read and obey these safety precautions before you operate the equipment or perform maintenance.

- Obey all cautions or warnings given in all applicable procedures.
- Never bypass or override machine safety devices.
- Always use sufficient personnel and/or lifting equipment to move the actuator.
- Do not contact the actuator drive shaft, either directly or indirectly, unless the system is de-energized, as injury may occur.
- This equipment contains high voltage and rotating parts (fans). Ignoring the safety and warning information may result in death, severe personal injury, or damage to property.
- Do not conduct maintenance procedures unless the equipment is de-energized.
- Do not begin work on the power stage and the connections until you have made sure that the system has been de-energized.
- Observe all applicable regulations and verify the proper operation of all safety devices when performing installation, repair, and maintenance procedures.
- Due to technical requirements, devices or motors may include individual components that contain dangerous materials.

- Do not replace or substitute Woodward products and components with non-Woodward devices without authorization from Woodward.
- Observe all applicable regulations during installation.
- PE (protective earth [ground]) connections as shown in this document are required to avoid personal injuries caused by high voltages.
- This driver may not be compatible with earth leakage circuit breakers (e.l.c.b.s or sometimes called ground fault breakers) due to high current leakage to ground in the converter and the motor.
- During operation, the principles on which the power converter and the motor work lead to leakage currents to earth that are dissipated via the specified protective earths and may result in a current-operated e.l.c.b. on the input side blowing prematurely.
- To operate the driver in an IT ground network environment, the IT EMI Filter type must be installed.
- Make sure the plastic covers over the power supply connections are in place before applying power.
- Before switching on the drive, you must carefully check the functions of all higher level safety equipment to prevent injury to people.
- Some movement of the actuator drive shaft is possible during the initial application of power. Proper precautions should be taken to avoid personal injury or damage to property.

Chapter 2.
Shipping

The components are packed at the factory. Handle the components carefully and avoid unnecessary shocks, such as when setting them down on the ground.

Before moving or unpacking the components, carefully examine the crate and packaging for damage caused during transportation to the installation site. Damage that has occurred to the crate or packaging can be an indication that damage may have occurred to the components themselves.

If external damage has occurred, assess the damage that may have also occurred to the components. If the components may have been damaged, contact the transportation carrier and Woodward. Make sure the carrier completes a transportation damage report immediately.

If any parts are missing, contact Woodward.

⚠WARNING

If the components have been damaged in transit, do not connect any parts to the mains until appropriate high-voltage testing has been carried out.

Ignoring this information can result in death, severe personal injury, or considerable damage to property.

IMPORTANT

Do not remove the packaging as that can invalidate any claims that may be made.

Fiberboard, cartridge paper, and/or wood are used as packaging materials and they can be disposed of in accordance with local regulations.

Chapter 3.
System Description

EM-80/-300 System Description

The EM-80/-300 system consists of an actuator, a driver, a suppressor filter, and interconnection cables.

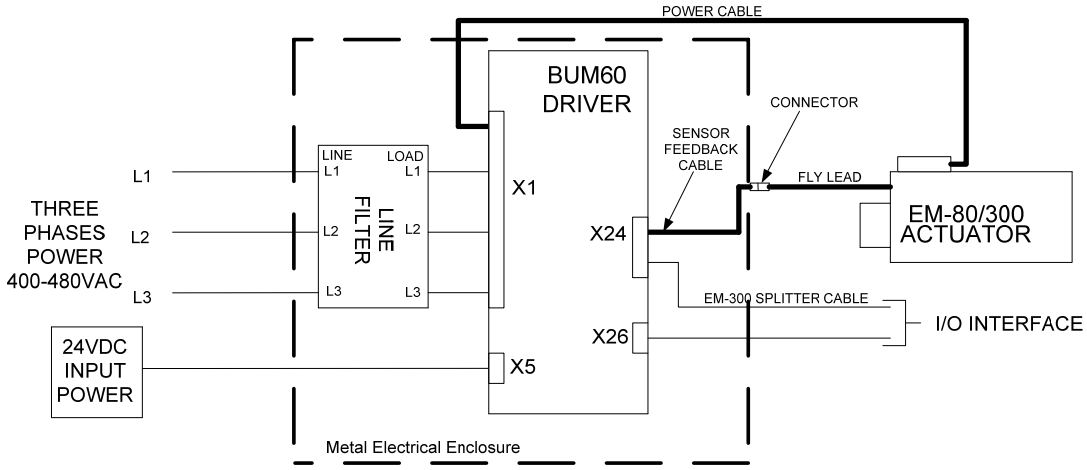


Figure 3-1 System Overview

The EM-80 and EM-300 are all-electric actuator systems that provide a nominal 40° of actuator output rotation. Each system consists of a three-phase brushless ac motor which drives a high-precision planetary reduction gear box. A dedicated driver controls the actuator position.

A complete system consists of:

- An actuator (Woodward-supplied) (Chapter 4)
- A driver (Woodward-supplied) (Chapter 5)
- A resolver cable (Woodward-supplied)
- Shielded power cable
- Shielded motor drive cable
- An EMI filter (Woodward-supplied) (Chapter 6)
- Metal cabinet enclosure
- 15- and 25-pin filter pin D-sub connector adapters (Woodward-supplied)
- Protected 24 Vdc power source
- ICL Module

Actuator

The actuator is available in two versions, offering two work output levels, EM-80 and EM-300 (see the specifications in Chapter 9). Both versions use the same three-phase brushless AC motor.

The difference in output is achieved by the use of two different gearboxes. The EM-80 uses a single-stage planetary 1:7 gear ratio, while the EM-300 uses a two-stage planetary 1:20 gear ratio.

The motor–gearbox combination comes assembled on a mounting bracket with a fixed hole pattern. Although the EM-300 is longer than the EM-80, both use the same mounting hole pattern, allowing the actuators to be interchangeable.

The output flange provides an easy mounting surface for a variety of lever configurations, and is equipped with a rugged pointer and scale for quick output position reference while working on the prime mover. A breakaway extension and two stop pins form a simple means of detecting whether the actuator has been driven outside its operating boundaries.

Electrical connections are made in a standard, shielded, three-phase terminal box mounted on the motor, and will accommodate standard cable. The resolver cable has a 1 m (39”) flying lead that removes the connector from the high vibration environment of the prime mover. The use of the specified resolver cable and connector will help ensure correct connections to the driver.

The EM-80 and EM-300 actuators have different position-sensing systems. Both systems use the same hollow shaft resolver, producing a sine and cosine wave output with an overall accuracy of 12 arc-minutes. This resolver is mounted at the rear of the motor and looks at the relative position of the motor shaft.

The EM-80 uses only the resolver since the 1:7 gear ratio within the gearbox allows full stroke of the actuator output flange with less than one full revolution of the motor shaft.

The EM-300 has a 1:20 gearbox ratio to achieve the required torque output. Because of this, the motor shaft rotates more than one full revolution to achieve full stroke. To ensure proper position indication over the full range, a 10-turn potentiometer is added behind the resolver to supply a coarse position signal from which the correct rotor revolution is deduced. The same resolver as used on the EM-80 gives the accurate position within that revolution.

For details on the actuator, see Chapter 4.

Driver

Both actuator versions use the same dedicated driver. This driver converts three-phase 400–480 Vac, 50–60 Hz power into a controlled supply for the motor. The driver outputs a peak current sufficient to develop the rated transient output torque. After a one-second delay, the current drops back to a maximum steady state current to maintain the rated steady-state torque. An internal PLC requires a separate 24 Vdc power supply.

This driver is designed for installation in a control cabinet and should not be installed directly on the prime mover. For the EM-300, a breakout box and splitter cable allows the signals from the potentiometer to be fed into the correct driver connector. For details on the driver, see Chapter 5.

Suppressor Filter

A suppressor filter is used to reduce the influence of any interference that may occur due to the power source. It also protects the power source from emissions that may occur due to the driver. The suppressor filter should be mounted as described in the wiring diagram. For details on the suppressor filter, see Chapter 6.

Necessary Cables

Mains Power Cable

The end user must provide the power input connection to the suppressor filter. It must be standard industry three-phase with ground (PE) wire, rated for 480 Vac, 50–60 Hz, 16 A, and giving consideration for the intended environment (temperature and chemical exposure).

Driver Power Cable

The end user must provide the power connection between the suppressor filter and the driver input. It must be standard industry shielded, three-phase, rated for 480 Vac, 16 A, and giving consideration for the intended environment (temperature and chemical exposure). Refer to Chapter 6 and Appendix A for connection details.

Actuator Power Cable

The end user must provide the power connection between the driver and the actuator. It must be shielded three-phase with ground wire, suitable for 480 Vac, 24 A, and giving consideration for the intended environment (temperature and chemical exposure). The maximum cable length between the driver and the actuator cannot exceed 60 m (197 ft).

Resolver Feedback Cable

The resolver connection between the driver and the actuator is a dedicated cable using special connectors on each end. The cable length is 30 m (98 ft), which can be lengthened up to 60 m (197 ft) if necessary by the end user. Optional cables are available at lengths of 10 m (33 ft) and 20 m (66 ft). If requested by the customer, the feedback cable can be removed from the Woodward scope of supply.

Woodward recommends that a factory 30 m (98 ft) cable be cut and spliced with a length of shielded cable when making cables longer than 30 m or when the application requires routing through conduit. Be sure to connect the cable shields at the splice point.

EM-300 Splitter Cable

For EM-300 applications, a splitter cable is provided to bring the potentiometer signal from the resolver feedback cable connection (X24) into the driver I/O cable connection (X26). The connector to the X26 port must be provided by the customer. See the control wiring diagram (Figure 3-2).

Metal Electrical Enclosure

The EM driver must be installed inside a metal electrical enclosure (cabinet). Cable shields must be electrically grounded (bonded) to the enclosure. The grounding of these shields at the cable penetration points into the cabinet is mandatory. See Figures A-1 and A-3 in Appendix A.

Filtered D-sub Connector Adapters

Filter pin connector adapters (Woodward-supplied) must be installed on driver connectors X24 and X26. These adapters are necessary to ensure compliance with the Marine radiated emissions requirements.

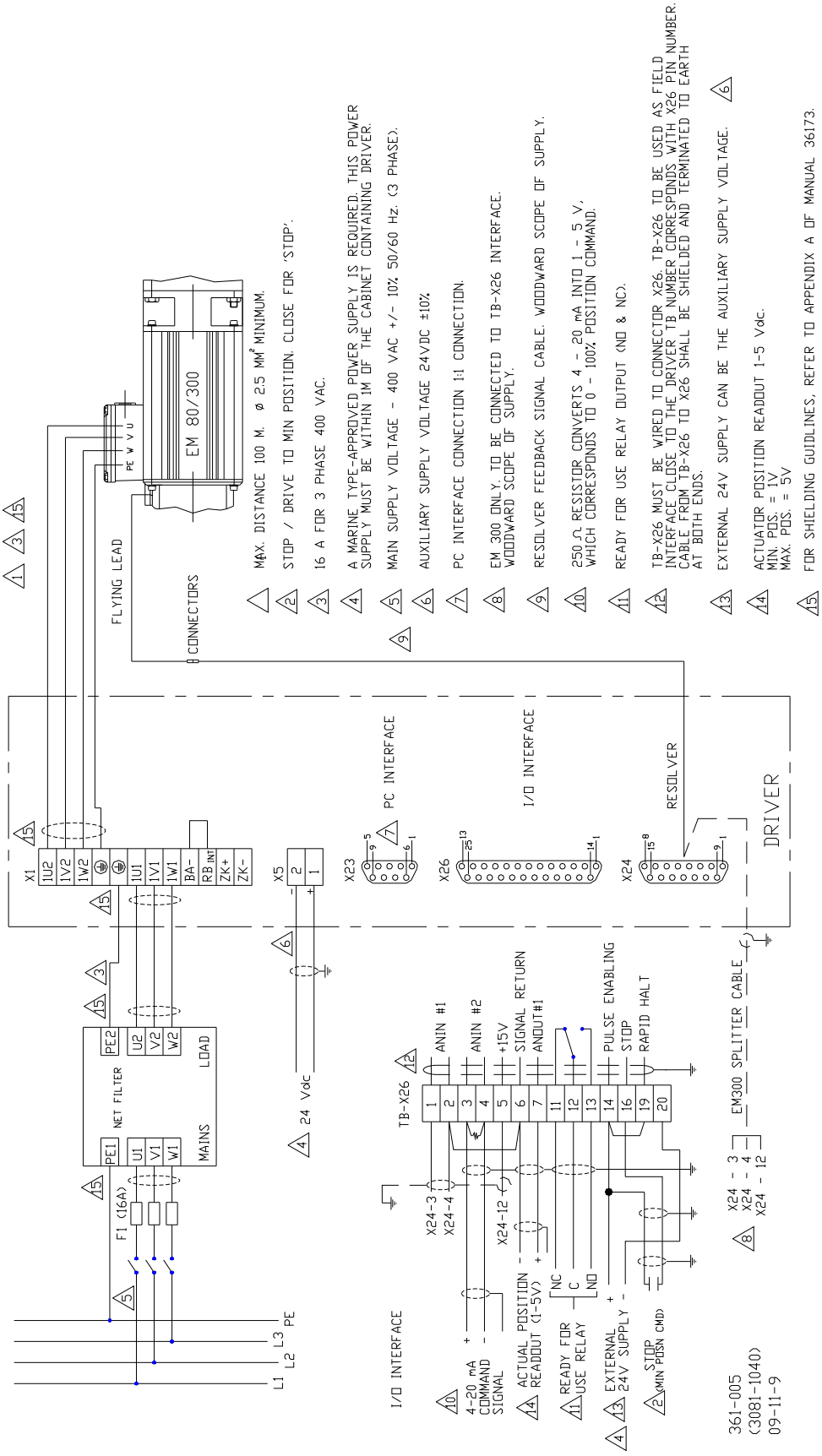
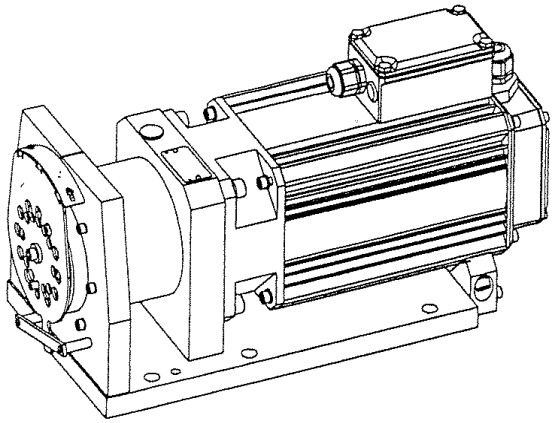


Figure 3-2. Control Wiring Diagram

Chapter 4.
EM-80/-300 Actuator

General



The EM-80 and EM-300 actuators include:
- a bracket for mounting on the engine or turbine
- an ISO 9409 actuator output flange
- an output position indicator

The actuators are equipped with a flying-lead position-sensor cable (including connector) to connect the actuator to the driver. This cable is the same for both the EM-80 and the EM-300.

⚠WARNING **Read and follow all safety instructions given in Chapter 1, General Safety Precautions.**

⚠CAUTION **The EM actuator is heavy. Use lifting equipment of sufficient capacity and the eyebolts provided while moving the actuator.**

The EM-80 actuator weighs 35 kg (77 lb), and the EM-300 actuator weighs 38 kg (84 lb). On the motor, two eyebolts have been mounted to allow the unit to be moved by lifting equipment. Be careful to balance the actuator in the correct mounting position—in some positions the center of gravity of the combined unit may be close to the forward lifting eye.

EM-80/-300 Actuator Mounting

The EM-80 and EM-300 actuator both use a similar mounting pattern (see Figure 4-1). Six 12 mm or 0.5” fasteners are used to attach the EM-80 actuator to its mounting surface. Eight 12 mm or 0.5” fasteners are used to attach the EM-300 actuator to its mounting surface.

Both mounting patterns are positioned such that the distance from the front flange to the first row of holes is identical at 68.0 mm (2.68”). This allows the actuators to be interchangeable without having to rearrange the linkage layout.

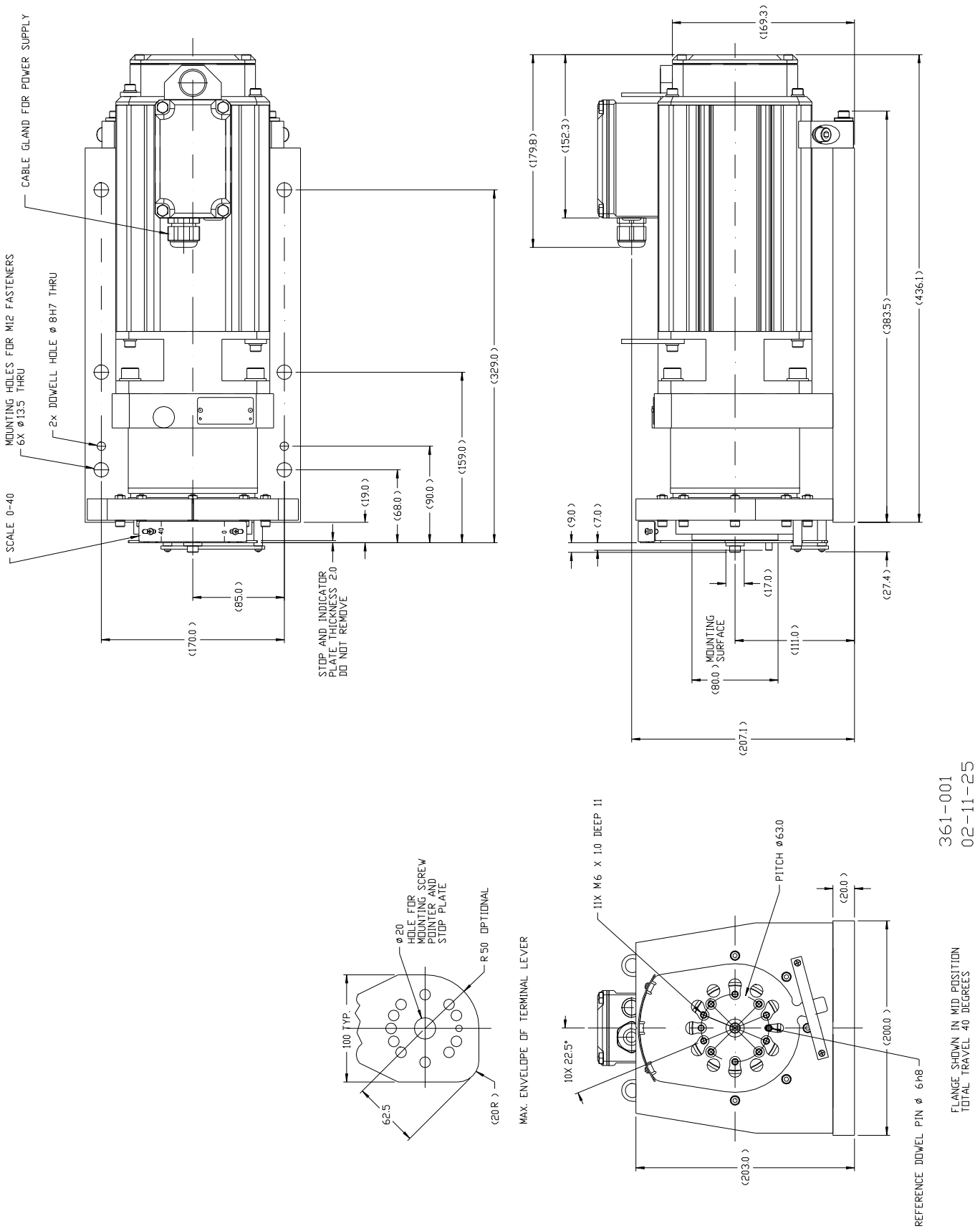


Figure 4-1a. Actuator Outline Drawing (EM-80)

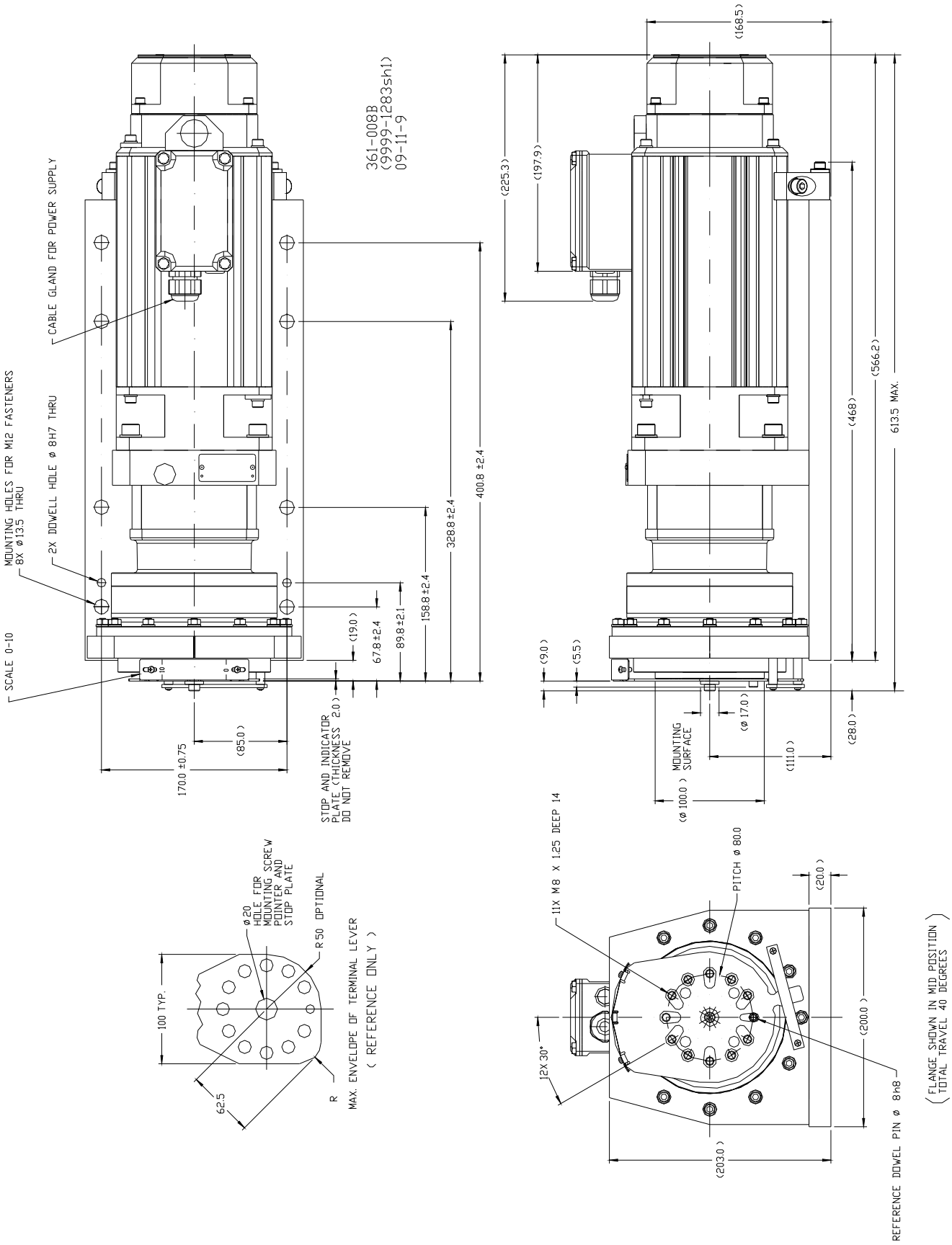


Figure 4-1b. Actuator Outline Drawing (EM-300)

To ensure interchangeability, the actuator mounting bracket contains two 8 mm (0.3”) H7 dowel pin holes close to the front flange. This hole pattern should be copied onto the engine mounting flange to be used to position the actuator mounting bracket.

The flatness of the mounting surface should be less than 0.2 mm (0.008”), and free of any nicks and burrs. Surfaces exceeding this flatness could introduce unacceptably high stresses in the actuator and actuator mounting bracket when torquing the fasteners. The actuator must be mounted such that the output flange is not more than 45 degrees above or below the opposite end of the actuator. The actuator can be mounted at any angle of rotation about the shaft axis of the motor.

EM-80/-300 Actuator Temperature Derating

The ambient air temperature surrounding the actuator must not exceed 85 °C. In addition, the temperature of the mounting surface must be controlled such that the mounting plate of the actuator never exceeds 85 °C.

In addition to this 85 °C limitation, the continuous torques listed in the specification section are acceptable to 40 °C. Above this temperature, the user must ensure that the continuous torque driven by the actuator falls below the envelopes defined by the graph below. Otherwise, overheating and possible damage of the motor will occur. Application of the actuators at this high a continuous torque is rare, but the limitation must be observed. In contrast, the listed transient torques are acceptable over the entire operating temperature range.

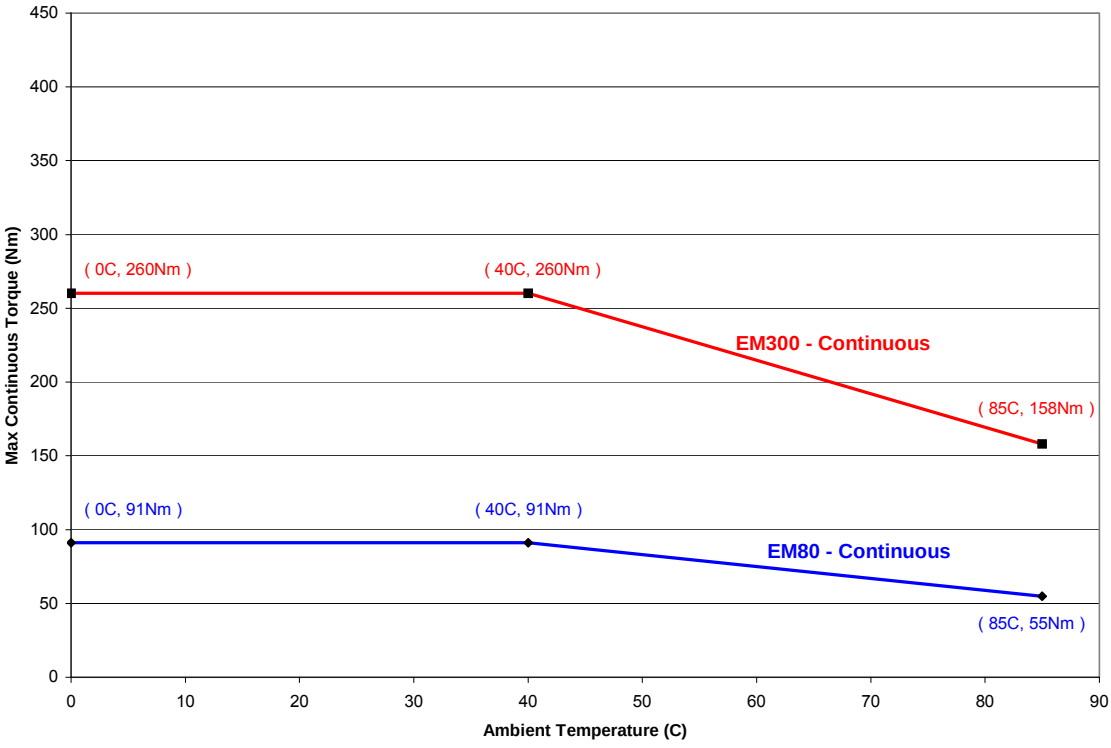


Figure 4-2. Ambient Temperature vs Torque

EM-80/-300 Actuator Electrical Connections

Power Cable Connections

The power cable must be provided by the customer. The power connection between the driver and the actuator uses shielded standard industry three-phase with ground wire, suitable for 480 Vac, 24 A and giving consideration for the intended environment (temperature and chemical exposure). The maximum cable length between the driver and the actuator is 60 m (197 ft).

Feedback Cable Connections

The actuator feedback connection consists of a standard Woodward-supplied feedback cable. The cable must be connected between the flying-lead cable on the actuator side to the X24 connector on the driver. For X24 pin assignment, see Chapter 5 (Driver).

For an EM-300 actuator, an additional splitter cable is required. This cable connection must be mounted at the driver side between the X24 connector and the actuator feedback cable. This splitter cable is a breakout module to enable connections of the feedback potentiometer, which is required for the operation of the EM-300 actuator. Connections of the additional potentiometer signals are shown in the control wiring diagram (Figure 3-2).

Engine Linkage Information

Output Flanges

Figure 4-1 shows the hole pattern for the EM-80 and EM-300 actuator output flange. The EM-80 has 11 M6x1 holes with a maximum flange depth of 11 mm. The EM-300 has 11 M8x1.25 holes with a maximum flange depth of 14 mm. In each instance, the thickness of the stop plate and the indicator plate (2 mm each) should be taken into consideration when determining the length of the fastener to be used. Use all 11 holes when attaching the lever onto the actuator output flange. The material of both the flange and the stop and indicator plate is steel.

Terminal lever design

The terminal lever for the EM-80 and EM-300 should have a flange mounting.

IMPORTANT

All usual recommendations for highly loaded flange mountings should be observed. Make sure the mounting surfaces of both the lever and the stop and indicator plate are clean and flat. Do *not* remove the stop and indicator plate.

Use all 11 fasteners and torque them to the correct value.

The following requirements must be considered in the lever design:

- The lower end of the lever must have a maximum radius of 62.5 mm (2.46”) as measured from the center of the actuator output flange in order to avoid contacting the protective strip.
- The lever needs to have a 20 mm (0.8”) diameter hole in the rotation center to clear the mounting screw which secures the stop and indicator plate.
- The output flange has a 6 mm (0.2”) dowel pin to position the stop and indicator plate. It is recommended to drill a hole of a larger diameter in the terminal lever at this location in order to avoid damage to the lever or the dowel pin. This pin could be used as a reference for the lever position.

The minimum length of the terminal lever should be at least 150 mm (6”), measured from the center of the actuator output flange to the center of the linkage connection.

Linkage Design—Effects on Slew Time and Acceleration

In designing the linkage required between the EM-80/EM-300 and the driven load, keep in mind the effect that the load torque and the inertia of the linkage have on dynamic performance.

Acceleration of the actuator, linkage, and load system is governed by the following general equation:

$$\alpha := \frac{T}{J}$$

Where:

α = Rotational Acceleration (rad/s²)
T = Net available torque (N·m)
J = Total linkage and load inertia at the actuator shaft (kgm²)

Note 1—The net available torque is the torque that is available for acceleration. This is the maximum torque of the actuator after correction for temperature (refer to the graph in Figure 4-2) minus the torque required to move the rack and overcome friction.

Note 2—The inertia at the actuator shaft is the combined inertia of the linkage and load plus the inertia of the actuator. The inertia of the actuators is:

EM-80	0.209 kgm²
EM-300	1.715 kgm²

Therefore, as the inertia of the linkage and load systems is increased, the acceleration of the system decreases proportionally. Also, as the net torque decreases due to higher and higher loads, the acceleration decreases proportionally.

Additionally, the slew time (time required to travel from stop to stop) of the system is defined by the following equation:

$$\text{Slew\_Time} := \sqrt{2 \cdot \frac{\text{Travel}}{\alpha}}$$

This requires the travel to be in radians, and gives the slew time in seconds.

Substituting for α gives:

$$\text{Slew\_Time} := \sqrt{\frac{2 \cdot \text{Travel} \cdot J}{T}}$$

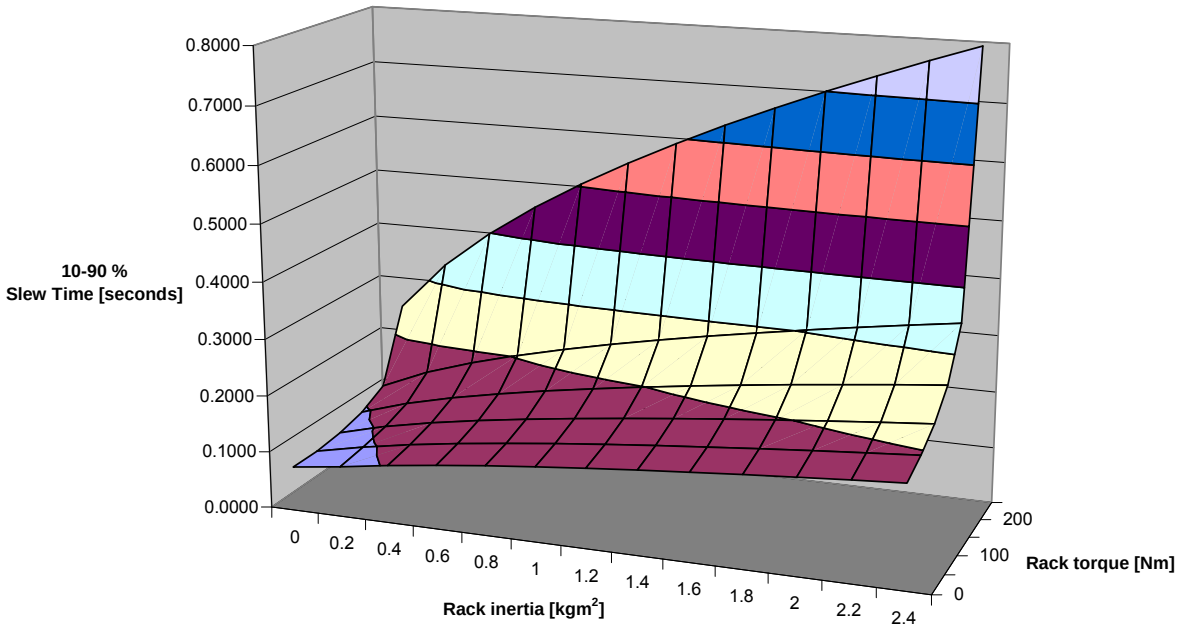
Therefore, as J, load and linkage inertia, increases, the slew time increases by the square root. For instance, if the user doubles the inertia coupled to the actuator, then the unit's acceleration will be 1/2 as fast and the total slew time will be doubled. Also, decreasing the net torque by increasing the load will decrease the acceleration as noted above and therefore also increase the slew time.

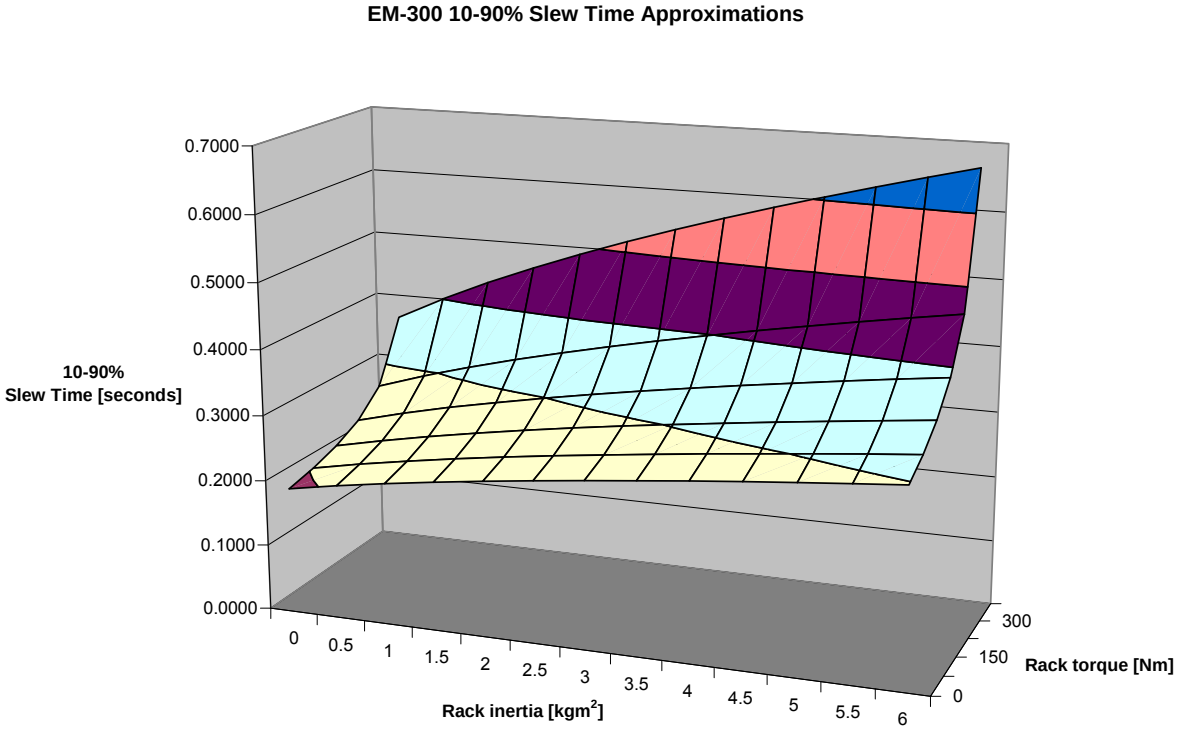
Keep in mind that the transient torque which the actuator can produce is limited to a maximum period of one second. Therefore, slew times close to or over one second should be avoided.

All these factors should be taken into consideration when designing the linkage and load levels to ensure that dynamic performance is not jeopardized.

Using the equations above plus actuator inertia values, the following graphs approximating slew time can be produced. These graphs are for reference in determining slew time changes with changing loads and inertias. The terms Rack Inertia and Rack Torque are the total inertia and torque of the linkage and load system as described above. Therefore, zero Rack Inertia and zero Rack Torque would correspond to a standalone actuator not attached to any load.

EM-80 10-90% Slew Time Approximations





Stops and Pointer Design

The EM-80 and EM-300 actuator does not have internal stops. The stroke of the actuator output flange is limited electronically in the driver to 40°.

For clockwise rotation, the relation between degrees and mA:

4 mA = 0° on the scale
20 mA = 40° on the scale

For counterclockwise rotation, the relation between degrees and mA is reversed such that:

4 mA = 40° on the scale
20 mA = 0° on the scale

Clockwise and counterclockwise rotation are defined looking at the stop and indicator plate end of the actuator where the output lever is attached.

The relation between degrees and the scale can be reversed by reversing the scale on the stop and indicator plate.

In order to prevent possible damage to the actuator gear box, it is recommended that two stops be designed for the fuel rack that would limit actuator travel to 40°.

The engine linkage and optional mechanical stops should be designed to accept the induced peak loads of the actuator (see specifications in Chapter 9).

If mechanical stops are positioned inside the 40° travel range of the actuator, the stops should be capable of absorbing the actuator mass moment of inertia plus the linkage inertia (see table below) in order not to overstress the actuator.

NOTICE

The EM-80 and EM-300 actuators are capable of creating high loads at maximum slew rate. If stopped suddenly, these loads create high levels of stress to the gearbox as well as to the external mechanical stops and the fuel linkage.

	EM-80	EM-300
Peak theoretical torque	300 N·m (221 lb-ft)	650 N·m (479 lb-ft)
Maximum kinetic energy	7.1 J (5.2 ft-lb)	15.1 J (11.1 ft-lb)
Minimum required spring scale of external stop at an equivalent radius of 0.15 m.	285 N/mm (1627 lbf/in)	625 N/mm (3569 lbf/in)

The system is designed to prevent the actuator from traveling outside the safe 40° zone. Under extreme conditions, it is possible that external influences can cause the actuator to go outside this zone. There are two soft stops at 47.5°, equally placed around the safe zone to prevent damage occurring if the travel is greater than 47.5°. Inside the 47.5° zone, the actuator can still recover from a power failure and find the correct working zone.

If the actuator travels outside the 47.5° zone, the actuator may not be able to re-locate the proper working zone. Therefore the actuator has a stop plate at the front with an indicator lip at the bottom underneath the protective strip. These stops are designed to prevent accidental rotation by hand of the output flange outside the 47.5° actuator range, but the stops cannot withstand the actuator peak torque. If the actuator travels outside the safe 47.5° zone, the strip will bend and the actuator must be recalibrated by Woodward.

A simple pointer device is installed on the top of the output flange, indicating the position of the output flange on a scale from 0–40°.

Unit to Unit Output Flange Position Repeatability

The variation in the position of the output flange of any actuator relative to its mounting plate is less than ±0.45°. Therefore, exchanging actuators should require minimal recalibration of the linkage system.

IMPORTANT

The pitch circular diameter for the output lever on the EM-80 is different from the one on the EM-300.

Maximum Side Loading

Actuator	Maximum radial load
EM-80	1.3 kN
EM-300	2.9 kN

EM-80/-300 Actuator Specifications

A complete listing of specifications and regulatory compliance is available in Chapter 9.

Chapter 5.
Driver

General Description

Read and follow all safety instructions given in Chapter 1, General Safety Precautions.

The driver is the device which receives the actuator position command signal from the controller and positions the actuator by means of controlling the current and potential of the three phases of the actuator electromotor. The driver is loaded with configuration settings for the EM-80 or EM-300 actuator and with an application file for the proper and safe operation of the actuator system.

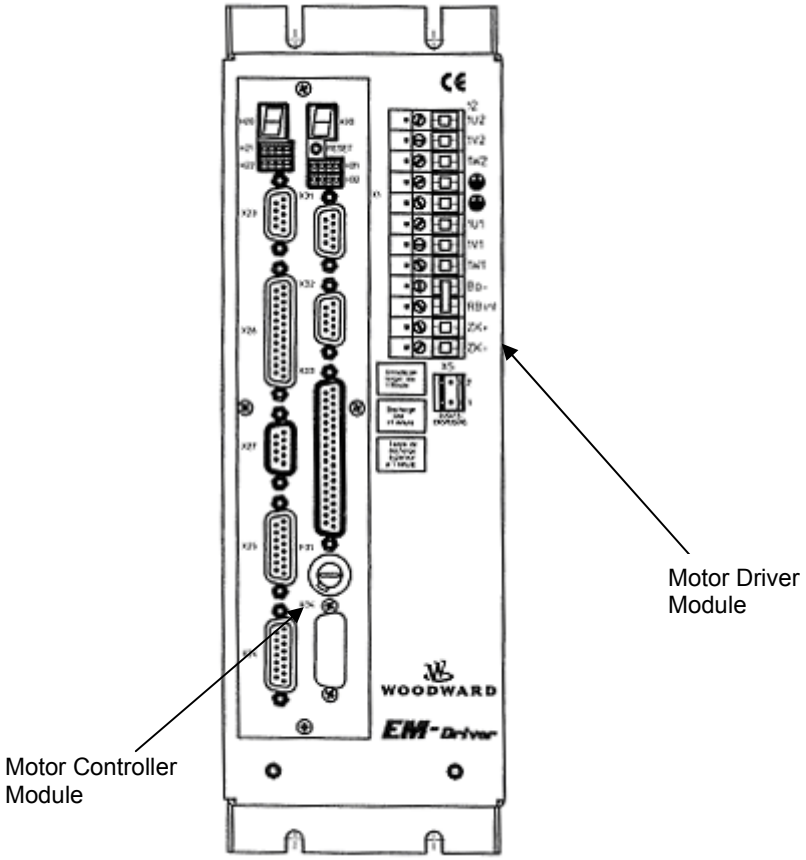


Figure 5-1. Driver Overview

The driver is an integrated package of two main modules.

- Motor Controller module
- Motor Driver module

Motor Controller Module Description

The motor controller module is a digital closed loop motor control, which works with a position loop at 62.5 µs. For position feedback, it receives a resolver signal form the motor shaft. The motor controller configuration is divided into several functional modules. The main modules are the:

- Positioning/encoder module
- Position control module
- Speed control module
- Torque/current control module
- PLC logic module

The positioning/encoder module manages the resolver feedback signal and the “engine” controller position command signal. The module receives both setpoint and actual and generates an output to the position control module. The position control module generates an output to the speed controller module. It signals the speed control module which direction to rotate and how fast. These three modules determine the dynamic behavior of the actuator system.

The speed control module generates an output to the torque/current control module. The torque/current control module controls the excitation of the proper motor phase with the proper current level. The current is limited to limit the torque.

The PLC logic module is programmed to convert the “engine” controller position command signal into a hexadecimal position address. The PLC is programmed with the specific algorithms to define rotation direction and stroke. The PLC and the motor controller module are communicating by means of a parallel interface. The interface takes care of the cyclic update of the position command signals and the non-cyclic calls for parameters.

The PLC logic program also defines the start-up sequence and enabling of the motor control module.

Motor Driver Module Description

The Motor Driver module consists of two parts, the feed current converter on the mains side and the motor-end inverter.

- The supply converter for generating the intermediate circuit voltage is designed as an unregulated diode bridge. To reduce the starting current inrush, the system charges the intermediate circuit capacitors via a charging resistor (an NTC thermistor).
- The IGBT motor-end inverter processes the transistor control signals, which the controller supplies, and provides the measuring signals for closed-loop control. The Motor Driver module has its own monitoring facilities (self-protecting power section).

Feed Current Converter

Within the Motor Driver module, the feed current converter is an unregulated rectifier with starting current load relief.

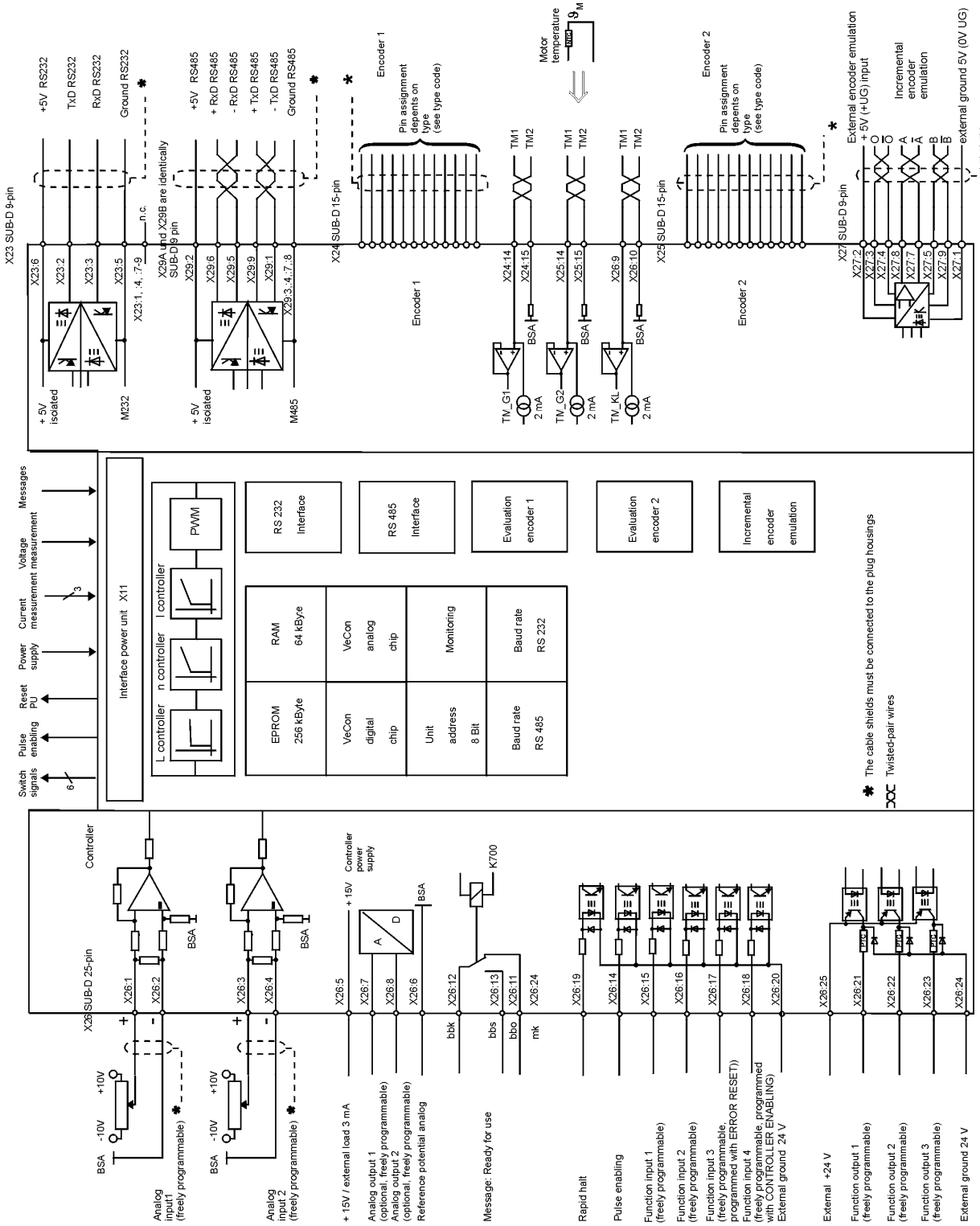


Figure 5-2. Motor Controller Functional Diagram

Starting Current Load Relief

If no measures are taken, the intermediate circuit capacitors lead to inadmissibly high levels of starting current inrush when the mains is switched on. To avoid this, the starting current is limited by a starting current limitation device.

For this, the Motor Driver module has an internal NTC thermistor integrated in the intermediate circuit. This thermistor limits the inrush current except for brief mains outages.

⚠WARNING

Sections carrying current take more than one minute to discharge.

NOTICE

The ground terminal of the driver and the motor must be connected to Protective Earth (PE) prior to connecting the driver to input power (Mains). Without the PE connection present, a short circuit to frame or ground may cause high leakage current.

The equipment may only be run on grounded supply networks.

You must not connect any additional capacitor capacity to the Motor Driver module's intermediate circuit, because there is a risk of destroying the charging resistors.

Motor-End Inverter

The motor-end inverter comprises the IGBT power unit and the self-protection facilities. Closed-loop control of the motor-end inverter is not part of the unit, but rather it is inserted as a stand-alone unit in the controller rack.

External Connections

24 Vdc Power Supply

The X5 connector is the main power connector to the motor controller module. The power supply must be 24 Vdc ±10%, rated for 55 W or more. The positive terminal of the power supply is connected to X5-1, negative to X5-2. It is recommended that a 2 to 5 A slow blow fuse be installed in the positive side of the supply. In order to comply with marine certification requirements, the power supply output must be electrically isolated from the driver chassis and actuator housing.

NOTICE

Over or under voltage of the 24 Vdc supply can lead to loss of position control of the actuator and/or damage to the controller. The EM-80/-300 requires 24 Vdc ±10% at the driver terminal for reliable operation.

⚠WARNING

An external low voltage detection may be necessary for the 24 Vdc line monitor to avoid system damage. Emergency shutdown valves and other safety devices necessary to avoid damage or injury should be set to activate any time a shutdown fault is detected.

3-phase Input Power

Three-phase input power is connected to the driver X1 connector, terminals 1U1, 1V1, and 1W1 through a suppressor filter as described in Chapter 6. The protective earth or shield must be connected to the ground terminal adjacent to terminal 1U1. A 16 A slow blow fuse must be installed in each 3-phase input line, prior to the filter, as shown in Figure 3-2. The input power specification is 400–480 Vac ±10% line-to-line. The relative phasing of the input terminals is unimportant.

In some field applications that have chosen to power the driver with redundant single-phase back-up power, the driver may be subjected to high in-rush currents if switched quickly to and from the single-phase power supply. Refer to Appendix D for wiring installation and operation.

3-phase Actuator Power

The driver power outputs to the actuator are at connector X1 terminals 1U2, 1V2, 1W2, and the protective earth/shield terminal adjacent to 1W2. Proper phasing between the output terminals and the actuator terminals must be observed: connect 1U2, 1V2, and 1W2 of the driver to the U, V, and W terminals of the actuator junction box respectively.

Control Signal Input and Output

The X26 connector is the I/O interface. It is recommended to wire the X26 connection to a terminal block to connect the field signals, as indicated in the control wiring diagram (Figure 3-2). This is recommended to enable easy and safe access to the X26 connector.

The following signals have to be connected to X26. Refer to the control wiring diagram (Figure 3-2) and the motor driver functional diagram (Figure 5-3) for details.

The Woodward-supplied filtered D-sub connector adapters must be installed prior to using the driver. These adapters are necessary to ensure compliance with the Marine radiated emissions requirements.

Position Command Input

This is the signal from the engine controller and represents the required actuator position. The analog input (analog input 2) of the driver accepts a 1–5 V input. The 1–5 V input corresponds to 0–40 degree stroke on the actuator. To convert a standard 4–20 mA control signal into a 1–5 V command input voltage, a 250 Ω resistor (1/4 W minimum, ±1% tolerance recommended) must be placed between terminals 3 and 4 on connector X26.

Actual Position Readout

The analog output (analog output 1) provides a 1–5 Vdc indication of the actuator's actual position. The 1–5 V output signal corresponds to 0–40 degree stroke on the actuator.

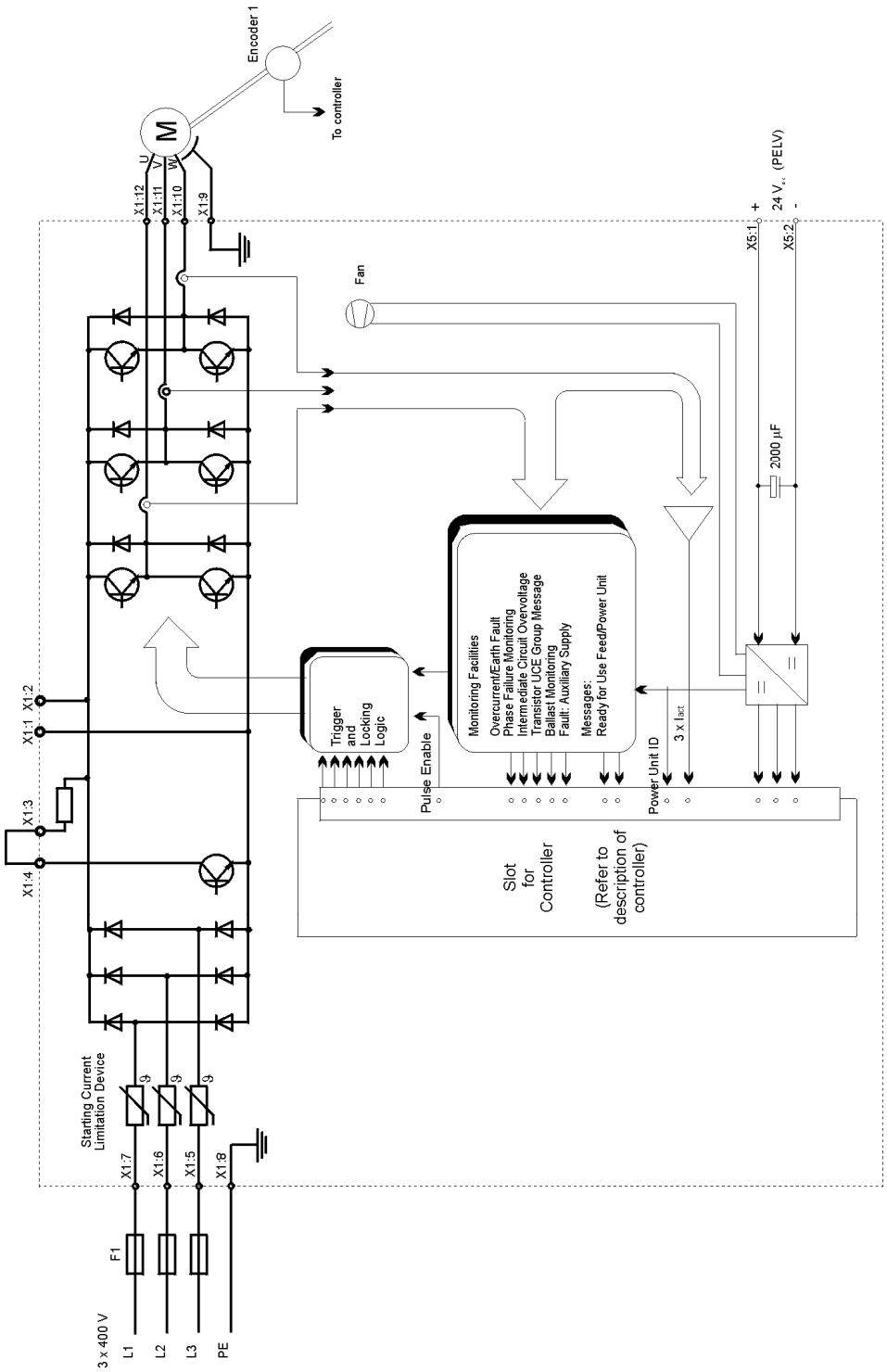


Figure 5-3. Motor Driver Functional Diagram

Pulse Enabling and Rapid Halt

These signals are digital input signals, which have to be set “high” to enable operation of the actuator. The 24 Vdc voltage source should be used to power the digital inputs, as shown in the control wiring diagram. It is recommended that these inputs remain hard-wired high. When open (low), power to the driver output is removed.

EM-300 Potentiometer Feedback

Connect the EM-300 potentiometer feedback signal according the control wiring diagram to enable the operation of the EM-300. This input signal is connected to analog input 1.

Stop–Drive Output to Minimum

Programmable DI#2 (function input #2). When closed, the actuator is actively driven to the closed position.

Ready for Use Relay

This relay output can be used by an external system to indicate an actuator system failure. The relay is energized when the driver faults are cleared indicating the unit is ready for use. Both normally closed and normally open outputs are provided.

⚠WARNING

The Ready for Use signal is de-energized when the 24 Vdc supply drops below 16.8 Vdc or the PLC stops functioning. Emergency shutdown valves and other safety devices necessary to avoid damage or injury should be set to activate any time a shutdown fault is detected by the EM-80/-300 driver.

Installation

⚠WARNING

HIGH VOLTAGE—The power converter's power cables are energized.

⚠WARNING

READY FOR USE RELAY—The NO contact of the Ready for Use Relay on TB-X26 of the EM-80/-300 driver must be integrated into the Emergency Shutdown system of the prime mover.

⚠WARNING

Stopping the drive using the enable inputs of the control electronics does not by itself represent a safe stop condition. A disturbance in the power converter's control electronics can lead to accidental starting of the motor.

The owner is responsible for assembly of the described device in accordance with safety regulations, such as DIN or VDE. You must ensure that all other relevant national and local regulations are met with regard to cable ratings and protection, grounding, disconnectors, overcurrent protection, etc.

In emergency shutdown situations, the driver should be shut down by simultaneously closing the STOP input contacts and setting the command input to 4 mA (1 V) or less.

Make sure that electrical components are not mechanically damaged or impaired as this could lead to personal injury!

NOTICE

During operation, the principles on which the power converter and the motor work lead to leakage currents to earth that are dissipated via the specified protective earths and may result in a current-operated earth leakage circuit breakers (e.l.c.b.) on the input side blowing prematurely.

Make sure that components have not been warped or damaged during transportation and handling.

Avoid touching electronic components and contacts. Drive converters contain components which can be damaged by electrostatic energy caused by incorrect handling.

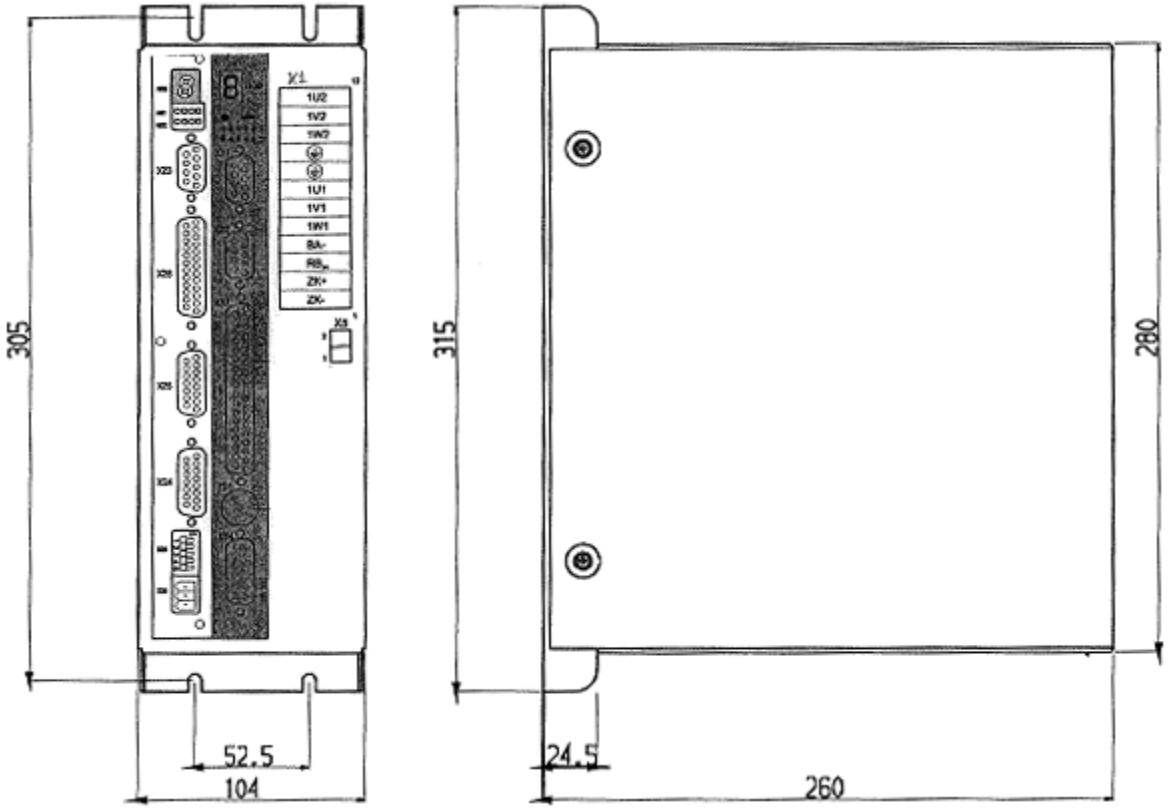


Figure 5-4. Driver Outline Drawing

Ventilation and Cooling

NOTICE

You must comply with the ventilation requirements listed below. Ignoring these requirements can lead to the device overheating.

Ensure that there is no blockage of cooling air flowing into and out of the equipment and that there is enough space above and below the equipment to prevent overheating.

The units must be installed in commercially available cabinets that meet the following requirements.

- Ventilation must be in the specified direction from the bottom to the top.
- Ensure that the flow of air is not obstructed.
- There must be a minimum clearance above and below the devices of 50 mm (2 inches), and you must ensure that there is enough cooling air that can circulate freely!
- The temperature of the coolant 50 mm below the devices may be up to 45 °C. At higher temperatures (up to a maximum of 55 °C), you must reduce the power of the devices by 3% per °C.
- Do not locate any additional sources of heat above or below the devices.

Checks Prior to Installation

Check the connections using the terminal diagram.

Driver Displays

H 20 Seven-Segment Display

A seven-segment display attached to the front of the driver provides the status of the motor controller module.

Display	Meaning
0	NOT READY TO START
1	INHIBIT START
2	READY TO START
3	SWITCHED ON
4	OPERATION ENABLED
5	OPERATION ENABLED; command “operation disabled“ active
6	OPERATION ENABLED; command “shut down“ active
7	RAPID_HALT_ACTIVE
E	FAULT_REACTION_ACTIVE
F	FAULT

In Figure 5-5 below, the display mode is active only in the status FAULT.

The status identifier "F" is shown for three seconds to indicate the fault status. The "F" is followed by the four digits of the error code. The system outputs them with a decimal point, which clearly differentiates this status from the others in the device control. After the last digit, the system deactivates the display—apart from the decimal point—for one second. After this, the entire procedure is repeated.

If there are several errors, the system displays the entire list in this way.

If you acknowledge an error that is just being shown in display mode, the system still continues to display it until the end of this sequence. The next time the error list is processed, this error is no longer visible.

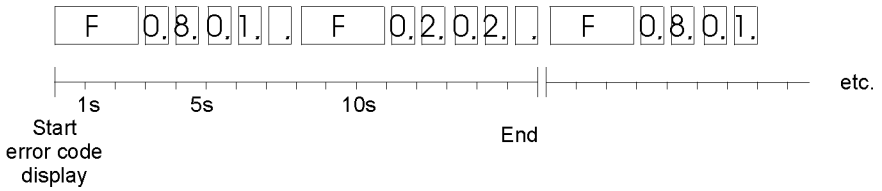


Figure 5-5. Example of Error Codes 0801 and 0202

For information on error codes, Appendix B (Driver Error Codes).

H 21 and H 22 LED Display Element

An LED display, giving additional information, is located below the H 20 seven-segment display.

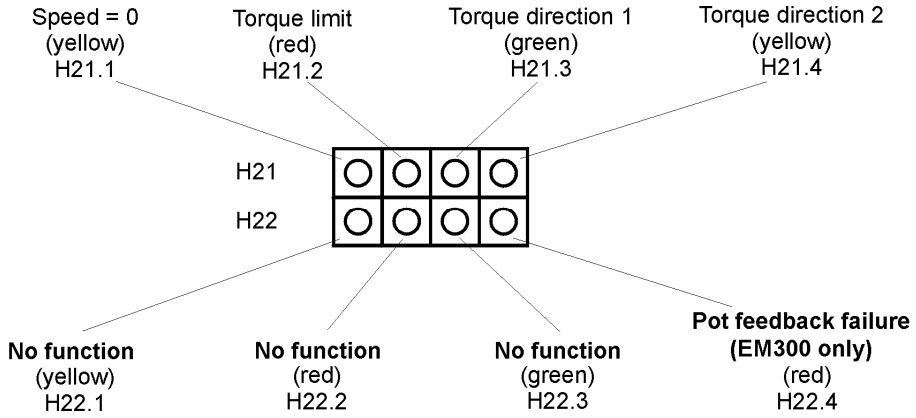


Figure 5-6. H21/H22 LED Display Element

H 30 Seven-segment Display

A seven-segment display is attached to the front of the driver provides the status of the PLC logic module.

The operating status of the PLC Logic module is graphically shown in the PLC State Machine figure below.

Status display	Operating status
0	POWER ON, without project
1	POWER ON, with project
2	Execution of SP 1021, Reset or POWER ON ⇒ RUN
3	RUN
4	Execution of SP 1022 RUN ⇒ STOP
5	STOP
6	Execution of SP 1023 STOP ⇒ RUN
7	Execution of SP 1019 RUN ⇒ HALT
8	HALT
9	Execution of SP 1020 HALT ⇒ RUN
F	Error, system restart

H31 and H32 LED Display Element

An LED display, giving additional PLC information, is located below the H 30 7-segment display.

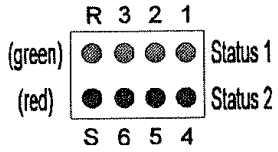


Figure 5-7. H31/H32 LED Status

LED Number	Meaning
1	Reserve
2	Reserve
3	Reserve
4	Pot feedback failure (EM-300 only)
5	Reserve
6	Reserve
S	SPS in status STOP
R	Reserve

Table 5-1. H31/H32 LED Indications

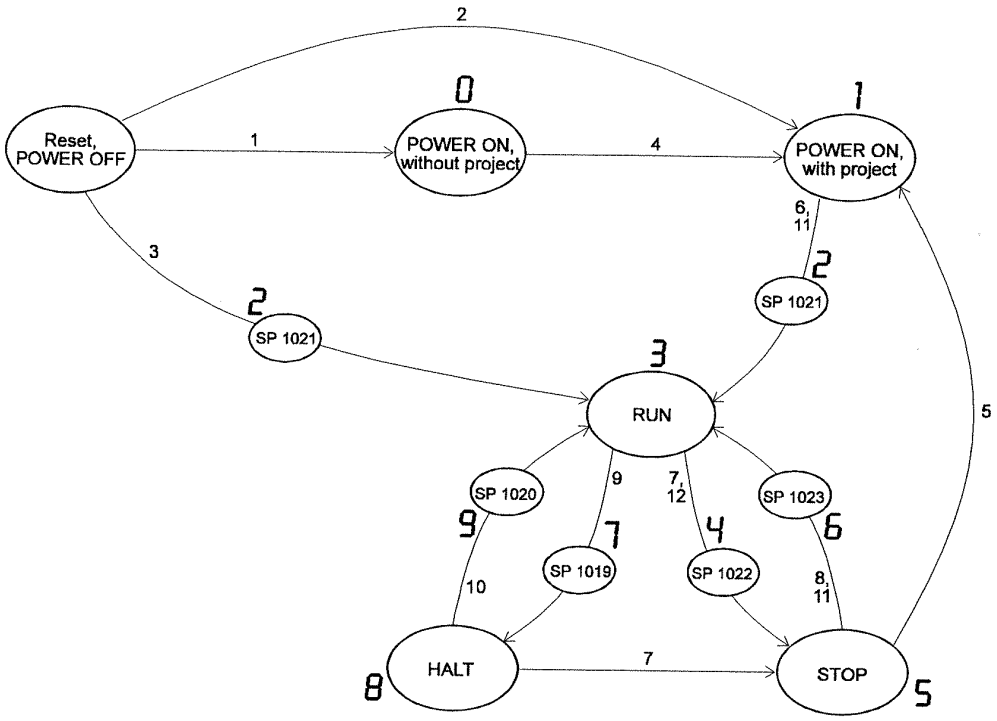


Figure 5-8. PLC State Machine

Technical Data

All specifications are listed in Chapter 9.

Connection Information

⚠WARNING

HIGH VOLTAGE/ROTATING PARTS—This equipment carries a dangerously high voltage and has dangerous rotating parts (fans). Ignoring the safety and warning information may result in death, severe personal injury or damage to property.

⚠WARNING

HIGH VOLTAGE—The intermediate circuit carries high voltage.

IMPORTANT

All the enables are edge-triggered except for the emergency stop input. The emergency stop input must be active before the other hardware enables.

Motor Driver Connections

IMPORTANT **All control voltages applied externally must comply with the regulations for PELV or SELV.**

K1	Main contactor with auxiliary contact for controller enable. **A controller enable on the controller may not be issued until the intermediate circuit capacitors have been completely charged (that is, 1 second at the earliest after switching on the main contactor).**
F	Circuit breaker according to VDE 0100, slow blow fuse, 2–2.3 times the rated current of motor protective switch matched to the power requirements of the drive and to the peak switch on current.
T	Isolating transformer for additional feed U_Z, special version, power 70 VA; U_k 4 ... 6%, one transformer per device! Option simplifies troubleshooting.
1U2, 1V2, 1W2, ⏚ X1: 12, 11, 10, 9	Motor connections, for installation, see EMC information. Cross-sections: 1.5 mm² up to 14 A, 2.5 mm² up to 19 A, 4 mm² up to 25 A, 6 mm² above 25 A rated motor current. Observe the assignment to the connections in the terminal box.
1U1, 1V1, 1W1, ⏚ X1: 7, 6, 5, 8	Connection to mains (transformer), for installation, see above.
ZK+, ZK– X1: 2, 1	Connections for checking intermediate circuit current. Discharging the intermediate circuit capacitor takes at least one minute. If necessary, the intermediate circuit can be rapidly discharged via a resistor. Connect an external ballast resistor between X1:2 ZK+ and X1:4 BA–.
X5:1, 2	Additional feed U_z feeds the mains unit and the controller but not the intermediate circuit. Task: Obtaining the error message with error messages in the case of disturbances, i.e. K1 drops. Controller supply is necessary for operation!
RBint X1:3 **BA– X1:4**	Connection of an internal ballast resistor. Connection of a ballast resistor. Connection of an external ballast resistor between X1:2 ZK+ and X1:4 BA–.

⚠WARNING **Parallel-switching several devices via the intermediate circuit connections is not allowed. This overloads the starting current limitation device and destroys it.**

When using an autotransformer, the intermediate circuit and the motor connections are live! When using an isolating transformer, ground the intermediate circuit.

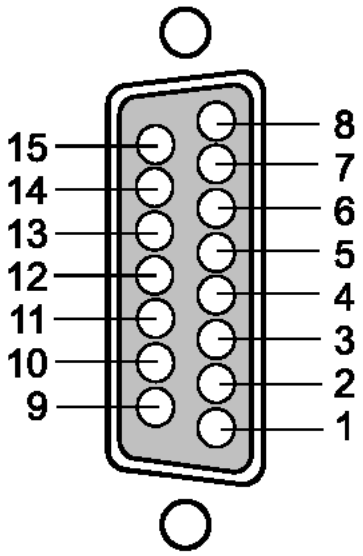
⚠WARNING **Power Cool-Down Cycle—Independent of power supply configuration, users should allow a minimum of 3 minutes cool-down after a power supply interruption or shutdown/key-off cycle.**

NOTICE **When using an external ballast resistor, you must remove the wire bridge between X1:3 and X1:4. Otherwise, the ballast transistor may be overloaded and destroyed.**

Control Terminals

Terminal No.	Assignment
1	+ 24 V (PELV) Connection for input power supply of the driver (+)
2	24 V Frame ground (PELV) Connection for input power supply of the driver (–)

Motor Controller Connectors



Pin No.	Assignment
1	Resolver ref–
2	Resolver ref+
3	Pot meter (EM-300 only)
4	Pot meter (EM-300 only)
5	Resolver cos+
6	Not assigned
7	Resolver sin+
8	Resolver sin–
9	Resolver cos–
10	Reserved
11	Reserved
12	Pot meter (EM-300 only)
13	Not assigned
14	Temperature motor TM1
15	Temperature motor TM2

Figure 5-9. Resolver Connector – X24

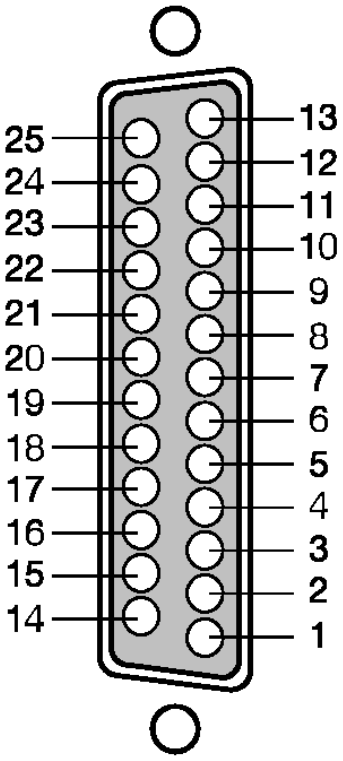
The resolver connection between the driver and the actuator is a dedicated cable using special connectors on each end. The cable length is 30 m (98 ft), which can be lengthened up to 100 m (328 ft) if necessary by the end user. This cable is also available in 10 m (33 ft) and 20 m (66 ft) lengths. If desired, it can be removed from Woodward's scope of supply and provided by the customer.

If supplied by the customer, it is the customer's responsibility to ensure shielding integrity of this cable. The shielding integrity must be equal to or better than the Woodward-supplied cable to ensure compliance with the Marine radiated emissions requirements.

Woodward recommends that a factory 30 m cable be cut and spliced with a length of shielded cable when making cables longer than 30 m or when the application requires routing through conduit. Be sure to connect the cable shields at the splice point.

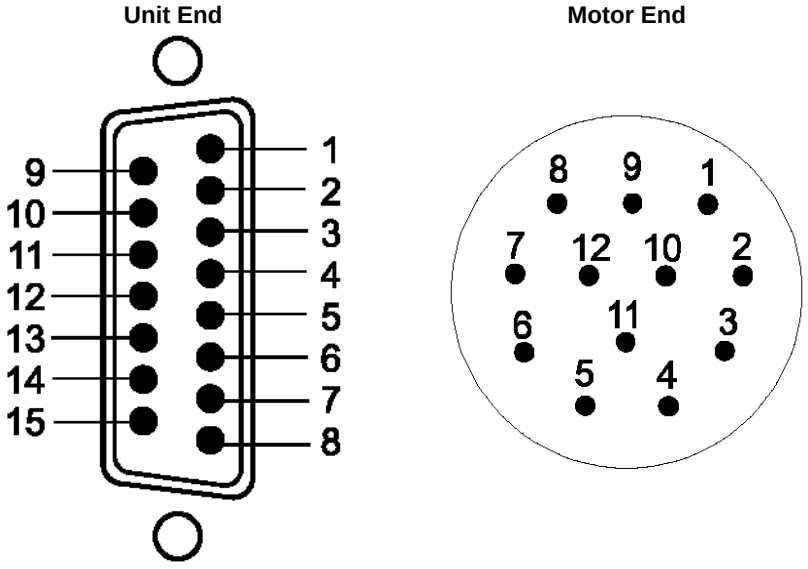
The Woodward-supplied filtered D-sub connector adapters must be installed prior to using the driver. These adapters are necessary to ensure compliance with the Marine radiated emissions requirements.

Checking the Temperature Probe
Remove the cable that connects to the closed-loop control unit. When the motor is cold (coil temperature of less than 80 °C), the resistance between the two connections in the cable must not exceed 1 kΩ.



Pin No.	Assignment
1	Analog input 1 + (EM-300 Shaft Position)
2	Analog input 1 – (EM-300 Shaft Position)
3	Analog input 2 + (Position Command)
4	Analog input 2 – (Position Command)
5	Analog power supply, + 15 V
6	Analog power supply, reference potential
7	Analog output 1–Actual Position indication
8	Analog output 2–spare
9	Input motor temperature +
10	Input motor temperature –
11	Ready for Use Relay (NC)
12	Ready for Use Relay (C)
13	Ready for Use Relay (NO)
14	Digital input (24 V)–Pulse enabling
15	Digital input 1 (24 V)–spare
16	Digital input 2 (24 V)–Stop
17	Digital input 3 (24 V)–spare
18	Digital input 4 (24 V)–spare
19	Digital input (24 V)–Rapid halt
20	Ground for digital inputs 1 to 4 respectively pulse enabling and rapid halt
21	Digital output 1 (24 V)–spare
22	Digital output 2 (24 V)–spare
23	Digital output 3 (24 V)–spare
24	Ground digital outputs 1 to 3
25	+24 V for digital inputs 1 to 4, pulse enabling, rapid halt and digital outputs 1 to 3

Figure 5-10. Analog/Digital Interface – X26 SUB-D Socket 25-pin



View of mating side
SUB-D plug, 15-pin

View of mating side
Metal round plug, 12-pin socket contacts (manufacturer Interconnection)

Figure 5-11. Resolver Feedback Connection Cable

Unit End Pin No.	Connection *	Motor End Pin No.
1	Blue Ø 0.5 mm	10
2	Red Ø 0.5 mm	12
3	Yellow	3
4	Green	4
5	Violet	8
6		
7	Grey	6
8	Pink	5
9	Black	1
10		
11		
12	Brown	2
13	White	11
14	Red/blue	9
15	Grey/pink	7

*** Colors may vary with cable manufacturer.**

Cable consists of 5x(2x0.14)+2x0.5 mm² cores twisted in pairs, total shielding via copper. The cable shield is connected to the round plug housing and the SUB-D plug connector shielding.

IMPORTANT **The connecting cable must be manufactured in accordance with the above table. Improper connections will result in malfunctions.**

Accessories	Woodward Part No.
Resolver cable 12/15 pin (cable length on request)	1745-371 (10 m) 1745-372 (20 m) 1745-373 (30 m)

General EMC Information about Converters

Modern semiconductor technologies such as MCTs and IGBTs are intended to minimize the power loss in the converter by switching more quickly and, with this, to continually reduce the size of the power section. As a result, when running converters you must meet specific conditions to avoid electromagnetic influences caused by switching operations.

Disturbances can occur because of:

- Capacitive fault currents caused by high rates of voltage rise when bipolar transistors and IGBTs switch.
- High currents and high rates of current rise in the motor lines. The disturbance energy bound in magnetic fields reaches frequencies of between a few Hertz and about 30 MHz. Due to the high rates of current rise, additional electromagnetic fields occur with frequencies of up to approximately 600 MHz.
- High clock rates and fast logic circuits (electromagnetic field/ 16 MHz...1 GHz).
- System perturbation and harmonics caused by commutations and non-sinusoidal network loading, in particular with line-commutated converters (100 Hz ... 20 kHz).

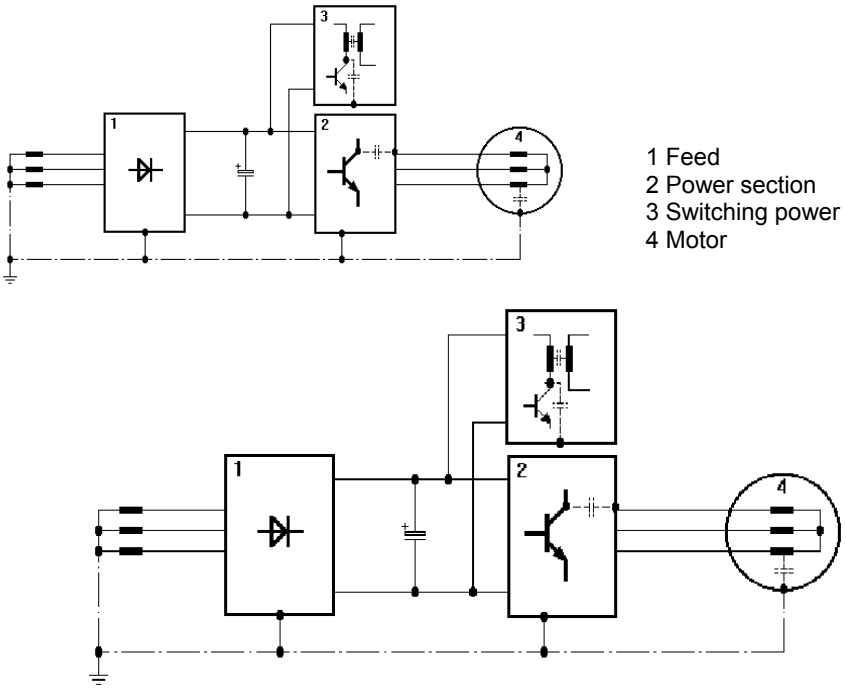


Figure 5-12. Converter Disturbances

Filtering

EMC filters are needed on the input power to ensure the driver and motor system complies with the requirements of the EMC Directive and Marine Type Approval.

Woodward offers a filter that allows the EM-80/-300 driver to operate in a TT or IT grounding network. The driver is shipped with a TT or IT network EMI filter, depending on the end users application [contact your Woodward authorized agent for more information].

TT (Terra Terra) Grounding System—In a TT earthing system, the protective earth connection of the user is provided by a local connection to earth, independent of any earth connection at the generator.

IT (Isolation Terra) Grounding System—In an IT network, the distribution system has no connection to earth at all, or it has only a high-impedance connection.

Filter pin connector adapters (Woodward-supplied) must be installed on driver connectors X24 and X26. These adapters are necessary to ensure compliance with the requirements of the EMC Directive and the Marine Type Approvals.

Filter Assembly

- Mount the filter immediately next to the converter—within a maximum distance of 1 m (39”). With lines that are more than 30 cm (1 ft) long, you must screen the mains line between the converter and the filter (frame-ground on both sides).
- Physically separate the filter's input and output lines by more than 30 cm (1 ft).
- Make a broad (large area) connection between the filter housing and frame ground.

Discharge Currents

TT Filter Application
The TT filter allows high leakage current from the power unit, the motor cable, and the motor winding of around 100 mA or higher.

NOTICE

The ⏚ connection cross-section must be at least 10 mm² (0.016 in²).

IT Filter Application
The IT filter allows leakage current from the power unit, the motor cable, and the motor winding of around 20 mA or less.

Commissioning

⚠WARNING

HIGH VOLTAGE—The power converter's power cables are energized!

The mains unit and the field connector of the power converter carry a dangerous voltage even when the main contactor has opened.

The ground terminal of the driver and the motor must be connected to Protective Earth (PE) prior to connecting the driver to input power (Mains). Without the PE connection present, a short circuit to frame or ground may cause a high leakage current.

⚠WARNING

HIGH VOLTAGE/ROTATING PARTS—This equipment carries a dangerous voltage and contains dangerous rotating parts (fans). Ignoring the safety and warning information may result in death, severe personal injury or damage to property.

Messages and Warnings

Error codes

In the event of an error, parameter M error code (P124) indicates the appropriate error code. This error is acknowledged when bit Reset disturbance in M control word (P120) is set from 0 to 1. If there is more than one error, the system shows the next one immediately after acknowledgement.

For details on individual error codes, refer to Appendix B (Driver Error Codes).

Monitoring Facilities of the Feed Unit

For the monitoring facilities to function, the 24 V auxiliary voltage (at X5) must be available.

Ballast Overload Monitoring

Ballast overload monitoring prevents inadmissibly high loading of the internal ballast resistor. You can deactivate this monitoring facility for external ballast resistors.

Main Input Power Failure / Phase Failure Monitoring

Phase failure monitoring detects a single-phase or three-phase failure of the supply voltage and prevents an internal ready-for-use signal.

IMPORTANT

The message can be reset by a RESET on X1 after 20 seconds if the 24 V auxiliary voltage or 230 V additional power supply remains.

For a normal switch-on, a simultaneously switch of the power supplies on X1 and X5 is recommended.

Monitoring Facilities on Motor-End Power Unit

The following monitoring facilities exist:

- Overcurrent in motor lines
- Earth-fault current
- Intermediate circuit voltage
- Power transistors (IPM)
- Auxiliary power supply.

Overcurrent Message

The system monitors the motor current in the motor phases and generates an overcurrent message if a phase current goes out of the upper range by 30% of the allowed peak current. This message is saved and results in a pulse disable.

The overcurrent message can be cleared by a reset signal from the controller.

IMPORTANT

The overcurrent message is intended as protection. The controller ensures limitation of the allowed peak current of the motor phase currents.

Earth Fault Monitoring

The system monitors the earth fault current of the power unit—and with this of the motor phases—to detect a motor earth fault. An earth fault current error message is generated if the fault current exceeds 10% of the allowed peak current of the power unit.

Earth fault monitoring can be cleared by a reset signal from the controller.

Intermediate Circuit Monitoring

The system monitors the level of the intermediate circuit voltage in the power unit. A message is issued if the intermediate circuit voltage reaches a value that is critical for the power unit.

Intermediate circuit monitoring can be reset by a reset signal from the controller.

IMPORTANT **The intermediate circuit voltage can rise until switch-off if the drive brakes and the ballast circuit on the intermediate circuit is either too small or non-existent.**

Monitoring Power Transistors

For the duration of the power transistors' switch-on command, the system monitors the collector/emitter saturation voltage. If too high a saturation voltage is detected in conducting status, a power transistor overcurrent is present; this can be due to a short circuit of the motor terminals, for example, and a controlled shutdown occurs that switches off the transistor and generates a message. In addition, the junction region temperature is monitored. The system issues a message if the junction region temperature exceeds 110 °C.

This message can be cleared by a reset signal from the controller.

Monitoring the PLC Health (24 Vdc Power Supply Low Voltage Condition)

The motor driver module monitors the health of the PLC. If a low voltage condition occurs in the external 24 Vdc power supply and the PLC stops functioning, the system will enunciate a fault and de-energize the Ready for Use output.

After stable power has been restored, the unit must be power cycled to return the unit to normal operation.

Monitoring the Heatsink Temperature

The power unit does not have its own temperature monitoring facility, since the temperature of the heatsink is not a time-critical variable.

On the heatsink, there is a linear temperature sensor whose measured value is passed on to the controller. This means that the controller carries out temperature monitoring (refer to the description of the controller).

Maintenance

⚠WARNING **HIGH VOLTAGE—Do not begin work on the power stage or the intermediate circuit until you have made sure that the unit is not carrying potential or a voltage (remnant charge).**

NOTICE **Before touching the modules, you must discharge electrostatic energy from your body to protect electronic components from high voltages resulting from electrostatic discharge. The easiest way to do this is to touch a grounded conductive object before handling components.**

The units supplied are maintenance-free. Do not attempt to make modifications.

Chapter 6.
Suppressor Filter

General

Read and follow all safety instructions given in Chapter 1, General Safety Precautions.

Suppressor (mains) filters consist of combinations of capacitors, reactors, resistors, and voltage limiters that are intended to reduce the electromagnetic influence of the environment. The direction of influence is bi-directional, that is, there is a reduction in the unit's emission of conducted disturbances and, at the same time, an improvement in the immunity of the drive to interference that occurs in the case of lightning strikes, fuses tripping, or simple switching activities.

The attenuation response of the suppressor filters has been specially designed for the EM driver power electronics systems. Using this filter allows you to comply with the limit values in the EMC product standard for variable-speed electrical drives that are required for industrial applications.

By using the suppressor filter in combination with the EM driver power units as shown in the wiring diagram, the protection requirements of the European EMC Directive (89/336/EEC) and Marine Type Approval are satisfied.

IMPORTANT

Emission of radio interference is heavily dependent on the wiring of the components, the amount of space required, and their arrangement in the system. Thus it is only possible to establish EMC compliance on the completely assembled system. The manufacturer or owner of the system is responsible for establishing EMC compliance of the system.

Description of Function

The resulting impedance of the components used in the filter has the effect of optimally mismatching the mains and the load impedance such that the interference currents are routed back to the interference source in the best way possible. This considerably reduces the harmonic voltages that drop on the mains impedance in the 9 kHz to 30 MHz frequency range.

IMPORTANT

To be able to route the interference currents at low impedance back to the interference source, the filter, the power unit, and the contact area of the motor cable shield must have a junction with the common mounting plate over as wide a surface area as possible that has good conductive properties. The best way to ensure this is to use unpainted zinc-coated mounting plates.

NOTICE

The filter is only suitable for use directly on a low impedance earthed low-voltage mains supply. The filter is not suitable for use directly on an isolated low-voltage mains supply. It must never be used as a motor filter on the converter output.

TT EMI Filter

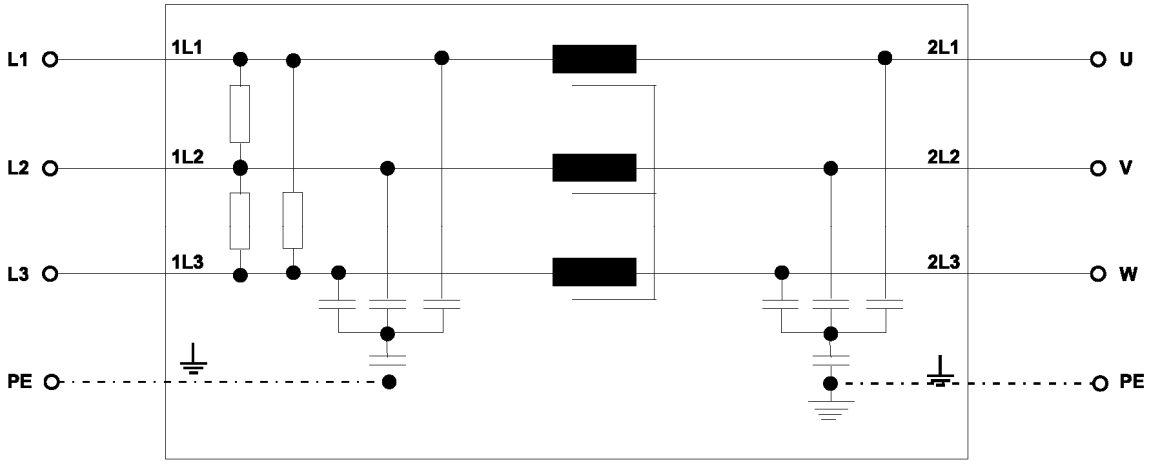
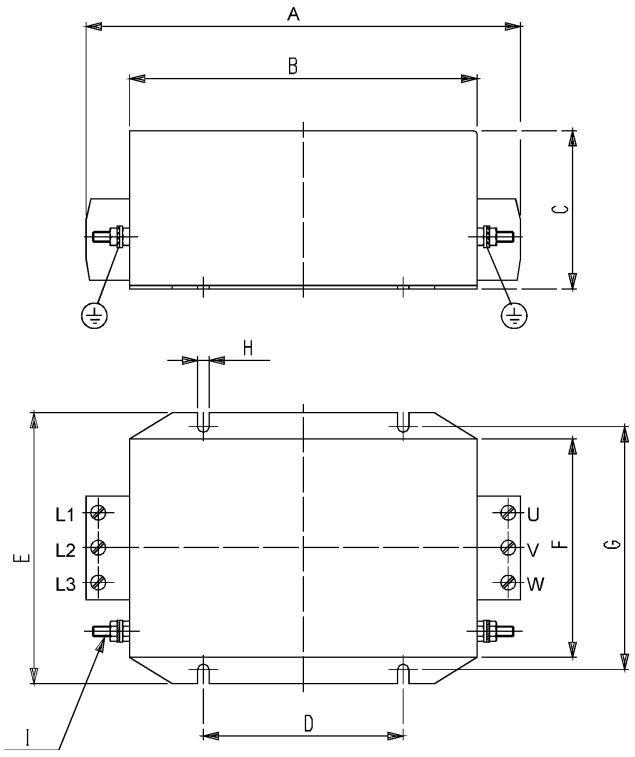


Figure 6-1. TT Simplified Block Diagram



A	163 mm
B	141 mm
C	81 mm
D	70 mm
E	113 mm

F	86 mm
G	100 mm
H	5.5 mm
I	M6

Figure 6-2. TT Filter Dimensions

IT Filter

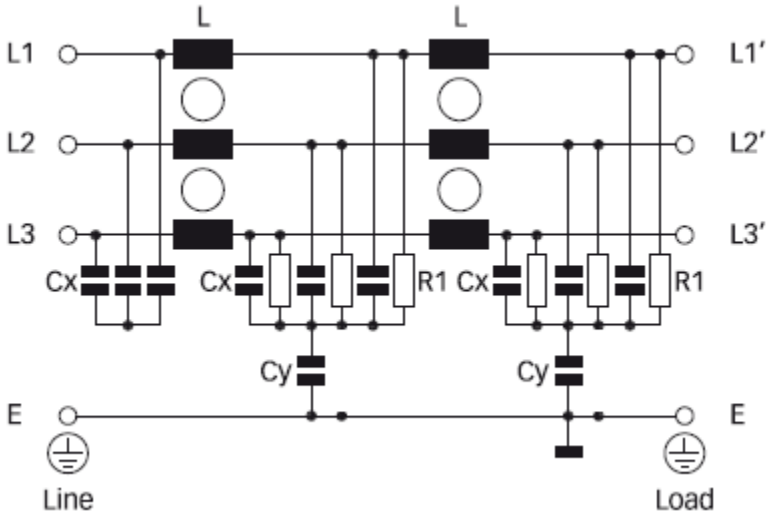
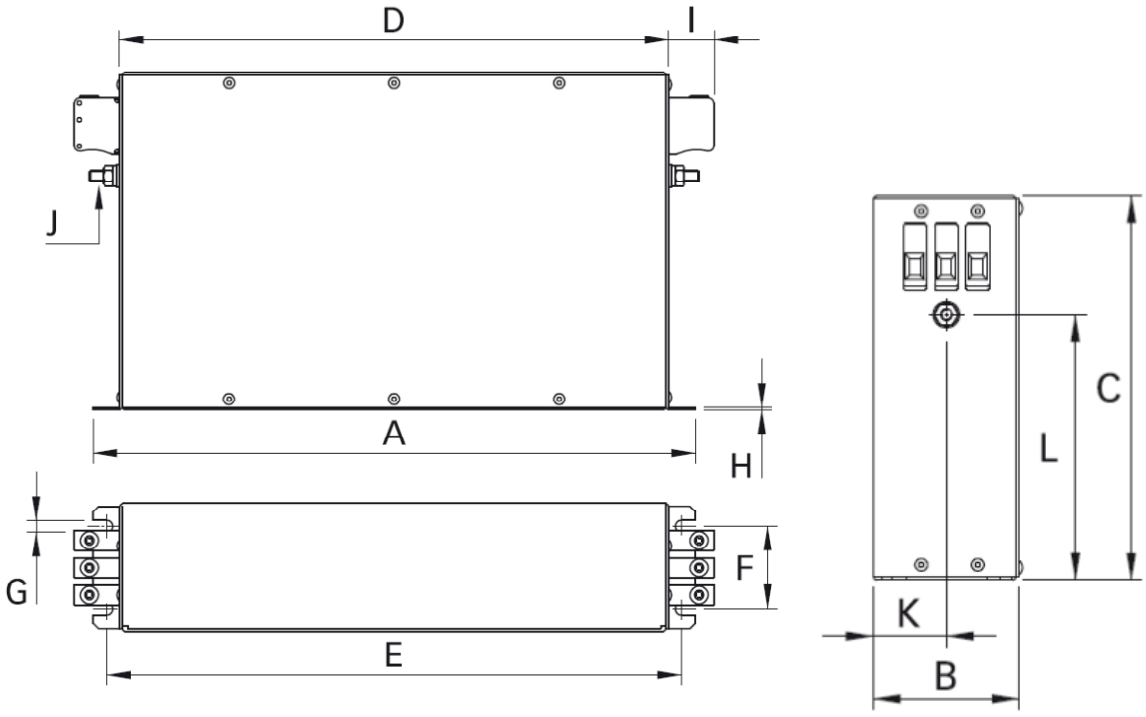


Figure 6-3. IT Filter Block Diagram



A	329 mm		G	6.5 mm
B	70 mm		H	1.5 mm
C	185 mm		I	25 mm
D	300 mm		J	M6
E	314 mm		K	35 mm
F	45 mm		L	130 mm

Figure 6-4. IT Filter Dimensions

Technical Data

Filter specifications are listed in Chapter 9.

NOTICE

Switching filters in-parallel to increase the filter rated current is not allowed. Due to the higher leakage currents to earth, the cross-section of the PE must be at least 10 mm² (0.016 in²).

Installation

General Information

⚠WARNING

The owner is responsible for assembly of the described device in accordance with safety regulations, such as DIN or VDE. You must ensure that all other relevant national and local regulations are met with regard to cable ratings and protection, grounding, disconnectors, overcurrent protection, etc.

For reasons of thermal safety and to ensure EMC, the following information must be followed:

- Ensure that the flow of air is not restricted.
- Ensure that there is a minimum clearance of 100 mm (4”) above and below the filter.
- Do not locate any additional sources of heat near the filter. Keep to the temperature range stated in the technical data.
- The units are intended for use in closed operating areas.

IMPORTANT

- **Ensure that the fastening screws are firmly seated.**
- **Ensure that the mounting surface has good conductive properties.**
- **Mount the filter as close as possible to the converter on the same mounting plate. In this connection, the connecting cable should be as short as possible and shielded. Connect the shield on both sides.**
- **The filter's input and output lines must be physically separated from one another (at least 30 cm/1 ft apart).**

The filter can be used for global removal of disturbances in the system. Install the device next to the mains feed location on the same mounting plate as the power units from which disturbances shall be removed. Use shielded connecting cables between the converter and filter. Bring the shield into contact at both ends.

NOTICE

The ⏚ connection cross-section must be at least 10 mm² (0.016 in²).

EMC Information

Refer to Appendix A for information about EMC.

General Information on Converters

The converters are equipped with IGBTs (Insulated Gate Bipolar Transistors). The power loss in the converter is minimized by fast-switching operation of the IGBTs. The size of the power modules is thus decreased. The fast switching operation of the IGBTs causes electromagnetic influences, which may influence other components.

Interference may be caused by:

- Capacitive fault currents. This is caused by high-voltage peaks and switching of bipolar transistors and IGBTs.
- High currents and current peaks in the motor cables. The interfering energy bound in magnetic fields reaches frequencies of a few Hz up to approximately 30 MHz. Due to the high voltage peaks, additional electromagnetic fields occur with frequencies of up to approx. 600 MHz.
- High chopping rates and fast logic circuits (electromagnetic field with 16 MHz to 1 GHz).

Filtering

No filters are necessary for the function of the converter. To comply with the limiting values as a result of EMC regulations, mains filters are required.

Filter Assembly

Mount the filter next to the converter on the same mounting plate. If the cables are longer than 30 cm (1 ft), screen the mains cable between converter and filter (grounding at both ends).

Physically separate (distance > 50 cm/20”) input and output cables of the filter. Connect the filter housing to ground over a large surface.

Leakage Currents

Capacitances in the filter, power stage, motor cable, and motor winding cause leakage currents of 100 mA and higher. This means that converters with an earth leakage circuit breakers (e.l.c.b.) may be incompatible!

NOTICE

The ⏚ connection cross-section must be at least 10 mm² (0.016 in²).

Connection Information

1L1, 1L2, 1L3, PE 2L1, 2L2, 2L3	Cross-section of mains connection, 2.5 mm² minimum. For cabling, refer to the EMC Information.

Maintenance

The supplied filters are maintenance-free.

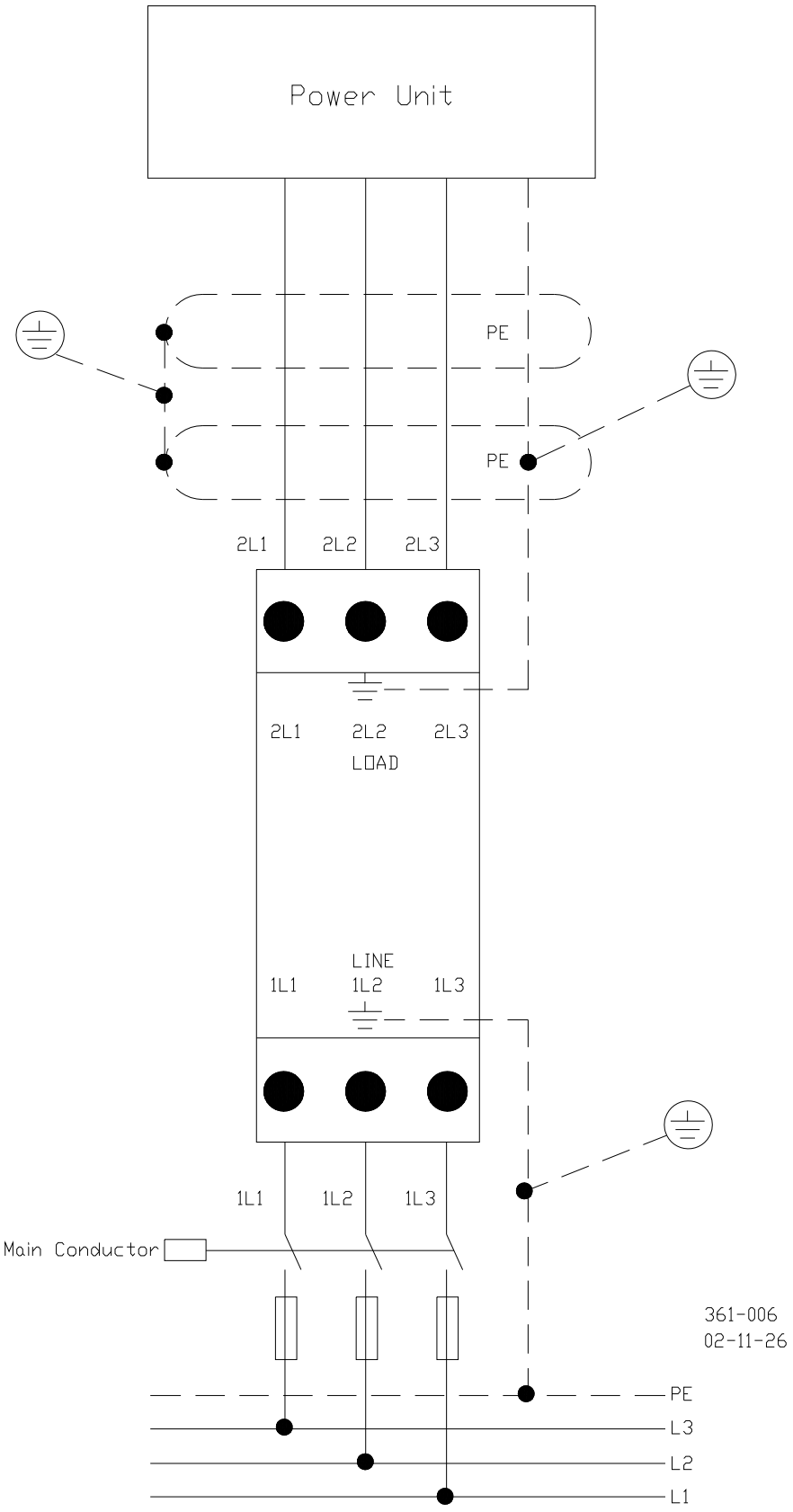


Figure 6-5. Connection Diagram

Chapter 7.
Maintenance

Read and follow all safety instructions given in Chapter 1, General Safety Precautions.

Under normal operating and environmental conditions as described in this manual, the actuator requires no interval maintenance.

Prolonged usage at the maximum temperature of 85 °C may require replacement of the gearbox oil after a period of approximately five years. If a unit is being used in such an extreme environment, it is advised that the customer contact Woodward for assistance in having the oil replaced by the gearbox manufacturer at five-year intervals. The gearbox is sealed, and it is not possible to replace the oil without complete disassembly.

Chapter 8. Troubleshooting

Introduction

Read and follow all safety instructions given in Chapter 1, General Safety Precautions.

Improper engine operation is often the result of factors other than governor operation. This chapter gives tips about engine problems which can resemble governor problems. Make sure the engine is operating correctly before making any changes in the governor. The following troubleshooting guide is an aid in isolating trouble to the control box, actuator, wiring, or elsewhere. Troubleshooting beyond this level is recommended ONLY when a complete facility for control testing is available.

Attempting to correct engine or load problems with untimely governor adjustment can make problems worse. If possible, isolate the governor from the engine to determine if the problem is with the governor and not with the engine or the load on the engine. Governor faults are usually caused by problems in the installation or the linkage between the actuator and the engine.

Carefully review all the wiring connections, the power supply, and the linkage before making any adjustments to the actuator or driver. Always check the fuel-control linkage from stop to stop as if the actuator were moving it. The linkage must move freely without friction and without backlash. Some fuel controls will present problems at particular fuel or rack positions because of a hesitation or binding in the linkage.

Fuel supply and injector conditions can also present problems which resemble governor problems. On spark-ignited engines, distributor, coil, points, and timing problems can all cause improper operations which may resemble faulty governor control.

NOTICE

The control can be damaged by the wrong voltage. When replacing a control, check the power supply, battery, etc., for the correct voltage.

Troubleshooting Procedure

This chapter is a general guide for isolating system problems. The guide assumes that the system wiring, soldering connections, switch and relay contacts, and input and output connections are correct and in good working order. Make the checks in the order indicated. Various system checks assume that the prior checks have been properly done.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. By making the checks appropriate to your engine/turbine before contacting Woodward for technical assistance, your system problems can be more quickly and accurately assessed.

Actuators

- Is the actuator wiring correct?
- Is the direction of the stroke correct?
- Has the feedback signal been calibrated?

Linkage

- Is there slop or lost motion?
- Is there misalignment, binding, or side loading?
- Is there visible wear or scarring?
- Does the linkage move smoothly?

Mechanical Troubleshooting Guide

Linkage and Actuator Stroke

Use as much of the 40 degrees of actuator stroke as possible. Carefully follow the guidelines in Chapter 4 in making linkage arrangements. Using less than optimum actuator movement will make stability more difficult, and will make the actuator more sensitive to external loading forces and friction.

Actuator exhibits "hunt" or large limit cycle:

- Check for loose terminal lever.
- Check for loose or worn linkage.
- Verify correct mounting hardware.
- Verify mounting bolts are tightened to appropriate torque values.

Unable to rotate stand-alone actuator in unpowered condition:

- Internal mechanical failure—replace actuator.

Actuator Problems

If the EM-80/-300 actuator fails to run, do the following actions.

Verify any fault indications on the driver (H20). If the actuator appears jammed, then:

- Monitor the actuator current. If the current is low, the actuator is not jamming.
- Remove the linkage from the actuator and verify that the linkage moves freely.

Electrical Troubleshooting Guide

EM Actuator Cabling

To verify electrical connections within the actuator and cables, disconnect the electrical cables at the EM driver and measure resistances between connector terminals. Note that the following resistances are approximate and do not include tolerances or electric cable resistance. This test is to check for open or short circuits only.

Motor Windings:

- X1 pins 11 to 12: approximately 0.5 Ω
- X1 pins 11 to 13: approximately 0.5 Ω
- X1 pins 12 to 13: approximately 0.5 Ω

Thermal Switch:

- X24 pins 14 to 15: should be shorted when cool (< 180 °C internal temperature)

Resolver Connector:

- X24 pins 1 to 2: approximately 65 Ω
- X24 pins 5 to 9: approximately 85 Ω
- X24 pins 7 to 8: approximately 85 Ω

Resolver

If the Resolver Feedback is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded.
- Check the wiring. Look for a loose connection at the connector and disconnected or misconnected cables. Make sure the cable is connected to the X24 connection.
- Verify cabling impedances per ‘EM Actuator Cabling’ section above.

Analog Input

If the Analog Input is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded.
- Measure the input voltage on the terminal block. It should be in the range of 0–5 V.
- Verify that there are no or minimal ac components to the Analog Input signal. AC components can be caused by improper shielding.
- Check the wiring. Look for a loose connection at the connector and disconnected or misconnected cables.
- If a 4–20 mA input control signal is used, verify that the correct resistor is installed as described in Chapter 5, External Connections.

Analog Output

If the Analog Output is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded.
- Check the load resistance, ensure that it is less than the specification limit for the output current.
- Check to ensure that the load wiring is isolated.
- Check the wiring, look for a loose connection at the terminal blocks and disconnected or misconnected cables.
- Disconnect the field wiring and connect a resistor across the output. If the output is correct across the resistor, there is a problem with the field wiring.
- If Watch Window Professional is available, the output current can be forced from the Test Mode to verify functionality. In addition, Offset and Gain adjustment are available in the Service Mode.

Discrete Inputs

If a discrete input is not functioning properly, verify the following:

- Measure the input voltage on the terminal block. It should be in the range of 18–28 Vdc.
- Check the wiring, look for a loose connection at the connector and disconnected or misconnected cables.

Alarm or Shutdown Conditions

If the driver has any fault conditions, refer to Appendix B for details on the exact cause of the condition. The H20 LED will indicate a flash code for fault conditions.

Discrete Output

If the discrete output is not functioning properly, verify the following:

- Measure the impedance of the relay output on the connector—relay is a SPST form-C (both NO and NC).
- Check the wiring, look for a loose connection at the connector and disconnected or misconnected cables.

Performance Troubleshooting Guide

General performance problems:

If the actuator buzzes, or has a fast limit cycle:

- Check for loose linkage.

If the actuator overshoots on steps, or is poorly damped:

- Verify that as much of the 40° of travel as possible is being utilized.

If the actuator has a slow limit cycle:

- Check for excessive friction in linkage.

If the actuator has steady state position error:

- Supply voltage too low.
- Actuator load too large or actuator too small.
- Free stuck linkage.
- Actuator fault—replace actuator.

Chapter 9. Specifications

Specifications

General Specifications	EM-80	EM-300
Nominal Torque Output (continuous) *	91 N·m (67 lb-ft)	260 N·m (192 lb-ft)
Maximum Torque Output (1 second max)	190 N·m (140 lb-ft)	429 N·m (316 lb-ft)
Output Travel	40°, no internal mechanical stops	40°, no internal mechanical stops
10–90% Slew Time	78 ms with no load	192 ms with no load
System Accuracy	< ±0.179 degree (includes driver, resolver and gearbox accuracies)	
Unit to Unit Repeatability	±0.45 degrees	

* Continuous torque output is limited for actuator ambient environments over 40 °C per "Actuator Temperature Derating" in Chapter 4.

Actuator Specifications	EM-80	EM-300
Storage Temperature Range	–30 to +100 °C (–22 to +212 °F)	
Ambient Temperature Working Range	0 to +85 °C (+32 to +185 °F)	
Mounting	Actuator needs to be mounted within 45º of horizontal.	
Vibration	Random: 0.01 G²/Hz at 10 Hz, 0.1 G²/Hz at 100 Hz, 0.1 G²/Hz at 1000 Hz, 0.05 G²/Hz at 2000 Hz (12.8 Grms) 3 hours per axis.	
Shock Qualification Testing	MS1 – 40 G 11 ms sawtooth	
Ingress Protection	IP64	
Humidity Qualification Test (pending test)	55 °C, 95% RH for two days at one cycle per day	
Actuator Inertia	0.209 kgm²	1.715 kgm²
Approximate Weight (including bracket)	35 kg (77 lb)	38 kg (84 lb)
Service Life	>20 000 hours between overhaul. Full speed impacts into a optional external stop of minimum spring scale: 10 000	

Driver Specifications	
Electrical Specifications	
Input	4-20 mA / 1-5 V
Power Supply	3 phase, 400–480 Vac, 50–60 Hz, ±10%
Rated Current	16 A
Rated Output Current	15 A (12 A eff.), 0 to 45 °C, derated to 10.5 A (8.4 A eff.) at 55 °C
Maximum Output Current	30 A (24 A eff.), 0 to 45 °C, derated to 21 A (16.8 A eff.) at 55 °C
Power Supply PLC	24 V ±10% (55 W max)
Storage Temperature Range	–30 to +70 °C (–22 to +158 °F)
Ambient Temperature Working Range	0 to +55 °C (+32 to +131 °F)
Relative Humidity	Up to 85% (no condensation)
Site Altitude	Below 2000 m (6500 ft) above sea level (higher altitudes on request)
Ingress Protection	IP20 per IEC529
Mounting	The driver box is designed for installation on the control cabinet and should not be installed directly on the engine.
Weight	7 kg (15 lb)
Cabling	Two cables are required between driver and actuator. 3-phase Power supply cable Position sensor cable The maximum length between driver and actuator is 100 m (328 ft).
Filter	An EMC filter must be added to the power supply to suppress emissions.
Switch-on: Ready for Operation After	≤ 1.5 s
Power Switching off from 3-phase	Minimum time after switch-off of a 3-minute cooldown time must be observed.
Output Voltage	0 to Connection voltage
Output Power	8 kVA
Typical Motor Power	4.5 kW
Power Loss in Rated Operation without Low-Voltage Supply, without Ballast	170 W
Mechanical Specifications	
Dimensions (B x H x T)	108 x 315 x 270 mm (4.2 x 12.4 x 10.6 in)
Weight without Controller Cassette	7 kg (15 lb)

Driver I/O Specifications	
Low Voltage Power Supply	24 Vdc ±10%, 150 mA
Accuracy of Whole System	Calculation accuracy 16 bit
Sampling Rate of Whole System	62.5 µs
Analog Output Voltage Range	–10 to +10 V
Maximum Output Current	1 mA
Resolution	12 bit
Analog Inputs	
Voltage Range	–10 to +10 V
Type	Differential input
Input Resistance	40 kΩ
Resolution	12 bit
Potential Free (discrete) Inputs	
Low Level	0 to +7.5 V
High Level	+13 to +30 V
Input Resistance	10 kΩ
Relay Output	
Maximum Contact Load	24 Vdc / 1 A
Maximum Potential against Electronic Ground	50 V

Filter Specifications	TT Filter Type	IT Filter Type
Rated Current	16 A	42 A
Peak Current	24 A for < 1 min per hour at 40 °C	63 A for < 1 min per hour at 40 °C
Connection Voltages	3 x 480 Vac, 50–60 Hz, ±10%	3 x 480 Vac, 50–60 Hz, ±10%
Ambient Operating Temperature Range	–25 to +55 °C (–13 to +131 °F) Reduction of rate current from 40 °C onwards by 1.4%	–25 to +100 °C (–13 to +212 °F)
Leakage Current	> 100 mA	21.6 mA
Maximum Altitude for Site at Rated Loading	1000 m (3300 ft) above MSL	1000 m (3300 ft) above MSL
Relative Humidity	15 to 85% no condensation	
Storage Temperature Range	–25 to +85 °C (–13 to +185 °F)	
Dimensions (L x W x H)	163 x 113 x 81 mm (6.147 x 4.45 x 3.19 in) With 4 x 5.5 (0.217 in) mounting slots	329 x70 x 185 mm (12.95 x 2.75 x 7.28 in)
Weight	2.2 kg (4.85 lb)	2.6 kg (5.73 lb)

Resolver Feedback Cable Specifications	
Temperature Range	–5 to +70 °C (+23 to +158 °F) (flexing) –30 to +80 °C (–22 to +176 °F) (static)
Construction	• 10 x 0.14 + 2x0.5 mm² cores twisted in pairs • total shielding via copper • shield securely fastened to both connectors • PVC-based outer sheath (RAL7001)
Approved Sources Cable Assembly Bulk Wire	 Baumüller Art Nr 00324218 Baumüller LiYCY (00213444)

Chapter 10.
Service Options

Product Service Options

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

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

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

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

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

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

www.woodward.com/directory

Woodward Factory Servicing Options

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

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

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

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

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

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

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

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

How to Contact Woodward

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

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (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:

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 A.
Electromagnetic Compatibility (EMC)

Introduction

The information in this appendix is intended to allow you to configure your system on the basis of the latest knowledge in the field of EMC (electromagnetic compatibility) and to comply with legal regulations.

To ensure EMC, you must observe the configuration information below.

IMPORTANT

Installation of other electronic equipment inside the cabinet that encloses the EM-80/EM-300 requires that the cabling for this equipment meet the same requirements that the cabling for the EM-80/EM-300 meets. See this appendix for further details.

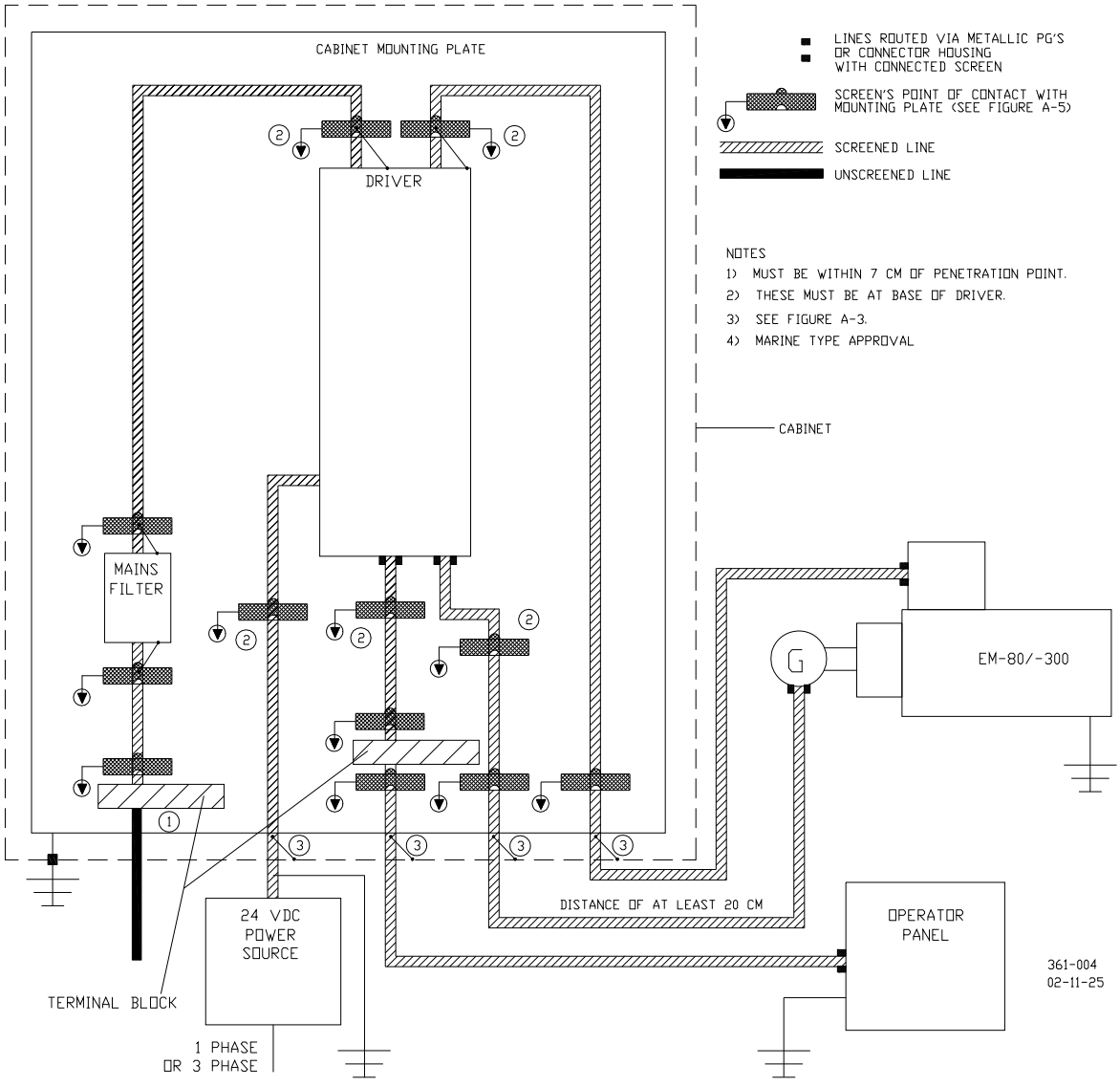


Figure A-1. Cabling

Cabling

To suppress radiated noise outside the converter, you should screen all the connected cabling. See also "Screening" later in this appendix.

Cables (wires) can act as an antenna, picking up (or transmitting) undesirable signals. Reduce effective antenna height by routing cables directly on the ground of the metallic rack.

Route all lines as close as possible to the conductors of the ground system to reduce the effective loop area for magnetic coupling.

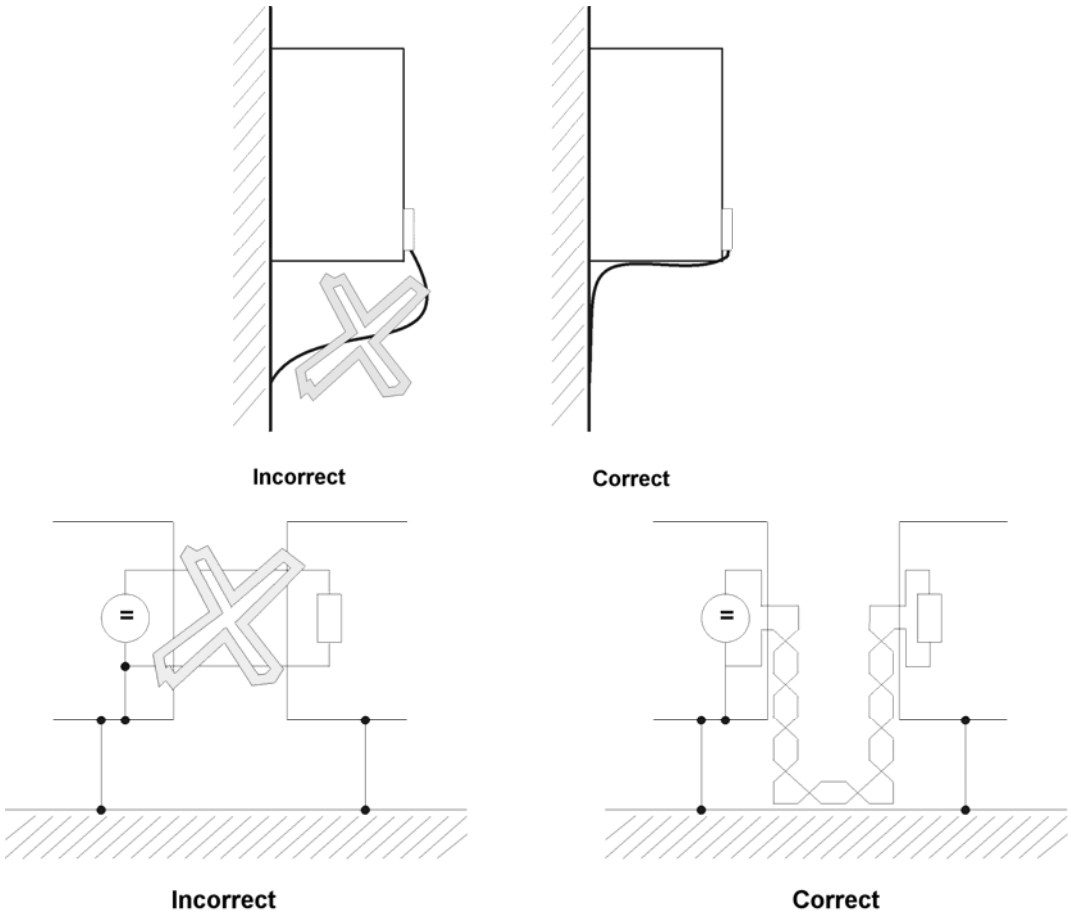


Figure A-2. Cable Routing

- When parallel-routing signal and control lines across power cables, the conductors must be at least 20 cm (8”) apart.
- Lines of different EMC categories should only cross at an angle of 90°.
- In the case of symmetrical signal transfer (such as differential amplifier inputs for the speed specified value), twist the conductors of each pair of wires together and twist the pairs of wires together.
- The converter to ground plate earth connection should be as short as possible (less than 30 cm/12”). Use large cross-sections (more than 10 mm²/7 AWG).
- Sources of interference such as fuses, transformers and chokes, and modules that are sensitive to interference like microprocessors, bus systems, etc., should be located at least 20 cm (8”) away from the converter and its cabling.

- Avoid reserve loops on overlong cables.
- You must ground spare lines at both ends (this has an additional screening effect, and avoids capacitively coupled, dangerous touch voltages).

Grounding

- From an EMC point of view, classical “star” grounding is no longer adequate for reducing the influence of disturbances at relatively high frequencies that occur as a result of converter operation. Better results can be achieved by a reference surface that must be linked to the devices' frame grounds over a wide area (form example, a bare, metallic mounting plate and parts of the housing).
- If it is not possible to use a broad reference place, it is sensible to mount the main equipotential bus bar directly next to the converter, since this device generates the greatest potential jumps, compared with the other components in the switching cabinet, due to the steep switching edges (the ground connection should be less than 30 cm/12” long if possible).
- Route all earth conductors and screens as closely as possible above the frame ground to prevent earth circuits.
- If it is possible to earth the controller reference voltage, make this connection with cabling that has as large a cross-section as possible and is less than 30 cm (12”) long.
- Remove insulating layers, such as varnish, adhesives, etc., from the frame ground connections. If necessary, use serrated lock washers to ensure a permanent, conductive contact. To prevent corrosion of frame ground connections, use suitable pairs of metals (electrochemical displacement series), and keep conductive electrolytes away from the connection by means of a protective coating (such as grease).
- Always connect screens at both ends to the frame ground—the connection should be over a wide area and conductive. This is the only way to suppress the effects of magnetic or high-frequency noise interference fields. If there are problems with earth circuits (such as double earth fault of the specified value conductor screen), the receive side should be galvanically connected and the transmit side capacitively connected.
- When routing cable screens through panels that separate different EMC areas, the cables must be in contact with the panel.
- Cables that are routed through the outer panels of screening housings without special measures (such as filtering), can have an adverse effect on the screening capability of the housing. For this reason, you must make a conductive connection of the cable screens to the screening outer panel at the point at which the cable enters the housing.

The distance of the last screen contact point to the exit from the cabinet must be as short as possible.

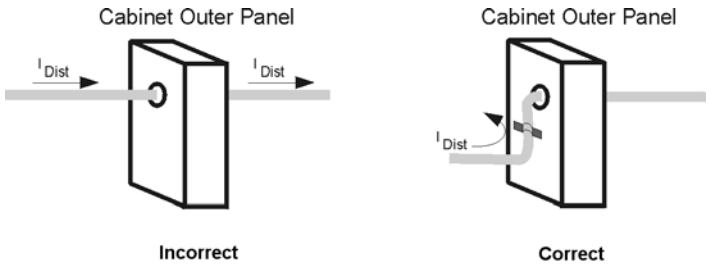


Figure A-3. Screening Contact

Screening

- The screen is effective against magnetic fields if it is connected to frame ground at both ends.
- With electrical fields, the screen is effective when it is connected to frame ground at one end. However, in the case of (electrical or magnetic) fields with high frequencies (depending on the length of the line), you must always connect the screen at both ends due to the linkage (electromagnetic field).

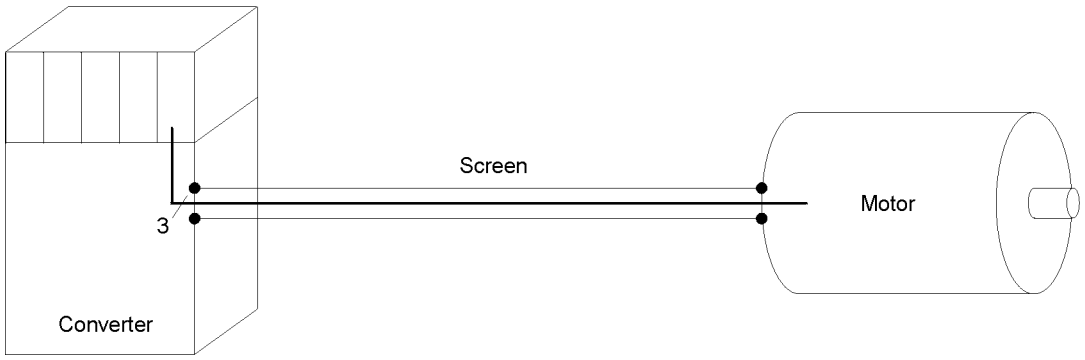


Figure A-4. Screening

Connecting the screen to frame ground at both ends ensures that the conductor does not leave the screening "system housing".

- Frame-grounding of conductor screens on both sides does not entirely rule out the influence of earth circuits (potential differences on the frame ground system). However, this is very rare if you carry out the measures described in the previous sections ("Cabling" and "Grounding").

  You can also make a capacitive RF connection of a screen to frame ground. This prevents low-frequency interference due to earth circuits.

  Screened cables that pass through different EMC areas must not be separated at terminals, since screen damping would otherwise be considerably reduced. The cables should be routed to the next module without interruption.

- Make the screen connection low-impedance and over a wide surface area. Cable tails that are only 3 cm (1.2”) long (1 cm of wire = 10 nH; 1” of wire = 25 nH) reduce the screening effect in the MHz range by up to 30 dB!

IMPORTANT **The braided screen must have a coverage of at least 85%.**

The following lines have particularly high levels of interference potential:
- The motor drive lines
- The line between the mains filter and the converter
- The DC power line between the converter and the cabinet penetration point
- The resolver cable
- The I/O Interface cables

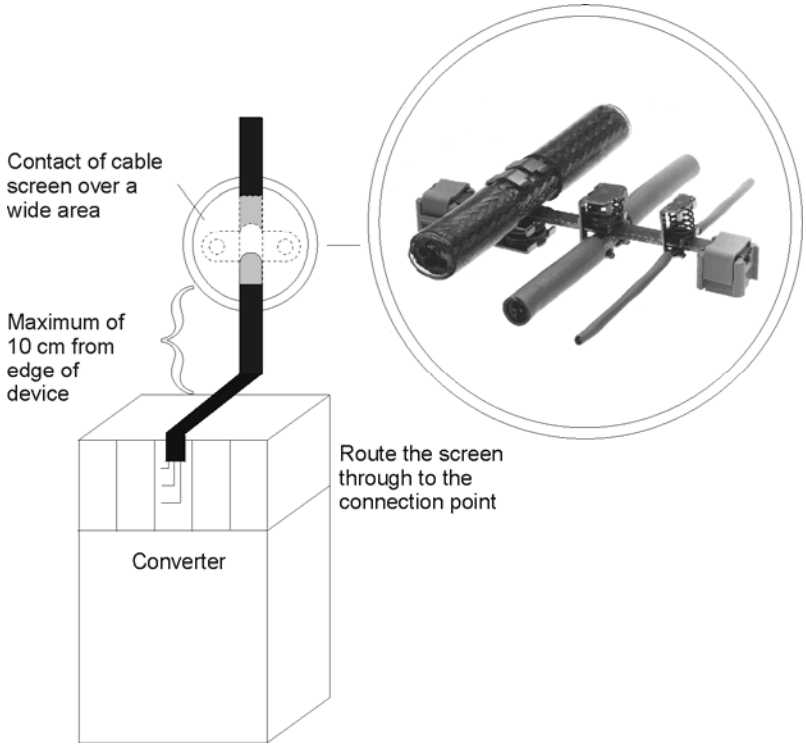


Figure A-5. Suggestion for Screen Connection

Appendix B.
Driver Error Codes

H 20 Error Codes

In the event of an error, parameter M error code (P124) indicates the appropriate error code. This error is acknowledged when bit Reset disturbance in M control word (P120) is set from 0 to 1. If there is more than one error, the system shows the next one immediately after acknowledgement.

Drive Manager Function Module (Error ID 00xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0001hex	BASS protocol timeout	The communications source set in P124 has not responded for longer than the timeout set in P128.	Set-up	Check communications (cables, daughterboard, etc.)
0002hex	USS protocol timeout			
0003hex	Dual-Port RAM time out (cyclical data)			
0004hex	Dual-Port RAM time out (working data)			
0005hex	System boot procedure	An error was determined while reading the boot data set from the EE PROM. You can get more information about the type of error by referring to parameter DSM Message (P192). This disturbance usually occurs if you replaced the controller firmware with firmware that is incompatible.	Inhibit pulses immediately	You should carefully check the data set in the controller's RAM and then program it in the EEPROM as the boot data set.
0010hex	Error switch (program error)	Only meaningful for software developers	Inhibit pulses immediately	

Power Supply Function Module (Error ID 01xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0110hex	Disturbance in power supply unit	No ready-for-use signal from supply unit.	Inhibit pulses immediately	Check the power supply. Reset the error memory in the power supply unit (refer to the power supply unit's operating instructions)
0006hex	Time-out error response	In case of an error (nonfatal error), the drive could not be braked down to n=0 within the time specified in P188.	Immediate pulse inhibit	Clarify the cause of the too long braking time. If necessary, increase P188 M fault response time.

Power Unit Function Module (Error ID 02xx)

See also Function Module Processor Error Recognition (Error ID 0Cxx).

Error ID	Error Text	Meaning	Error Reaction	Remedy
0201hex	Overvoltage UZK	The bus voltage, UZK, has exceeded a value of 800 V ±1%	Inhibit pulses immediately	Check the ballast resistor. If no ballast resistor is available see P269.
0202hex	Overcurrent	At least one of the power unit's three phase currents has overwritten the value of 1,3 x Imax (= 1,3 x P113)	Inhibit pulses immediately	Check the current controller's setting
0203hex	Error current	An error current was determined in the power unit that exceeded a specific amount. (For more detailed information, refer to the power unit description.)	Inhibit pulses immediately	Check the motor cables for a ground fault
0204hex	Disturbance in auxiliary voltage supply	There is no power supply for transistor control in the power unit.	Inhibit pulses immediately	Check control of the safety relay
0205hex	Overtemperature of power unit	The temperature of the power unit has risen above 85 °C.	Set-up	The disturbance cannot be acknowledged until the power unit temperature shown in P118 has fallen below 85 °C.
0206hex	Disturbance in safety relay	The safety relay in the power unit is OFF even though it should be ON. This means that the auxiliary voltage supply for transistor control is deactivated.	Inhibit pulses immediately	Check control of the safety relay. Check in addition the setting of bit 2 in P090 PU mode.
0207hex 0208hex 0209hex 020Ahex 020Bhex 020Chex 020Dhex	Transistor error (group message) Phase U top Phase U bottom Phase V top Phase V bottom Phase W top Phase W bottom	UCE monitoring of one or more power transistors has tripped due to, for example, a short circuit or ground fault or because of defects in the transistor.	Inhibit pulses immediately	Check the motor cables for a short circuit or ground fault. Allow the power unit to cool down. If the disturbance keeps occurring, replace the power unit.
020Ehex	Power unit ID unknown	The control unit does not know the read identifier	Inhibit pulses immediately	Read off the power unit version from the rating plate and compare it with the list in P117. The error cannot be acknowledged.
020Fhex	Wrong power unit type	The stored power unit type does not match the one the system read, for example because no data set has been stored yet or you plugged the control unit into another power unit.	Inhibit pulses immediately	Check the parameterization and, if necessary, change it. Save the data set and acknowledge the error.
0210hex	Disturbance in power unit	The ready for use signal from the power unit is missing even though there are no other power unit disturbance messages.	Inhibit pulses immediately	Refer to the power units operating instructions.
0D01hex	Short circuit temperature sensor	The power unit temperature is below the temperature threshold of –40 °C. Normally, this disturbance occurs if there is a short circuit in the temperature detection during operation.	Error response can be set in P090.	Temperature detection defective, the disturbance cannot be eliminated.

Overload Monitoring Function Module (Error ID 04xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0401hex	I²t monitoring of motor	Calculated I (P091) is greater than 100%	Error reaction can be set in P189	Leave the drive in the inhibited status until the I²t actual value (P091) drops below 100%.

Motor Temperature Function Module (Error ID 05xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0501hex	Overtemperature of motor	P152 = 1 (sensor) The motor temperature has exceeded the shutdown threshold (P156). This disturbance may also occur, if the motor temperature detection is interrupted during operation.	Error response can be set in P090.	Allow the motor to cool down until the motor temperature has dropped below the limit value. Check the encoder cable and the temperature sensor (see motor temperature connector X28)
0502hex	Short circuit temperature sensor	P152 = 1 (sensor) The motor temperature is below the temperature threshold of –40 °C. Normally, this disturbance occurs if there is a short circuit in the temperature detection during operation.	Error response can be set in P189.	Check the encoder cable and the temperature sensor (see motor temperature connector X28)

Position Controller Function Module (Error ID 06xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0601hex	Deviation, dynamic	In motion, e.g. positioning, synchronous operation, the deviation (P210) has become greater than the dynamic deviation error limit (P203).	Error reaction can be set in P189	Check the settings of the dynamic deviation limit and, if necessary, correct them. Reset the error enable for the dynamic deviation in mode parameter P201, bit number 0.
0602hex	Deviation, static	At standstill (e.g. target position reached, n=0), the deviation (P210) has become greater than the static deviation error limit (P212).	Error reaction can be set in P189	Check the settings of the static deviation limit and, if necessary, correct them. Reset the error enable for the dynamic deviation in mode parameter P201, bit number 1.

Speed Controller Function Module (Error ID 07xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0702hex	Blocking monitoring	During the blocking time set in P056, the drive was stationary with maxi mum torque of N = 0.	Error reaction can be set in P189	Check the drive machine for blocking.

Encoder 1 Function Module (Error ID 08xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0801hex *)	Invalid module code	The adapter module's code is not known.	Inhibit pulses immediately	The adapter module is either not fitted or not supported in this version of the firm ware.
0802hex *)	Wrong adapter module	The encoder adapter in the unit is not suitable for the desired encoder type and communications protocol set tings.	Inhibit pulses immediately	Change the set tings in the encoder mode or use an other adapter.
0803hex *)	No communication with the encoder	Reading the absolute position from the encoder did not function.	Inhibit pulses immediately	Check the encoder cable, on the motor and unit sides.
0804hex **)	Wire break encoder 1	The encoder signals are useless for evaluation.	Inhibit pulses immediately	Check the encoder cable, on the motor and unit sides.
0805hex	Wrong address in the reply message		Immediate pulse inhibit	If this error occurs more than 3 times in a row despite all the EMC interference suppression measures taken, the encoder must be replaced.
0806hex	Encoder reports error	The encoder has detected an internal error during the self-test.	Immediate pulse inhibit	
0807hex	Wrong command in the reply message		Immediate pulse inhibit	
0808hex	Wrong checksum in the reply message		Immediate pulse inhibit	
0809hex	Error position correction		Immediate pulse inhibit	Check the encoder cable on the motor side and the device side.
080Ahex	Unknown encoder code	The encoder cannot be clearly identified due to an unknown encoder code.	Immediate pulse inhibit	
080Bhex	Communication time-out error	Encoder does not send a reply message within 50 ms.	Immediate pulse inhibit	

*) Errors cannot be acknowledged.
**) After acknowledgement, the encoder is reinitialized; in this connection, the reference to a reference point can be lost.

Data Set Management Function Module (Error ID 09xx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0901hex	EEPROM copy error	A data difference was determined at copying of the EEPROM during initialization of data set management.	Error reaction can be set in P189	This error cannot be acknowledged and you can only eliminate it by switching the electronics supply off and on again. If the error occurs repeatedly, this indicates that there is a defect in the controller hardware.
0902hex	Missing boot data set	There is no boot data set (DS no. 0) in the EEPROM.	Error reaction can be set in P189	You must create the boot data set in RAM and then save it to the EEPROM.
0903hex	Checksum error in boot data set	At checking of the boot data set, the system calculated a different check sum than the one that was expected, i.e. a boot data set is present but it is invalid due to data corruption.	Error reaction can be set in P189	You must create the boot data set in RAM and then save it to the EEPROM.

Operating System Function Module (Error ID 0Bxx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0B01hex	Main program computing time exceeded		Error reaction can be set in P189	P160 selection = 0 P169 value = 0 Store the data set again and acknowledge the error. If necessary deactivate functions not needed for instance digital and analog I/Os by parameterization
0B02hex	Task computing time exceeded		Error reaction can be set in P189	
0B03hex	Sync. IR computing time exceeded		Error reaction can be set in P189	
0B04hex *	DSP computing time exceeded		Inhibit pulses immediately	

*) Errors cannot be acknowledged.

Function Module Processor Error Recognition (Error ID 0Cxx)

Error ID	Error Text	Meaning	Error Reaction	Remedy
0B05hex	Error in linking the program modules		Immediate pulse inhibit	Test the RAM
0B06hex	Error in the time segment system configuration			
0C01hex	Illegal external bus access	Further information see memory 0xFA00 up to 0xFA0F.	Inhibit pulses immediately	Re-boot controller
0C02hex	Illegal instruction access			
0C03hex	Illegal word operand access			
0C04hex	Protection fault			
0C05hex	Undefined opcode			
0C06hex	Stack underflow			
0C07hex	Stack overflow			
0C08hex	External non-maskable interrupt			
0C09hex	Watchdog time-out			

Function Module Power Unit Continued (Error ID 0Dxx)

Error ID	Error text	Meaning	Error Reaction	Remedy
0D01hex	Short circuit of the temperature sensor (power unit)		Error response can be set in P189.	

Appendix C.
Safe Disposal

Disposal of Driver/Actuator

The equipment consists of the following components and materials:

Component	Material
Housing, various intermediate panels, fan impeller, mounting panels	Sheet steel
Heat sink in the power stage	Aluminum
Various spacer bolts	Steel
Various spacers, housing of current converter and unit fan, etc.	Plastic
Bus bars in the power stage	Copper
Cable harnesses	PVC-insulated copper wire
Power electronics: Module thyristors mounted on a heat sink, ICL Assembly	Metal base plate, semiconductor chip, plastic housing, various insulation materials
PCBs on which all the open and closed loop electronics are mounted	Base material: Epoxy-resin fiberglass woven material, copper-coated on both sides and plated-through, various electronic components such as condensers, resistors, relays, semiconductors, etc.
Actuator and gearbox	Steel, aluminum, copper; PVC-insulated copper wire; various electronic components.

Disposal of Filter

The equipment consists of the following components and materials:

Component	Material
Housing	Sheet steel / aluminum
Several mechanical parts	Steel
Various spacers, housing of current converter and unit fan, etc.	Plastic
Cable harnesses	Copper wire
PCBs on which all electronics are mounted	Base material: Epoxy-resin fiberglass woven material, copper-coated on both sides and plated-through.
Potting compound	Synthetic resin

Electronic components must not be opened, since beryllium oxide is used as internal insulation (for example in various semiconductors). The beryllium dust set free when the components are opened is dangerous to your health.

Hazardous materials may be created or released in case of fire.

⚠WARNING

For technical reasons, electronic components might need to contain dangerous materials, so you should not open them.

In case of fire, dangerous compounds may result or hazardous materials may be released.

If the components are used correctly, there is no danger to humans or to the environment.

You must dispose of or recycle equipment or components according to national regulations as well as any applicable local or regional regulations.

Appendix D.
EM-80/-300 Driver Power Redundant Application

Introduction

This appendix covers the specific application when a power redundancy design is implemented. That is, primary power is 3-phase and the backup power is single-phase. In normal operation, primary power is supplied to the EM-80/-300 Driver. Backup power is only used in case primary power fails. The switchover should occur with no loss of actuator control. During switchover, the inrush current may increase. Implementing an additional inrush current limiter can be done at the discretion of the customer.

Operation

The EM-80/-300 Driver contains internal NTC (Negative Thermal Coefficient) thermistors to limit the inrush current from the power supply to an acceptable level. The NTC thermistors are high resistance when cool and low resistance when hot. The NTC thermistors can be hot during normal operation. During power switchover, 3-phase power to the EM-80/-300 Driver is switched quickly to single-phase power, often in less than 150 ms.

Potential Issue

Typically, the NTC thermistors internal to the EM-80/-300 Driver will be hot from normal operation and are in a low-resistance state. Also, a significant load on the motor output could require additional current during the 150 ms switchover time. Thus, the switchover from 3-phase power to single-phase can result in a high inrush current manifesting in an internal bridge rectifier failure.

Solution

Woodward provides an Inrush Current Limiter (ICL) assembly to reduce the unwanted current surge during the switchover from 3-phase power to single-phase. It consists of two main functions:

- A module containing NTC thermistors to limit inrush current after switchover from 3-phase to single-phase
- Three external NTC thermistors to limit inrush current when switching back from single-phase to 3-phase

After the switchover, relay contacts within the ICL assembly are actuated in approximately 200 ms to jumper the NTC thermistors to preclude heating. It is important to recognize that switching from single-phase back to 3-phase operation is also critical. Therefore, a 3-minute wait period is recommended to sufficiently cool all NTC thermistors of the ICL assembly (both ICL Module and NTC Terminal Block) before switching back to primary power.

Conclusion

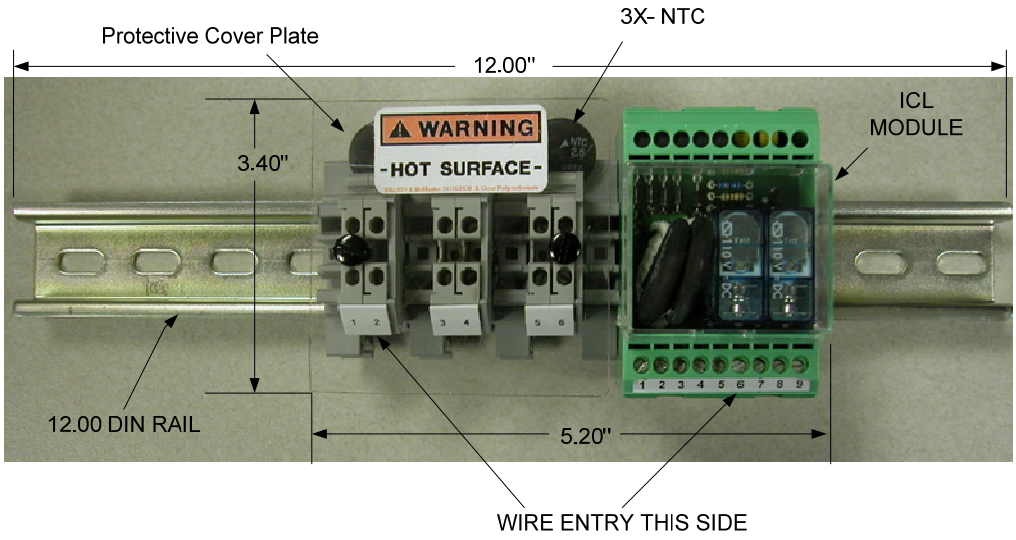
The ICL assembly uses NTC thermistors to limit the inrush current to provide safe switched operation during the single-phase power switchover. The ICL assembly cools the NTC thermistors after switchover. The external NTC thermistors of the ICL assembly are designed to reduce the 3-phase inrush current when switching back from single-phase to 3-phase.

NOTICE

Woodward recommends that end users implement a 3-minute wait period whenever switching 3-phase power to off. This ensures a sufficient amount of time for the NTC thermistors internal to the EM-80/-300 Driver to cool.

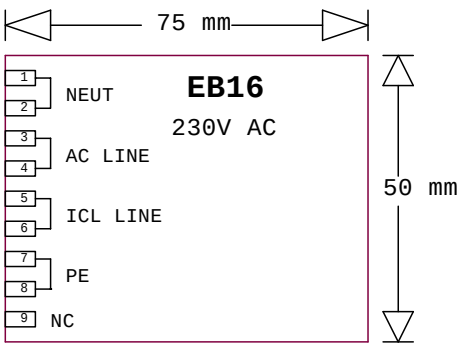
ICL Assembly Module

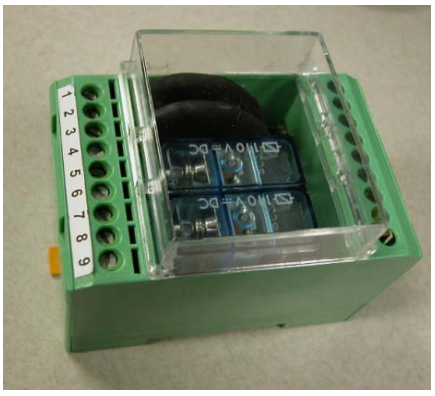
(Woodward Part Number 5466-1081)



Module Identification

Woodward Part Number:	1751-6572
Description:	Inrush Current Limiter (ICL) Module
Dimensions (L x W x H):	(75 x 50 x 60) mm
	DIN Rail Mounting
	Fits 35 mm DIN Rail Type





Electrical

Operating Voltage Range:	240 V (ac)
Operating Temperature Range:	(0 to 45) °C

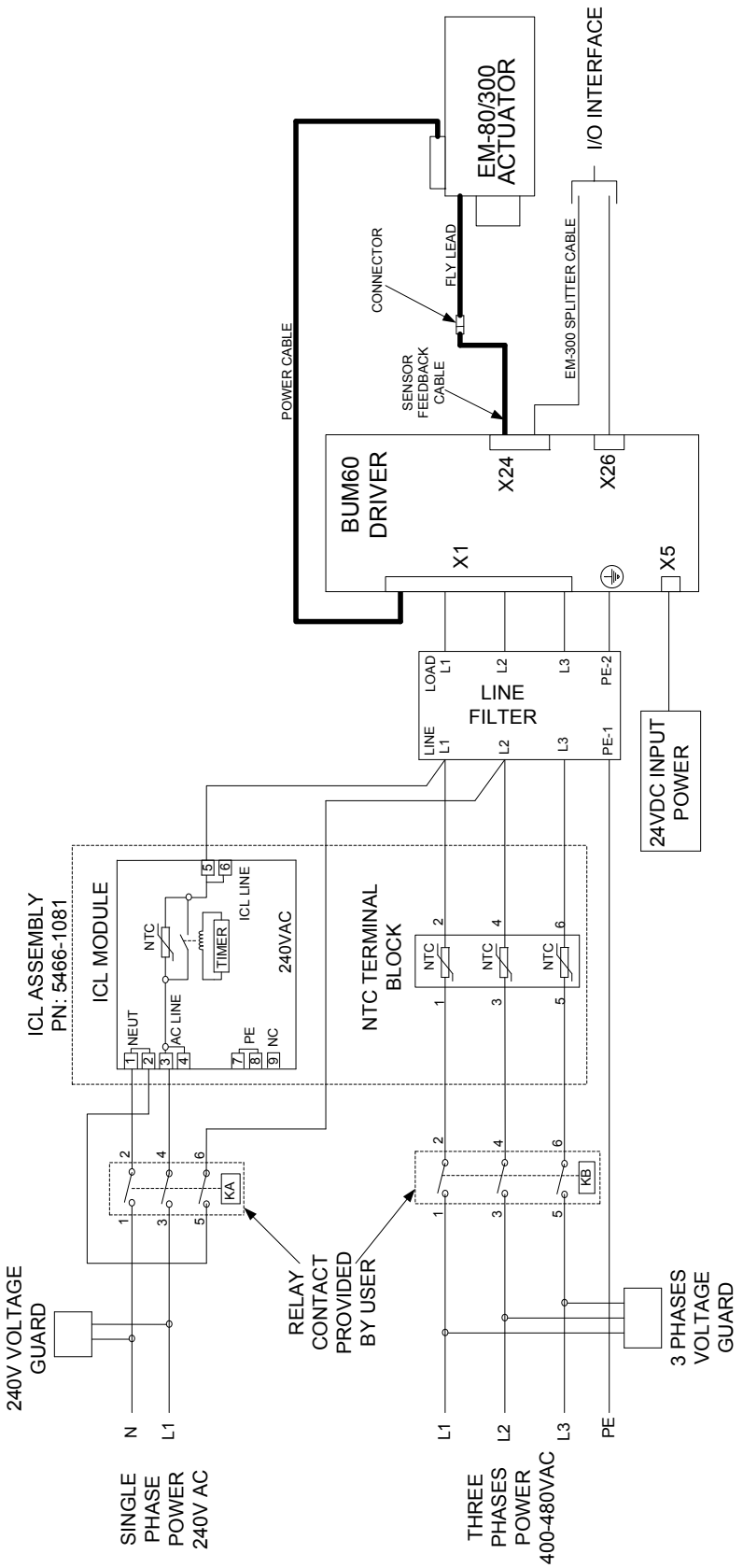


Figure D-1. Wiring Diagram

ICL Assembly Installation Instructions

(Woodward Part Number 5466-1081)

⚠WARNING

Serious personal injury or death, or property damage, can result if the following precautions are not observed:

- **The power to EM-80/-300 Driver must be completely off.**
- **Local safety procedures must be followed.**
- **Only qualified personnel must carry out the installation.**

⚠WARNING

The owner is responsible for the installation of the ICL Assembly in accordance with the safety regulations of the authority having jurisdiction. You must ensure that all relevant national and local regulations are met with regard to operator access, wire and cable ratings, protection, grounding, disconnects and overcurrent protection.

The following instructions are provided for a power redundant system field installation only. These instructions may not apply to end users who do not use the EM-80/-300 driver in a power redundant application.

Allow adequate space around the ICL Assembly unit for servicing and cable routing. Allow 50 mm (2 inches) free space between the NTC surface area and any cable or other object.

1. Mount the ICL Assembly (part number 5466-1081) into the cabinet.

2. The layout relay contacts (KA and KB) in Figure 1 are provided by the end user.

Install the wiring to ICL Assembly (ICL Module and NTC Terminal Block) according to the wiring diagram in Figure 1.

Before Applying Power

Carefully check all cable wiring to ensure proper connection before applying any power to the system.

⚠WARNING

Failure to follow this procedure may result in serious personal injury or death, or property damage.

Revision History

Changes in Revision G—

- Updated Compliance information (UL, Low Voltage Directive, Marine; and Baumüller certificate)

Changes in Revision F—

- Updated Compliance information (added ABS)
- Added new Declaration of Incorporation

Changes in Revision E—

- Emergency Shutdown clarification added to 24 Vdc Power Supply and Installation sections
- Explanation expanded for Monitoring the Auxiliary Voltage Supply section

Declarations

CE

EG-Konformitätserklärung

gemäß

- Richtlinie 2006/95/EG (betreffend elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen)

Hersteller

Baumüller Nürnberg GmbH
Ostendstr. 80 - 90
90482 Nürnberg
Deutschland
Tel. +49 9 11 54 32 - 0
Fax: +49 9 11 54 32 - 1 30
E-Mail: mail@baumueller.de
Internet: www.baumueller.de

Hiermit erklären wir, dass die nachfolgend genannten Produkte aufgrund ihrer Konzeption, Konstruktion und Bauart in der von uns in Verkehr gebrachten Ausführung den Anforderungen der oben genannten Richtlinie einschließlich der zum Zeitpunkt der Erklärung geltenden Änderungen entsprechen.

Hinweise:
1. Bei Umbau oder Änderungen am Produkt verliert diese Erklärung mit sofortiger Wirkung ihre Gültigkeit.
2. Diese Erklärung bescheinigt die Übereinstimmung mit der genannten Richtlinie / den genannten Richtlinien, stellt aber keine Zusicherung von darüber hinausgehenden Produkteigenschaften dar.

Angewandte harmonisierte Normen:

- DIN EN 60034-1:2005-04
  Drehende elektrische Maschinen – Teil 1: Bemessung und Betriebsverhalten
- DIN EN 60034-5:2007-09
  Drehende elektrische Maschinen – Teil 5: Schutzarten aufgrund der Gesamtkonstruktion von drehenden elektrischen Maschinen (IP-Code) – Einteilung

(fortgesetzt)

EU-Declaration of Conformity

according to

- Directive 2006/95/EC (relating to electrical equipment designed for use within certain voltage limits)

Manufacturer

Baumüller Nürnberg GmbH
Ostendstr. 80 - 90
90482 Nürnberg
Deutschland
Tel. +49 9 11 54 32 - 0
Fax: +49 9 11 54 32 - 1 30
E-Mail: mail@baumueller.de
Internet: www.baumueller.de

We declare, that the products referred to in the following are conformant in their concept, in their construction and in their design as launched by us with the above mentioned directive and their respective changes which were valid at the point of declaration.

Notes:
1. By modifying or alterating the device(s) this declaration immediately becomes invalid.
2. This declaration confirms the compliance with the directive listed, but it is no covenant of any further product properties.

Applied harmonised standards:

- DIN EN 60034-1:2005-04
  Rotating electrical machines – Part 1: Rating and performance
- DIN EN 60034-5:2007-09
  Rotating electrical machines – Part 5: Degree of protection provided by the integral design of rotating electrical machines (IP code) – Classification

(continued)

(abgeschlossen)

- DIN EN 60034-6:1996-08
  Drehende elektrische Maschinen – Teil 6:
  Einteilung der Kühlverfahren (IC-Code)
- DIN EN 60034-9:2008-01
  Drehende elektrische Maschinen – Teil 9:
  Geräuschgrenzwerte
- DIN EN 60034-14:2008-03
  Drehende elektrische Maschinen – Teil 14:
  Mechanische Schwingungen von bestimmten Maschinen mit einer Achshöhe von 56 mm und höher – Messung, Bewertung und Grenzwerte der Schwingstärke
- DIN EN 61800-5-1:2008-04
  Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 5-1:
  Anforderungen an die Sicherheit – Elektrische, thermische und energetische Anforderungen

(finished)

- DIN EN 60034-6:1996-08
  Rotating electrical machines – Part 6:
  Methods of cooling (IC-Code)
- DIN EN 60034-9:2008-01
  Rotating electrical machines – Part 9:
  Noise limits
- DIN EN 60034-14:2008-03
  Rotating electrical machines – Part 14:
  Mechanical vibration of certain machines with shaft heights 56 mm an higher – Measurement, evaluation and limits of vibration severity
- DIN EN 61800-5-1:2008-04
  Adjustable speed electrical power drive systems – Part 5-1:
  Safety requirements – Electrical, thermal and energy

Produkt / Product	Jahr der erstmaligen Ausstellung der CE- Konformitätserklärung Year in that the CE Declaration of Conformity was issued the first time
DS 3 phase AC Servomotors DS (x)(x)-xxx-x-x-x	1997

Nürnberg, 27. 04. 2009

i.V. Peter Lemke
Entwicklungsleiter Motoren
Director Development Motors

ppa. Willi Bruckner
Werksleitung Baumüller Nürnberg GmbH, Werk Kitzingen
Plant manager Baumüller Nürnberg GmbH, plant Kitzingen

be in motion be in motion be in motion

BAUMULLER

www.baumueller.com

EG – Konformitätserklärung

Dok.-Nr.: 5.13007.00
Datum: 12.03.2013

- Original -

gemäß EMV Richtlinie 2004/108/EG und Niederspannungsrichtlinie 2006/95/EG

Hiermit erklärt der Hersteller: Baumüller Nürnberg GmbH
Ostendstraße 80-90
90482 Nürnberg, Deutschland,

dass das nachstehende Produkt:

Bezeichnung: BUS 60X – X – X – 54 – X – XXX
BUM 60X – X – X – 54 – X - XXX
Typ: Leistungsmodul BUS 60 / Einzel-Leistungseinheit BUM 60
ab Herstelldatum: 12.03.2013

in Übereinstimmung mit der EMV Richtlinie 2004/108/EG und der Niederspannungsrichtlinie 2006/95/EG entwickelt, konstruiert und gefertigt wurde.

Angewandte harmonisierte Normen:

Norm	Titel
DIN EN 62061:2010-05	Sicherheit von Maschinen – Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme
DIN EN 61800-5-1:2008-04	Drehzahlveränderliche elektrische Antriebe – Teil 5-1: Anforderungen an die Sicherheit - Elektrische, thermische und energetische Anforderungen
DIN EN 61800-5-2:2008-04	Drehzahlveränderliche elektrische Antriebe – Teil 5-2: Anforderungen an die Funktionale Sicherheit
DIN EN 61800-3:2005-07	Drehzahlveränderliche elektrische Antriebe – Teil 3: EMV-Anforderungen einschließlich spezieller Prüfverfahren

Die Einhaltung der Richtlinien setzt den korrekten Einbau der Produkte und die Beachtung aller Hinweise und Sicherheitshinweise in der zugehörigen Betriebsanleitung voraus.

Nürnberg / 12.03.2013
Ort / Datum

Norbert Scholz
Geschäftsführer

i.V. Heinrich März
Entwicklungsleiter Elektronik

be in motion be in motion be in motion

BAUMULLER

www.baumueller.com

EC – Declaration of Conformity

Doc.-No.: 5.13007.00
Date: 12.03.2013

- Original -

according to EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC

The Manufacturer: Baumüller Nürnberg GmbH
Ostendstraße 80-90
90482 Nürnberg, Deutschland

declares, that the product:

Designation: BUS 60X – X – X – 54 – X – XXX
BUM 60X – X – X – 54 – X - XXX

Type: Power module BUS 60 / Mono power unit BUM 60

Manufactured since: 12.03.2013

is developed, designed and manufactured in accordance with the EMC Directive 2004/108/EC and the Low Voltage Directive 2006/95/EC.

Applied harmonized standards:

Standard	Title
DIN EN 62061:2010-05	Safety of Machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
DIN EN 61800-5-1:2008-04	Adjustable speed electrical power drive Part 5-1: Safety requirements - Electrical, thermal and energy
DIN EN 61800-5-2:2008-04	Adjustable speed electrical power drive Part 5-2: Safety requirements - Functional
DIN EN 61800-3:2005-07	Adjustable speed electrical power drive Part 3: EMC requirements and specific test methods

The products must be installed correctly and all notes and safety notes of the referring instruction handbook must be complied with, to guarantee the compliance to the guidelines.

Nürnberg / 12.03.2013
Place / date

Norbert Scholz
Managing Director Sales

i.V. Heinrich März
Director Development Electronic

Thomatronik GmbH
Brückenstraße 1
D-83022 Rosenheim
Telefon (0 80 31) 21 75 - 0
Telefax (0 80 31) 21 75 30
www.thomatronik.de

Konformitätserklärung
Declaration of Conformity
Declaration de Conformité

Wir We Nous	IIE Ingenieurbüro für Industrieelektronik Karolinenstrasse 32a
Anschrift Address Adress	83109 Großkarolinienfeld Germany

erklären in alleiniger Verantwortung, daß das Produkt
declare under our sole responsibility, that the product
declarons sous notre seule responsibilité, que le produit

Bezeichnung/ Name/ Nom	Einschaltstromdämpfung
Typ,Modell,Artikel-Nr., Größe Type,Model, Article No.,Taille Type, Modèle, Mo.d'Article,Taille	EB16P
Seriennummer Serial No. Mo.d'Article	3xxx

mit den Anforderungen der Normen und Richtlinien
fulfills the requirements of the standard and regulations of the Directive
satisfait aux exigences des normes et directives

RICHTLINIE 2004/108/EG DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 15. Dezember 2004 zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit

DIN EN 61000-6-1; VDE 0839-6-1:2007-10 Elektromagnetische Verträglichkeit (EMV) - Teil 6-1: Fachgrundnormen - Störfestigkeit für Wohnbereich, Geschäfts- und Gewerbebereiche sowie Kleinbetriebe (IEC 61000-6-1:2005); Deutsche Fassung EN 61000-6-1:2007
DIN EN 61000-6-3; VDE 0839-6-3:2007-09 Elektromagnetische Verträglichkeit (EMV) - Teil 6-3: Fachgrundnormen - Störaussendung für Wohnbereich, Geschäfts- und Gewerbebereiche sowie Kleinbetriebe (IEC 61000-6-3:2006); Deutsche Fassung EN 61000-6-3:2007

RICHTLINIE 2006/95/EG DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 12. Dezember 2006 zur Angleichung der Rechtsvorschriften der Mitgliedstaaten betreffend elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen

DIN EN 60950-1; VDE 0805-1:2006-11 Einrichtungen der Informationstechnik - Sicherheit - Teil 1: Allgemeine Anforderungen (IEC 60950-1:2005, modifiziert); Deutsche Fassung EN 60950-1:2006

übereinstimmt und damit den Bestimmungen entspricht.
corresponds to the regulations of the Directive.
correspond aux règlement de la Directive.

15.07.2009

Ort und Datum
Place and Date of Issua
Lieu et date d'établissement

Name und Unterschrift des Befugten
Name and Signature of authorized person
Nom et signature de la personne autorisée

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

Manufacturer's Name:	WOODWARD INC	
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525	3800 N. Wilson Ave. Loveland, CO, USA 80538
Model Names:	EM-80/300 Actuator and Driver	
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	
Applicable Standards:		

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

Suhail Horan
Signature

Suhail Horan
Full Name

Quality Manager
Position

Woodward Inc, Loveland, CO, USA
Place

28-Feb-2012
Date

5-09-1182 (REV. 10) 00283-04-EU-MD-02-03

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 36173G.

B36173:G

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.