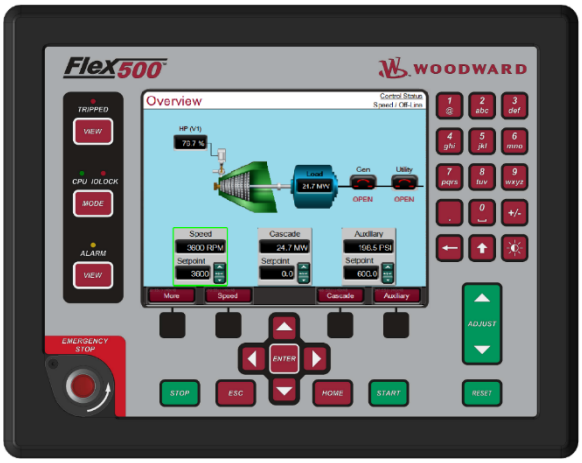
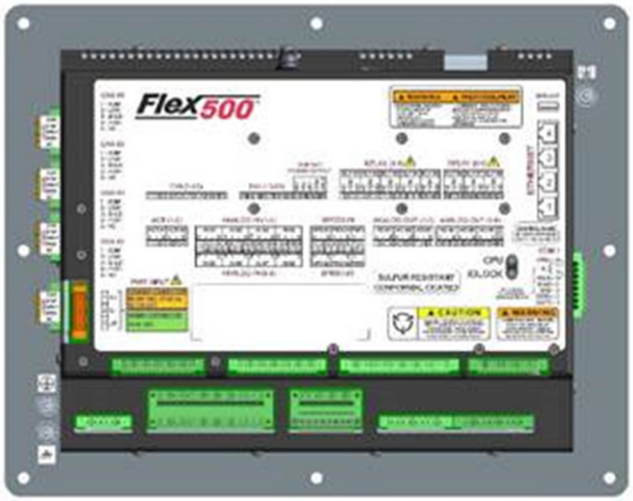
Released

WOODWARD

Product Manual 26838
(Revision F, 03/2022)
Original Instructions





Flex500 Digital Control

Panel Mount
Bulkhead Mount

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

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The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

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

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 26838

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Important Definitions

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

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

⚠WARNING

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

NOTICE

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

NOTICE

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

⚠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

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

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

IOLOCK. When a CPU or I/O module fails, watchdog logic drives it into an IOLOCK condition where all output circuits and signals are driven to a known de-energized state as described below. Design the System such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.

- **CPU and I/O module failures will drive the module into an IOLOCK state**
- **CPU failure will assert an IOLOCK signal to all modules and expansion racks to drive them into an IOLOCK state.**
- **Discrete outputs / relay drivers will be non-active and de-energized**
- **Analog and Actuator outputs will be non-active and de-energized with zero voltage or zero current.**

The IOLOCK state is asserted under various conditions including

- **CPU and I/O module watchdog failures**
- **Power Up and Power Down conditions.**
- **System reset and hardware/software initialization**
- **Entering configuration mode**

NOTE: Specify additional watchdog details and any exceptions to these failure states in the related CPU or I/O module section of the manual.

⚠CAUTION

Emergency Disconnecting Device

An emergency switch or circuit breaker shall be included in the building installation that is in close proximity to the equipment and within easy reach of the operator. The switch or circuit breaker shall be clearly marked as the disconnecting device for the equipment. The switch or circuit breaker shall not interrupt the Protective Earth (PE) conductor.

⚠CAUTION

Risk of Calibration and Checkout

Authorized personnel knowledgeable of the risks posed by live electrical equipment should only perform the calibration and checkout procedure.

⚠CAUTION

Fuse Power Supply Mains

Properly fuse the Power Supply MAINS according to the NEC/CEC or Authority Having Final Jurisdiction per the Input Power Specifications.

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.

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*.

Regulatory Compliance

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking. Refer to DoC for applicability by part number.

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

ATEX – Potentially Explosive Atmospheres Directive: Declared to Directive 2014/34/EU on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.
Zone 2, Category 3, Group II G, Ex ic nA IIC T4 X Gc IP20

Low Voltage Directive: Declared to Directive 2014/35/EU on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.

Other European and International Compliance:

IECEx: Ex ic nA IIC T4 Gc T4 Certificate: IECEx CSA 15.0020X
IEC 60079-0: 2011 – Explosive Atmospheres – Part 0 Equipment General Requirements
IEC 60079-11: 2011 – Explosive Atmospheres – Part 11 Equipment Protection by Intrinsic Safety “i”
IEC 60079-15: 2010 – Explosive Atmospheres – Part 15: Equipment protection by type of protection “n”

RoHS Directive: Restriction of Hazardous Substances 2011/65/EU:
Woodward Turbomachinery Systems products are intended exclusively for sale and use only as a part of Large Scale Fixed Installations per the meaning of Art.2.4(e) of directive 2011/65/EU. This fulfills the requirements stated in Art.2.4(c) and as such the product is excluded from the scope of RoHS2.

North American Compliance:
These listings are limited only to those units bearing the CSA identification.

Units bearing only the CSA identification are restricted for use only in Ordinary Locations in North America.

Units bearing the CSA identification in addition to the marking indicating Class I, Div 2, Groups A, B, C and D are acceptable for use in North American Hazardous Locations.

CSA: CSA Certified for Class I, Division 2, Groups A, B, C, & D, T4 at 70 °C surrounding air temperature. For use in Canada and the United States.
CSA Certificate 70006135
CSA Certificate 70217045

This product is certified as a component for use in other equipment. The final combination is subject to acceptance by the authority having jurisdiction or local inspection.

Marine Compliance:

Lloyd’s Register of Shipping: LR Type Approval Test Specification No. 1, July 2013; Environmental Categories ENV1, ENV2 and ENV3

DNV-GL Temperature Class D, Humidity Class B, Vibration Class A, EMC Class A, Enclosure; Required protection according to the Rules shall be provided upon installation on board.

Lloyd’s: Type Approval Conditions

Where this controller is used to perform safety critical functions or system Shutdowns, a valid Lloyd's Register Software Conformity Assessment Certificate Is required. Where the controller is used for control and alarm purposes, a separate, independent safety system must be provided.

Installation of this equipment for marine applications is to be in accordance with current Lloyd's Register Rules and Regulations.

Radiated and conducted emissions meet the requirement for equipment in the general power distribution zones.

DNV-GL: Type Approval Conditions
The Type Approval covers hardware listed under Product description. When the hardware is used in applications to be classed by DNV, documentation for the actual application is to be submitted for approval by the manufacturer of the application system in each case. Reference is made to DNV Rules for Ships Pt. 4 Ch. 9 Control and Monitoring Systems.

Product Certificate
If specified in the Rules, ref. Pt. 4 Ch. 9 Sec. 1, the control and monitoring system in which the above listed hardware is used shall be delivered with a product certificate. For each such delivery the certification test is to be performed at the manufacturer of the application system before the system is shipped to the yard. The test shall be done according to an approved test program. After the certification the clause for application software control will be put into force.

Clause for application software control
Record all changes in software as long as the system is in use on board. Forward the records of all changes to DNV for evaluation and approval. Verify approved major changes in the software before installing the software in the computer.

Application/Limitation
Ex-certification is not covered by this certificate. Application in hazardous area to be approved in each case according to the Rules and Ex-Certification/Special Conditions for Safe Use listed in valid Ex-certificate issued by a notified/recognized Certification Body.

Special Conditions for Safe Use

The Flex500 Digital Control as well as the FTM shall not be installed in areas exceeding Pollution Degree 2 as defined in IEC 60664-1 and Overvoltage Category II.

The controls containing a LCD and Keypad must be mounted in a vertical position with air vents located at the top and bottom of the unit. The Bulkhead mount control can be mounted in a vertical or horizontal position. Regardless of the mounting orientation, the air temperature surrounding the control cannot exceed 70˚C.

A fixed wiring installation is required. Field wiring must be in accordance with North American Class I, Division 2 (CEC and NEC), or European Zone 2, Category 3 wiring methods as applicable, and in accordance with the Local Inspection Authority having jurisdiction. On high voltage versions of the control the interior of the enclosure shall not be accessible in normal operation without the use of a tool.

A switch or circuit breaker shall be included in the building installation that is in close proximity to the equipment and within easy reach of the operator. The switch or circuit breaker shall be clearly marked as the disconnecting device for the equipment. The switch or circuit breaker shall not interrupt the Protective Earth (PE) conductor.

Field wiring must be suitable for the following temperatures:
- Power Input rated minimum of +95˚C.
- All remaining connections; +10˚C above highest ambient temperature.

Protective Earth Grounding of the Flex500 Digital Control connection to the PE terminal is required.

Hazardous Locations

The Low Voltage ATEX Flex500 Digital Control is suitable for use in Class I, Div 2, Gas, Groups A, B, C and D & European Zone 2, Group IIC environments

The risk of electrostatic discharge is reduced by permanent installation of the Flex500, proper connection of the equipotential ground lugs, and care when cleaning. Verify that the area is non-hazardous prior to the device being cleaned or wiped off.

The Real Time Clock Battery located on the CPU board is not to be recharged and is not user replaceable. Contact a Woodward Authorized Service Center if replacement service is needed.

The controls with an LCD and Keypad must be installed in an area or enclosure providing adequate protection against high impact. (4 Joules and 7 Joules) The control is rated for 2 Joules impact.

The Flex500 Bulkhead control must be installed in an area or enclosure that protects the control from any impact.

ATEX/IECEx locations require that the Flex500 Control with a keypad and display be installed in a cabinet or enclosure coded Ex nA or Ex e that provides a minimum IP54 ingress protection per IEC 60529 for the rear of the control. The front bezel, keypad and display have been tested and are rated IP54 while the rear of the control is rated IP20 due to the ventilation slots required for heat dissipation. The installer shall ensure that the maximum surrounding air temperature in the enclosure does not exceed the rated temperature of +70˚C.

The Flex500 Bulkhead Control without the front panel display or keyboard must be installed in a cabinet or enclosure coded Ex nA or Ex e that provides a minimum IP54 ingress protection per IEC 60529. The installer shall ensure that the maximum surrounding air temperature in the enclosure does not exceed the rated temperature of +70˚C.

Transient Protection for the Flex500 is to be provided externally by the end user at the supply terminals of the control. The transient protection device is to be set at a level not exceeding 140% of the maximum rated peak voltage of 36Vdc.

⚠WARNING

Explosion Hazard

For ATEX/IECEx installation compliance, the input voltage shall be limited to 36 Vdc. When selecting an external power supply to supply the Control, it shall be ATEX/IECEx approved for Zone 2 Group IIC, Category 3G Applications.

⚠WARNING

Explosion Hazard

Due to the Hazardous Location Listings associated with this product, proper wire type and wiring practices are critical to the operation.

⚠WARNING

Explosion Hazard

ENCLOSURE REQUIREMENT—
ATEX/IECEx Zone 2, Category 3G applications require the final installation location provide a minimum IP-54 ingress protection enclosure against dust and water per IEC 60529. The enclosure must be coded Ex nA or Ex e.

⚠WARNING

Explosion Hazard

Do Not Remove Covers or Connect/Disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous

⚠WARNING

Explosion Hazard

Substitution of components may impair suitability for Class 1, Division 2, or Zone 2.

⚠WARNING

Explosion Hazard

Properly connect the external ground lugs shown on the installation drawing to ensure equipotential bonding. This will reduce the risk of electrostatic discharge in an explosive atmosphere. Perform cleaning by hand or water spray while the area is non-hazardous to prevent an electrostatic discharge in an explosive atmosphere.

⚠WARNING

Explosion Hazard

MOUNTING
Controls containing a LCD and Keypad must be mounted in a vertical position. The installer shall ensure the maximum surrounding air temperature of the control does not exceed 70˚C at the final location.

⚠WARNING

Explosion Hazard

Class I, Div 2 Groups A, B, C, D and Zone 2, Group IIC applications require the input voltage to the relay contacts not exceed 32Vac rms or 32Vdc.

⚠AVERTISSEMENT

Risque d'explosion

Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous situez bien dans une zone non-explosive.

⚠AVERTISSEMENT

Risque d'explosion

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2 et/ou Zone 2.

⚠AVERTISSEMENT

Risque d'explosion

Ne pas utiliser les bornes d'essai du block d'alimentation ou des cartes de commande à moins de se trouver dans un emplacement non dangereux.

Safety Symbols


Direct Current


Alternating Current


Both Alternating and Direct Current


Caution, risk of electrical shock


Caution, refer to accompanying documents


Protective conductor terminal


Frame or chassis terminal

Chapter 1.
General Information

Introduction

The Flex500 Digital Control is a real-time, deterministic turbine controller that is available with or without an integrated HMI display. Enhanced communication options for Serial, Ethernet, and CAN are key features for improved networking and I/O expansion. Controller I/O may be easily expanded into rugged environments using CAN and Woodward RTCnet and LinkNet-HT nodes.

Flex500P versions are panel mounted and include a color graphical display that has the capability of customization to unique turbine, OEM, and customer requirements.

Table 1-1. Flex500P Part Number Options

Part Number	Power
8200-1340	LVDC (18-36 Vdc) Ordinary Location Compliance
8200-1341	AC/DC (88-264 Vac or 90-150 Vdc) Ordinary Locations Compliance
8200-1342	Marine/ATEX Compliance LVDC (18-36 Vdc)
8200-1343	LVDC (18-36 Vdc) Dual Redundant Version, Ordinary Location Compliance
8200-1344	AC/DC (88-264 Vac or 90-150 Vdc), Dual Redundant Version, Ordinary Location Compliance

Flex500B is a bulkhead-mounted version of the Flex500. Configured without a display, the Flex500B is ideal for remote environments.

Table 1-2. Flex500B Part Number Options

Part Number	Power
8200-1350	LVDC (18-36 Vdc) Ordinary Location Compliance
8200-1351	AC/DC (88-264 Vac or 90-150 Vdc) Ordinary Locations Compliance
8200-1352	Marine/ATEX Compliance LVDC (18-36 Vdc)
8200-1353	LVDC (18-36 Vdc) Dual Redundant Version, Ordinary Location Compliance
8200-1354	AC/DC (88-264 Vac or 90-150 Vdc), Dual Redundant Version, Ordinary Location Compliance

Product Highlights

- Designed for real-time, deterministic control
- Designed for easy expansion with Woodward RTCnet / LinkNet HT nodes
- Plug-N-Play integration with Woodward GAP software and RateGroups

Features

- Operating temperature range of –30 °C to +70 °C (with display)
- Operating temperature range of –40 °C to +70 °C (without display)
- Input power options for Low Voltage (24VDC) and High Voltage (AC/DC)
- Real-time I/O with deterministic and synchronous updates of 5 ms to 160 ms
- Isolated communication ports for Ethernet, CAN, and RS232/485
- CAN ports support Woodward valves and I/O nodes (RTCnet / LinkNet-HT)

A Flex500 Digital Control system using RTCnet / LinkNet-HT distributed I/O nodes and with Woodward's GAP programmed software provides a powerful control environment. Woodward's unique RateGroup structure ensures that control functions execute with determinism at intervals defined by the System Engineer. GAP allows critical control loops to be processed as fast as 5 milliseconds while less critical

code is assigned to a slower execution rate like 160 ms. The RateGroup structure prevents the possibility of changing system dynamics when adding additional code so the control functions are always deterministic and predictable.

Flex500 Digital Control provides control configuration, diagnostics, and monitoring through standard Woodward interface and GAP tools like Monitor GAP and SOS OPC server.

The FLEX500 controller can be designed to be a redundant system by using 2 units, refer to Appendix A for detail.

Flex500 Product Family

Figure 1-1. Flex500P Digital Control (With Display)

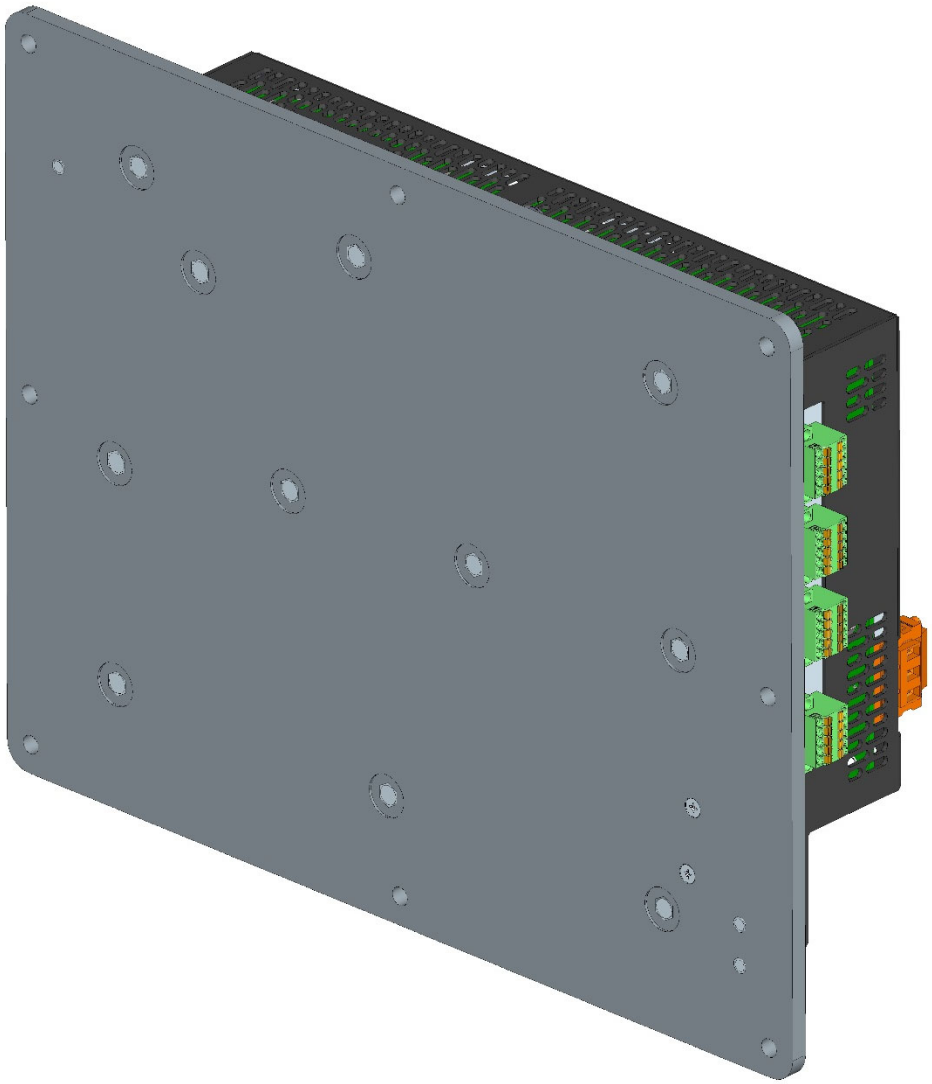


Figure 1-2. Flex500B Digital Control (Without Display)

Chapter 2.
Installation

Introduction

This chapter provides the basic installation guidance for mounting location selection, installation, and wiring of the controller, including hardware dimensions, ratings, and requirements for mounting and wiring the control in a specific application.

Shipping Carton

Before unpacking the Flex500, refer to the inside front cover and page VI of this manual for WARNINGS and CAUTIONS. Be careful when unpacking the Control. Check for signs of damage such as bent or dented panels, scratches, and loose or broken parts. If you detect any damage, immediately notify the shipper.

The Control ships from the factory in an anti-static foam lined carton. Use this carton for transportation or storage when the Controller is separate from the system.

General Installation

When selecting a location for mounting the Control, consider the following:

- Protect the unit from direct exposure to water or to a condensation-prone environment.
- The control design is ideal for installation in a protective metal enclosure such as a standard cabinet with ingress protection rating of IP54 or greater for Hazardous locations.
- For best airflow, mount the Flex500 in a vertical orientation with ventilation slots at the top and bottom of the control.
- Provide an ESD strap or other discharge methods as ESD mitigation inside the cabinet; it must be used for handling the equipment and plugging/unplugging the connectors.
- Provide adequate ventilation for cooling. Mount in a location that is able to maintain an ambient operating temperature within the range of rated maximum and minimum ambient temperatures. Shield the unit from radiant heat sources as needed to maintain ambient temperature within the rated range.
- Do not install the unit or its connecting wires near inductive, high-voltage, or high-current devices. If this is not possible, shield both the system connecting wires and the interfering devices and/or its wires.
- Allow adequate space around the unit for airflow, servicing, and wiring.
- Do not install where damage may occur from objects dropped on the terminals or inside the unit.
- Use the chassis ground lugs with a large a gage wire to Earth Ground the unit for proper safety and shielding effectiveness. Recommend use of the power input ground wire, especially when installed in noisy, high corrosion, or high vibration environments.

General Wiring Guidance

IMPORTANT **Terminal block wiring must use multi-stranded wires to provide best results.**

IMPORTANT

Do not tin (solder) the wires that terminate at the node terminal blocks. The spring-loaded CageClamp or screw down terminal blocks is designed to flatten stranded wire, and if those strands are tinned together, the connection loses surface area and is degraded. The solder tinned wire end will also cold flow over time potentially further degrading or break the connection.

⚠WARNING

CAN NETWORKS. It is possible to disrupt an existing CAN network by attaching an improperly configured device.

Shielded Wire, Shield Termination Lead Preparation

Where shielded cable is required, cut the cable to the desired length, and prepare the cable as instructed below.

1. Strip outer insulation from both ends, exposing the braided or spiral wrapped shield. Do not cut the shield or nick the wire inside the shield.
2. Using a sharply pointed tool carefully spread the strands of the braided shield to form a hole.
3. Take hold of the inner conductor(s) wire's insulation and pull the wires out of the shield one at a time.
    a. If the shield is the braided type, twist the braid it to prevent fraying; twist it with the drain wire if one is present. Use as much of the shield braid and drain combined as possible to terminate the shield.
    b. Foil shields or shields of foil combined with braid require the drain to be brought out and excess foil may be removed.
4. Remove 6 mm (1/4 inch) of insulation from the inner insulated signal conductors.
5. Connect wiring and shield as shown in plant wiring diagram.
6. If a shield connection is not required or desired, fold back and secure or remove the excess shield as needed. (If there is a landing/connection point for the shield, it should be used to get optimal signal performance.)

General Wiring Installation

All signal lines except power supply, Discrete Input and Discrete Output, wiring should be shielded to prevent picking up stray signals from adjacent equipment. These may also be shielded if desired.

For noise suppression reasons, it is recommend that all low current and low voltage wires be separated from all high current and/or high-voltage wiring.

Recommend strain relief for cables as strain relief of cables is a wise practice.

Input power ground terminal, not power return, should also be wired/bonded to earth ground in applicable cases like environments that lead to corrosion or hazardous atmosphere environments.

All shielded cable must be twisted conductor pairs, triples or multiple pairs. The nodes are designed with AC (Capacitor) and direct shield terminations to earth ground at the cable landing points to facilitate shield termination.

Installations with severe electromagnetic interference (EMI) and maintaining electromagnetic compatibility (EMC) may require additional shielding precautions, such as wire run in conduit or double shielding. In general, the devices are designed with a level of immunity to EMI and to maintain EMC for the typical installation environment and added precautions are not needed. Contact Woodward for more information.

In general, terminate shields to their landing point on the terminal block. They may also be required to be landed/terminated at the opposite end.

Directly ground shields from the unit to its loads or input sources to earth at both ends, but only if the cable length is sufficiently short to prevent ground loop current in the shield. (E.g. Shields within a single cabinet or where the shortest straight-line distance between shield to chassis/earth connection points is no further than 10 m to 30 m apart).

If long cables are used where termination end point separations are greater than 10 to 30 m, and both shield ends must be terminated, a capacitor must be used at one end to terminate the shield to earth/chassis. The preferred point for the capacitor is at the remote end, but individual device sensitivity makes this a determinative process, to find the end most applicable to using it. Using a 0.01 µF, 1500 V, capacitor is typically sufficient.

If intervening terminal blocks are used in routing a shielded signal cable, the shield should be continued through the terminal block. If shield grounding is desired at the terminal block, it should be AC (capacitor) coupled to earth. It is suggested to limit the number of TB break points along the cabling between the field device end and node end to a minimum, zero would be best. In general, at least 39 inches (1 m) of cable with an intact shield should present between breaks in the shield. Daisy chained CAN drop cabling has an exception.

Avoid multiple, spread out, direct or high capacitance connections of a shield to earth. Multiple shielding connections imparts a risk of high levels of low frequency ground current, such as 50/60 Hz, flowing within the shield. If there are multiple connections made, add the impedance of them up and ensure it is much greater than safety grounds impedance required by local laws.

Shielding and Enclosure Installations: If the device is installed in a metal enclosure, as expected and intended by hazardous location installations, shielded I/O must be AC or DC terminated directly to the enclosure (earth ground) at the entry to the enclosure, as well as at the intended shield pins on the nodes.

As noted, shield termination can be a deterministic process. AC shield connections (capacitors) on shield I/O may be dictated at the node, instead of the direct earth connection provided. Typically, shields at signal inputs are connected directly to earth, and shields at signal outputs are AC-coupled to earth or floating. All shields from the nodes, except CAN are designed directly terminated to earth / chassis. See Woodward application notes 50532, *Interference Control in Electronic Governing Systems*, and 51204, *Grounding and Shield Termination,* for more information.

Specifics are in each individual installation section.

Chapter 3.
Hardware Specifications

Flex500 Description and Features

The Flex500 Digital Control is a real-time, deterministic turbine controller that is available with or without an integrated HMI display. Enhanced communication options for Serial, Ethernet, and CAN are key features for improved networking and I/O expansion. To expand Controller I/O use into rugged environments, use CAN and Woodward RTCnet and LinkNet-HT nodes.

Flex500P versions are panel mounted and include a color graphical display that has the capability of customization to unique turbine, OEM, and customer requirements.

Flex500B is a bulkhead-mounted version of the Flex500. Configured without a display, the Flex500B is ideal for remote environments.

Power Input
- (LV) input power: 18-36 Vdc input, isolated
- (HV) input power: 88-264 Vac / 90-150 Vdc, isolated

Communications
- (4) Ethernet 10/100 communication ports, isolated
- (4) CAN communication ports (1 Mbit), isolated
- RS-232/RS-485 port, isolated
- RS-232 Service port, isolated

I/O circuits
- GAP configurable update rates of 5 ms to 160 ms
- (4) Speed Sensor inputs (2 MPU and 2 Prox with Prox Power)
- (8) Analog input 4-20 mA channels (with Loop Power)
- (6) Analog output 4-20 mA channels
- (2) Actuator output channels (configurable 4-20 mA/20-200 mA)
- (20) Discrete input channels (with Contact Power)
- (8) Relay outputs (form-c)

I/O Expansion options using RTCnet / LinkNet-HT
- Refer to RTCnet / LinkNet-HT manual # 26640
- Analog Inputs (4-20mA), RTD inputs, Thermocouple inputs
- +24V Discrete Inputs, Discrete Outputs, Analog Outputs (4-20mA)

HMI
- 8.4” LCD Display (800x600) and Keypad (Flex500P)

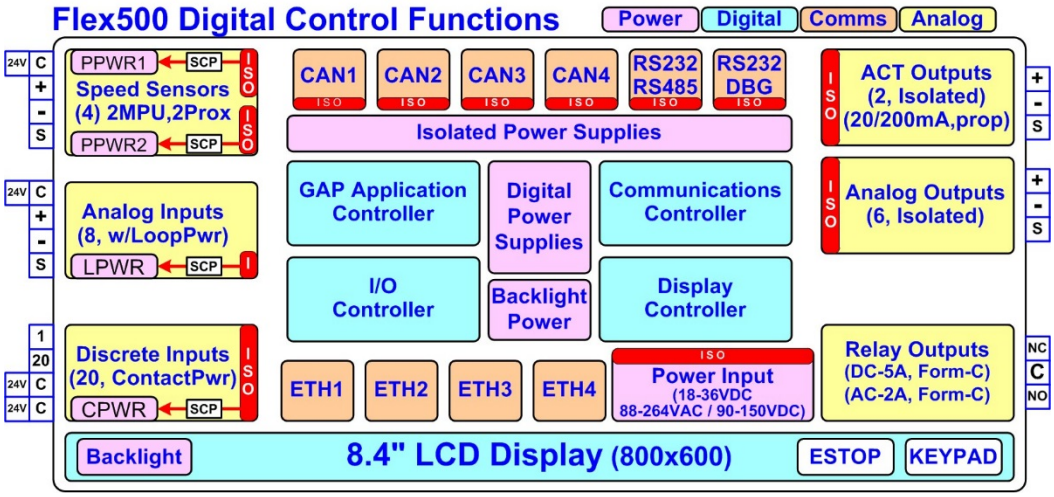


Figure 3-1. Functional Block Diagram (Flex500 Control)

Environmental Specifications

Table 3-1. Environmental Specifications

Operating Temperature[1]	Operating range of –30 °C to +70 °C (with display) (Flex500P) Operating range of –40 °C to +70 °C (without display) (Flex500B)
Storage Temperature	Recommended 10 °C to 40 °C (50˚F to 104˚F)
Vibration	Flex500P 8.2 Grms, industrial skid mount, per Woodward RV1 Flex500B 1.04 Grms control room per Woodward RV5
Shock[2]	10 G, 3x each axis, 11 ms Half Sine Pulse per Mil-STD 202F method 213B basic test J
Humidity[3,4]	5 % to 95 %, non-condensing
Altitude	3000m (9842 ft.) Maximum
Installation Rating	Pollution Degree 2, Overvoltage Category II
Conformal coating	Polyacrylate, sulfur resistant (see Applications Note #51530)
EMC Emissions[5]	EN 61000-6-4 (Heavy Industrial) IACS UR E10 (Commercial Marine)
EMC Immunity[5]	EN 61000-6-2 (Heavy Industrial) IACS UR E10 (Commercial Marine)
Ingress Rating	As shipped: IP-20 IP-56 when installed in an appropriate IP-56 or higher rated enclosure. (Non ATEX/IECEx Applications) IP-54 for ATEX/IECEx Applications when installed in an enclosure coded Ex nA and providing a minimum ingress protection rating of IP-54 as defined in IEC 60529.

[1]Limited by LCD display
[2]Limited by internal relay specification
[3]Relative humidity levels of < 55% will prolong LCD life
[4]Cyclic condensing humidity is supported with an appropriate enclosure
[5]Marine specification applies to the ATEX/Marine qualified unit

Maintenance Info and Recommendations

The Flex500 Digital Control design allows for continuous operation in a typical industrial environment and includes no components that require periodic service. However, to take advantage of related product software and hardware improvements, we recommend that you send your product to a Woodward Authorized Service Facility after every five to ten years of continuous service for inspection and component upgrades.

Clock battery

The Real Time Clock (RTC) battery is designed to last approximately 10 years during normal turbine operation. When powered, the RTC automatically disables the battery usage to preserve it. During power-off the battery is enabled and only used to maintain date and time. For long-term storage, the battery is specified to last > 5 years.

The RTC battery is a replaceable lithium coin cell Woodward PN 1743-1017. Contact a Woodward Authorized Service Center if a replacement service is needed.

Calibration and Functional verification

Recommend calibration verification and functional operation every 24-36 months. This is especially important for spare units that need to be ready for immediate use. Contact a Woodward Authorized Service Center for assistance.

Aluminum Electrolytic capacitors

Recommend to apply power to spare units every 24-36 months for 3 hours to reform the electrolytic capacitors used in the power module.

Display LCD with backlight

The Flex500 display version uses a low power LED backlight display with a life expectancy of 60K hours to half brightness, at maximum operating temperature. If the display appears dim, use the “SCREEN SETTINGS” menu to verify the brightness setting and adjust as needed with the ADJ ARROW-BRIGHTNESS keypad combination. When display damage or quality is unacceptable, contact a Woodward Authorize Service Center for a replacement display.

Electromagnetic Compatibility (EMC)

The Flex500 Digital Control family complies with Heavy Industrial EMC requirements per EN 61000-6-4 & EN 61000-6-2 specifications. Marine Type Approval is also met per IACS UR E10 EMC test requirements when a Marine qualified version is used.

Emissions EN 61000-6-4 & IACS UR E10

- Radiated RF Emissions Limits 150 kHz to 5000 MHz per IEC 61000-6-4 & Marine Type Approval.
- Power Line Conducted RF Emissions Limits 10 kHz to 30 MHz per IEC 61000-6-4 & Marine Type Approval.

Immunity EN 61000-6-2 & IACS UR E10

- Electrostatic Discharge (ESD) immunity to ±6 kV contact / ±8 kV air per IEC 61000-4-2.
- Radiated RF Immunity to 10 V/m from 80 MHz to 3000 MHz per IEC 61000-4-3.
- Electrical Fast Transients (EFT) Immunity to ±2.0 kV on I/O and Power Supply inputs per IEC 61000-4-4.
- Surge Immunity on DC Power Supply inputs to ±1.0 kV line to earth and ±0.5 kV line to line per IEC 61000-4-5.
- Surge Immunity on AC Power Supply inputs to ±2.0 kV line to earth and ±1.0 kV line to line per IEC 61000-4-5.
- Surge Immunity on I/O to ±1.0 kV line to earth per IEC 61000-4-5.
- Conducted RF Immunity to 10 V (rms) from 150 kHz to 80 MHz per IEC 61000-4-6.

- Conducted Low Frequency Injection Immunity at 10% of the nominal supply level from 50 Hz to 12 kHz on Power Inputs per Marine Type Approval test requirements.

Outline Drawing for Installation

See figures below for the physical outline dimensions for the Flex500 Digital Control. See Woodward Reference drawing 9989-3210 for additional details if necessary.

NOTICE

This Flex500 Digital Control has the identical mounting hole pattern as the older 505 and Atlas controls, however the holes do not come through the front of this unit; therefore mounting screws of correct length must be used.

Flex500P Panel Mounting information:

- There are 8 x 10-32 UNF-2B tapped holes to mount the Flex500.
- The holes are tapped to 0.312” min Depth. Choose the proper length screw to not exceed this depth into the Bezel.
- Use screw 1069-949 (.375 Long, 10-32) for panel thickness (including washers) .065” - .100"
- Use screw 1069-948 (.438 Long, 10-32) for panel thickness (including washers) .101”- .125”
- Use screw 1069-946 (.500 Long, 10-32) For panel thickness (including washers) .126” - .187”

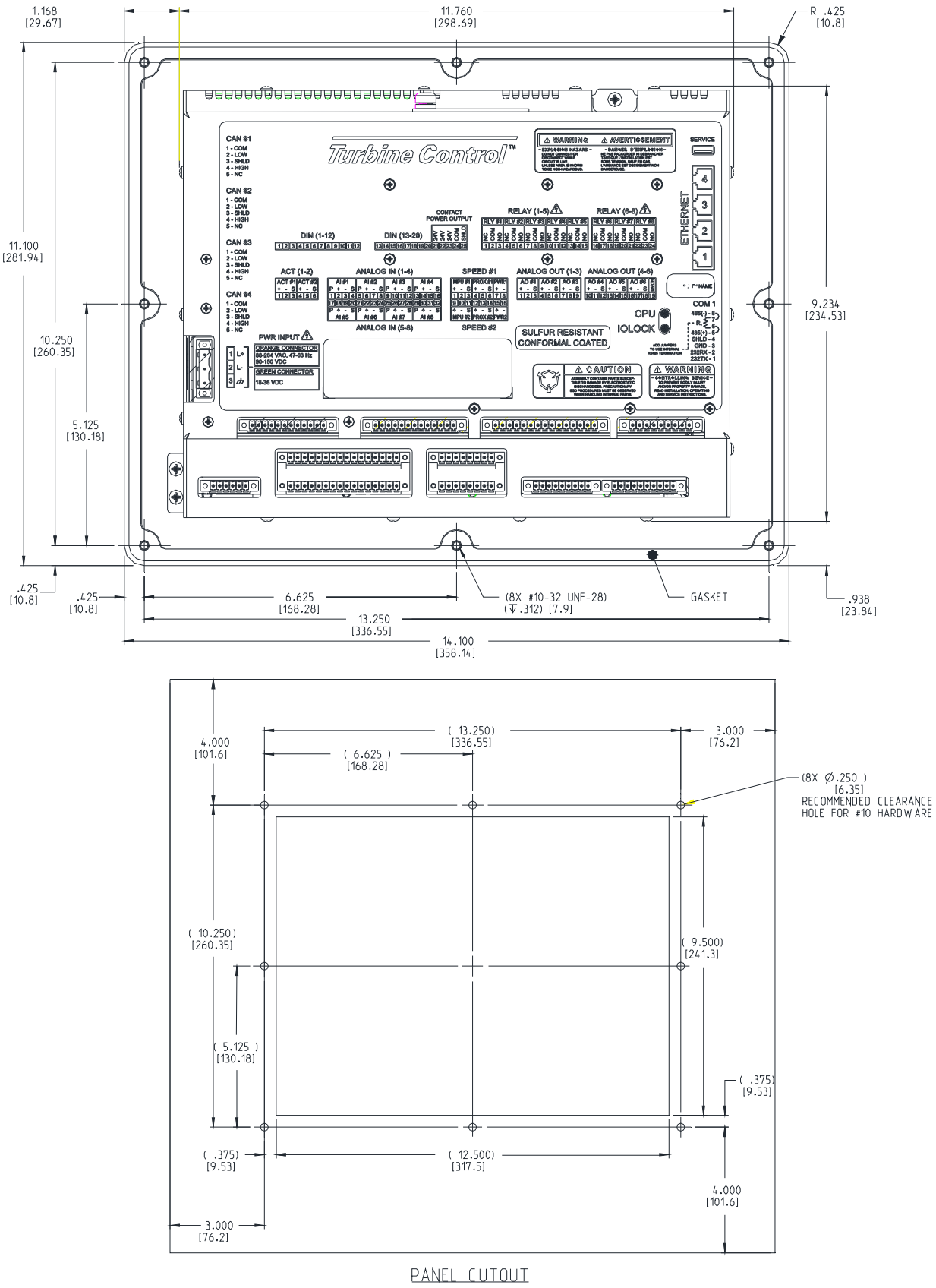
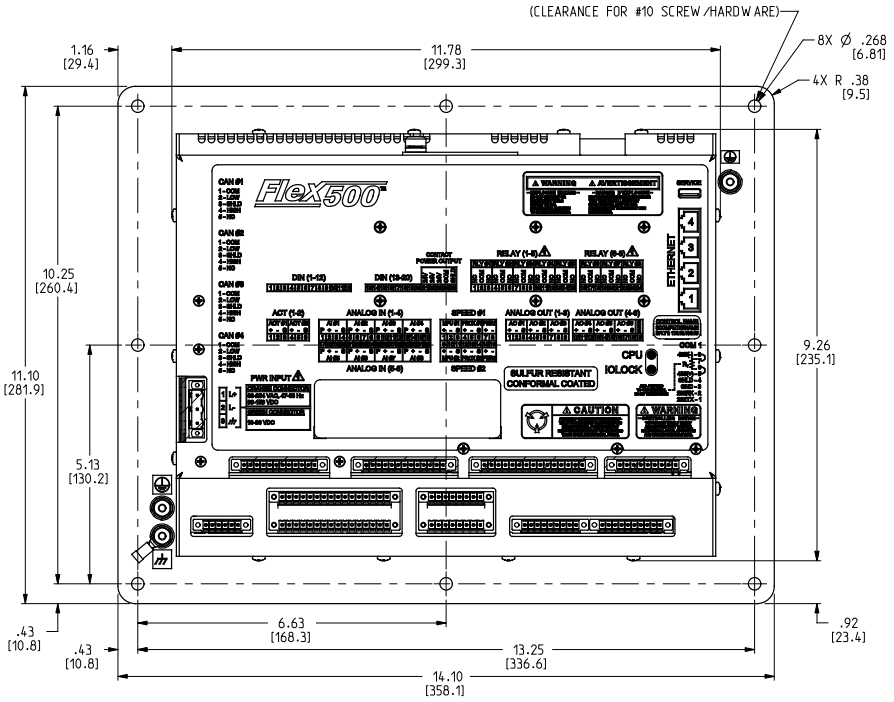


Figure 3-2. Flex500P Outline Drawing

Flex500B Panel Mounting information:

- There are 8x.268” diameter clearance holes for mounting the Flex500HL. The holes are for 8 x 10-32 bolts with a nut and washer to mount the unit.
- Use screw length 1069-955 (.750 Long, 10-32) for panel thicknesses .100” or less. This assumes using a .25” thick nut and two .062” thick washers to mount the unit.
- Use screw length 1031-1216 (.875 Long, 10-32) for panel thicknesses .101” i - .187”. This assumes using a .25” thick nut and two .062” thick washers to mount the unit.



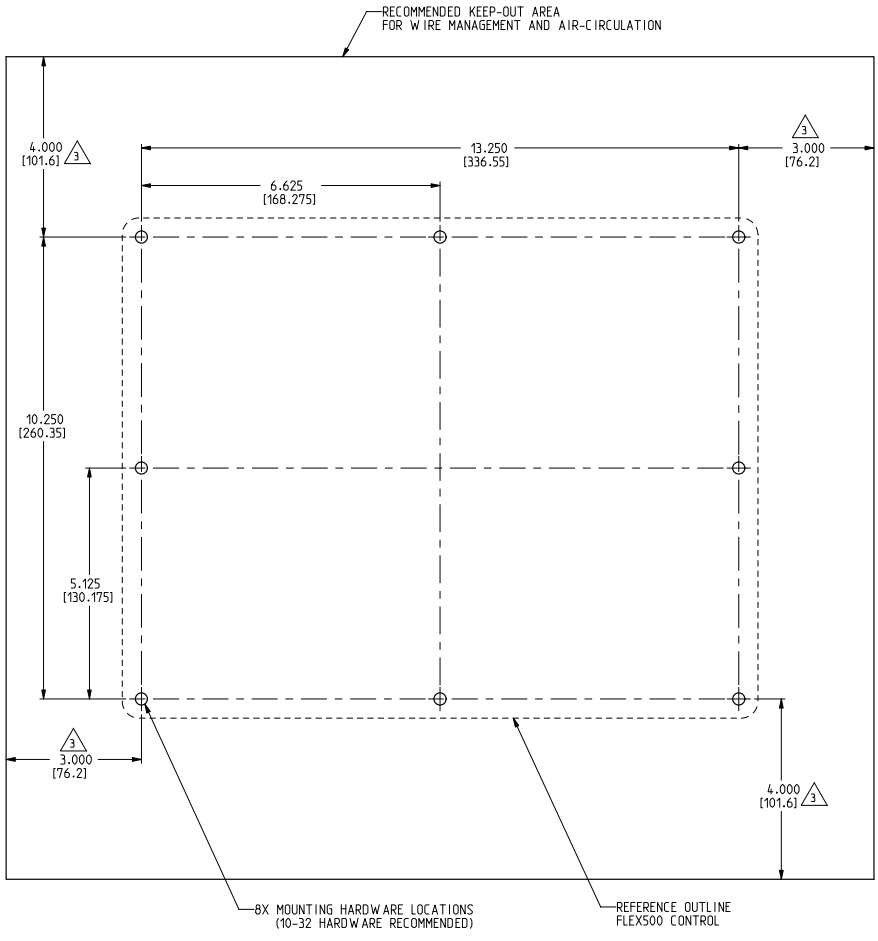


Figure 3-3. Flex500B Outline Drawing

Input Power Specification

Table 3-2. Specifications (LV)

LV Input Voltage range:	18-36 Vdc
Input Power (max):	< 77 W, 4.3 A max (Flex500P) < 71 W, (Flex500B)
Output Voltage Holdup time:	> 14 ms with 24 Vdc input voltage
Isolation to other circuits:	> 500 Vrms to all other circuits
Isolation to EARTH:	> 500 Vrms to EARTH
Input Overvoltage Protection:	±60 Vdc @ 25 °C
Reverse Polarity Protection:	60 Vdc @ 25 °C
Input Undervoltage shutdown:	~11 Vdc, non-latching

Note: Recommend breaker or power-line fusing of 8 A min to protect the power-wiring network from possible wiring shorts.

Table 3-3. Specifications (HV)

HV Input Voltage range:	88-264 Vac / 90-150 Vdc
HV Input Frequency range:	47-63 Hz
Input Power (AC max):	< 73 W, 1.6 A max (Flex500P) < 67 W, 1.5 A max (Flex500B)
Input Power (DC max):	< 73 W, 0.8 A max (Flex500P) < 67 W, .75 A Max (Flex500B)
Output Voltage Holdup time:	> 30 ms with 110 Vac input voltage
Output Voltage Holdup time:	> 120 ms with 220 Vac input voltage
Isolation to other circuits:	> 3000 Vrms to all other circuits
Isolation to EARTH:	> 1500 Vrms to EARTH
Input Overvoltage Protection:	±375 Vdc @ 25 °C
Reverse Polarity Protection:	375 Vdc
Input Undervoltage Shutdown:	~65 Vdc, non-latching

Note: Recommend breaker or powerline fusing of 3.5 A min to protect the power-wiring network from possible wiring shorts.

Power Connector

Input Power is provided through a three-position, latching terminal block with removable plug. Green connectors are used for low voltage DC units. Orange connectors are used for high voltage AC/DC units.

Table 3-4 Input Power Connector Pinout

Board Connection	PIN	Name	Description
	1	L+	Input Power (+)
	2	L-	Input Power (–)
	3	EARTH	Earth / shield connection
Plug Type: Side entry 7.62 mm, 12 A, pluggable with latching screw down			

⚠WARNING

Electric Shock

To reduce the risk of Electrical Shock the Protective Earth (PE) must be connected to the PE ⏚ terminal on the enclosure. The conductor providing the connection must have a properly sized ring lug and wire gauge equal to or larger than 4mm² (12AWG).

Visual Indicators (LED's) & CPU Configuration

Visual indicators are located on the Front Panel keypad, the controller board, back cover, and related communications ports for diagnostic use.

CPU OK indicator (green/red):
This bi-color LED indicates the CPU status is operational (green) or faulty (red). The CPU will flash fault codes (red) if they exist. This LED exists on both the Front Panel and back cover.

IOLOCK indicator (red):
Indicate the controller is shutdown and held in an IOLOCK state. This LED exists on both the Front Panel and back cover.

ALARM indicator (yellow):
Viewable from the front panel and controlled by GAP software.

TRIPPED indicator (red):
Viewable from the front panel and controlled by GAP software.

Ethernet LED's:
(Green=link, Yellow=traffic) on each RJ45 connector indicate port status and operation.

CPU Hardware Configuration
The CPU Configuration Switch (S1) is reserved for future use and is not active at this time.

Communications (Ethernet)

There are four isolated RJ45 Ethernet Ports (10/100 Mbit/sec) available to the application software for system use. These ports are full duplex with auto crossover detection.

Features
- Interface standard: IEEE 802.3 (Ethernet)
- Port Isolation: 1500 Vrms to PS, EARTH, and all other circuits
- Control configuration using Woodward AppManager
- Control monitoring, trending, and datalog collection
- Control configuration of Ethernet IP addresses
- General communications such as Modbus master/slave
- Manage Configuration data and tunables with Control Assistant
- Network time setup and control (SNTP)

Network Configuration
Ethernet ports (ETH1-4) can be configured for the customer network as desired. See the on-site Network Administrator to define an appropriate I/P address configuration.

IMPORTANT

ETHERNET CABLES—Max cable length is 100 meters. To ensure signal integrity and robust operation, double shielded (SSTP) Cat5 Ethernet cables are required for customer installations. (Woodward PN 5417-394, 10 feet)

IMPORTANT

This module has been factory configured with fixed Ethernet IP addresses of

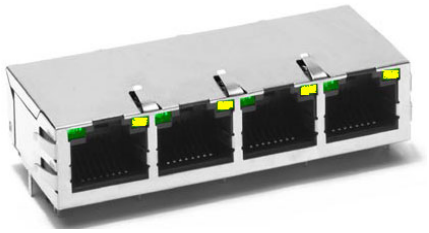
- **Ethernet #1 (ETH1) = 172.16.100.15, Subnet Mask = 255.255.0.0**
- **Ethernet #2 (ETH2) = 192.168.128.20, Subnet Mask = 255.255.255.0**
- **Ethernet #3 (ETH3) = 192.168.129.20, Subnet Mask = 255.255.255.0**
- **Ethernet #4 (ETH4) = 192.168.130.20, Subnet Mask = 255.255.255.0**

IMPORTANT

Each of the ETHERNET ports is required to be configured for a unique subnet (domain) (view default settings as an example).

Ethernet Connector (RJ45)

Table 3-5 Ethernet Ports #1-4 (10/100)

Board Connection	Description
	Pin 1 – TX+ Pin 2 – TX- Pin 3 – RX+ Pin 4 – not used Pin 5 – not used Pin 6 – RX- Pin 7 – not used Pin 8 – not used SHIELD = Chassis GND

Network Configuration Utility (AppManager)

Use Woodward's ***AppManager*** software to configure network setting and load Control software (GAP), HMI display software (QT), and operating system service packs. Download the *AppManager* utility from **www.woodward.com/software**.

A PC connection must be made to Ethernet #1 (ETH1) using a RJ45 Ethernet cable.

Note: Use AppManager to “discover/view” the current CPU IP Address, however, to modify settings or load applications, when the PC running. Reconfigure AppManager on the same “network” as the CPU.

- Locate the ControlName on the module faceplate and highlight it in *AppManager*.
- To VIEW the IP address configuration, select menu option CONTROL - CONTROL INFORMATION. Look for the Ethernet adapter addresses under the Footprint Description.
- To CHANGE the IP address configuration, select menu option CONTROL - CHANGE NETWORK SETTINGS.

Communications (CAN)

Four Isolated CAN ports are available for general communications as well as simplex or redundant distributed control. Compatible devices include Woodward RTCnet nodes, LINKnet HT nodes, DVP valve products, and other third party devices. Removable latching connector plugs are provided for field wiring.

Network Termination:

CAN networks must include a **120 Ω** termination resistor at each end of the trunk line.

Network Topology:

Recommend Daisy chain connections between multiple devices. Any drop cable connection of a device to the trunk line should be as short as possible and much less than six meters.
Recommend the network trunk design be less than 100 meters with a max cumulative drop length of less than 39 meters.

Important:

For one Mbit/sec communication it is required that each drop cable be less than one meter and as short as possible.

Table 3-6. CAN Specifications

Interface Standard	CAN 2.0B, CANopen
Network Connections	(4) CAN ports, separate connectors
Network Isolation	500 Vrms to EARTH, other CAN ports, all other I/O
Network Speed/Length	1 Mbit @ 30 m 500 Kbit @ 100 m 250 Kbit @ 250 m (thick cable only, otherwise limited to 100 m) 125 Kbit @ 500 m (thick cable only, otherwise limited to 100 m)
Network Termination:	(120 ± 10) Ω is required at each end of the network trunk line. **The termination resistor is NOT built into the hardware.
CAN Address	Software configurable
CAN Baud Rate	Software configurable for 125 K, 500 K, 250 K, and 1 Mbit
Cable / Part Number	2008-1512 (120 Ω, 3-wire, shielded twisted pair) —Belden YR58684 or similar
Cable Drops (1 Mbit)	CAN Cable drops shall be < 1 m and as short as possible
Cable Drops (500K, etc.)	CAN Cable drops shall be < 6 m and as short as possible

**If needed, an isolated CAN to USB converter is IXXAT, HW221245

Table 3-7. CAN Connector Pinout

Board Connection

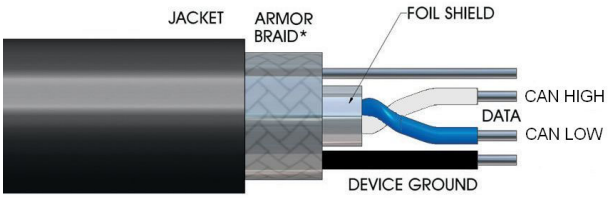
PIN	Color	Description
1	BLACK	CAN Signal Ground
2	BLUE	CAN Low
3	Shield	CAN Shield (30 Meg + AC coupled to EARTH)
4	WHITE	CAN High
5	n/a	Not used, no internal connection

Plug Type: Side entry 3.5 mm, 8 A, pluggable with latching screw down
Max wire size: 1.3 mm² / 16 AWG for single wires, 0.5 mm² / 20 AWG for two wires

CAN Cable Specifications

Belden YR58684 (Woodward PN 2008-1512) communications / CAN cable is approved and recommended. This is a smaller and more flexible 0.3 mm² / 22 AWG, low capacitance cable suitable for tight routing in industrial environments.

Table 3-8. Belden YR58684, bulk cable (Woodward PN 2008-1512)



Impedance:	120 Ω ±10 % at 1 MHz
DC resistance:	17.5 Ω per 1000 ft.
Cable capacitance:	11 pF/ft. at 1 kHz
Data Pair:	0.3 mm² / 22 AWG, 7 strands, individually tinned, FEP insulation (BLUE, WHITE twisted pair)
Ground:	0.3 mm² / 22 AWG, 7 strands, individually tinned, FEP insulation (BLACK)
Drain / Shield Wire:	0.3 mm² / 22 AWG, 7 strands, individually tinned
Shielding:	Foil 100 % with outer Braid 65 %
Jacket:	FEP Insulation, BLACK
Cable type:	1.5 pair, twisted shielded
Outer Diameter:	0.244 inch
Bend Radius:	2.5 inches
Temperature:	–70 °C to +125 °C
Similar Cable:	Belden 3106A (has different colors & lower temperature specs)

CAN Wiring / Shield Terminations & Limitations

For robust communications performance, the CAN cabling needs to minimize the exposed, non-shielded cable section that occurs at terminal blocks. The exposed length of CAN wiring must be limited to less than 3.8 cm / 1.5 inches from the end of the shield to the terminal block.

CAN shields are terminated to chassis (EARTH) through a capacitor-resistor network. This is designed into the Flex500 hardware products. However, the shield must also be directly terminated to chassis (Earth) at one point in the network. In the case of Woodward equipment, the direct ground is meant to be located at the master device end, as it exits the master device's enclosure.

IMPORTANT

Always use shielded cables for improved communications in industrial environments. Wire terminations should expose as little un-shielded cable as possible (less than 3.8 cm / 1.5 inches).

Communications (RS-232/RS-485)

An isolated, configurable RS-232/485 serial port is available for customer use, as configured by the GAP software application. RS-422 communications is NOT supported.

Specifications

- Interface standard: RS-232C and RS-485
- Isolation: 500 Vrms to EARTH and all other I/O
- Baud Rates: 19.2K, 38.4K, 57.6K, and 115.2 K
- Max Distance (RS-232): 15 m (50 feet) max
- Max Distance (RS-485): 1220 m (4000 feet) max
- A shielded cable is required when using this port.
- RS-485 networks require termination at both ends with approx. 90–120 Ω impedance that matches the characteristic impedance of the cable used.

Cable Note: Woodward cable 2008-1512 (3-wire) is a shielded, low capacitance 120-ohm cable that is designed for communications. This cable is also used for CAN communications.

Table 3-9. COM1 Serial Port Connector

Board Connection	Description
 (8 pins)	Pin 1 – RS-232 Transmit Pin 2 – RS-232 Receive Pin 3 – Signal Common Pin 4 – Shield (AC) Pin 5 – RS-485 (+) Pin 6 – Termination Resistor (+) Pin 7 – Termination Resistor (-) Pin 8 – RS-485 (-)

Plug Type: Side entry 3.5 mm, 8 A, pluggable with latching screw down
Max wire size: 1.3 mm² / 16 AWG for single wires, 0.5 mm² / 20 AWG for two wires

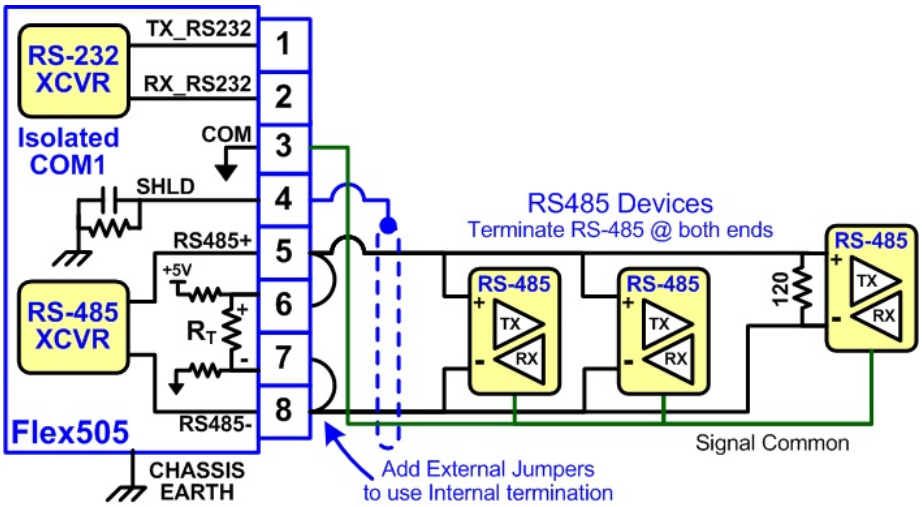


Figure 3-4. COM1 Example RS-485 wiring

Communications (Service Ports)

RS-232 Service Port

An isolated RS-232 service port is located on the CPU board. Isolation is specified at 500 Vrms and baud rate is fixed at **115.2K** baud, 8 data bits, no parity, 1 stop-bit, and no flow control. This port is for VxWorks operating system use only and cannot be configured for application software use.

For debug use, a **Woodward PN 5417-1344**, USB to serial debug cable is required to attach this port to a PC. Trained Field Service personnel use this port only!

Dura-Clik connector (male)
Pin 1 – RS-232 Transmit
Pin 2 – RS-232 Receive
Pin 3 – Signal Ground

Figure 3-5. CPU Service Port (3 pin, 2 mm)

USB Service Port

Note: Currently, a USB service port one of the service ports, but is disabled.

Hardware - Terminal Blocks & Wiring

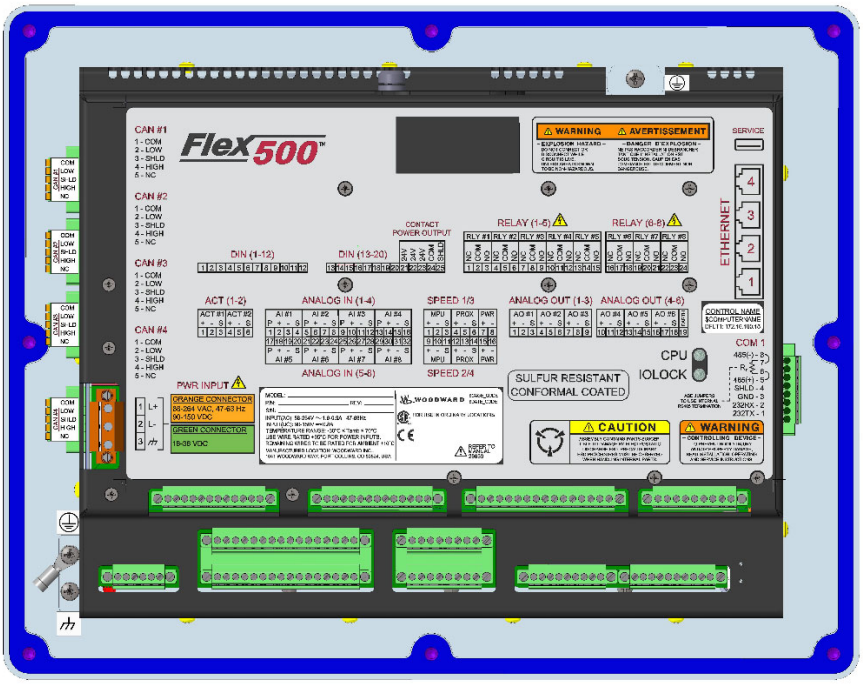


Figure 3-6. Flex500 Back Cover Label – Ordinary Location Compliance

Above back cover label is used in 8200-1340, 8200-1341 for Flex500P (panel-mounted version) and 8200-1350, 8200-1351 for Flex500B (bulkhead-mounted version).

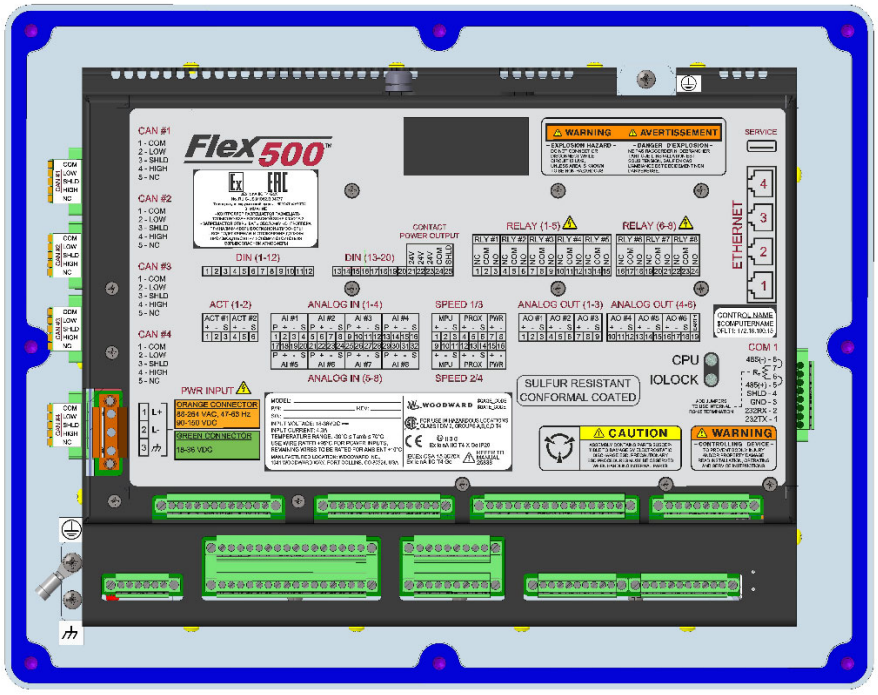


Figure 3-7. Flex500 Back Cover Label - Marine/ATEX Compliance

Above back cover label is used in 8200-1342 for Flex500P (panel-mounted version) and 8200-1352 for Flex500B (bulkhead-mounted version).

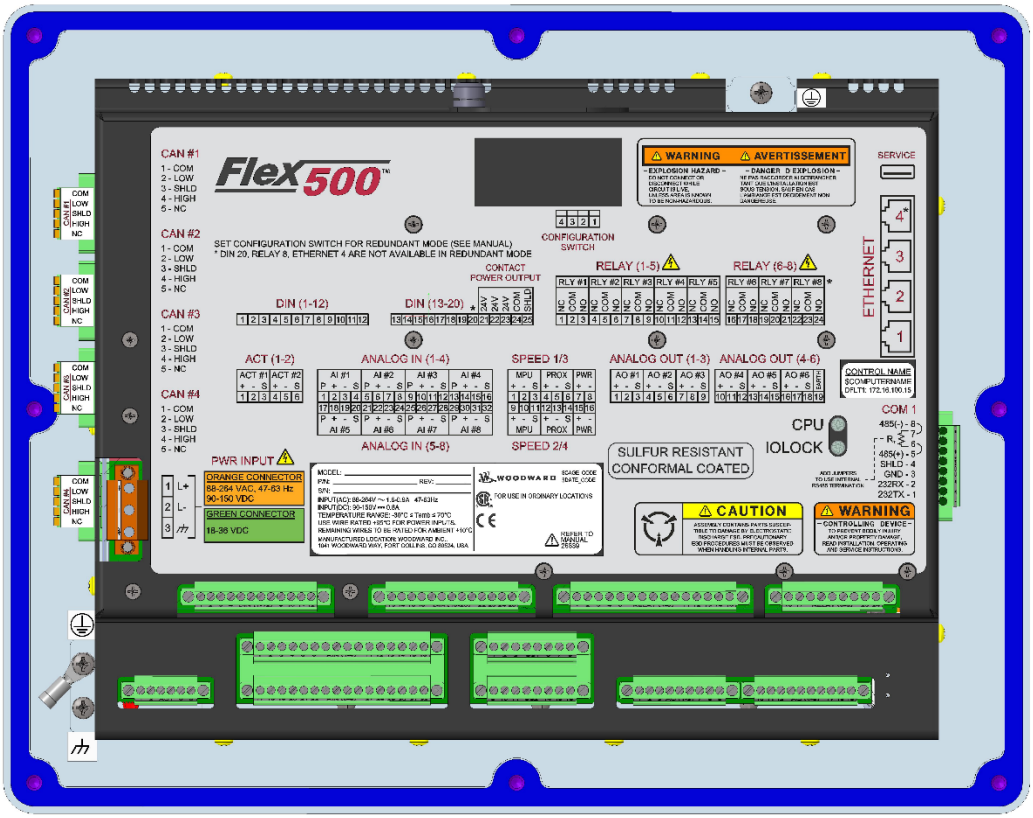


Figure 3-8. Flex500 Back Cover Label – Dual Redundant version (Ordinary Location Compliance)

Above back cover label is used in 8200-1343, 8200-1344 for Flex500P (panel-mounted version) and 8200-1353, 8200-1354 for Flex500B (bulkhead-mounted version).

Terminal Block Connectors

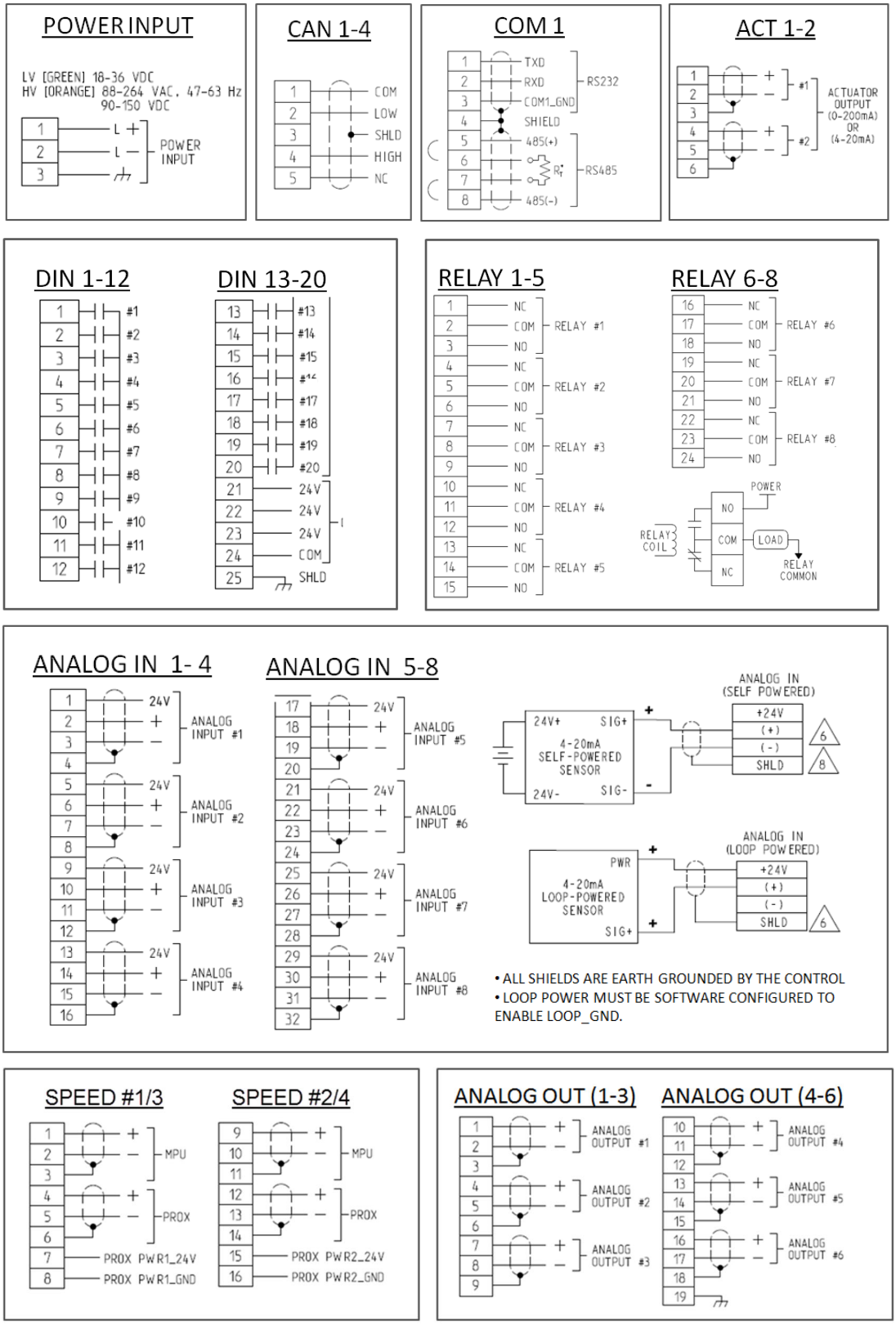


Figure 3-9. Flex500 Terminal Block Connectors

Hardware - Speed Sensor Inputs

This controller includes four Digital Speed Sensor circuits. Two circuits are capable of interfacing to MPU sensors and two circuits are capable of interfacing to Proximity speed probe sensors. The channels are isolated from each other. A dedicated and isolated, PROX power (+24 V) is provided on each channel for proximity sensor use.

Note: Do not use the Prox Power outputs to power any other type devices.

Features

- Four Digital Speed Sensor circuits, group isolated as MPU/Prox pair
- Two MPU sensors and two Proximity sensors
- Separate terminals provided for MPU and Prox sensors
- Isolated Prox Power (+24 Vdc) is provided with short-circuit protection
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms

Table 3-10. Specifications (MPU/PROX)

MPU Input Voltage:	1 to 35 Vrms
MPU Input Frequency:	10 Hz to 35 KHz
MPU Input Impedance:	2000 Ω, DC
MPU Input Isolation:	500 Vrms to EARTH and all other I/O 500 Vrms to other MPU and PROX channels
Prox Input Voltage:	0-32 VDC
Prox Input Frequency:	0.04 Hz to 35 KHz (low limit depends on range)
Prox Input Impedance:	
Prox Threshold:	Low is < 8 VDC High is > 16VDC
Prox Input Isolation:	500 Vrms to EARTH and all other I/O 500 Vrms to other MPU and PROX channels.
Prox Power1+2 out:	24 VDC ± 14%, 0-200 mA, short circuit & diode protected
Prox Power Isolation:	500 Vrms to EARTH, all other I/O, & other Prox Power
Max Speed Range:	software selectable from 5 kHz to 35 kHz
Accuracy (-40,70c):	< ±0.01% of full scale range selected
Resolution:	> 22 bits
Speed Filter (ms):	5-10,000 ms (2 poles)
Derivative Filter (ms):	5-10,000 ms (speed filter + 1 pole)
Derivative Accuracy:	0.1% of full scale range, over full temperature range
Acceleration limit:	1-10,000 %/sec

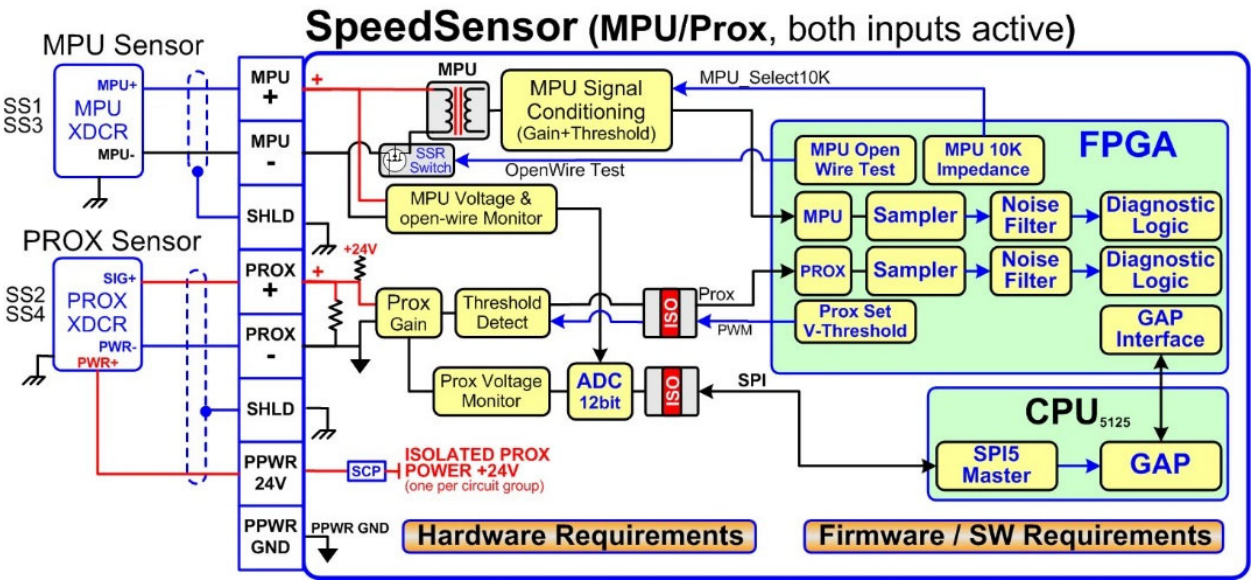


Figure 3-10. Speed Sensor Block Diagram

Hardware - Analog Inputs (4-20 mA)

AI Description and Features

The Flex500 Digital Controller includes eight 4–20 mA input channels for I/O monitoring and control. Each channel is differential (self-powered) but can be software configured for Loop Power mode. An Isolated Loop Power (+24 Vdc) is provided for analog input transducers and includes short-circuit/over-voltage protection.

Note: Do not use the Loop Power output to power any other type devices.

Features

- Eight 4–20 mA Analog Input Channels, 16 bit resolution
- Differential inputs with high common-mode voltage capability
- Isolated Loop Power +24 V is provided with short-circuit protection
- Fast AI channel #7 and #8 for special control functions
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms
- GAP configurable for Loop power operation

Table 3-11. Specifications (AI)

Number of channels	8
AI Input Range	0 to 24 mA
AI Input Isolation	0 V channel to channel. 500 Vrms to EARTH and all other I/O (except USB)
AI Accuracy (@ 25 °C)	≤ 0.024 mA (0.1% of FS=24 mA)
AI Accuracy (–40, +70 °C)	≤ 0.06 mA (0.25% of FS=24 mA)
AI Resolution	~16 bits of full scale
AI Hardware filter	2 poles @ ~10 ms **Fast channels (Ch. 7 & Ch. 8) have 2 poles @ ~5ms
AI Input Impedance	200 ohms (Rsense = 162 ohms)
AI Loop power output	24 V ±14% (0-250 mA) short circuit & diode protected
AI Loop power Isolation	500 Vrms to EARTH and all other I/O
AI CMRR over temp	> 70 dB @ 50/60 Hz (typical 86 db)
AI CMVR	> 200 V (dc) to EARTH
AI Overvoltage	±36 V (dc) continuous at room temperature

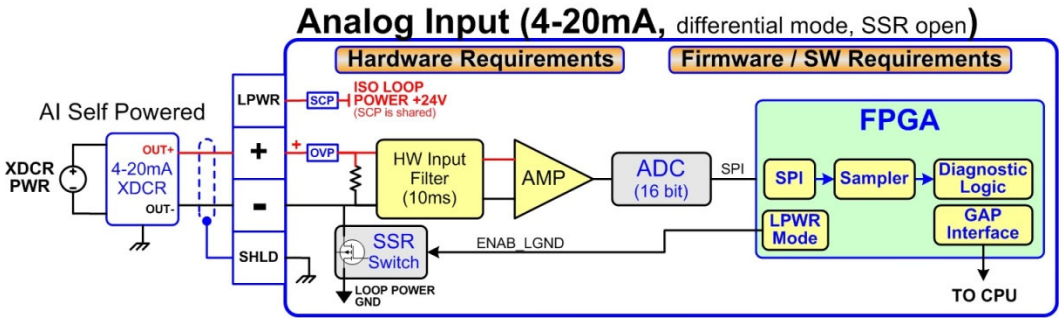


Figure 3-11. Analog Input – Self-Powered Block Diagram

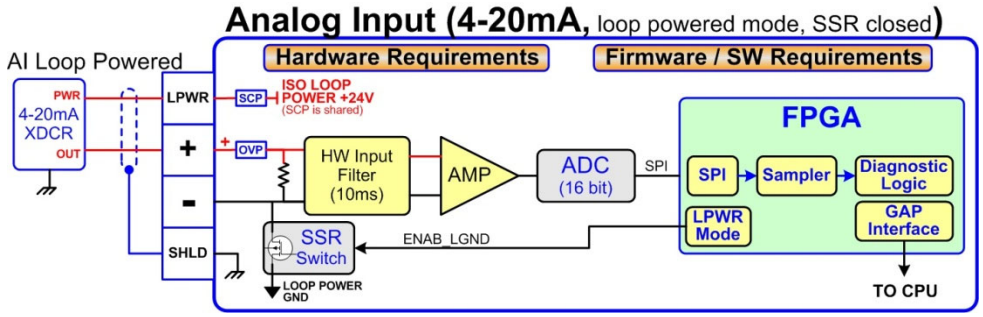


Figure 3-12. Analog Input – Loop-Powered Block Diagram

Hardware - Analog Outputs (4-20 mA)

This control provides an isolated group of six 4-20 mA outputs for customer use. Each output can drive up to 600-ohm loads and provides fault monitoring of individual source and return currents.

Features

- Six Analog Output channels (4-20 mA)
- Source and return current monitors
- Group isolated from other circuits
- Capable of driving higher impedance loads up to 600 ohms
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms

Table 3-12. Specifications (AO)

Number of channels	6 (each with readback)
AO Output Range	0 to 24 mA, 0 mA during shutdown
AO Output Isolation	0 V channel to channel 500 Vrms to EARTH and all other I/O
AO Accuracy (@ 25 °C)	≤ 0.024 mA (0.1% of FS=24 mA)
AO Accuracy (–40, +70 °C)	≤ 0.120 mA (0.5% of FS=24 mA)
AO Resolution	~14 bits of full scale
AO Hardware filter (max)	3 poles @ 250 µs
AO Load Capability	600 Ω at 20 mA
AO Output Readbacks	(0 to 24) mA, source and return
AO Readback Accuracy	< 1% at 25°C, < 3% over full temperature range
AO Readback HW Filter	~0.5 ms nominal
IOLOCK state	AO circuits are driven to 0 mA during power-up, power-down, core voltage failures, and watchdog failures

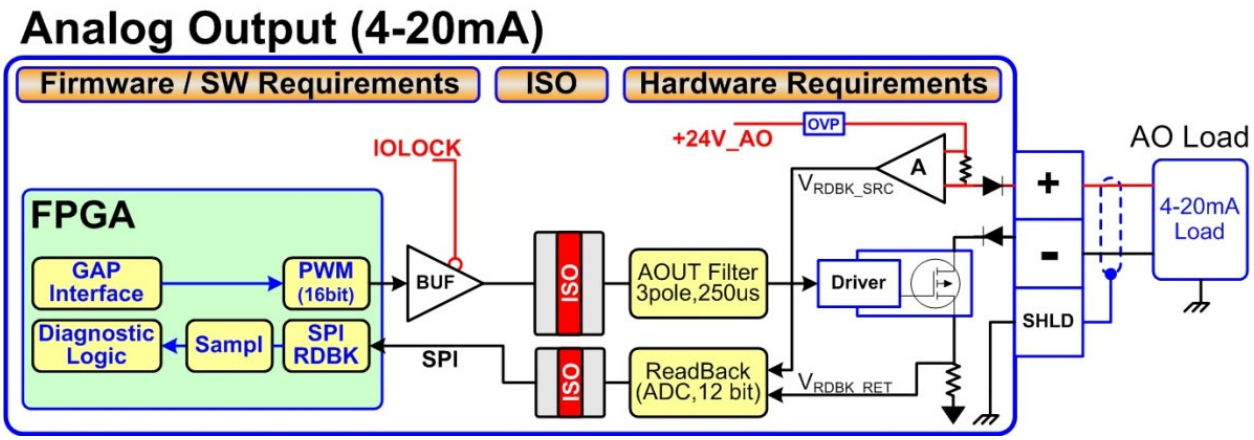


Figure 3-13. Analog Output Block Diagram

Hardware - Actuator Outputs

This control provides an isolated group of two Actuator outputs for customer use. Each driver can be configured for low-range (20 mA) or high-range (200 mA) operation. Fault monitoring of individual source and return currents is included.

Features

- Two Actuator Output channels (4-20 mA, 20-200 mA)
- Source and return current monitoring
- Group isolated from other circuits
- Capable of driving higher impedance loads
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms

Table 3-13. Specifications (ACT)

Number of channels	2 proportional drivers with source & return readbacks	
ACT Output Range	Configurable for 24 mA or 200 mA range	
ACT Output Range (low)	0-24 mA, 0 mA during shutdown (FS = 24 mA)	
ACT Output Range (high)	0-200 mA, 0 mA during shutdown (FS = 210 mA)	
ACT Output Isolation	0 V channel to channel 500 Vrms to EARTH and all other I/O	
ACT Accuracy (25 °C)	Low Range ≤ 0.024 mA (0.1%)	High Range ≤ 0.21 mA (0.1%)
ACT Accuracy (–40, +70 °C)	Low Range ≤ 0.120 mA (0.5%)	High Range ≤ 1.00 mA (0.5%)
ACT Resolution	~14 bits of full scale	
ACT Hardware filter (max)	3 poles @ 500 µs	
ACT Load Capability (low)	600 Ω at 20 mA	
ACT Load Capability (high)	65 Ω at 200 mA	
ACT Output Readbacks	(0 to 24) mA, source and return	
ACT Readback Accuracy	< 1% at 25°C, < 3% over full temperature range, (source & return)	
ACT Readback HW Filter	~0.5 ms nominal	
ESTOP action	Front panel ESTOP button will shutdown the actuator circuit, remove actuator power, and set an alarm in GAP software.	
IOLOCK action	During IOLOCK, ACT power is shutdown and ACT circuits are driven to 0 mA during power-up, power-down, core voltage failures, and watchdog failures.	

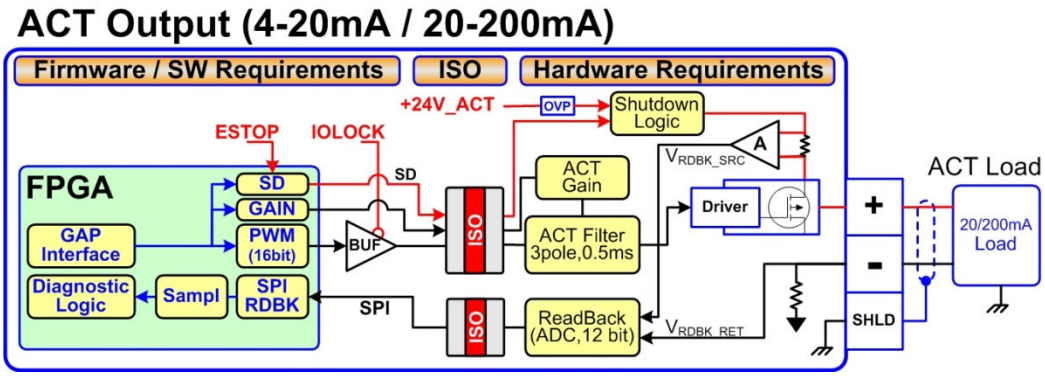


Figure 3-14. Actuator Output Block Diagram

Hardware - Discrete Inputs

This control provides an isolated group of 20 discrete input channels for use with +24 V (dc) signals. An isolated Contact Power voltage supply of +24 V (dc) is provided for use with the discrete inputs. This supply includes short-circuit and over-voltage protection.

Note: Do not use the Contact Power output to power any other devices.

Features

- 20 Discrete Input Channels for +24 V (dc) signals
- +24 V Contact Power with short-circuit and diode protection
- Isolated power and discrete input group
- Woodward GAP block, diagnostics, and configuration support
- GAP configurable update rates of 5 ms to 160 ms
- Time-stamping capability (1 ms)

Table 3-14. Specifications (DI)

Number of Channels	20
DI Input Low State	(0 to 8) V (dc)
DI Input High State	(16 to 32) V (dc)
DI Input Current	< 5 mA per channel
DI Input Impedance	25K approx
DI Hardware Filter	1.0 ms approx at room temp
DI Channel Isolation	0 V channel to channel 500 Vrms to EARTH and all other I/O
DI Overvoltage	Overvoltage to 36 V (dc) for inputs
Contact Power Output	24 V ±14 %, 150 mA (max), short circuit & diode protected
Contact Power Isolation	500 Vrms to EARTH and all other I/O

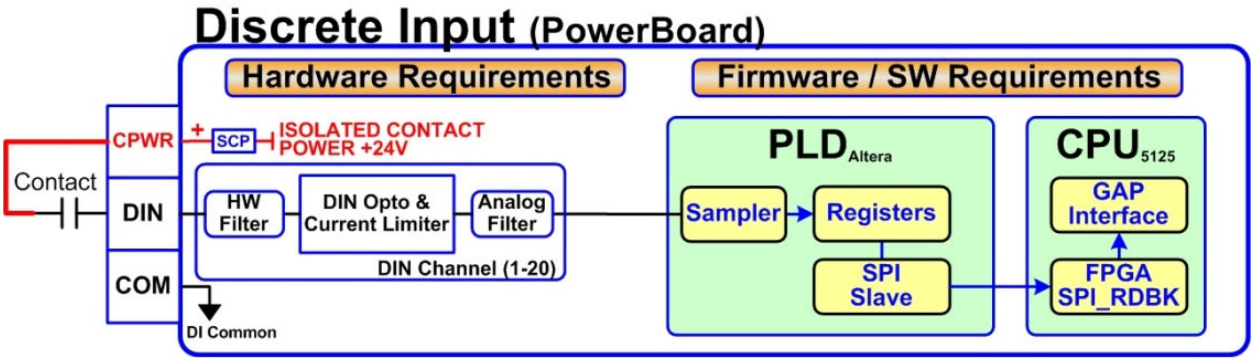


Figure 3-15. Discrete Input Block Diagram

Hardware - Relay Outputs

This control provides eight Isolated, Form-C Relay outputs with NO, COM, NC contacts available at the terminal block.

Features

- Eight Relay Output Channels
- Each Relay Output provides NO, COM, and NC contacts
- Each Relay Output channel provides a coil voltage readback fault
- Woodward GAP block, diagnostics, and configuration support
- Contact isolation maintained at terminal blocks
- ATEX approved version available using hermetically sealed relays
- GAP configurable update rates of 5 ms to 160 ms

Table 3-15. Specifications (Relay outputs)

Number of channels	8 relays
Contact Type	Form-C with NO, COM, and NC terminals
STD Relay, contacts (DC)	5 A, 5-30 Vdc (resistive)
STD Relay, contacts (AC)	2 A, 115 Vac (resistive)
STD Relay, operate time	< 15 ms typical
RELAY Coil Readback	Coil voltage readback status is available
RELAY Coil Rdbk Filter	1 ms approx at room temp
RELAY Output Isolation	500 Vrms minimum to EARTH and all other I/O
RELAY Contact Isolation	500 Vrms minimum between open contacts
RELAY to RELAY Isolation	500 Vrms minimum between relays
IOLOCK State	Relay outputs are de-energized during power-up, power-down, core voltage failures and watchdog failures
ATEX version:	The ATEX approved control uses a Hermetically sealed relay
ATX Relay, contacts (DC)	5 A, 5-30 Vdc (resistive), 0.2-0.5 A (inductive)
ATX Relay, contacts (AC)**	2 A, 115 Vac (resistive), 0.1-0.2 A (inductive), non-hazardous area

⚠WARNING

Explosion Hazard

****ATEX/IECEx and North American Hazardous Locations Compliance requires relay contact loads be limited to ≤ 32 Vac rms / ≤ 32 Vdc.**

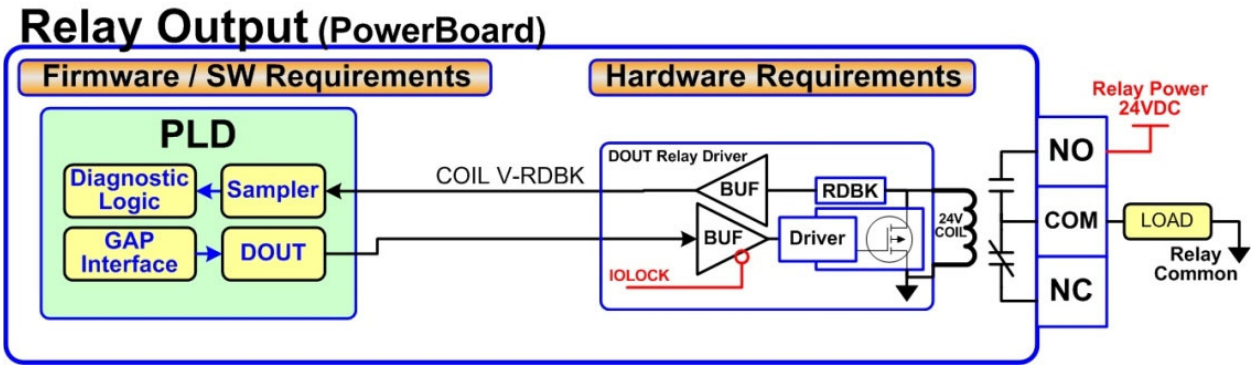


Figure 3-16. Relay Output Block Diagram

Troubleshooting Fault Codes

The CPU board runs diagnostics that display troubleshooting messages through the debug Service Port and AppManager. Additional information on diagnostics tests, subsequent LED flash codes, and serial port messages is contained in the VxWorks manual.

Table 3-16. CPU Fault LED Flash Codes

Failure	Flash Code
CPU not operational, IOLOCK state	Solid Red
RAM Test Failure	2, 1
FPGA Test Failure	2, 9
Watchdog not enabled	2, 10
RAM drive error	2, 11
Flash drive error	2, 12

Troubleshooting & Commissioning checks

Power checks

- Verify proper polarity on power connections
- Verify power source and wire size is sufficient for all loads
- Verify input power voltage is correct (i.e.: low voltage unit is 18 V to 36 Vdc)
- Verify PS(+) and PS(–) impedance to EARTH is > 10 MΩ

Ethernet checks

- Verify cabling meets CAT-5 or better performance specs
- Verify cables are shielded properly per Woodward spec (using inner foil and outer braid)
- Verify each port is connected to the desired port & cable is labeled with correct port number
- Verify the cable installation has a bend radius is > 3 inches to prevent cable stress/breakage
- Verify that any tie-wraps used for cable installation are not overly tight to prevent cable stress
- **Verify IP Address** of each port is set correctly according to your plant network & administrator
- A list of the default IP address for all ports is in the Hardware/Ethernet section of this manual.
- The Woodward AppManager tool can be used to review & change IP Address settings
- Verify that Woodward Tools use Ethernet #1 (AppManager, OPC Server, & Control Assistant)
- Consider using color coded tie wraps for ports (i.e.: ETH1 = blue, ETH2=red, ETH3=yellow)
- For best performance, verify that Ethernet traffic is < 70% and GAP rategroup loading is < 80%

RS-232 wiring checks

- Verify the RS-232 wiring uses a high quality shielded communication cable. For example, Woodward 2008-1512 (Belden YR58684) or equivalent low capacitance, shielded communications wire.
- Verify the RS-232 wiring uses the signal common (COM1_GND)
- Verify RS-232 network length is within specifications (typically < 50 feet)
- Verify Signal wires (TX+,RX-) are not shorted to each other
- Verify Signal wires (TX+,RX-) are not shorted to COM1_GND
- Verify Signal wires (TX+,RX-) are not shorted to COM1_SHLD
- Verify Signal wires (TX+,RX-) are not connected to PS(+), PS(–), EARTH
- Verify COM1_GND is not connected to PS(+), PS(–), EARTH
- Verify the overall cable shield is terminated to EARTH at only (1) location.

RS-485 wiring checks

- Verify the RS-485 wiring uses a high quality shielded communication cable. For example, Woodward 2008-1512 (Belden YR58684) or equivalent low capacitance, shielded communications wire.
- Verify RS-485 network length is within spec for the baud-rate (typically < 4000 feet)
- Verify the network is terminated properly at both ends with approx. 90–120 Ω
- Verify the RS-485 wiring uses the signal common (COM1_GND)

- Verify Signal wires (RS-485+, RS-485–) are not shorted to each other
- Verify Signal wires (RS-485+, RS-485–) are not shorted to COM1_GND
- Verify Signal wires (RS-485+, RS-485–) are not shorted to COM1_SHLD
- Verify Signal wires (RS-485+, RS-485–) are not connected to PS(+), PS(–), EARTH
- Verify COM1_GND is not connected to PS(+), PS(–), EARTH
- Verify the overall cable shield is terminated to EARTH at only (1) location.

CAN wiring checks

- Verify the CAN wiring uses a high quality, 3-wire, shielded communication cable. For example, Woodward 2008-1512 (Belden YR58684) or equivalent low capacitance, shielded communications wire.
- Verify CAN network length is < max length spec for the baud rate being used
- Verify network is terminated properly at both ends with 120 Ω, ±10%
- Verify the CAN wiring uses the signal common (CAN_GND)
- Verify CAN drop cables to each device are as short as possible and meets spec.
- Verify CANH is not connected to PS(+), PS(–), EARTH
- Verify CANL is not connected to PS(+), PS(–), EARTH
- Verify CAN_COM is not connected to PS(+), PS(–), EARTH
- Verify CAN_SHLD shield wire is not shorted to PS(+), PS(–)
- Verify the CAN overall cable shield is terminated to EARTH at only (1) location for each network.
- For redundant CAN, verify redundant networks are not miswired or connected together.

Speed Sensor MPU/PROX wiring checks

- Verify MPU sensors are wired to MPU terminal block location
- Verify PROX sensors are wired to PROX terminal block location
- Verify that each sensor is wired to the correct channel (ie: MPU1 to channel1)
- Verify that MPU+, PROX+ is not connected to PS(+), PS(–), EARTH
- Verify that MPU-, PROX- is not connected to PS(+), PS(–), EARTH
- Verify shield wires are not shorted to signals (MPU+, MPU-, PROX+, PROX-)
- Verify shield wires are not shorted to input power PS(+), PS(–)
- Verify MPU voltage amplitude meets spec (i.e.: > 1Vrms)
- Verify PROX voltage amplitude meets spec (i.e.: < 8V for low, >16V for high)
- If Prox Power#1 output is used, make sure it is ONLY used for sensor power1
- If Prox Power#2 output is used, make sure it is ONLY used for sensor power2
- If using Prox Power, verify that wiring is correct and isolation between sensors is maintained
- If using Prox Power, verify PPWR1+,PPWR2+ are not connected to PS(+), PS(-), EARTH
- If using Prox Power, verify PPWR1-,PPWR2- are not connected to PS(+), PS(-), EARTH
- If using Prox Power, verify PPWR1+,PPWR2+ are not connected to each other
- If using Prox Power, verify PPWR1-,PPWR2- are not connected to each other

AI (non-loop), Analog Input wiring checks

- Verify that external XDCR's are NOT used with these self-powered channels.
- Verify each AI (+,–) is not shorted to another input channel.
- Verify each AI (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI shield wire is not shorted to PS (+), PS (–).
- Verify each AI shield wire is terminated at the node properly.
- Functionally verify the wiring for each AI channel using a simulator source.

AI (Loop power), Analog Input wiring checks

- Verify that external XDCR's are connected to these channels.
- Verify the LPWR voltage level (+24 V dc) is correct for the XDCR.
- Verify each LPWR (+) terminal is wired to the XDCR POWER (+).
- Verify each LPWR (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AI shield wire is not shorted to PS (+), PS (–).
- Verify each AI shield wire is terminated at the node properly.
- Verify that all XDCR's channels use less than 250 mA of LPWR.
- Functionally verify the wiring for each AI channel using a simulator source.

AO, Analog Output wiring checks

- Verify each AO (+,–) is not shorted to another output channel.
- Verify each AO (+,–) is not shorted to another Analog Input channel.
- Verify each AO (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AO (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each AO shield wire is not shorted to PS (+), PS (–).
- Verify each AO shield wire is terminated at the node properly.
- Functionally verify the wiring for each AOUT by driving 4 mA and 20 mA to the load from the GAP application. Verify correct output current with a meter. Verify the correct SRC_RDBK & RET_RDBK values in GAP.

DI, Discrete Input wiring checks

- Verify each DI (+) is not shorted to another input.
- Verify each DI (+) is not shorted to CPWR (+), CPWR (–), PS (+), PS (–), EARTH.
- Verify each DI (+) wiring is functional by setting each input HIGH (>16 V DC) and then LOW (<8 V DC). Verify GAP software detects the state change.
- When possible, consider using a shielded DIN cable.

DI, Contact Power (CPWR) wiring checks

- CPWR (+) is an output voltage, it should never be connected to any other supply.
- To maintain node isolation, verify CPWR (–) is not shorted to PS (–).
- Using the internal isolated Contact Power output (CPWR,COM) is highly recommended to maintain discrete input isolation for other plant devices / controls
- Verify CPWR (+) is not connected to CPWR (–), PS (–), EARTH.
- Verify CPWR (–) is not connected to CPWR (+), PS (+), EARTH.
- Verify CPWR voltage meets spec at the terminal block (18 to 32 V dc).

DO Relays, Relay wiring checks

- Verify each Relay output (NO, C, NC) contact is connected to the load properly
- Verify each Relay output (NO, C, NC) is not shorted to another output channel.
- Verify the function of each Relay output (NC, NO) wiring by driving each output ON then OFF. Verify the GAP software detects the readback state change.
- When possible, consider using shielded wiring for relay cables.

Additional wiring checks when using RTCnet/LINKnet nodes

TC, Thermocouple Input wiring checks

- Verify each TC (+,–) is not shorted to another input channel.
- Verify each TC (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each TC (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each TC shield wire is not shorted to PS (+), PS (–).
- Verify no wires are landed accidently on the NC, no-connect terminals.
- Verify each TC shield wire is terminated at the node properly.
- Functionally verify the wiring for each TC channel using a simulator source.
- TC OPENS: A TC input will read MAX DegC if the (+) or (–) wire is broken / open.
- TC SHORTS: A TC input will read 0 DegC if the (+) and (–) wires are shorted.

NOTICE

GROUND FAULTS: Input channels accidently shorted to EARTH will be more susceptible to spurious noise events related to the installation and environment.

RTD, Input wiring checks

- Verify each RTD (+,–) is not shorted to another input channel.
- Verify each RTD (+) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each RTD (–) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each RTD (sense) terminal is not shorted to PS (+), PS (–), EARTH.
- Verify each RTD (sense) terminal is connected properly for 3-wire sensors.
- Verify each RTD (sense) terminal is jumpered to RTD (–) for 2-wire sensors.
- Verify each RTD shield wire is not shorted to PS (+), PS (–).
- Verify each RTD shield wire is terminated at the node properly.
- Functionally verify the wiring for each RTD channel using a simulator source.
- RTD OPENS: RTD channels will read MAX DegC if the (+) or (–) wire is broken.

Chapter 4.
Manual Network Setup

Factory Set IP Addresses for the Control

Table 4-1. Factory set IP addresses for the 505 / Flex500 CPU

Port name	IP address	Subnet Mask
Ethernet #1	172.16.100.15	255.255.0.0
Ethernet #2	192.168.128.20	255.255.255.0
Ethernet #3	192.168.129.20	255.255.255.0
Ethernet #4	192.168.130.20	255.255.255.0
Default Gateway	<none>	

Factory Set Network Passwords

Note: See AppManager Help for more information.

The control Operating System enforces security by requiring the user to login with valid permissions before accessing privileged control services. A login is required in order to connect the AppManager tool to the control.

The following logins are the default account settings for accessing the control. **The Administrator login is reserved for the system administrator and is only valid when Account Management is enabled**. The Administrator account may be used to create, modify, and delete other accounts.

Note: All account names and passwords are case sensitive!

Table 4-2. Factory set account names and passwords for newer controls

Account name	Password	Level	Permissions
Administrator	Admin@1	15	Read, Write, Execute
ServiceUser	ServiceUser@1	11	Read, Write, Execute
Configure	wg1113	3	Read
Service	wg1112	2	Read
Operator	wg1111	1	Read
Datalog	Datalog@1	1	Read

Network setup instructions for the control

Here is a simple flowchart, which shows the steps for configuring the control's network settings to work on your network. The listing of factory set IP addresses are in Table 4-1 and detailed instructions for the steps in the flowchart are below:

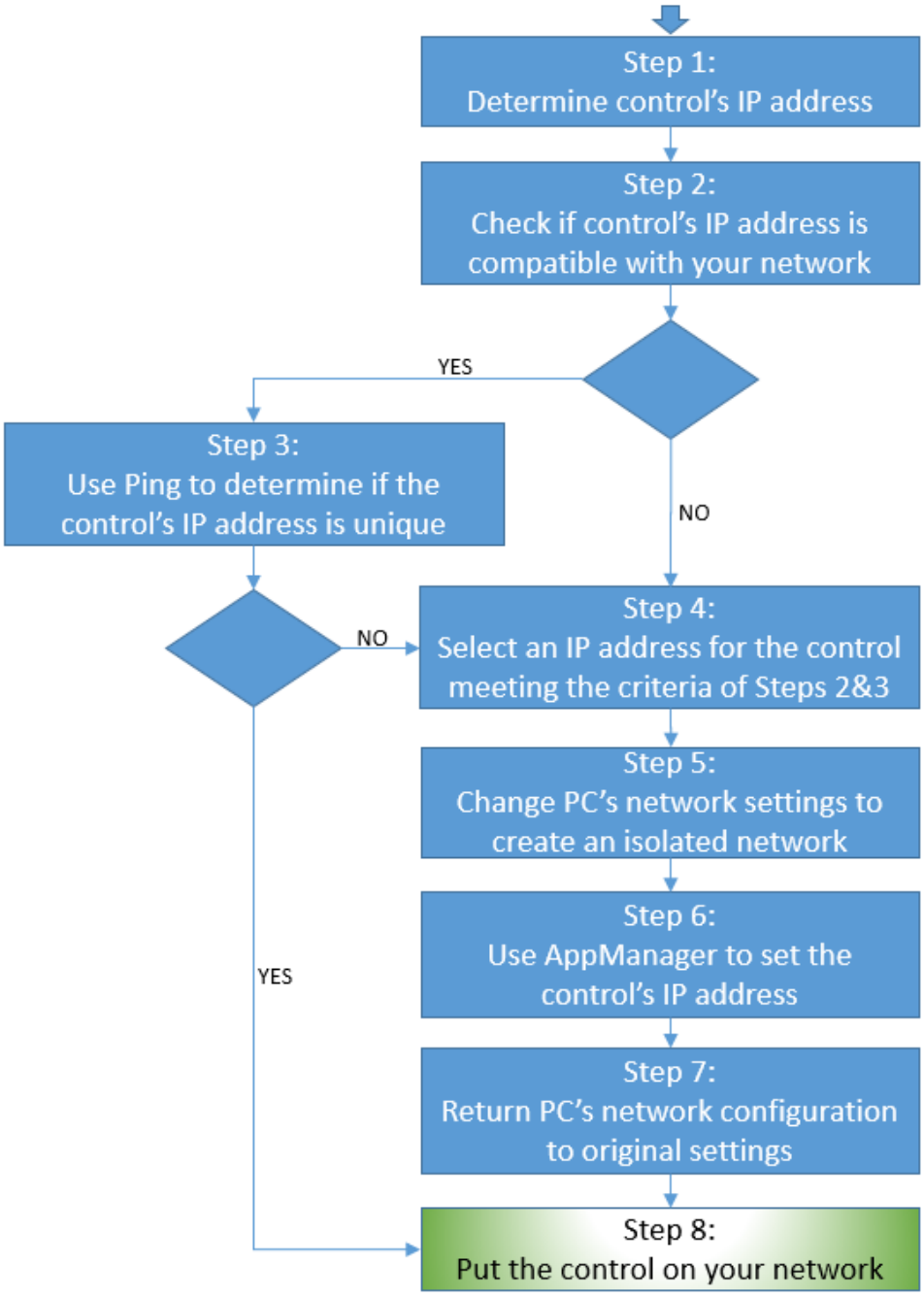


Figure 4-1. Network Setup Flowchart

Detailed network setup instructions for the control

Execute the following steps (up to 8) to configure your control to work with your network. The control's primary IP address must be compatible with your network, but cannot collide with an existing device's address.

1. Get control's current IP address:

Determine the current IP address of your control. The current address listed under "Ethernet #1" in table 4-1, 4-2, or 4-3 at the beginning of this chapter.

2. Check control's IP address for network compatibility:

Determine if the control's primary IP address is compatible with your network. This compatibility can be determined by looking at the IP address and subnet mask on your PC. These are viewed by running "ipconfig" from a cmd window on your PC (to open a cmd window, click on "Run…" in the Start menu and type in "cmd"). You are likely to be interested in the values for the Local Area Connection.

If you translate the Subnet Mask of your PC to binary, you can see which values of the control IP address must match the PC's IP address. For example, if the subnet address is "255.255.0.0", then the first two octets must match:

- **172**.**16**.99.4 *matches* **172**.**16**.100.1
- **172**.**18**.100.1 *does not match* **172**.**16**.100.2

For example, if the subnet address is "255.255.240.0", then the first two octets must match and the first 4 bits of the third octet must match (240 is 11110000 in binary and "1"s indicate a required bit position match):

- **172.16.107.4** *matches* **172**.**16**.**100**.1 because 110 is "**0110**0100" in binary and 107 is "**0110**1011" in binary
- **172.16.116.4** *does not match* **172**.**16**.**100**.1 because 100 is "**0110**0100" in binary and 116 is "**0111**0100" in binary

If you are not sure what the PC's IP address or subnet mask are or if your network has some other complexity, consult with your IT department for help in determining or establishing a compatible IP address for the control.

Is the control's primary IP address compatible with the PC's network?

If NO, or if you need to change the network settings for another reason, go to Step 4 below.
If YES, continue to STEP 3 below.

3. Check control's IP address for uniqueness:

Determine if the current IP address of your control (from Step 1) is in use in your network. To see if it is already used, Ping the IP address from a PC on the network. The description of the Ping command is in Chapter 8 *Ethernet Networking*. If it does not respond with "Destination host unreachable.", the IP address is already used and is not available for the new control. If this is the case, skip to Step 4 where you will change the control's primary IP address.

Is the control's IP address already in use?

If YES, or if you need to change the network settings for another reason, go to Step 4 below.
If NO, jump to STEP 8.

4. Select a new IP address for the control's Ethernet #1 port:

If your network contains many devices, you should consult with your network administrator to find an available IP address for you to claim and use. If your network is simple or you do not have an administrator, you could try guessing a suitable IP address by taking your PC's IP address and changing the final octet to a different number until you find an available IP address (see STEP 3). For example, if your PC's IP address is "10.14.129.37", you could try "10.14.129.38", "10.14.129.39", etc. Keep trying different values until you find one that works.

Note: Any IP address you choose must still match the subnet mask of the PC, as described in Step 2.

5. Create an isolated network between the PC and the control:

To avoid IP address conflicts on your network, isolate the control and the PC that you will be using for setting up the control from the network. Two examples of recommended methods appear in Figure 4-2.

1. On your PC, shut down your network applications but do not log off.
2. Temporarily change your PC's IP address to be compatible with the current IP address of the control (from Step 1). A simple compatible IP address would be to take the control's address and add 1 to the final octet (e.g. use "172.16.100.2" to connect with a control at "172.16.100.1". Keep a record of your PC's current IP address.
3. Connect as shown in Figure 2-2 and power up the Woodward control.

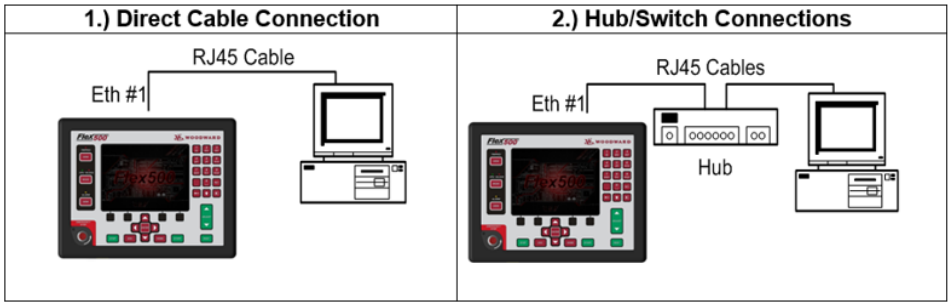


Figure 4-2. Network Cable Connections

When you have the proper connection between the Woodward control's Ethernet Port #1 and your PC, you will see the green "Link" LED remain on (solid) on your PC *and* on the control.

IMPORTANT

A Hub/Switch will cause your PC's Link light to be on even when a control is not connected. The Flex500 has two LEDs for each connector.

IMPORTANT

If you cannot see the control in AppManager, open a DOS Command Prompt window on your PC and try to "ping" the control's IP address of the port to which you are connected. See the "Pinging the Network" section of the Ethernet Networking chapter. If pinging is successful, your PC's networking settings may need to be changed. Contact your Network Administrator.

6. Configure the Ethernet port:

The Woodward software tool "AppManager" is needed to change the Woodward control's Ethernet IP settings to make the control's Ethernet port accessible to your local PC. Download AppManager from the Woodward website. See "Obtaining Software Tools" section within this chapter for details on obtaining AppManager. Install AppManager on your PC if it is not already there.

Using AppManager, change the control network settings as follows:

1. On your PC, open AppManager.exe.
2. You should see the Woodward control's Computer Name in the AppManager window. Select the control's Computer Name. If necessary, Login by using the credentials from Table 4-4 or 4-5. If the control name is not listed, check your connections and verify that the Link lights are on. If clicking on the control produces an error, verify that you have chosen a compatible IP address for your PC in Step 5.
3. Click "Control" in the top header of the AppManager window, use the pull down menu, and select "Change Network Settings".

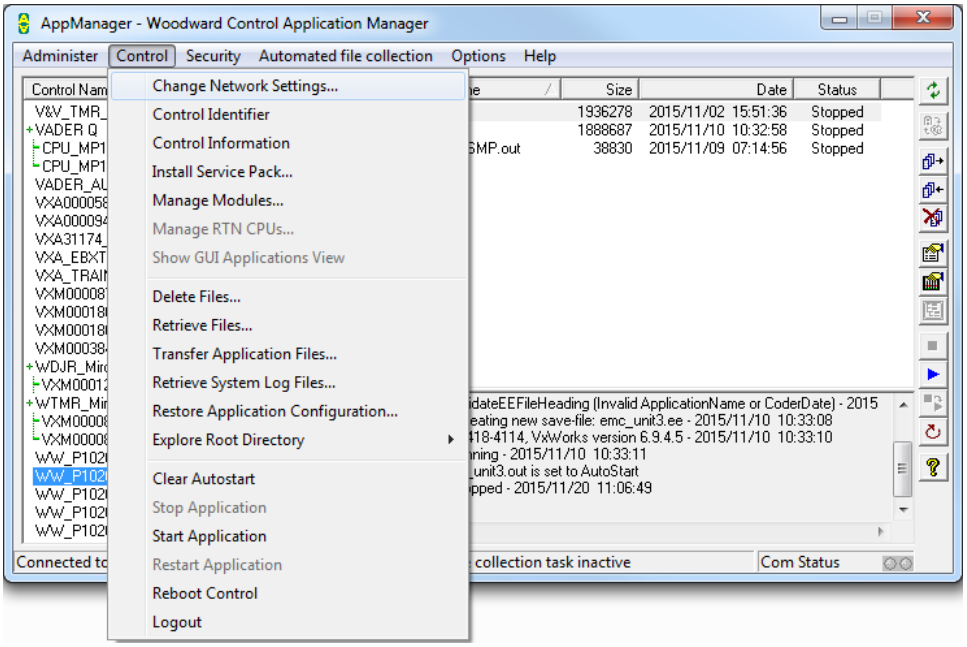


Figure 4-3. AppManager Control Dropdown Menu

AppManager—Control Information Screen

The AppManager Control Information screen shows information about the CPU board and its hard drive. Use this screen to confirm the application of new network configurations above.

Select the control in the Control Window (login if required). Then select *Control Information* from the *Control* menu or press the Control Information button in the toolbar: 

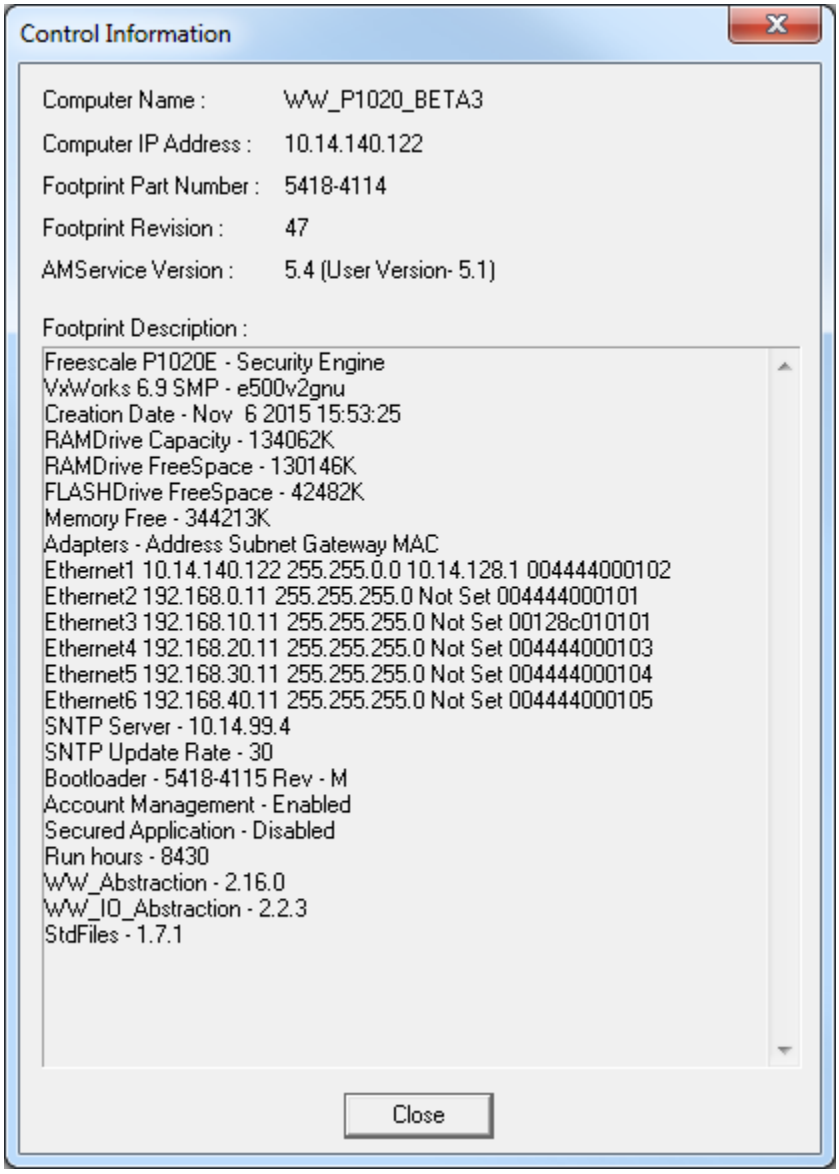


Figure 4-4. AppManager Control Information Page

4. Select the desired Ethernet port (adapter) and the desired IP Address settings to affect the desired change. Port 1 is the only port that supports a Default Gateway, and Port 1 is the only port that supports DHCP.

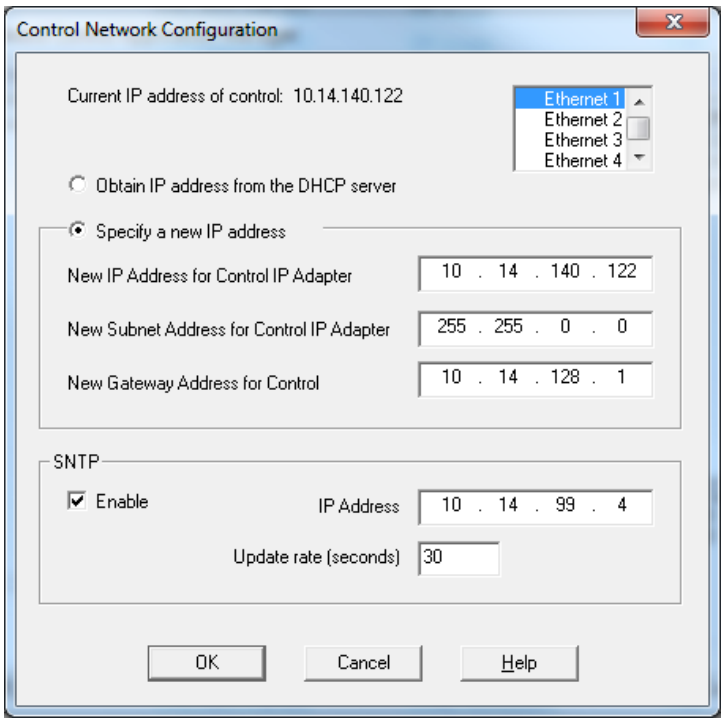


Figure 4-5. Control Network Configuration Page

5. Select “Yes” to change the settings

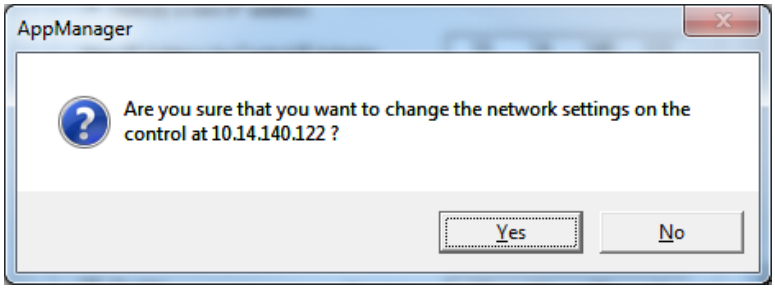


Figure 4-6. AppManager Yes/No Window

6. AppManager will report that the control settings changes and prompt to reboot the control. The changes are invoked when the control reboots.

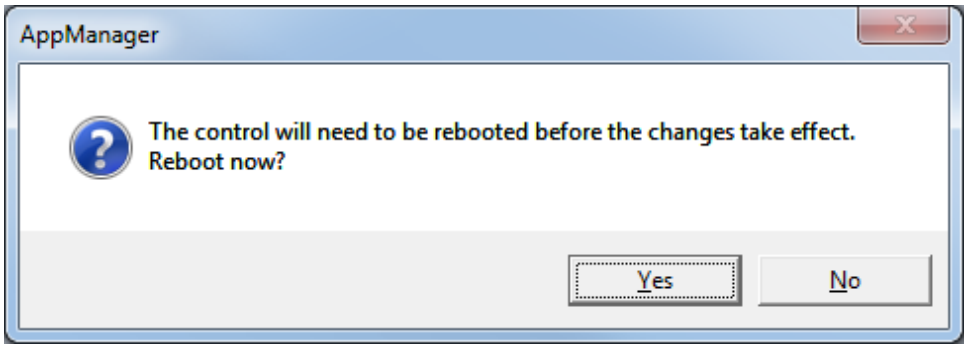


Figure 4-7. AppManager Reboot Prompt Window

7. Configure the PC's network configuration to its original settings:

When the control has rebooted, the IP address changes that you specified are viewable. The control may no longer be compatible with your current PC settings. If you had changed your PC network settings, you should now revert to the previous settings. If everything worked correctly, the control will now be compatible with your PC's network.

8. Connect the PC and the control to the network:

Physically reconnect the PC and control to your network. Confirm that the control has the correct network settings using the Control Information feature of AppManager:

AppManager—Control Information Screen

The AppManager Control Information screen shows information about the CPU board and its hard drive. This page confirms the network configurations that you entered above are or are not applied.

Select the control in the Control Window (login if required). Then select *Control Information* from the *Control* menu or press the Control Information button in the toolbar: 

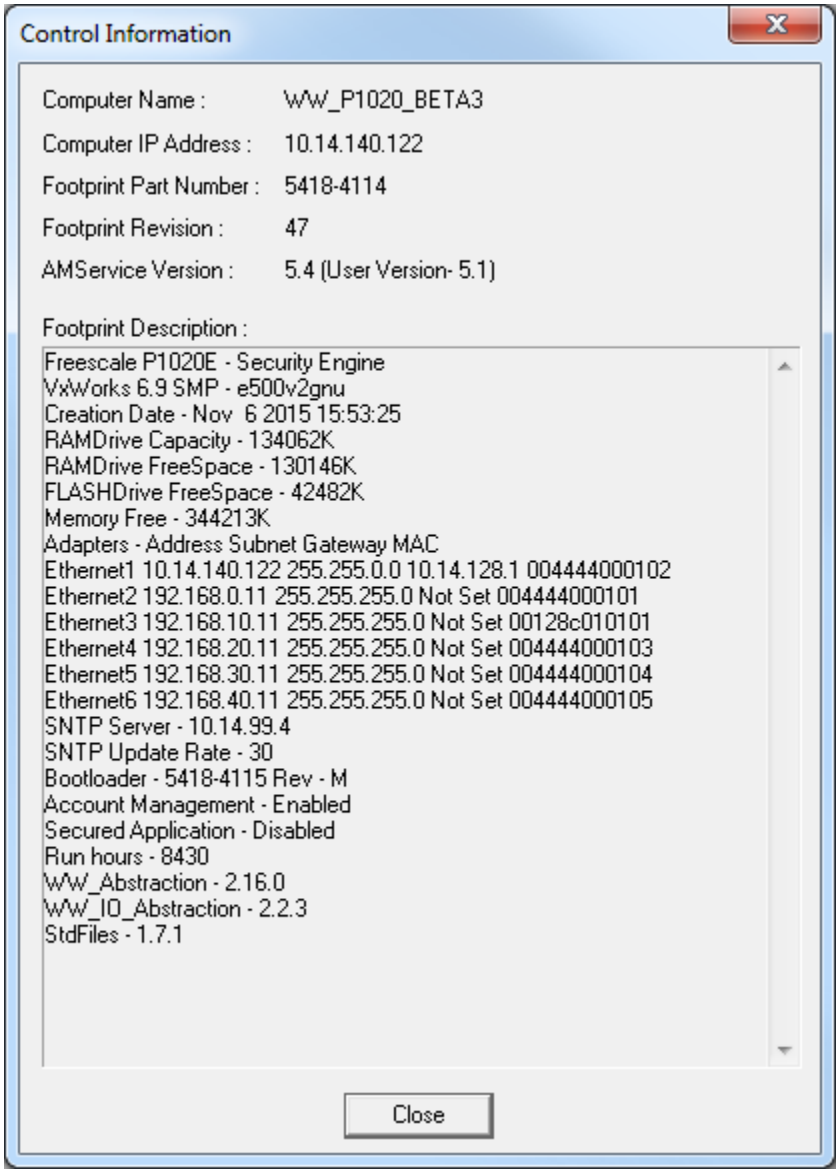


Figure 4-8. AppManager Control Information Page

Software Tools

Overview

Programming Tools build a control application. GAP (Graphical Application Programmer) and Ladder Logic creates the application. The output feeds into the Coder, which assembles, compiles, and links the code with the resulting executable file is loaded into the target control. Use the Woodward NetSim simulation tool to test the application on a PC.

Service Tools are the interface programs that allow an operator to move files, start and stop the application, configure settings, troubleshoot hardware and software, view status, and ultimately operate the controlled machinery.

⚠WARNING

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

Programming Tools

These tools are useful for creating new applications or for modifying existing ones.

IMPORTANT

All of the following programming tools will only function in a Windows Operating System such as Windows XP, Vista, 7, 8, or 10. The Windows .NET library version 4.0, which is usually included on such PCs, is required for most of these tools to run.

Woodward GAP

GAP (Graphical Application Programmer) allows users to design their control system logic with an integrated drawing package that runs on a PC in the Windows environment. Once you graphically enter the control logic, GAP checks the application for correctness and generates a meta-data (.cdr) file for use with Woodward Coder.

Monitor GAP

Monitor GAP is a mode in GAP that allows the engineer to view and tune GAP values in context while the application is running. It interfaces with the Ethernet or serial ports via the Woodward SOS Servlink OPC Server tool.

Woodward Coder

Coder is the program that converts the GAP application into code. If there are no problems, it calls the assembler, compiler, and linker to create the file that can be loaded onto the hardware using AppManager. Error files help in debugging if the Coder finds problems.

Secured Application Tool

SAT is a program used to manage Authorization Encryption Files (AEF) and to create Secured Applications from GAP output (.out) files. Secured Applications run only on Secured Application controls for which they have been programmed.

NetSim

 NetSim is Woodward's Windows PC based simulator software used for testing control software. It provides a closed loop simulation environment when connected to a modeling package or open loop testing when run in stand-alone mode. NetSim supports connections to ACSL based and MATLAB/Simulink modeling packages. The NetSim Control Executive ("NetSim CE") communicates with the Woodward SOS Servlink OPC Server to provide OPC data to presentation tools like Monitor GAP and Control Assistant.

Ladder Logic

 Woodward Ladder Logic extends a GAP application and permits customer programming and monitoring of a Woodward control. It is easy for anyone familiar with the basic structure of ladder logic to write and use Woodward Ladder Logic. Activate commands using a simple point and click Windows interface.

The Woodward Ladder Logic program runs on a Windows PC connected to a serial or Ethernet port of a Woodward digital control system. The Ladder Logic program can be written and changed using the PC while the hardware is controlling the running prime mover—changes do not take effect until the Ladder Logic program is loaded into the hardware.

Qt Creator

 Qt Creator is a design environment used to develop the Graphical User Interface (GUI) screens for the Flex500. This package includes Woodward component libraries (gauges, adjust buttons, analog adjust components, display components etc.) which can be placed on screens and tied directly to GAP parameters. Once the GUI screens are developed, Qt Creator compiles the screens into a *.WGUI file that can be loaded and run on the control (Flex500 Panel Mount) or loaded on to the control and launched from a remote PC.

IMPORTANT **The Flex500 control supports only Ladder Logic versions 2.10 or higher.**

Service Tools

These tools are useful for system debugging, variable monitoring, tunable maintenance, real time data collection, data analysis, and remote control. See your Woodward sales engineer for additional information.

IMPORTANT **All of the following service tools will only function in a Windows Operating System such as Windows XP, Vista, 7, 8, or 10. The Windows .NET library version 4.0, which is usually included on such PCs, is required for these tools to run.**

Application Manager

 AppManager is a Windows based remote access tool for Woodward CPUs. AppManager allows local and remote access to control applications for transferring files, retrieving files, starting, stopping, and restarting. The MicroNet Plus, 505, Flex500 and Atlas-II are loaded with a service that allows them to interface with AppManager. AppManager can change Ethernet Network addresses, Administer Accounts, load service packs, and continuously retrieve Datalog files.

IMPORTANT **AppManager will only function in a Windows Operating System such as Windows XP, Vista, 7, 8, or 10.**

Control Assistant

 Control Assistant is a Windows program designed to support the following control features via OPC Ethernet communications:

- *Tunable Maintenance*. This feature supports tunable capture, sorting, comparing vs. baseline/GAP, saving, and uploading of new tunable values into the control.
- *Variable Trending*. Using a strip chart displays live variable information. It requires a software license to run.
- *Datalog Plotting*. This feature supports the capture and plotting of high-speed Datalog information. It requires a software license to run.
- *WinPanel* is an OPC client designed for communication with the Woodward Servlink OPC Server to display and control all control system data. Variables can be selected from this interface for both control and monitoring purposes.
- Variable access through the Servlink OPC Server.
- Loading and saving of different configurations.
- Hierarchical Tree View of available data.
- The WinPanel views support multiple data sheets.
- Tunable modifications.
- Updating of EEPROMs.

Servlink OPC Server (SOS)

The SOS Servlink OPC Server is an OPC server designed to communicate with a control using the Woodward Servlink Protocol over an Ethernet or Serial connection. This protocol allows OPC clients like Control Assistant, Monitor GAP and off-the-shelf HMI programs to access and modify internal control parameters.

ToolKit

 Use ToolKit to create and run custom administration tools for many Woodward electronic products. Use the resulting tools to configure, calibrate, monitor, and troubleshoot your device over a serial, CAN, or TCP/IP connection.

Obtaining Software Tools

The following software tools are available on the Woodward web site (**www.woodward.com/software**):

- AppManager
  - No license required unless using enterprise version of automatic file retrieval (4+ controls at once)
- Control Assistant
  - License required for graphing/trending features only
- GAP Editor and Monitor
  - Separate licenses required for editing and monitoring
- GAP Programmer (Woodward Coder)
  - No license required (license required for GAP Editor)
- Ladder Logic
  - No license required
- NetSim
  - License required
- Secured Application Tool
  - No license required
- SOS Servlink OPC Server
  - No license required
- ToolKit
  - The Basic version requires no license. It may be used to open and work with pre-built tools
  - A Developer license is required for designing custom tools
- Woodward Control Service Packs
  - No license required
- Qt Creator
  - License required for screen development

Chapter 5.
Distributed I/O Expansion

The Flex500 Digital Control can be expanded to higher I/O counts by using the Woodward RTCnet and LINKnet-HT distributed I/O nodes. GAP3.04 and Coder 6.0 or later software tools are required. Contact Woodward Marketing and Sales for compatibility with other Woodward products.

IMPORTANT

Reference information:
- **Manual 26838—For Flex500 Digital Control manual.**
- **Manual 26640—For RTCnet and LINKnet HT nodes.**
- **Manual 26166—For MicroNet RTN Ethernet switches and cables.**
- **Manual 26612—For RTN Gateway information, cables, and setup.**

Network Wiring Considerations

The CAN network may be routed using either a simple daisy-chain wiring strategy (preferred) or a trunk and daisy-chain wiring strategy. The primary requirement is that the CAN network is terminated with 120 Ω ±10 Ω resistors at each end of the “trunk” cable.

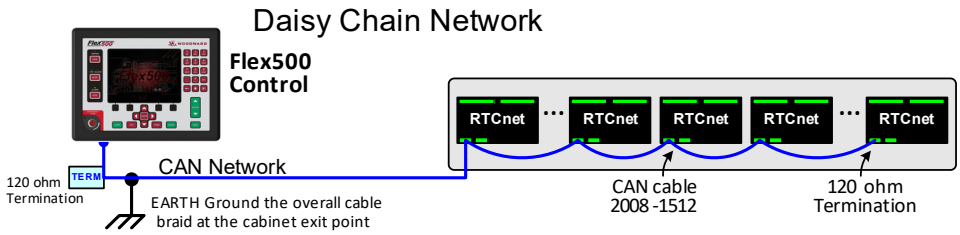


Figure 5-1. Daisy Chain Network (preferred)

Figure 5-2. Trunk and Daisy Chain Network

IMPORTANT

Recommended shielded CAN cable is 2008-1512. Thicker trunk CAN cable and connectorized options can be found on Woodward Reference drawing 9097-2097.

Table 5-1. Useful Woodward Part Numbers at the Time of Writing

CAN Cables (reference drawing 9097-2097)	
5417-1127	Cable - CAN MicroNet drop, 7/8 inch male to M12 female (1 m)
5417-1142	Cable - CAN drop, 7/8 inch male to pigtail (1 m, mid gauge)
5417-1148	Cable - CAN mid trunk cable (3 m, mid gauge)
1635-1463	Connector - CAN network tee, 7/8 inch M/F with F drop
1635-1464	Connector - CAN terminator 7/8 inch, male 121 Ω
1635-1465	Connector - CAN terminator 7/8 inch, female 121 Ω
2008-1512	Cable - CAN RTCnet High Temp (1.5 pair, 0.3 mm² / 22 AWG, 125 °C)
8923-1889	KIT - RTCnet CAN termination resistor (121 Ω, qty 20)

Ethernet Switches and cables	
5417-394	Cable - Double Shielded CAT-5 Ethernet (SSTP), 10 foot
1752-423	Hirschmann Copper Ethernet switch (RS2-TX, 8 port)
1711-1069	Hirschmann Fiber Optic Switch (RS2-4TX/1FX)
1751-6077	Hirschmann Fiber Optic Switch (RS2-3TX/2FX)

Chapter 6.
Product Support and Service Options

Product Support Options

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

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

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

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized 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.

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

Product Service 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**.

Contacting Woodward's Support Organization

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

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

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
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

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Turbine Model Number _____

Type of Fuel (gas, steam, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

_____

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

Appendix
Redundant Controls using the FLEX500

Overview

The Flex500 control can be applied as a redundant system by using 2 controllers. This functionality is available using the hardware part numbers in chapter 1 listed as “Dual Redundant”. These versions of the hardware require the GAP application to be programmed in Coder Flex500 1.04 or later. This coder version will support the design of both simplex and redundant applications.

The purpose of this appendix is to identify how to properly design a redundant Flex500 control system. There are strict wiring requirements for hand-shaking between the controls, I/O wiring isolation and GAP application programming requirements. The Flex500 redundant system can be designed to meet a range of signal output failover performance requirements, from 250ms transitions (Flex500 local I/O) to completely bumpless transitions, using CAN RealTime network I/O modules and/or Woodward digital drivers.

Woodward uses the term SYSCON to refer to the unit that is in control of the system outputs and the term BACKUP for the other unit. Since these controls have I/O circuitry that is local and unique to each controller, the design of a redundant system is slightly more complex than the Woodward MicroNet Plus implementation.

The use of the optional DR-FTM is strongly recommended to provide robust control-to-control connections, output signal sharing/voting and to simplify field wiring. It includes cable harnesses to each of the controllers with screw down terminal blocks on each end and supports approximately half of the Flex500 local I/O.

General GAP Application Requirements

The following is a bullet list of the application programming requirements to design a redundant GAP control application. The primary focus of this appendix is to detail the hardware and wiring requirements. For complete details and examples on designing the GAP application program, refer to Application Note 51620.

- Must use Coder Flex500 1.04 or later
- Must add the FLEX_DR chassis block to the application and link it to the FLEX_500 block
- Must use the AO_4_20_FLEX_DR and ACT_FLEX_DR analog output blocks
- Must include RELAY_FLEX_DR block on Relay #8 – this output will not be available to the application
- Must include BI_FLEX_DR block on Discrete Input #20 – this input will not be available to the application
- Ethernet port #4 will NOT be available to the application
- The application will need to have logic to trigger ‘Transfers’ of control from the SYSCON to the BACKUP unit related to specific signal faults
- The application will need to have logic to annunciate faults on the BACKUP unit and decide whether that unit is available or not

General Hardware Requirements

The following is a bullet list of the hardware configuration and control interlocks required to operate the Flex500 controllers in a redundant mode.

- Must use the correct hardware p/n controller identified in chapter 1
- Must set DIP switches on top of controller to configure one as the Primary unit
- Must set DIP switches on top of controller to configure the other one as the Secondary unit
- Must use a CAT5 or 6 Ethernet cable and make a direct connection between ETHERNET port 4 of each controller
- Must wire DI 24vdc power of each controller to the COM terminal of Relay #8 of the other controller and wire the NO terminal of Relay #8 back to DI #20

Chassis Configuration

Configuration DIP switch settings Primary/Secondary

The back panel label shows information on the orientation of the configuration switches that are located on the top of the unit, under the thumb screw access panel. To set the switches, open the panel and set one unit to be the primary and one unit to be the secondary. The default setting of these switches, from the factory, are that all switches are in the OFF position. Reference the images below for guidance in setting these switches – all the image views are of the top of the unit with the back (label) of the unit toward the bottom of the image.

Simplex applications will require that the switches are set to the factory default settings. Redundant applications will require a primary/secondary pair and internal operating system diagnostics will annunciate errors in AppManager if the wrong settings are detected.

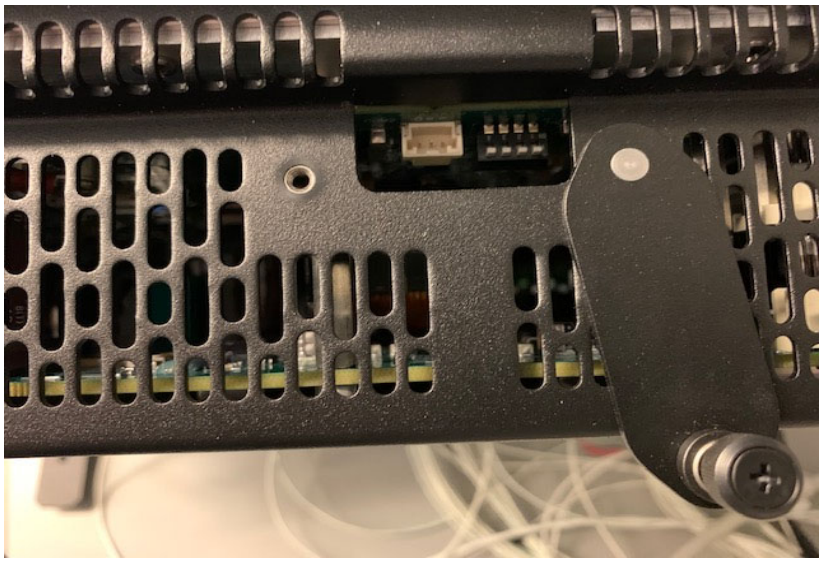


Figure A-1. Factory Default Settings of Switches (Simplex Mode)

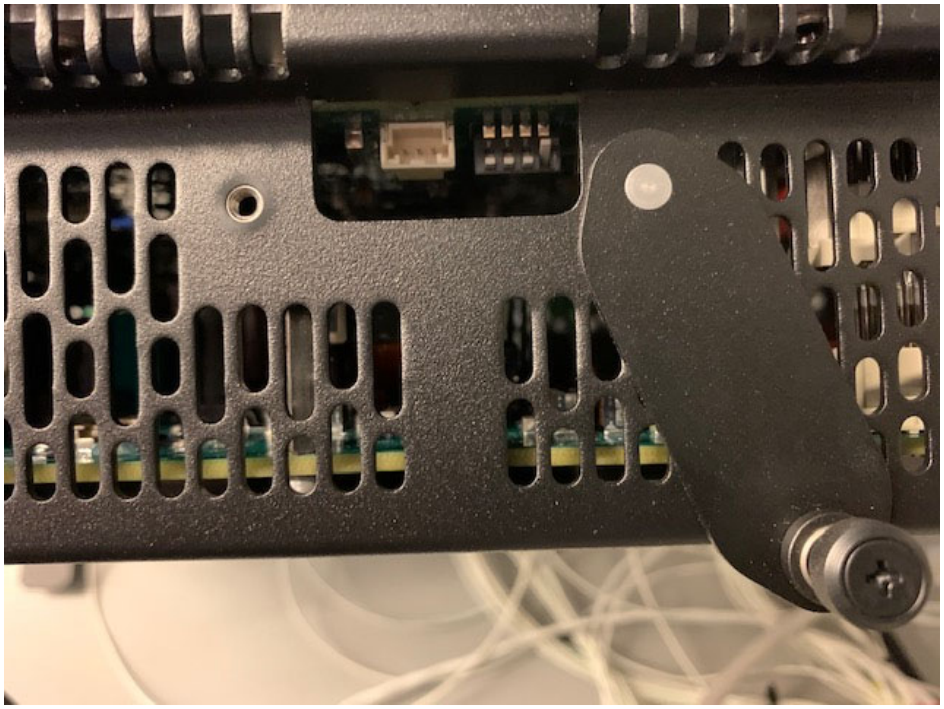


Figure A-2. Switch Settings for Primary Unit (Redundant Mode)

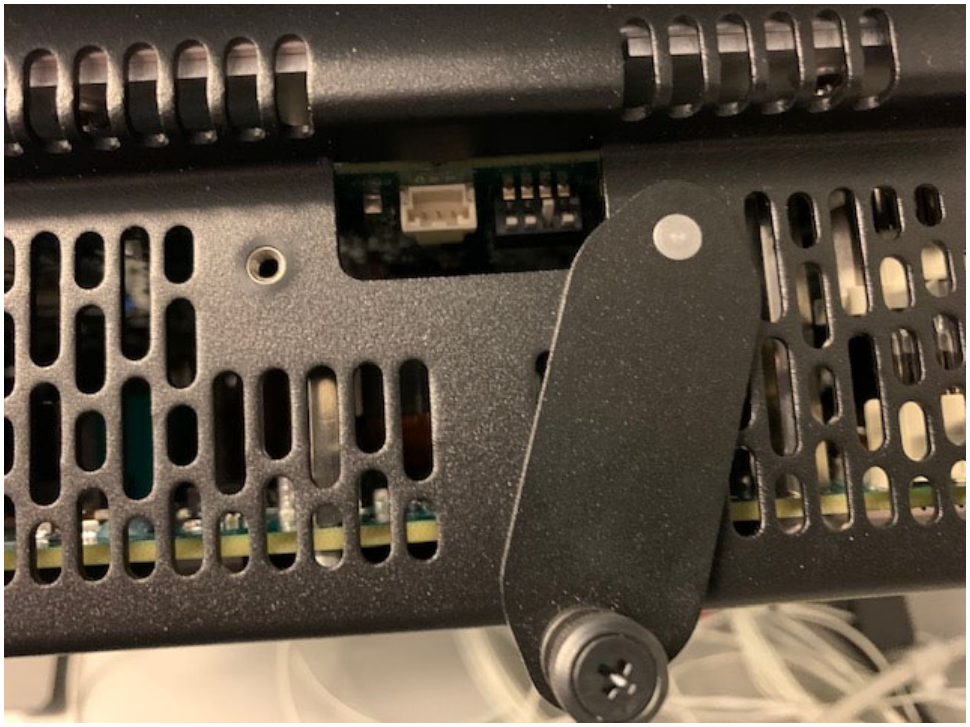


Figure A-3 Switch Settings for Secondary Unit (Redundant Mode)

Ethernet Port 4 Link (DR_COMMS)

It is required that an Ethernet cable be directly connected between the Ethernet port #4 of each unit. It requires a CAT5 or CAT6 cable with RJ45 connectors. A cable (length of 2m) for this connection is included in the DR-FTM kit.

Figure A-4 Ethernet port 4 for DR communication link (redundant mode)

DI/DO Interlock connection (Criss-Cross)

It is required that the discrete input # 20 of each unit, be wired through the NO and COM terminals of the Relay #8 of the other unit to create a hardwired interlock between the primary and secondary units. This interlock wiring is done internally on the DR-FTM and cable harnesses, so if the DR-FTM kit is used, no field wiring it required to complete these connections.

Table A-1. Interlock wiring for Discrete Input 20 and Relay 8

Primary Unit	Secondary Unit
DIN (13-20) - 21 (pwr)	Relay (6-8) – 24 (RLY8-NO)
DIN (13-20) - 20 (DI-20)	Relay (6-8) – 23 (RLY8-COM)
Relay (6-8) – 24 (RLY8-NO)	DIN (13-20) - 21 (pwr)
Relay (6-8) – 23 (RLY8-COM)	DIN (13-20) - 20 (DI-20)

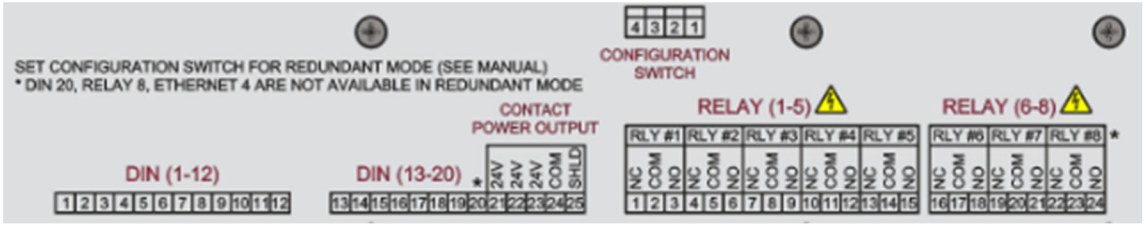


Figure A-5. Discrete Input 20 through Relay 8 Interlock (Redundant Mode)

Woodward Flex500 DR FTM Kit (5541-705)

Introduction

Flex500 Dual Redundant (DR) Field Termination Module (FTM) kit is used to provide simplified wiring of field device signals, isolated inputs into, and shared outputs from each controller for redundant applications. In addition to the FTM, the kit includes cable harnesses to connect the DR-FTM to each of the controllers. These cable harnesses have screw down terminal blocks at each end. This kit provides the Discrete Input / Relay output interlock between the controllers and supports single point landing of approximately half of the local I/O channels.

While this kit is optional, it is strongly recommended by Woodward to help provide a robust redundant control solution.

Table A-2. Flex500 DR FTM Family Part Numbers.

Part Number	Description
5541-705	FTM AND CABLES KIT, FLEX500/505/VERTEX REDUNDANT
└ 5404-1484 (2x)	HARNESS KIT, FTM, FLEX500/505/VERTEX REDUNDANT
└ KP-50001	PATCHCABLE RJ45 S/FTP CAT6A (10GBIT) LENGTH L=2M GREY
└ 5501-503	FTM MODULE, FLEX500/505/VERTEX REDUNDANT

The FTM can be used in the same Environmental Specifications as Flex500 units (see Table 3-1 in Chapter 3. Hardware specifications).

Note: One deviation is shock resistance (malfunction): 6G peak min. limited for relays NC contacts (see relay outputs section in this appendix for details).

The FTM is CE marked and fully meets the requirements of LVD and EMC EU directives. The FTM is also listed for North America market **but is restricted for use in ordinary location only**. It utilizes the CSA 70217045 certificate of compliance. FTM is a product certified as an open type equipment and must be installed within other equipment or special enclosure. The final combination is subject to acceptance by the authority having jurisdiction or local inspection.

FTM shall meet all the requirements described in Special Conditions for safe use given in Regulatory Compliance section, where applicable. For detailed information about safety precautions and all the listings please see Regulatory Compliance section. To see CE Declaration of Conformity please see sections Declarations at the end of this manual.

The FTM complies with Heavy Industrial EMC requirements per EN 61000-6-4 & EN 61000-6-2 specifications. No calibration is required on the FTM module. Field replacement can be easily accomplished as a complete kit using dedicated module and field wiring. Each type of circuit is isolated to earth ground and others circuits.

Overview

Flex500 FTM kit utilizes following input/outputs from Flex500 units:

- Two Speed Sensor inputs MPU #1, MPU #2 (MPU inputs).
- Four Analog input 4-20 mA channels AIN #1 – AIN #4 (only in self-powered mode).
- Three Analog output 4-20 mA channels AO #1 – AO #3.
- Two Actuator output channels ACT #1 – ACT #2 (can work in 4-20 mA/20-200 mA current range).
- Seven Discrete input channels DI #13 – DI #19 with Contact Power (DI24V_1, DI24V_2, DI_COM).
- Two Relay outputs RELAY #6, RELAY #7 (form-c).
- Relay output RELAY #8 and Discrete input DI #20 used to control interlock in redundant mode (connection between RELAY#8 from one Flex500 unit to DIN#20 from second Flex500 unit and vice versa).

Flex500 FTM kit connects to the terminal block with removable plugs on the back of the Flex500 modules and provide cage-clamp terminal connection points for field wiring. It also provides shield termination and EMI protection. FTM can be mounted on 35 mm DIN Rails and take the place of interposing terminal blocks to field wiring. The Harness kit supports connection to two Flex500 units with wire harness length of two Meters to each of them.

The cage-clamp terminals on the FTM accept a maximum of one #12 AWG wire or two #18 AWG wires. Field wiring hookup is performed by stripping the wire back 0.312 inches (8 mm), inserting into the cage clamp and tightening the screw.

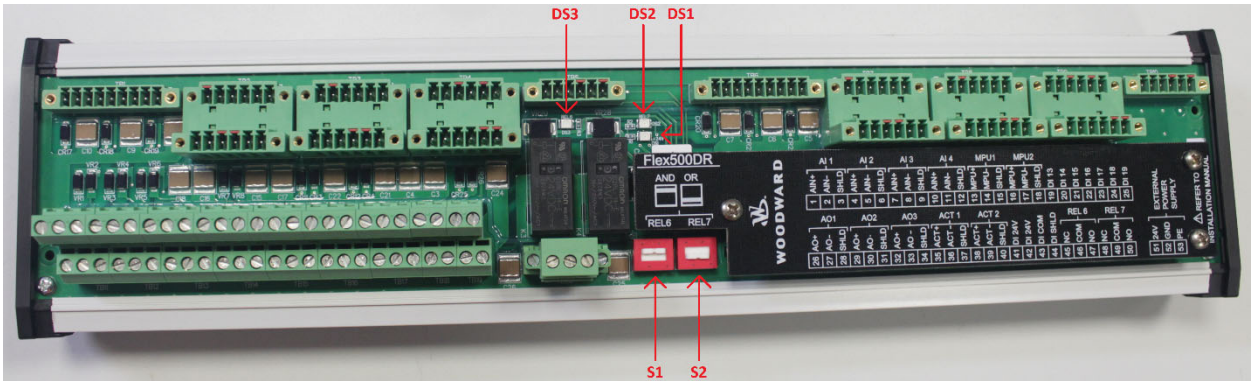


Figure A-6. Flex500 DR FTM module.

Table A-3. Status indication (LEDs).

LED	Description
DS1 (red)	Module power on
DS2 (red)	RELAY #7 energized
DS3 (red)	RELAY #6 energized

Table A-4. Relays configuration switches meaning.

Switch	Description
S1	Flex500 relay contacts configuration for OR/AND logic of RELAY #6
S2	Flex500 relay contacts configuration for OR/AND logic of RELAY #7

Figure A-7. Flex500 DR – Harness Kit.

See figures below for the physical outline dimensions for the Flex500 DR FTM module.

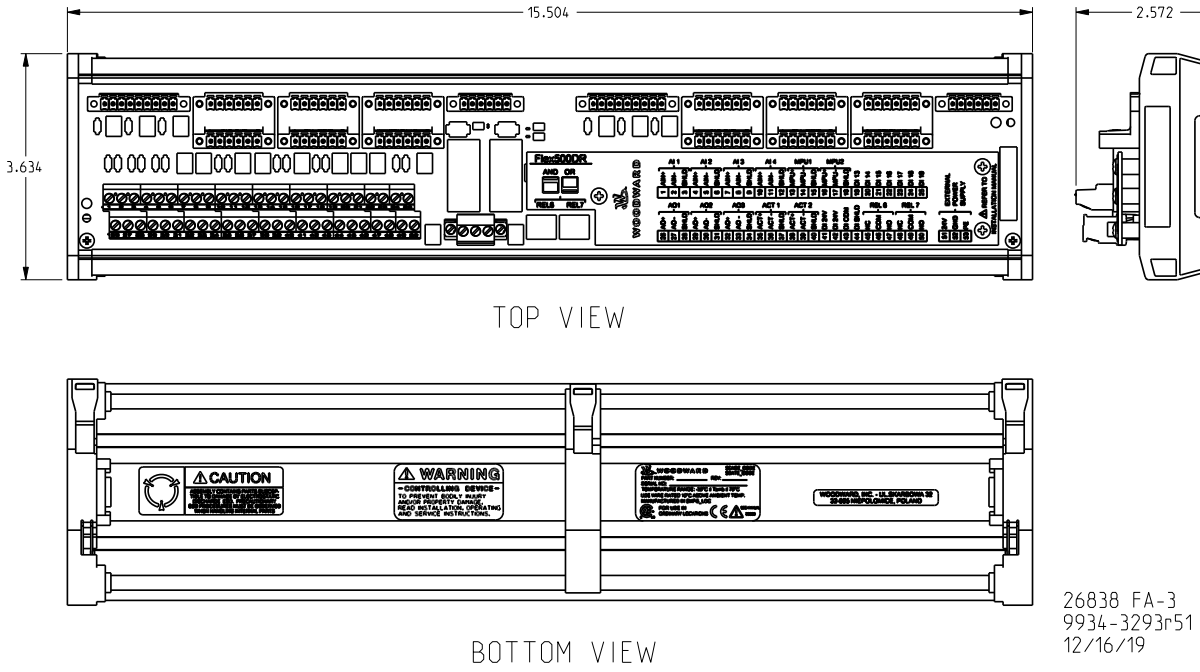


Figure A-8. DR FTM Module Outline Dimensions.

Hardware – Terminal Blocks

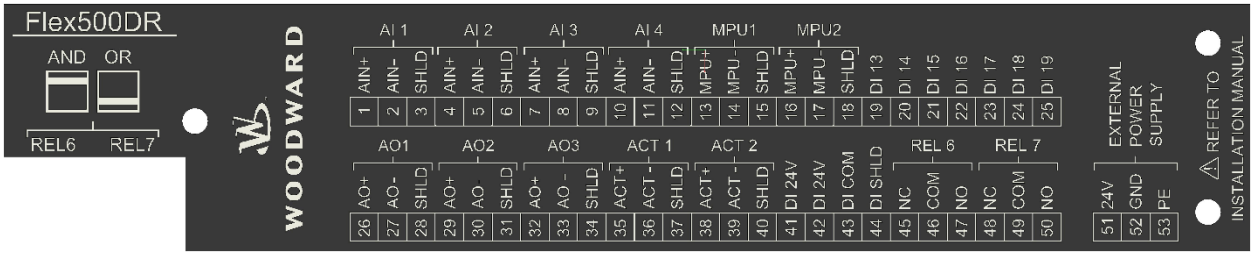


Figure A-9. Flex500 DR FTM Wiring Diagram.

Hardware – Speed Sensor Inputs

The Flex500 DR FTM includes support for two MPU Speed Sensors. The channels are isolated from each other and from other input and output circuits in the system. Active speed probes like Proximity speed probe sensors, must be wired directly to the controllers.

Flex500 DR FTM doesn't change electrical parameters of Speed Sensor Inputs, except that the MPU input impedance will be 1000 Ω, DC (instead of 2000 Ω, DC for Flex500 single module). Rest of parameters are in accordance with Table 3-10.

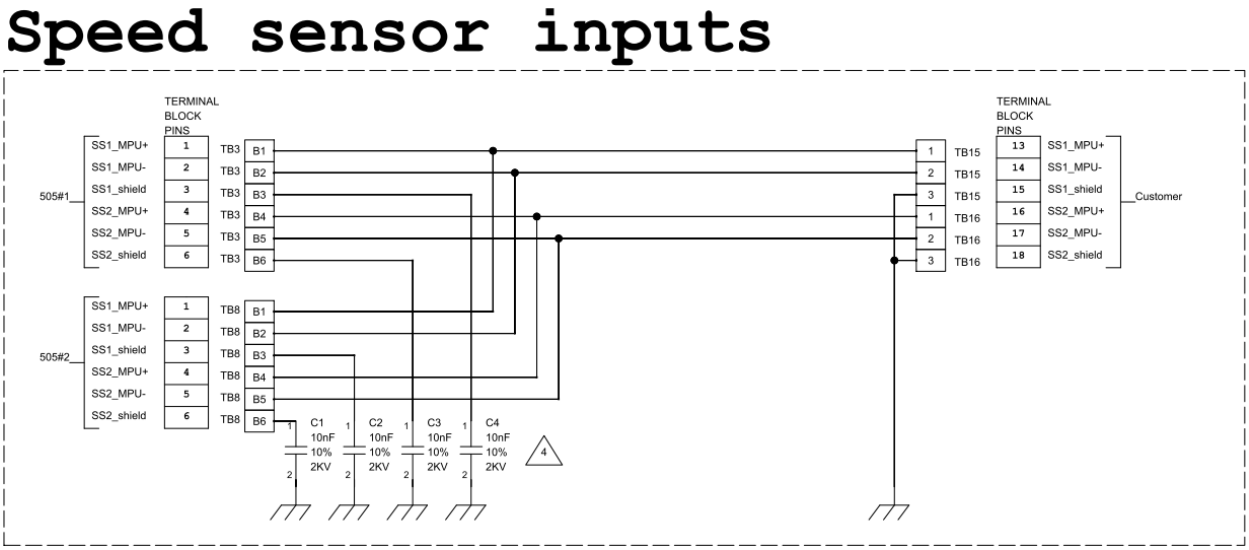


Figure A-10. Flex500 DR FTM Schematic – Speed sensor inputs.

Hardware – Analog Inputs (4-20 mA)

The Flex500 DR FTM includes field termination blocks for the first four (AIN #1 – AIN #4) 4–20 mA input channels. The channels are isolated from other circuits. Each channel on FTM is differential (self-powered) and can't be used in Loop Power mode. The other four 4-20 mA analog inputs channels (AIN #5 – AIN #8) are available on the back of Flex500 module and can be software configurable for Loop Power mode.

Using the Flex500 DR FTM doesn't change electrical parameters of Analog Inputs, with the exception of the analog input impedance which is 400 Ω (instead of 200 Ω for Flex500 single module) Rest of parameters are in accordance with Table 3-11.

Because one redundant analog input channel on the FTM is connected in series through both Flex500 modules there is required minimum 12V power source to be provided for analog input transducers to be able to drive two input load in case of one input fail.

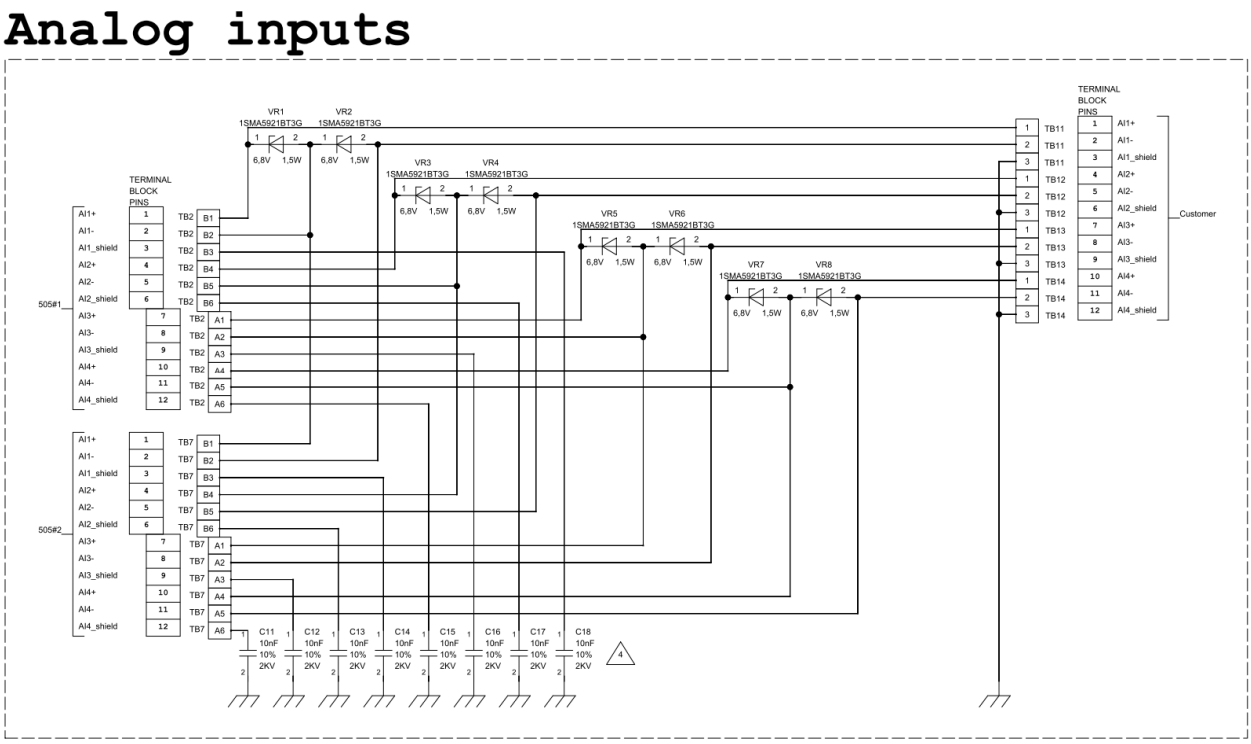


Figure A-11. Flex500 DR FTM Schematic – Analog Inputs.

Hardware – Analog Outputs (4-20 mA)

The Flex500 DR FTM includes field termination blocks for the first three 4-20 mA output (AO #1 – AO #3) channels. The other three 4-20 mA analog outputs channels (AO #4 – AO #6) are available on the back of Flex500 module and can be used independently.

Using the Flex500 DR FTM doesn't change electrical parameters of Analog Outputs. Parameters are in accordance with Table 3-12.

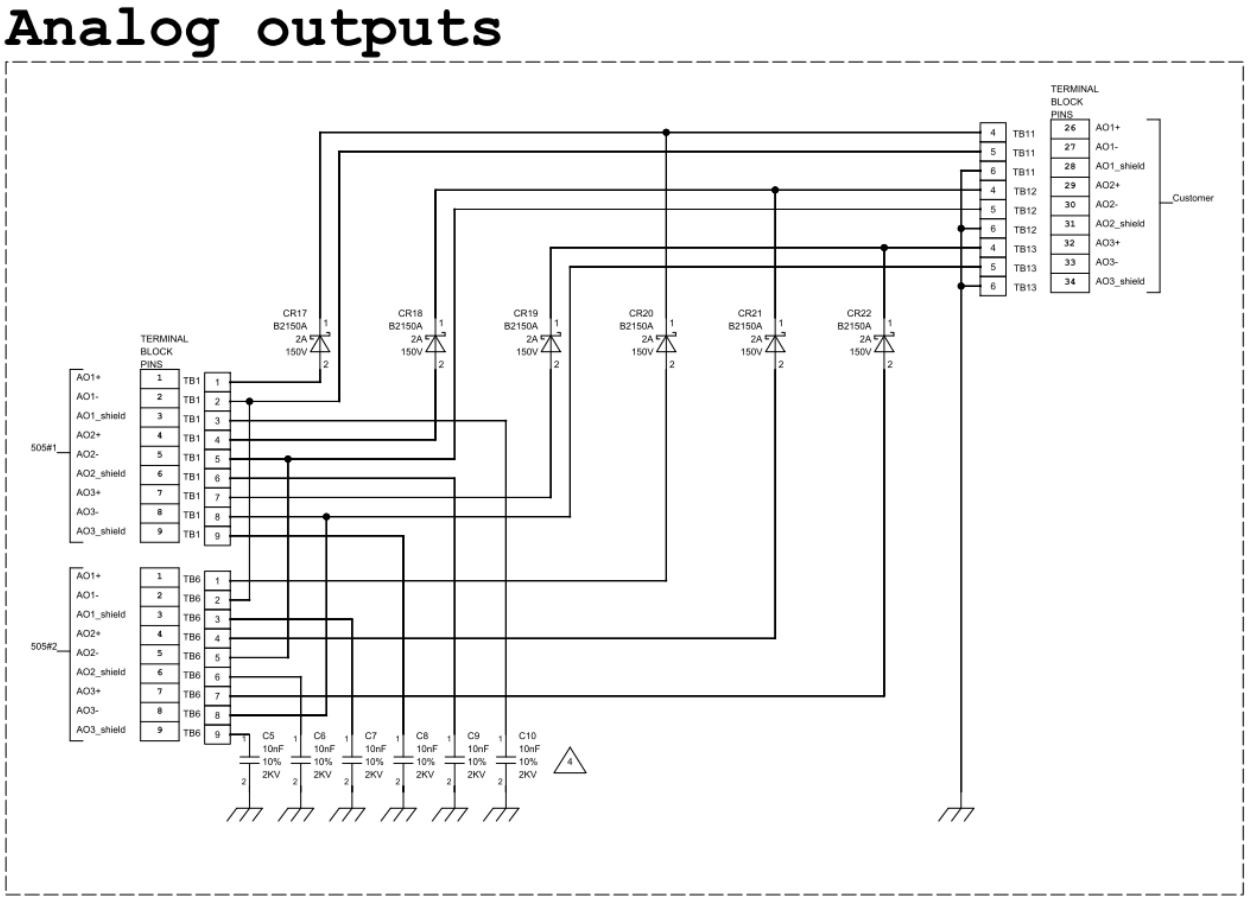


Figure A-12. Flex500 DR FTM Schematic – Analog Outputs.

Hardware – Actuator Outputs

The Flex500 DR FTM includes field termination blocks for the two actuator output (ACT #1 – ACT #2) channels. Each channel can be configured for either the low-range (20 mA) or high-range (200 mA) current circuits.

Flex500 DR FTM doesn't change electrical parameters of Actuator Outputs. Parameters are in accordance with Table 3-13.

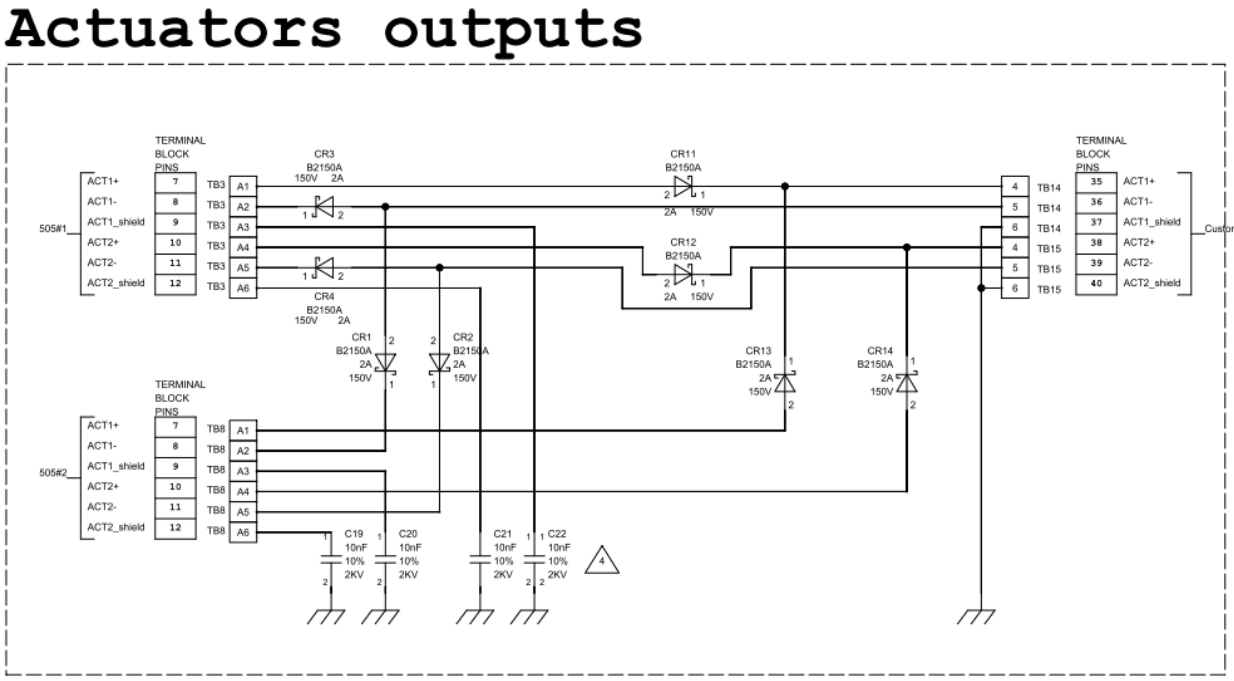


Figure A-13. Flex500 DR FTM Schematic – Actuator Outputs.

Hardware – Discrete Inputs

The Flex500 DR FTM provides an isolated group from other circuits of 7 discrete input channels (DI #13 – DI #19) for use with +24 V (dc) signals. A contact power voltage supply (DI24V_1, DI24V_2, DI_COM) of +24 V (dc) is provided for use with the discrete inputs.

Note: Do not use the contact power output to power any other devices.

Other discrete inputs channels (DI #1 – DI #12) are available on the back of Flex500 module and can be used independently.

Note: Discrete input channel DI #20 of Flex500 module is used to control interlock in redundant mode and can't be used for other purposes.

Except for DI input impedance which is approximately 12.5 kΩ per channel (instead of 25 kΩ per channel for Flex500 single module) Flex500 DR FTM doesn't change electrical parameters of discrete inputs. The remaining parameters are in accordance with Table 3-16.

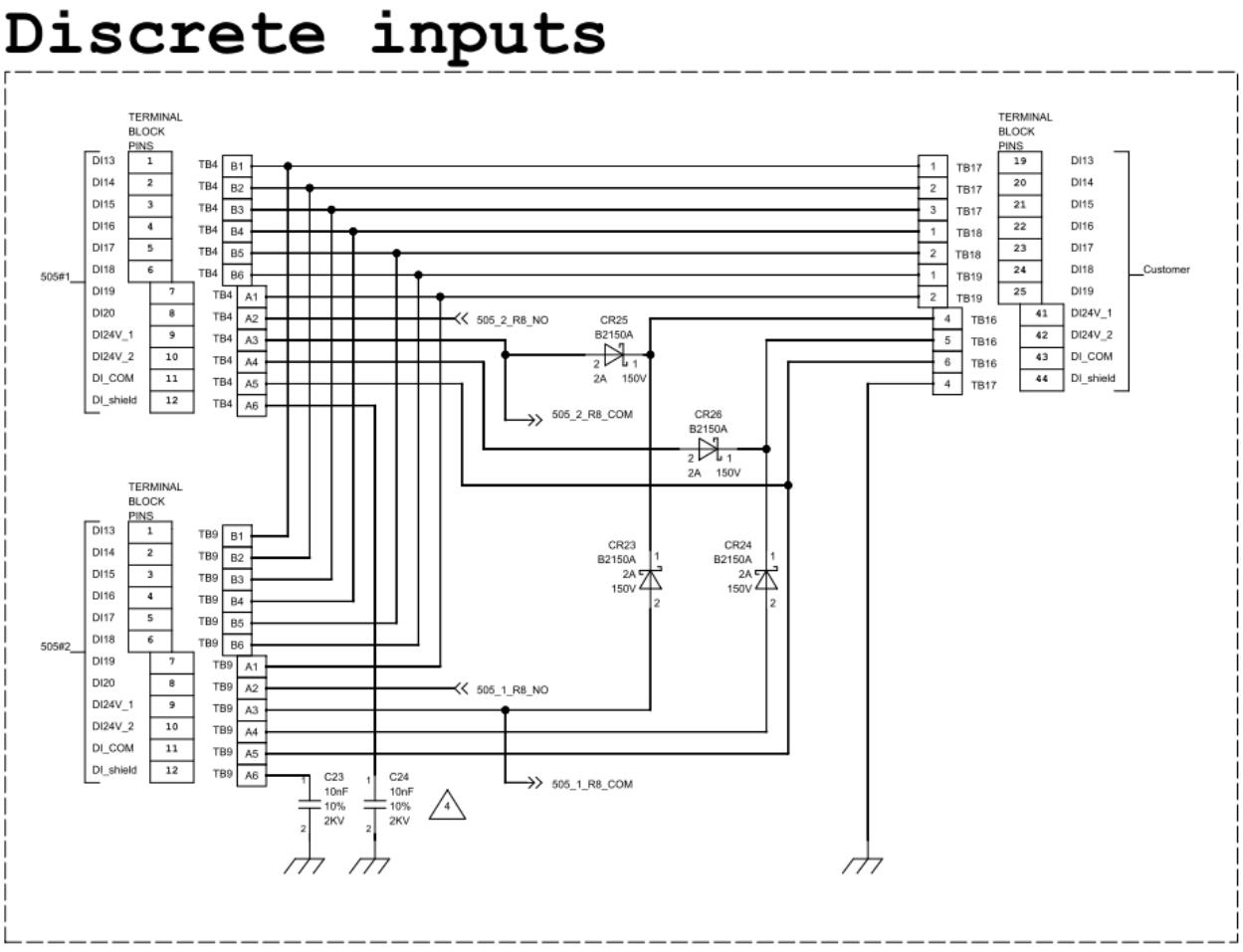


Figure A-14. Flex500 DR FTM Schematic – Discrete inputs.

Hardware – Relay Outputs

The Flex500 DR FTM provides two (RELAY #6, RELAY #7) Form-C Relay signal outputs with NO, COM, NC contacts available at the terminal block. The relays contacts are isolated from each other and other circuits.

Relay contacts for the VAC signals (115VAC, 2Amps) shall be connected to a control circuit equipped with the transformer or other source of supply providing double or reinforced insulation from the main circuits.

Note: Many power supplies meeting NEC 725.41 (B) for North America or Low Voltage Directive for EU meet this requirement.

Others relays output channels (RELAY #1 – RELAY #5) are available on the back of Flex500 module and can be used independently.

Note: RELAY #8 of Flex500 module is used to control interlock in redundant mode and can't be used in others purpose.

Table A-5. Specifications (Relay Outputs).

Number of channels	2 relays
Contact Type	Form-C with NO, COM, and NC terminals
Relay, contacts (@ 5-30 Vdc)	5 A, (resistive) 0.2-0.5A (inductive)
Relay, contacts (@ 115 Vac)	2 A (resistive) 0.1-0.2A (inductive)
Relay, operate time	< 15 ms typical
Shock resistance (malfunction)	6G, 3x each axis, 11 ms Half Sine Pulse (per MIL-STD 202F, Method 213B basic test J)
RELAY Output Isolation	1500 Vrms minimum to all I/O's (SELV) and 1000 Vrms to EARTH
RELAY Contact Isolation	1000 Vrms minimum between open contacts
RELAY to RELAY Isolation	1500 Vrms minimum between relays

Relay outputs

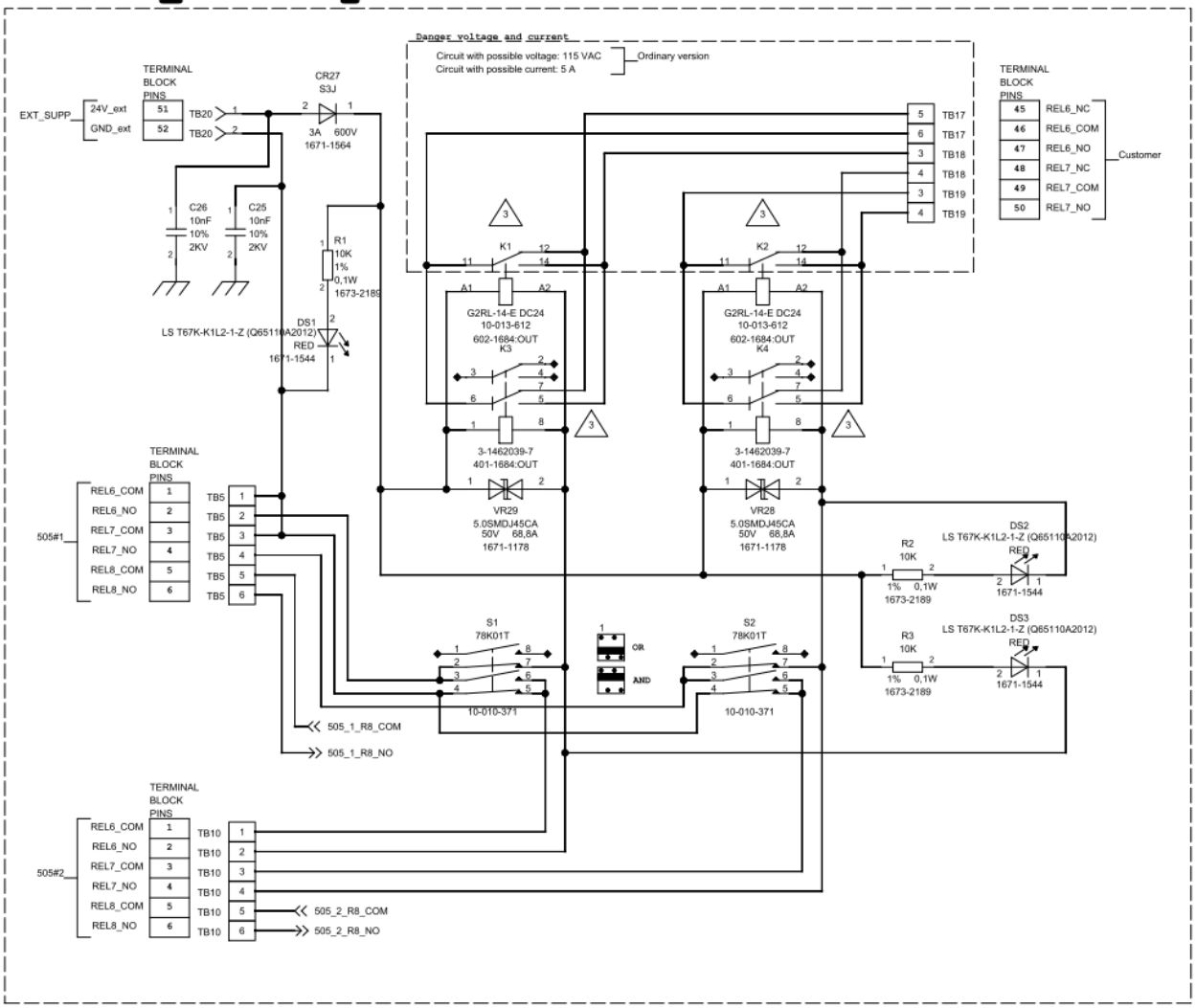


Figure A-15. Flex500 DR FTM Schematic – Relay outputs.

The relay states used on the Flex500 DR FTM is controlled by the relay states from both of the Flex500 control modules. The FTM has switches which configure the connection between the Flex500 relay contacts for operation in OR or AND logic. The S1 switch supports the REL6 relay, and the S2 switch supports the REL7 relay.

Table A-6. Relay state switches configuration.

Switch configuration	Flex500 #1 relay state	Flex500 #2 relay state	FTM relay state
OR			
	OFF (de-energized)	OFF (de-energized)	OFF (de-energized)
	ON (energized)	OFF (de-energized)	ON (energized)
	OFF (de-energized)	ON (energized)	ON (energized)
	ON (energized)	ON (energized)	ON (energized)
AND			
	OFF (de-energized)	OFF (de-energized)	OFF (de-energized)
	ON (energized)	OFF (de-energized)	OFF (de-energized)
	OFF (de-energized)	ON (energized)	OFF (de-energized)
	ON (energized)	ON (energized)	ON (energized)

Hardware – External Power Input

External power source must be provided to TB20 connector on Flex500 DR FTM. This power supply is needed to energize relays on FTM. This circuit is isolated 500 Vrms to other circuits.

Table A-7. External Power Input Specifications.

Input Voltage range:	18-30 Vdc (SELV)
Input Power (max):	< 1,5 W
Isolation to other circuits:	> 500 Vrms to all other circuits
Isolation to EARTH:	> 500 Vrms to EARTH
Reverse Polarity Protection:	100 Vdc @ 25 °C

Note: Recommend breaker or powerline fusing of 5 A min to protect the power-wiring network from possible wiring shorts.

Power Connector

Input power is provided through a three-position, latching terminal block with removable plug.

Table A-8. Input Power Connector Pinout.

Board Connection	PIN	Name	Description
	1	+	Input Power (+)
	2	-	Input Power (–)
	3	EARTH	Local earth/ shields grounding*
Plug Type: Side entry 5.08 mm, 12 A, pluggable with latching screw down			
* Shall be shorter than 20cm, copper braid preferred			

Field Signal Wiring Guidelines

The Flex500 redundant application uses a single software block (1 I/O channel) that monitors the input and provides the output for each I/O channel on the two controllers (2 circuits). Thus, the control application is expecting that each channel of each controller is connected to the same device (input or output). For example, if a single field sensor is used, it should be wired to the same channel of both controllers, as shown in examples below. If redundant field sensors are used, then 2 channels should be defined in the application. It is not recommended that different sensors be wired to the same channel of each controller.

For all signals that are wired directly to both of the controllers (those not going through the DR-FTM), the following wiring guidelines must be followed to insure that:

- Proper signal isolation using external diodes to maintain control isolation
- Proper output signal sharing/voting is provided to the end devices
- Proper signal fault detection can be done in the control application
- Replacement of an entire controller can be done without affecting turbine operation (reparability)

Field Signal Wiring examples

Speed Sensor Input

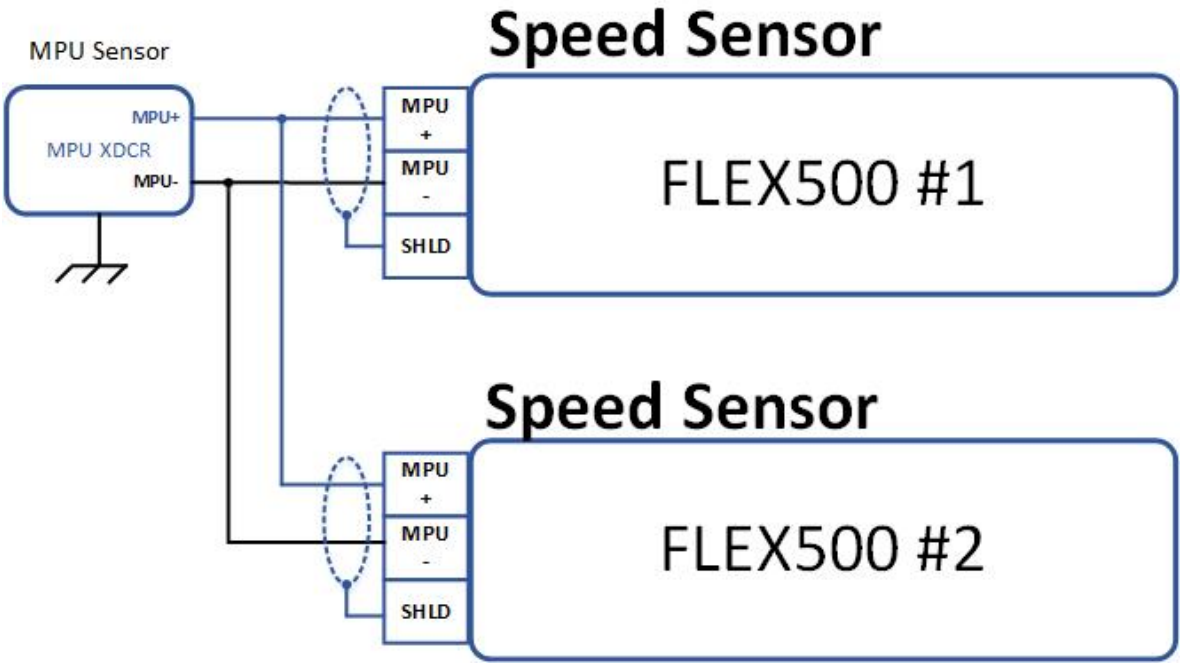


Figure A-16. Speed Sensor Input Block Diagram.

NOTICE

Redundant operation mode for the speed sensor input is only possible in MPU mode. In the PROX mode it is not possible to make a redundant connection.

Analog Input

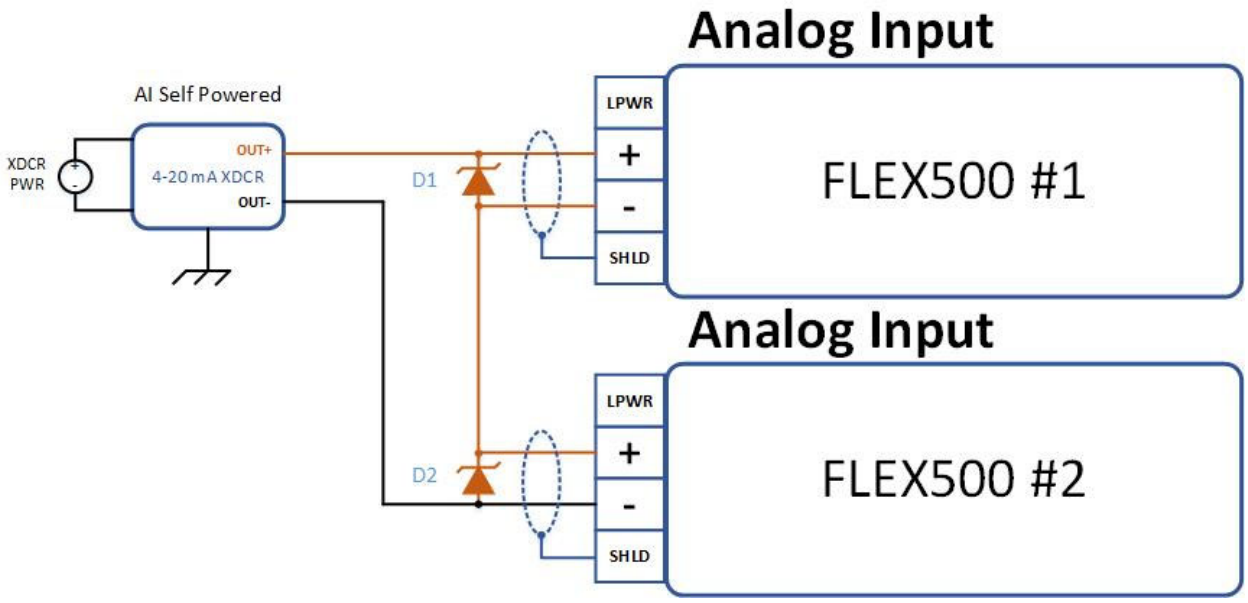


Figure A-17. Analog Input Block Diagram.

Table A-9. Analog Input Recommended External Diode

Diode	Manufacture part number
D1, D2	BZX85C6V8

NOTICE

Redundant operation mode for the analog input is only possible in Self Powered mode. It is not possible to make a redundant connection In the Loop Powered mode.

Analog Output

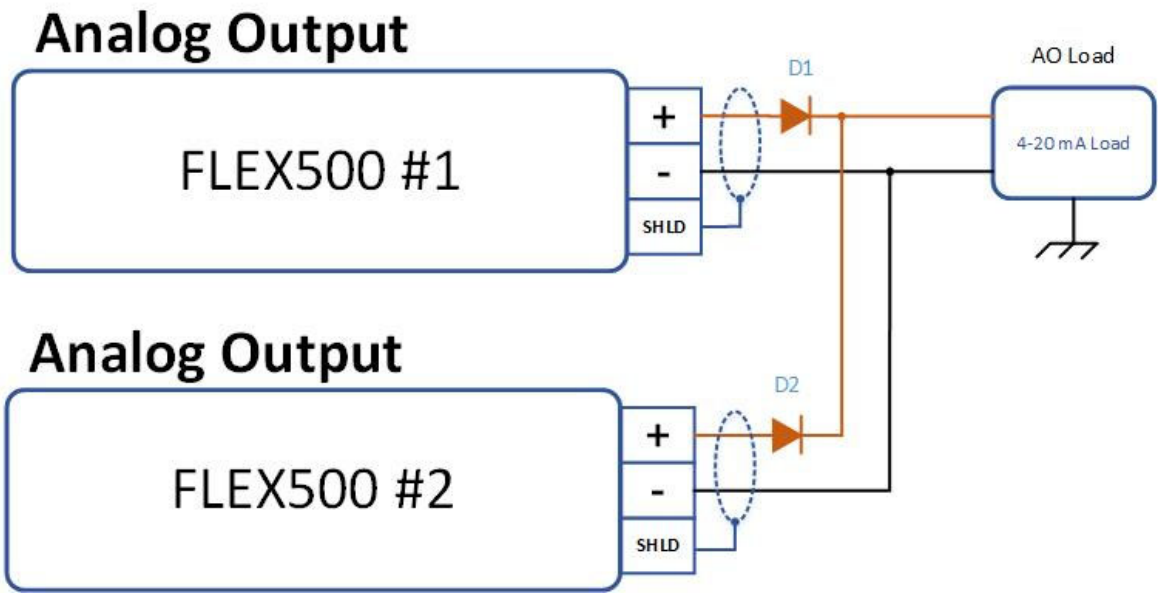


Figure A-18. Analog Output Block Diagram.

Table A-10. Analog Output Recommended External Diode

Diode	Manufacture part number
D1, D2	STPS2150

Actuator Output

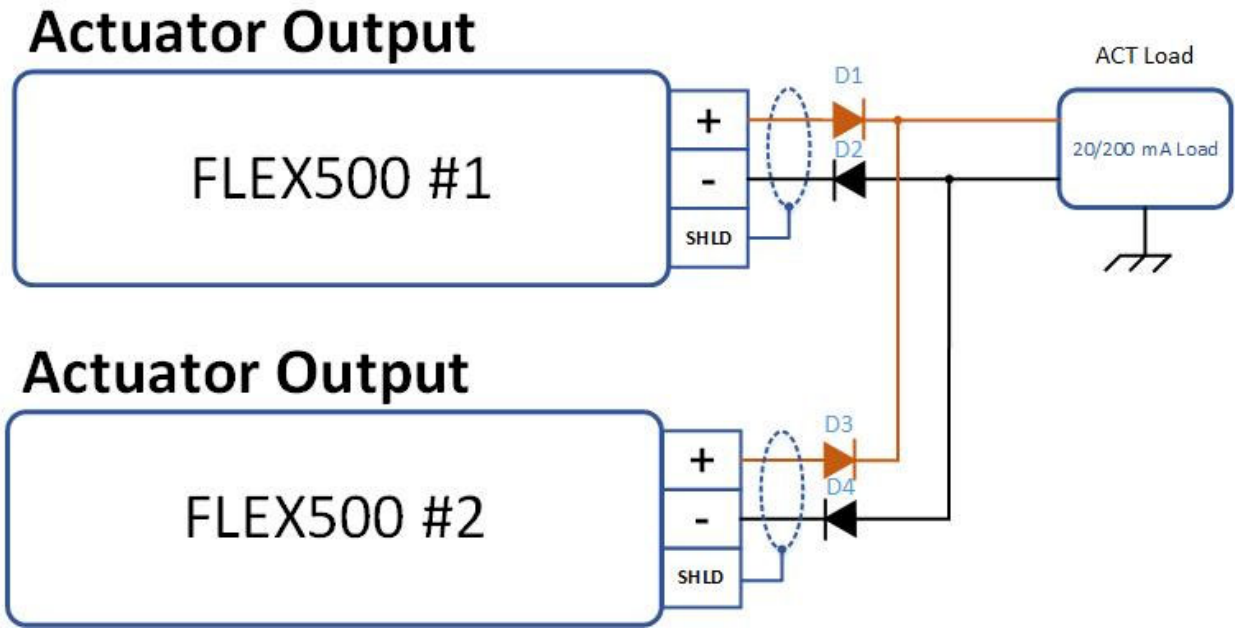


Figure A-19. Actuator Output Block Diagram.

Table A-11. Actuator Output Recommended External Diode

Diode	Manufacture part number
D1, D2, D3, D4	STPS2150

Discrete Input

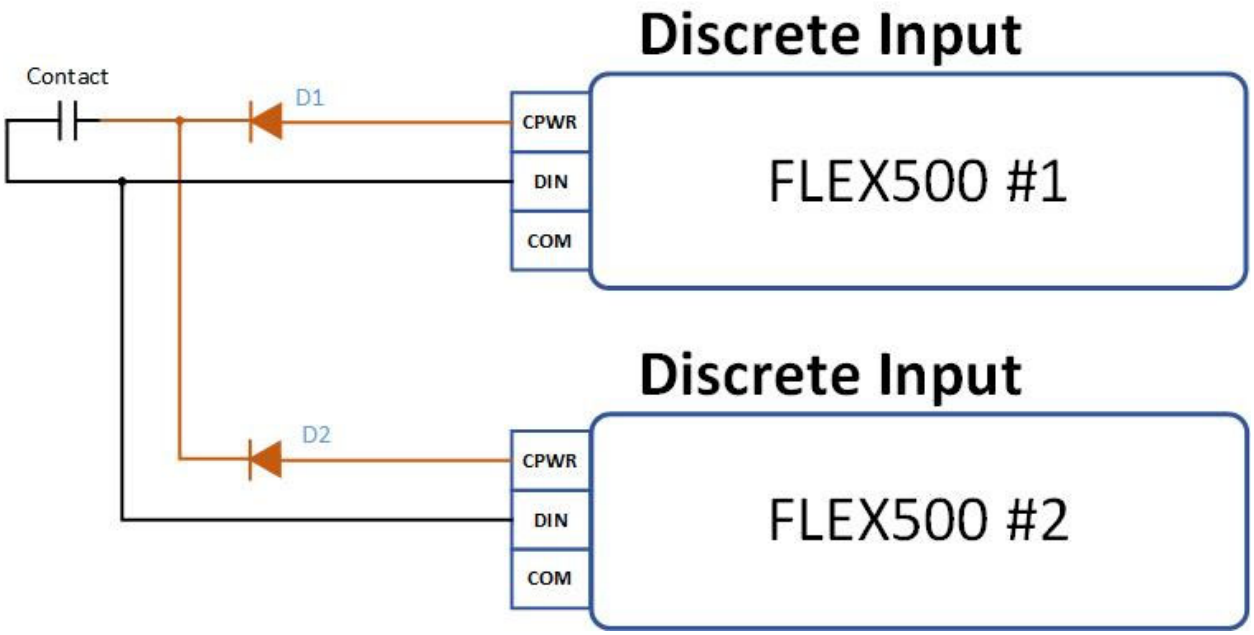


Figure A-20. Discrete Input Block Diagram

Table A-12. Discrete Input Recommended External Diode

Diode	Manufacture part number
D1, D2	STPS2150

⚠WARNING

The power supply for the digital input should be taken from the dedicated DI24V connector (2 pieces) and DI COM.
Do not connect voltage from external power input to digital input.

Relay

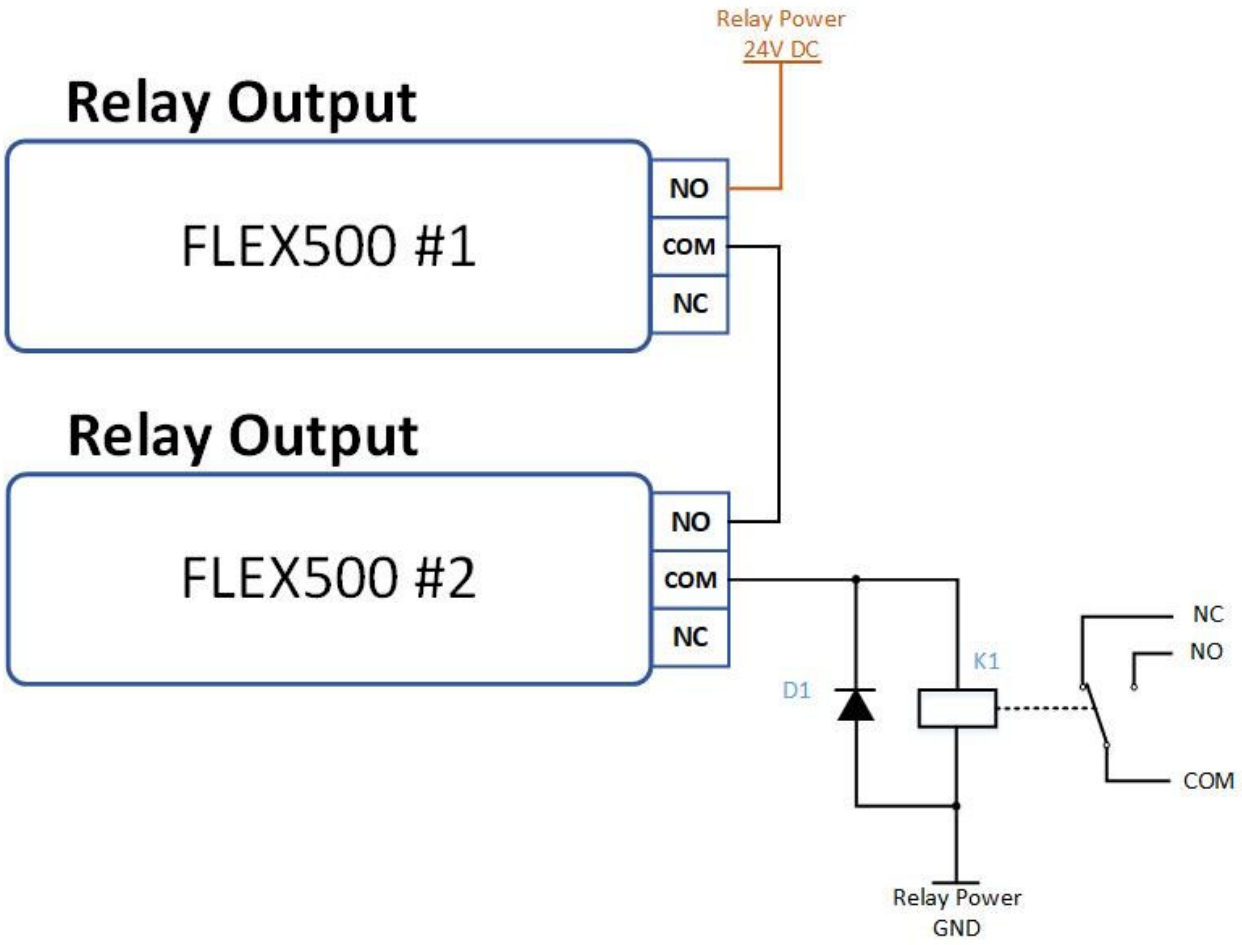


Figure A-21. Relay AND Mode Output Block Diagram.

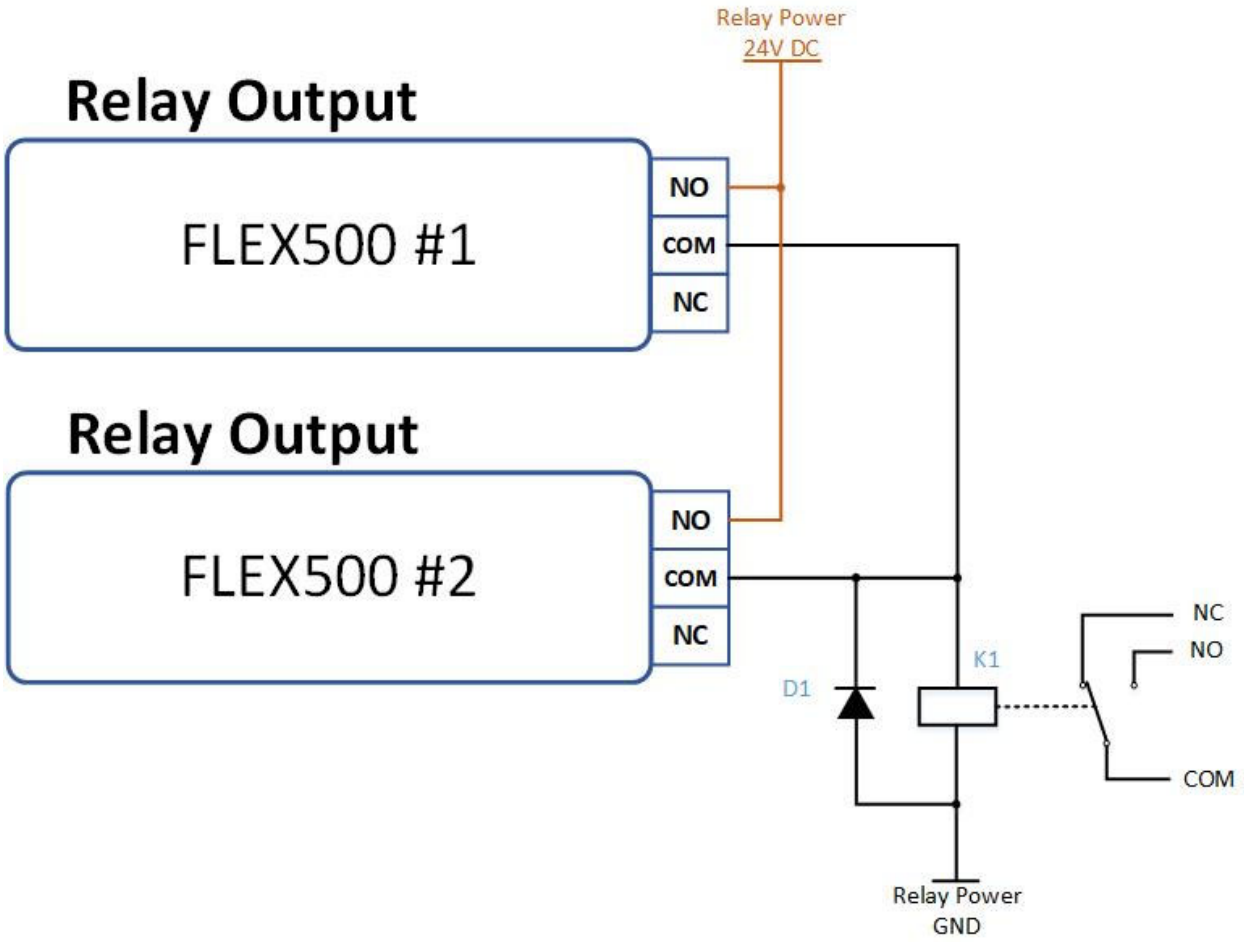


Figure A-22. Relay OR Mode Output Block Diagram.

Table A-13. Relay Output Recommended External Elements

Diode	Manufacture part number
D1	STPS2150
K1	G2RL-14-E DC24

Revision History

Changes in Revision F—
- Removed EAC info from the Regulatory and Compliance section

Changes in Revision E—
- Replaced the CSA certification reference in the Regulatory Compliance section and the third paragraph below Table A-2
- Replaced the second paragraph and added a note below the heading in the Hardware – Relay Outputs section

Changes in Revision D—
- Added RoHS Directive to Regulatory Compliance section
- Added content to the first paragraph under Special Conditions for Safe Use in the Regulatory Compliance section
- Replaced Figures 1-1, 3-1, 3-3, 3-4, and 3-6
- Added new part numbers an information to Tables 1-1 and 1-2
- Added new paragraph to page 14
- Added part number references to pages. 31 - 33
- Replaced Figures 3-6, 3-7 and 3-8
- Replaced DoC 00466-04-EU-02-01
- Added Appendix

Changes in Revision C—
- Replaced Figures 1-1, 3-1, 3-3, 3-4, and 3-6
- Updated Speed Sensor Inputs in I/O Circuits (Chapter 3)
- Replaced content in the first paragraph and under Features on pg. 33
- Replaced content under Features and in Table 3-11 on pg. 34
- Edited the Speed designations in Figure 3-8

Changes in Revision B—
- Added EAC Customs Union Certification to Compliance Section
- Added new content to the Special Conditions for Safe Use Section

Changes in Revision A—
- Flex500B images and information added throughout the manual.
- References to 505 and/or 500 have been changed to read Flex500
- Nomenclature for Flex500 OCP changed to Flex500P
- Removed Mounting Requirements (pg. 9) and Recommended Grounding Practices (pg. 10)
- Added Manual Network Setup (New Chapter 4)
- Updated figures for Flex500P
- Updated DOC and DOI

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00466-04-EU-02-02.DOCX
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	505D (LV-ATEX) 18-36Vdc P.N. 8200-1302 505XT (LV-ATEX) 18-36Vdc P.N. 8200-1312 Flex500 (LV-ATEX) 18-36Vdc P.N. 8200-1342 Flex500 Bulkhead (LV-ATEX) 18-36Vdc P.N. 8200-1352
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/EU on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)
Markings in addition to CE marking:	Ex Category 3 Group II G, Ex ic nA IIC T4X Gc IP20
Applicable Standards:	EN 61000-6-4, 2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments EN60079-0, 2012 : Explosive Atmospheres - Part 0: Equipment – General requirements EN60079-11, 2012 :Explosive Atmospheres – Part 11 : Equipment protection by intrinsic safety "i" EN60079-15, 2010 : Explosive Atmospheres - Part 15: Equipment protection by type of protection "n"

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

MANUFACTURER

Signature	
Full Name	**Christopher Perkins**
Position	**Engineering Manager**
Place	**Woodward, Fort Collins, CO, USA**
Date	**11-May-2016**

5-09-1183 Rev 26

EU DECLARATION OF CONFORMITY

EU DoC No.:	00466-04-EU-02-01
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	505D, 505XT, 505DR, Flex500, Flex500 Bulkhead, Vertex, Vertex Bulkhead and 505-HT (HV-STD) 88-264Vac, 90-150Vdc 505D, 505XT, 505DR, Flex500, Flex500 Bulkhead, Vertex, Vertex Bulkhead and 505-HT (LV-STD) 18-36Vdc FTM MODULE, FLEX500/505/VERTEX REDUNDANT
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC) Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits
Applicable Standards:	EN 61000-6-4, 2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments EN61010-1, 2010 : Safety Requirements for Electrical Equipment for measurement, control and laboratory use – Part 1 : General Requirements
Conformity Assessment:	Woodward EMC Conformity Assessment 00466-04-EU-EMC-03-05

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

MANUFACTURER

Signature

Mike Row
Full Name

Engineering Supervisor
Position

Woodward, Fort Collins, CO, USA
Place

11-December-2019
Date

5-09-1183 Rev 33

Released

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26838.

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