WOODWARD

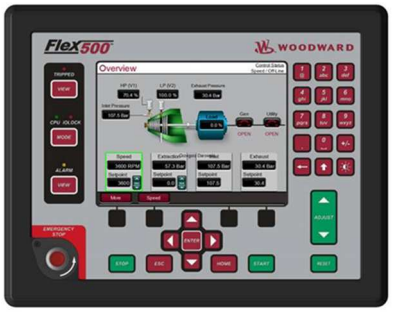
Product Specification **03433**
(Revision C, 2/2020)

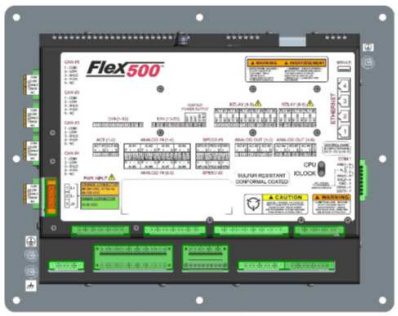
Flex500

Digital Control for Turbines, Engines, or Compressors

Applications

The Flex500 control system represents a new generation of turbine and engine control. This controller is based on a standard industrial hardware platform that offers robust, low-cost control for a wide variety of turbine, engine, and compressor applications. The platform's real-time operating system and dedicated inputs and outputs provide deterministic performance for key prime-mover-control functionality. The control is available in both Front Panel Mount (with integrated HMI) and Rear Panel Mount versions and may be configured for either Simplex or Dual-Redundant applications.





Designed to function as a distributed control system, Woodward-based RTCnet™ and/or LINKnet HT™ distributed I/O modules can be used in conjunction with this platform to expand the number and type of input and output signals as required by the specific application.

Ethernet, serial and CAN communication ports, and the related Modbus® * TCP/IP and CANopen protocols also make this platform ideal for functioning as part of an overall plant distributed control system (DCS) or as a standalone controller. Four Ethernet ports and four CAN ports allow for the network flexibility and redundancy necessary for today's critical control system architectures. The Flex500 controller is a custom-programmed hardware platform designed specifically for prime-mover-control applications such as:

- Gas turbines
- Compressor control and protection
- Gas and diesel engines
- Steam turbines
- Hydro turbines

All controller inputs, outputs, and statuses can be monitored, and all start/stop or enable/disable commands can be given, through industry-standard Modbus TCP or OPC protocols. The Flex500 platform uses SNTP (synchronized network time protocol) over Ethernet to allow users to synchronize its real-time clock to a plant distributed control system.

* Modbus is a trademark of Schneider Automation Inc.

Optionally users can apply two Flex500 controllers in a dual-redundant configuration for critical applications requiring high availability, up-time, and on-line programming changes. For these applications Woodward offers an optional dual-redundant field termination module kit, which is designed to manage I/O signal marshalling between the two Flex500 controllers as well as allow for easy installation and controller replacement.

- Powerful real-time control
- Optional integrated HMI
- Fast, accurate on-board I/O expandable with RTCnet and LinkNet HT distributed I/O modules
- Deterministic scan rates as fast as 5 ms
- 4 Ethernet and 4 CANopen ports
- Low cost, high performance alternative to a general purpose PLC
- Full Redundant Control Configurations
- On-Line Program Changes
- Sulfur-resistant conformal coating
- Certified for Hazardous Locations
- Achilles Cybersecurity certified

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Description

The Flex500 control is packaged in an industrial hardened enclosure designed to be mounted on the front panel (with HMI) or on a rear bulkhead/panel without the HMI. The unit can be mounted in a plant control room or in a cabinet next to the turbine/engine. HMI models include an 8-inch (20 cm) graphical front panel screen and keypad. Either version can be mounted within an Ordinary Location or Div2/Zone-2 Hazardous Location environment.

The control's optional front panel serves as both an engineering station and operator control panel (OCP). This user-friendly front panel allows plant operators to easily start/stop the turbine and enable/disable any control mode, as well as enabling engineers to access and service the unit as required. Password security is used to protect access to all unit operation and service modes. The optional 8-inch graphical display allows operators to view actual and setpoint values from the same screen, simplifying operation. The same screens can be used on a networked PC in the control room or maintenance office using Woodward's Remote View application.

Woodward's Control Interface Studio (CIS) is an Integrated Development Environment (IDE) that control engineers or graphical user interface (GUI) developers can use to create custom graphical user interfaces for use with the Flex500 control platform. Once installed onto a computer this software program allows users rapid development of custom GUI applications, which can be downloaded onto the Flex500 platform or to a PC or touch panel for use with Woodward's Remote View application. Refer to product spec 03448 for more information on this program.

The Flex500 controller has many tunable values allowing users (with the correct level login and password) to make system adjustments (PID settings, ramp rates, etc.) while the controller is on-line controlling a prime mover normally. With dual-redundant controller applications full on-line programming changes are possible as well.

Interface to the Flex500 control's on-board input and output channels and communication ports is located on the controller's side and lower panels (see Figure 1). Un-pluggable terminal blocks allow for easy system installation, troubleshooting, and replacement. Optionally users can increase the number and type of input and output signals to/from the Flex500 controller by utilizing and connecting Woodward's RTCnet and or LINKnet HT distributed I/O modules to the Flex500's CAN communication ports. Refer to Woodward product specification 03402 to better understand the application of RTCnet and LINKnet HT distributed I/O modules.

An FTM (Field Termination Module) with integrated harnessing is available to accommodate I/O multiplexing for dual-redundant applications.

> **Note**: the FTM is certified for use with Ordinary Location only. The FTM is not certified for use in Hazardous Location environment

The Flex500 control's on-board and remote I/O are optimized for prime mover control. This controller's 0.5 ms I/O scan times, high accuracy, and software program synchronization make it ideal for use in controlling and protecting critical high speed rotating equipment.

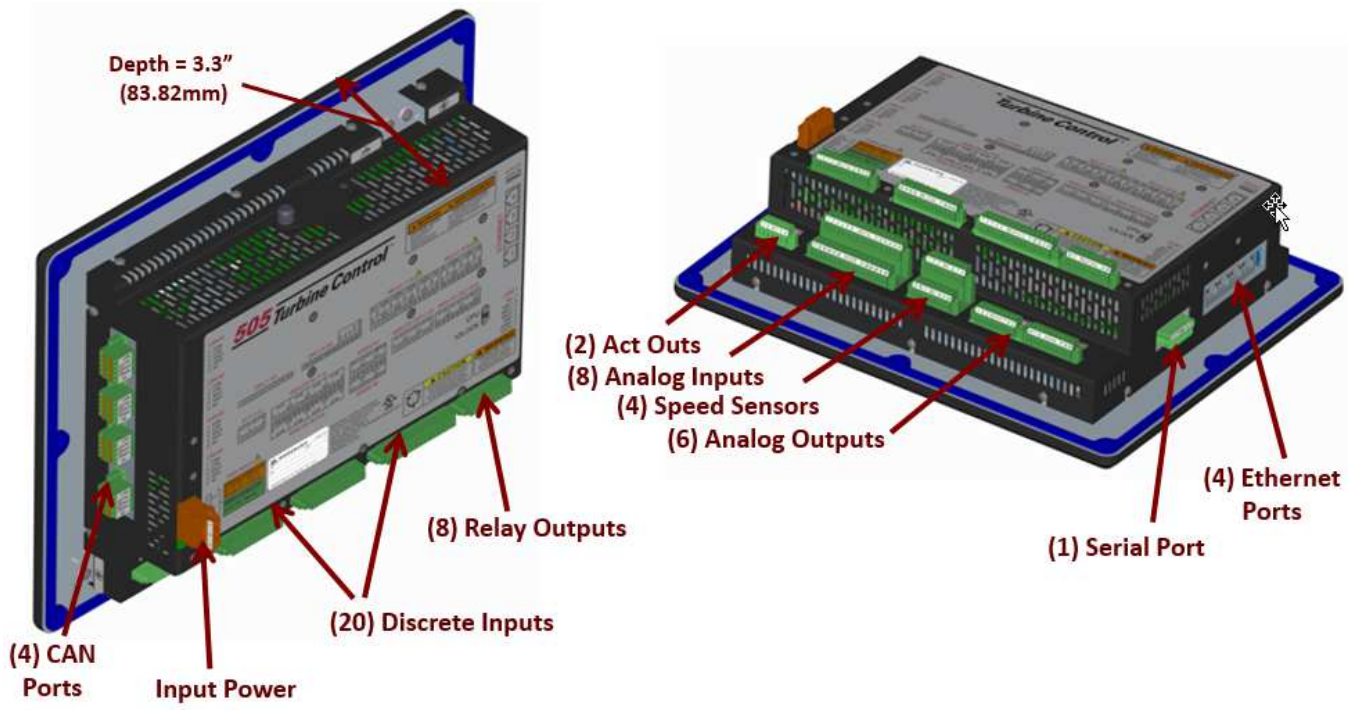

Figure 1. On-Board Inputs and Output Channels

Programming and Simulation

The Flex500 control is programmed via Woodward's industry standard GAP™ (Graphical Application Programming) environment, which has been qualified and standardized on by rotating original equipment manufacturers (OEMs) globally. This pictures-to-code programming environment allows rotating machinery experts to easily and efficiently create complex control algorithms without having to be software programming experts as well. Woodward's GAP environment is a mature IEC1131-3 compliant programming environment which allows users to program logic and algorithms using function blocks, ladder logic, and/or structured text.

One of the major advantages of Woodward's GAP language is its many libraries of field-proven function blocks designed to control and protect, turbines, engines, and compressors. These blocks of functional algorithms have been used by turbine, compressor, and engine OEMs for years to quickly and efficiently implement complex (or simple) control logic and or algorithms. Users can easily drag and drop functions into the program, then connect them via drawn lines between the function blocks.

An essential part of any complex rotating control system is the capability to test and validate the related control logic and algorithms before using it to operate/protect a real machine. Woodward's NetSim™ simulation program links the prime mover and package models (created in standard modeling packages—MATLAB®/Simulink® *, MATRIXX® **, ACSL) to the created GAP software application program. With this simulation program, the created GAP-based control code can be completely tested and validated within an office environment before field commissioning begins.

* MATLAB and Simulink are trademarks of The MathWorks, Inc.
** MATRIXX is a trademark of MATRIXX Software, Inc.

The performance of Woodward's NetSim software program is optimized to provide simulation results that correlate very tightly to actual field results. The NetSim program is often used by plants to train operators and engineering teams on how to start, operate and troubleshoot their turbine and compressor packages. Woodward's worldwide organization has unequaled turbine and engine control expertise, and are ready to assist users with creating and validating site specific simulation programs. To support its OEM and packager customers, Woodward and our channel partners can supply software tools, or entire solutions, or a variety of options in-between.

Real-Time Operating System (RTOS)

The Flex500 controller's structured scan rate and synchronized software-to-I/O architecture enforce fast, deterministic, and completely repeatable dynamic behavior. Thorough and extensive FFT testing has proven that screw-to-screw response times are exactly the same for every scan rate, regardless of what is happening elsewhere in the controller. PLCs make use of a less rigid scan rate and synchronization structures that can introduce dynamic instability as the processor becomes busy or code is added or removed.

Communications

The Flex500 control can communicate directly with plant Distributed Control Systems and/or touch-screen operator control panels through four Ethernet ports using Modbus TCP or OPC communication protocols, or via one serial Modbus port. The included serial port supports either RS-232 or RS-485 communications and can be configured to use ASCII or RTU Modbus protocols. Communications between the Flex500 control and a plant DCS can also be performed through hardwired connections.

Advantages over PLCs:

- Purpose built for turbines, engines, & compressors (deterministic response, special purpose algorithms, etc.)
- Rated for installation in hazardous and high temperature locations (skid mountable)
- Integrated graphical operator control panel reduces installation and support costs
- Scalable with Woodward distributed I/O modules designed for hazardous and high temperature locations
- Open architecture allows users with the right security level to perform software program changes as needed
- PLC based logic and related operator control panel screens can easily be added as needed
- All modules protected by sulfur/corrosive-resistant conformal coating
- Full control redundancy (Power, CPU, inputs, outputs, on-line programming) - dual redundant systems
- Simple to replace a controller or make program changes while turbine is on-line running normally
- Entire plants can standardize on one control system for all of their turbines, compressors, and, engines (difference is software program only)

Engineering Service Tools

Control Assistant Service Tool—Windows-based trend viewing tool used to view high-speed datalog captures or perform other useful utilities (program compare functions, etc.; see product specification 03201).

AppManager Service Tool—Windows-based tool used to upload and download GAP and GUI (graphical user interface) based application programs, retrieving datalog files, and starting/stopping the programs

Control Specifications

INPUTS

Power:	LV models = 18–32 Vdc HV models = 88–264 Vac & 90–150 Vdc
Speed:	2 MPU and 2 Prox with Prox Power
Discrete Inputs:	20 configurable contact inputs (optionally, additional inputs can be added via distributed I/O modules)
Analog Inputs:	8 Configurable 4–20 mA Inputs (optionally, additional inputs can be added via distributed I/O modules)

OUTPUTS

Valve/Actuator Drivers:	2 actuator outputs, 4–20 mA or 20–200 mA
Discrete Outputs:	8 configurable relay outputs (2 relays rated for 24 Vdc @ 5 A, 6 relays rated for 24 Vdc @ 2 A) (optionally, additional outputs can be added via distributed I/O modules)
Analog Outputs:	6 programmable 4–20 mA outputs (optionally, additional outputs can be added via distributed I/O modules)

COMMUNICATIONS

Ethernet:	4 ports (Modbus TCP or OPC protocols)
Serial:	1 Modbus port (ASCII or RTU) comm ports (RS-232 or RS-485 compatible)
CAN:	4 ports (CANopen protocol)

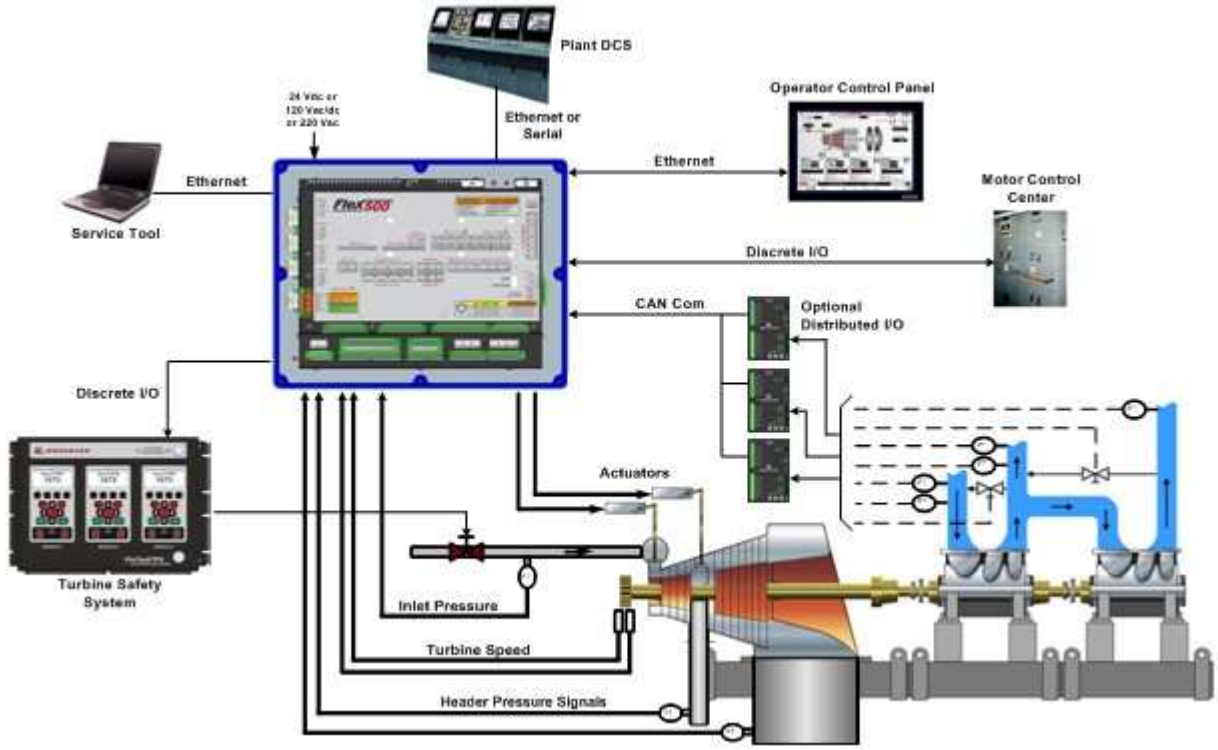

Figure 2. Typical Flex500 Application—Simplex Rear-Panel Mount

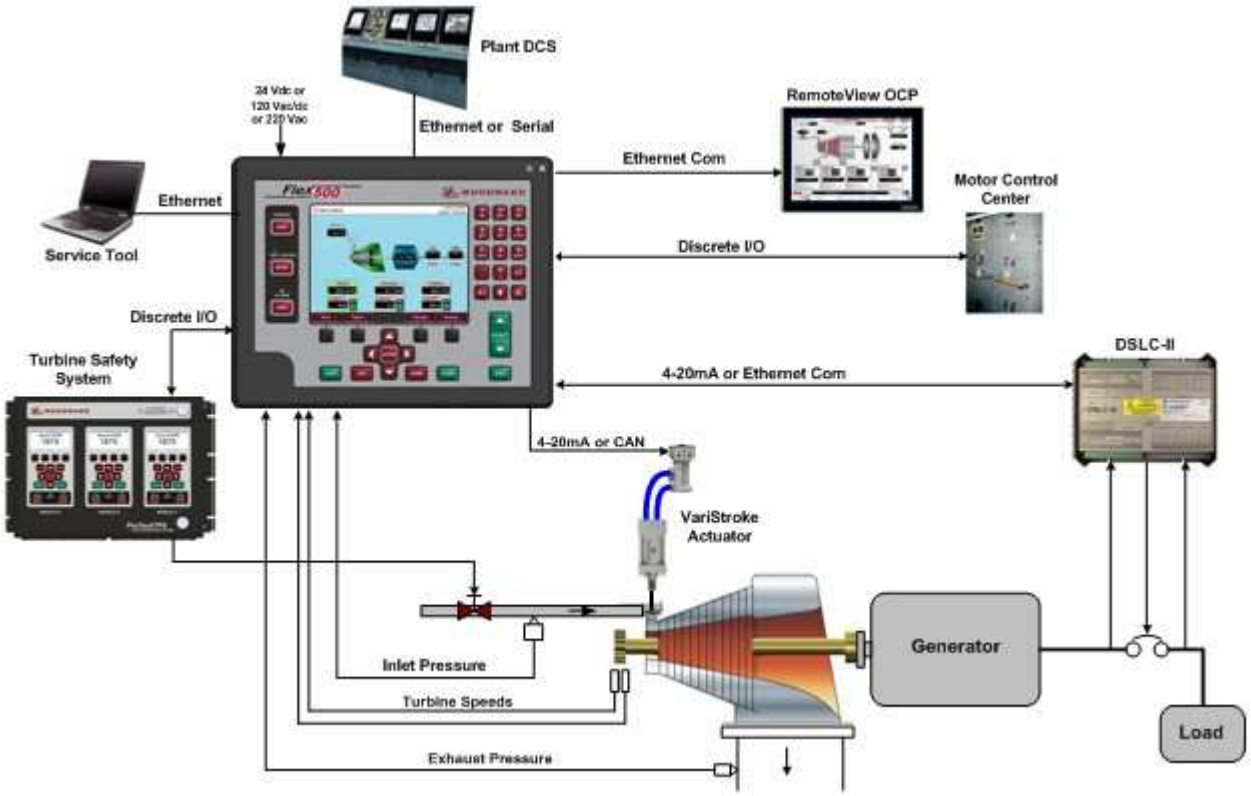

Figure 3. Typical Flex500 Application—Front Panel-Mount

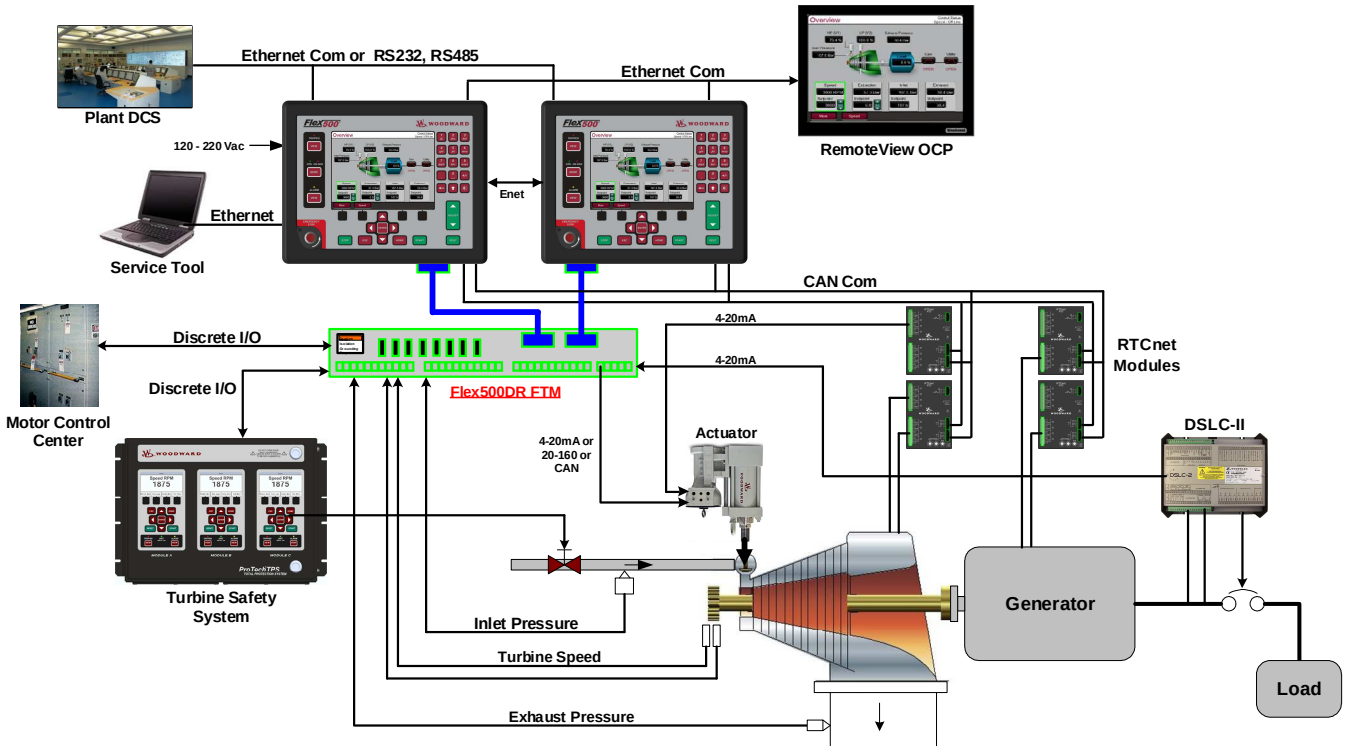

Figure 4. Typical Flex500 Application – Dual Redundant

Operating Conditions

- -30 to +70 °C ambient air temperature range with LCD/Panel Mount
- -40 to +70˚C ambient air temperature without LCD/Bulkhead Mount
- Humidity: 5% to 95% per Lloyd's ENV3 test #1
- Dry Heat: Lloyd's ENV3
- Shock: 10G, 3x Axis per Woodward MS1 Procedure
- Vibration: 8.2Grms, Industrial Skid mount per Woodward RV1
  Lloyd's ENV3, Vibration Test #1

Pollution Resistance

- Particulate Pollution Resistance: IEC 60664-1, Pollution Degree 2 (Normally only non-conductive pollution occurs).
- Gaseous Pollution Resistance: Module conformal coating withstands NO_2, CO_2, SO_2, and H_2S gases.

Regulatory Compliance

European Compliance for CE Marking

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

- EMC Directive: 2014/30/EU COUNCIL DIRECTIVE
- LVD Directive: 2014/35/EU COUNCIL DIRECTIVE
- ATEX Directive: 2014/34/EU COUNCIL DIRECTIVE II 3 G

Other International Compliance

- IECEx Ex ic nA IIC T4 Gc: Certificate No. IECEx CSA 15.0020X
- EAC CU-TR: Certified as 2Ex ic nA IIC T4 Gc X
  Note: the FTM is certified for use with Ordinary Location only. The FTM is not certified for use in Hazardous Location environment

North American Compliance

- CSA Listed for Ordinary Locations Certificate 70006135 (LR 79726)
- CSA Listed for Class I, Division 2, Groups A, B, C, and D, T4 at +70 °C: Certificate 70006135 (LR 79726)
  Note: the FTM is certified for use with Ordinary Location only. The FTM is not certified for use in Hazardous Location environment

Marine Type Approval Compliance

- Lloyd's Register (LR): Environmental Category ENV1, ENV2, ENV3, Lloyd's Register Type Approval Test Specification Number 1, 2013.
- 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, Standard for Certification No. 2.4, April 2006.

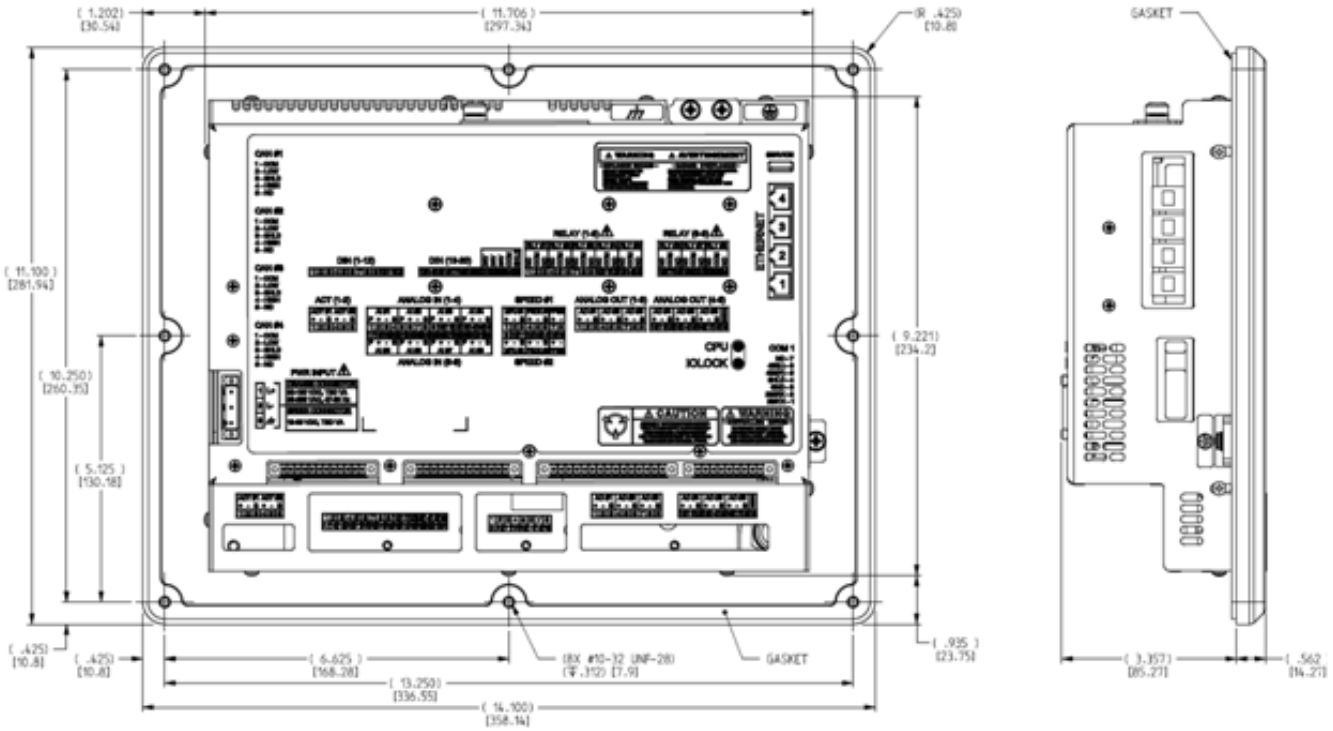

Figure 5. Flex500 Dimensions (Do not use for construction)

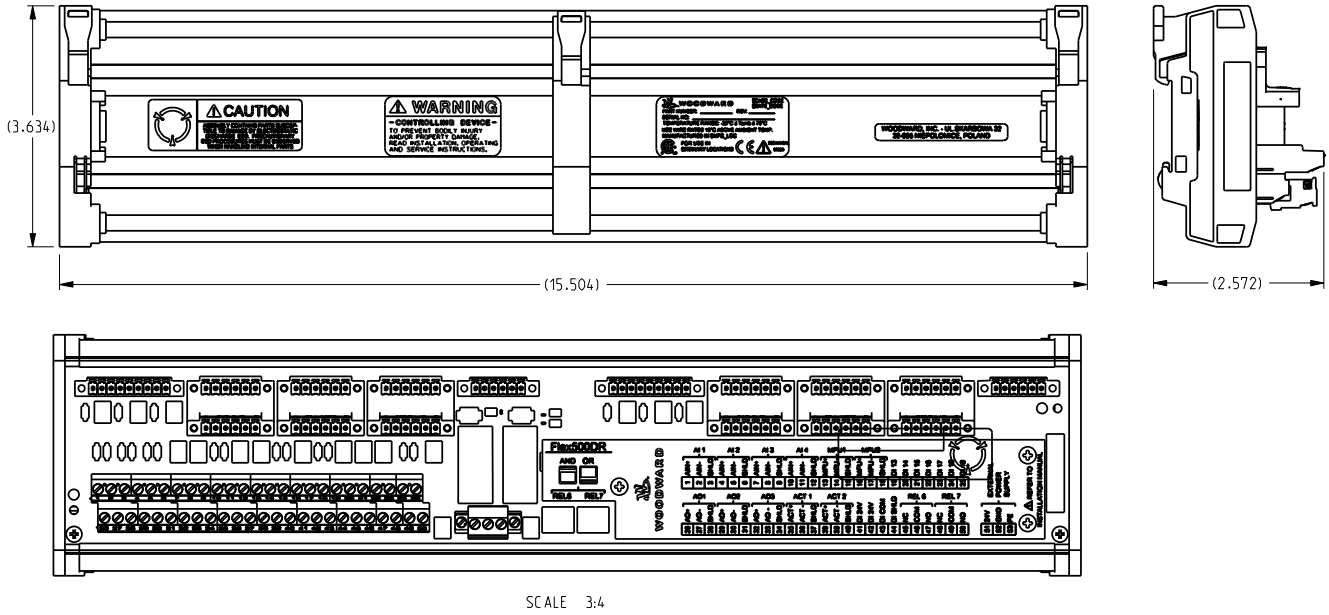

Figure 6. Flex500 FTM Outline (Do not use for construction)

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Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world. Complete address / phone / fax / email information for all locations is available on our website.

For more information contact: