WOODWARD

Product Specification **03363**
(Revision F, 2/2019)

MicroNet TMR® Control System

Applications



The MicroNet TMR® (triple modular redundant) controller is a state-of-the-art digital control platform designed to reliably control and protect steam turbines, gas turbines, and compressor trains used in system-critical applications which have risk of safety issues or large economic losses. The MicroNet TMR®'s 2-out-of-3 voting architecture ensures that problems are responded to correctly and that the prime mover continues to safely operate with or without any single-point failure. This controller's robustness, fault tolerance, accuracy, and availability make it the choice of turbine and compressor OEMs and operators around the world.

The MicroNet TMR®'s superior architecture and diagnostic coverage combine to create a system with 99.999% availability and reliability. The MicroNet TMR® can be applied as a component of protection and safety systems to allow the overall system to meet IEC61508 SIL-3 compliance standards. IEC61508 calculations and application assistance are available upon request.

- Typical MicroNet TMR® application experience and use:
- Refrigeration Compressors (Ethylene, Propylene)
- Methane and Syn Gas Compressors
- Gas Cracker Compressors
- Charge Gas Compressors
- Hydrogen Recycle Compressors
- Critical Turbine Generator Sets
- Turbine Safety Systems

For IEC61508 SIL-3 based applications, a MicroNet Safety Module (MSM) is required as part of the MicroNet system. The MSM functions as the system's SIL-3 logic solver, and it's fast (12 millisecond) response time and integrated overspeed and acceleration detection/protection functionality make it ideal for applications on critical high-speed rotating motors, compressor, turbines, or engines. For more information on the MicroNet Safety Module, refer to Woodward product spec 03375.

- IEC61508 SIL-3 Certified (requires MSM)
- Achilles CyberSecure Certified with on-board firewall
- Superior reliability and availability
- Deterministic scan rate using synchronized I/O
- On-line repairable
- On-line tunable changes
- No single points of failure
- Expandable high density I/O
- LinkNet HT distributed I/O
- IEC61131 programming tools
- OEM qualified algorithms
- Interfaces to all major DCS systems
- Engineering Support Available

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Description

The MicroNet TMR® control platform utilizes a robust rack-mounted chassis with on-line replaceable I/O modules and triple modular architecture to achieve its 99.999% availability. This triple modular redundant based system consists of three isolated kernel sections (A, B, C) housed within the platform's compact chassis. Each kernel section includes its own CPU, CPU power supply, and up to four I/O modules. The I/O modules can be used for simplex I/O, redundant I/O, triple redundant I/O, or any redundancy combination. I/O is expandable using system expansion chassis or through rugged LinkNet HT distributed I/O.

This platform's high-density modules and integrated application program provide first-out indication for monitored system events to reduce troubleshooting time. These purpose-built modules time-stamp discrete events within 1 millisecond and analog events within 5 milliseconds. The MicroNet TMR® uses two power supplies, each of which powers the control from a separate power source. Inside each power supply are three independent power converters, one for each CPU and I/O section. This triplicate power architecture provides maximum protection against single or multi-point hardware failures.

The control's special TMR® Discrete I/O modules are designed for use in critical discrete circuits. This module accepts discrete inputs and distributes these inputs to each of the separate kernel sections, as well as output relay-based contacts to drive discrete application logic. The module's special TMR® outputs utilize a six-relay configuration and integrated latent fault detection logic to allow the failure of any one or in some cases two relays without affecting the integrity of the output contact. This type of architecture allows routine relay testing to be performed as well as on-line reparability, without affecting the integrity of the output or system.

Designed from the outset as a turbine control system, the MicroNet TMR® controller's actuator driver modules are designed to interface with proportional or integrating turbine valve servos using single or dual redundant coils, with AC or DC feedback position sensors. The MicroNet TMR® control can accommodate any combination of Woodward MicroNet I/O modules and LinkNet HT distributed I/O to provide maximum application flexibility.

Available Inputs and Outputs include:

- Magnetic pickups (MPUs) and proximity probes
- Discrete I/O
- Analog I/O
- Thermocouple inputs
- Resistance temperature devices (RTDs)
- Proportional and integrating actuator drivers (integrated AC and DC position inputs)
- Ethernet and Serial communications
- Distributed Analog, Discrete, Thermocouple and RTD I/O is available with LinkNet HT

Fault Tolerance

Each of the MicroNet TMR® controller's kernel sections individually monitors all input data, performs all application calculations, and generates all output values and responses. This control's architecture allows it to operate without shutting down under any single point of failure. Architected for reliability and safety, the system's CPU fault tolerant 3-2-0 logic allows the control to function normally with any CPU module failed or removed, and ensures a safe shutdown with multiple CPU failures. An analog I/O fault tolerance logic of 3-2-1-0 allows the control to function normally with any one or two analog modules failed or removed. A discrete I/O fault tolerance logic of 3-2-1-0 allows the control to function normally with any one or two discrete modules failed or removed. A power supply fault tolerance logic of 2-1-0 allows the control to function normally with any one power supply failed or removed.

Each kernel CPU module runs the identical software program, in "lock-step" with the other two CPUs. All inputs from each kernel are distributed to the other two kernels. For each sensed input, each CPU compares its read value with the value the other two CPUs read before outputting a signal to the application software. All CPUs use the same voted input signals in the same application calculations to generate the same outputs.

All output values are then exchanged between kernels, the results are voted, and the appropriate value is output.

Programming

The MicroNet TMR® control system provides an IEC1131-3 environment for programming. Application code is generated by use of Woodward's GAP™ Graphical Application Programming environment or Woodward's Ladder Logic programming environment.

- Function Block Programming — through Woodward GAP
- Sequential Function Chart Programming — through Woodward GAP
- Ladder Logic Programming — through Woodward Ladder Logic Programmer

The MicroNet TMR® operating system together with Woodward's GAP programming language produces a powerful control environment designed for control and protection of industrial turbines and compressors of all sizes. The MicroNet platform's unique rate group/scan rate structure ensures that control functions execute deterministically at the defined rates, with critical control loops processed within 5 milliseconds, and rotor speed and acceleration sensed at 100 microsecond scan rates. This ultra-fast sampling coupled with its deterministic architecture allow the MicroNet TMR to quickly and reliably respond to system transients, failures, and or safety events.

Communications

The MicroNet TMR® platform's open-architecture easily interfaces with plant DCSs, HMIs, and distributed I/O devices for system operation, as well as control programming and service. Multiple communication ports and protocols are available for system communications, allowing users to select their desired communication method and level of communication redundancy. MicroNet-to-DCS communications have been performed and qualified with all major DCS vendors. The following communication ports are available for use:

- Ethernet ports (10/100 BaseT)
- RS-232/-422/-485 Serial ports
- CANOpen network for LinkNet HT® Distributed I/O Modules

Protocols Supported:

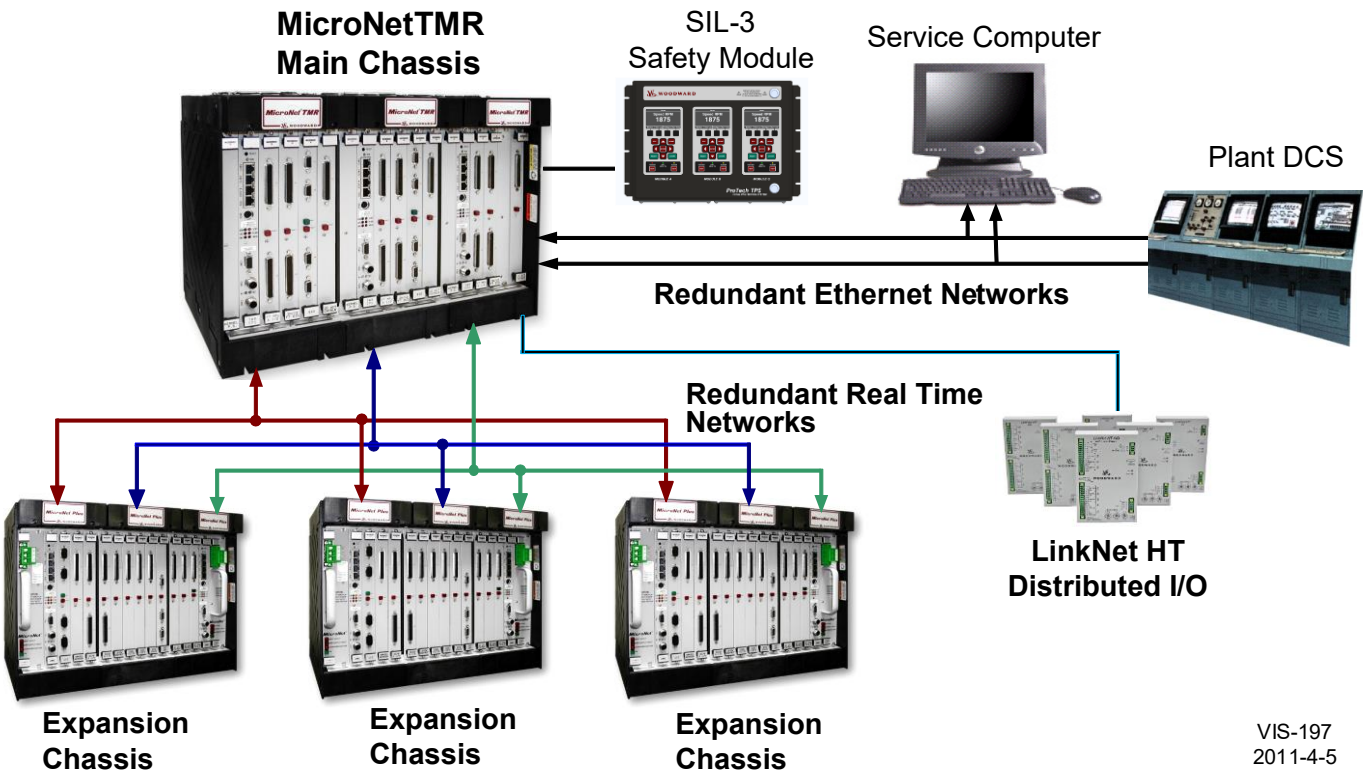
- Modbus® * (Serial or Ethernet)
- Ethernet TCP/IP & UDP
- OPC (OLE for Process Control)
- Printer Drivers, Modems, Data Loggers

*—Modbus is a trademark of Schneider Automation Inc.

Woodward also offers a suite of software service-tools to simplify system troubleshooting and service. These tools provide high-speed (5 milliseconds) operational and analytical information such as graphical display of operating data, historical trending, event logging, X-Y plotting, system overviews, calibration pages, and other functions.

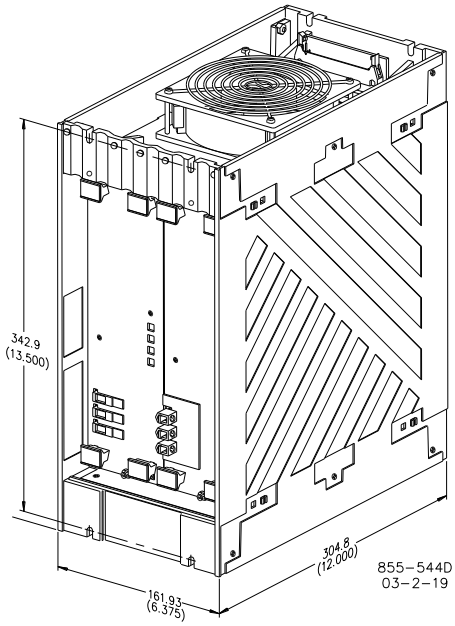
Expandability

The MicroNet TMR® platform is expandable using 8- or 14- slot expansion chassis as needed for large systems. The expansion chassis will support any mix of standard MicroNet I/O. Redundant "Real-Time Ethernet" networks are utilized between main and expansion chassis to ensure a fast and reliable communications. The TMR® architecture allows all remote I/O points to be automatically shared with each kernel CPU, increasing system robustness and availability.



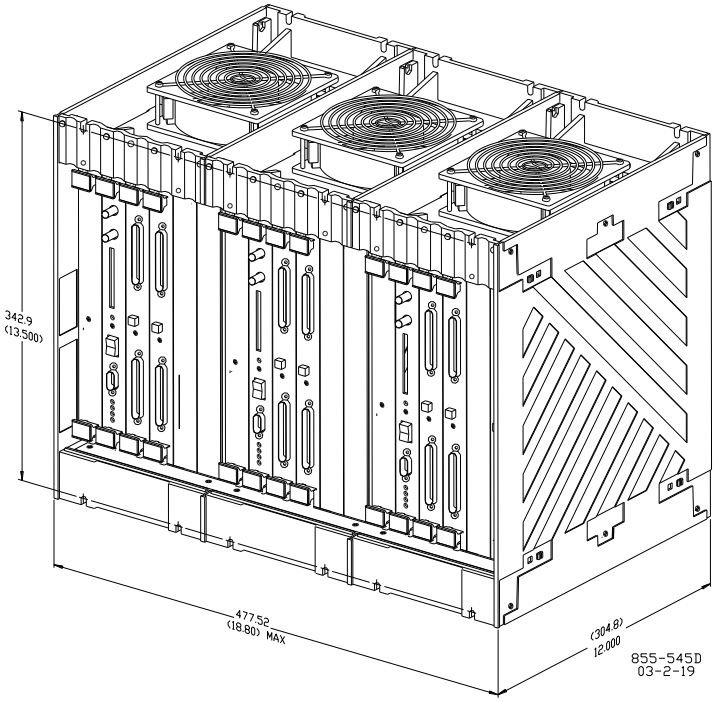
Typical MicroNet TMR® System Architecture





MicroNet TMR® Power Supply Chassis (Do not use for construction)





MicroNet TMR® Control Chassis (Do not use for construction)

Specifications

Operating Conditions

Temperature
(0 to 55) °C / (32 to 131) °F ambient air temperature range
Shock
US MIL-STD-810C, method 516.2-1, procedure 1B
Vibration
Lloyd's ENV2 test #1
Emissions *
EN61000-6-4
Immunity *
EN61000-6-2
Certifications *
CE, CSA (Class I, Division 2)
Cybersecurity Certification
Achilles Level 1 Certification, Certificate #432-012919
Other International Compliance
TÜV: TÜV certified for SIL-3 per IEC 61508 Parts 1-7, Function Safety of Electrical / Electronic / Programmable, Electronic Safety Related Systems (requires MicroNet Safety Module)

MicroNet TMR® Chassis —18 slot chassis

Bulkhead mounted or adaptable to 483 mm (19 inches) rack mount back panel.
Control Chassis Dimensions
478 mm wide x 363 mm high x 307 mm deep (18.8 inches wide x 14.3 inches high x 12.1 inches deep)
Control Chassis Weight
25 kg (55 lb)
Power Chassis Dimensions
163 mm wide x 363 mm high x 307 mm deep (6.4 inches wide x 14.3 inches high x 12.1inches deep)
Power Chassis Weight
7 kg (16 lb)

Power Supply Input Options

(18 to 36) V (dc), (100 to 150) V (dc), (88 to 132) V (ac) / (47 to 63) Hz, (180 to 264) V (ac) / (47 to 63) Hz

*—Specifications apply to most components and modules. Some certifications may be pending. Contact Woodward for further information. Do not use the drawings in this specification for construction.

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