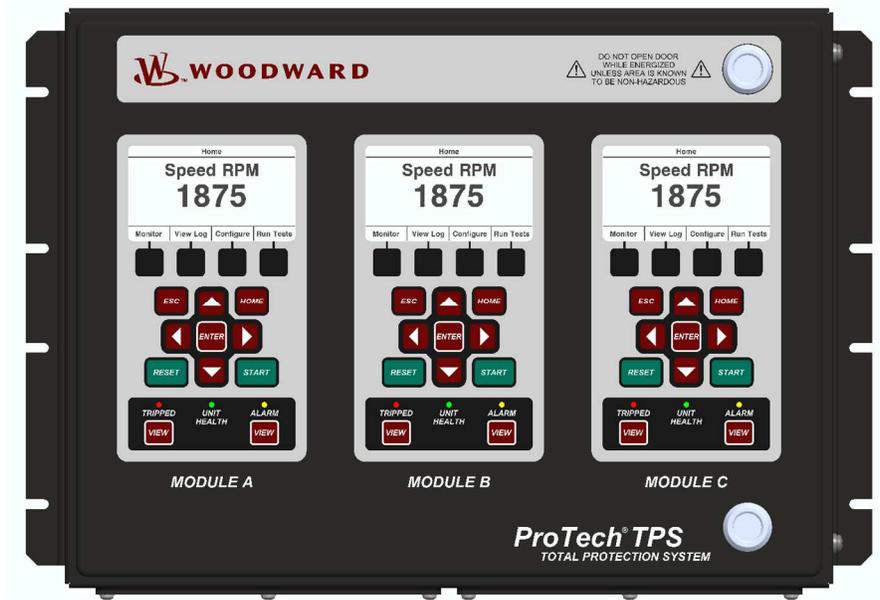




**Product Manual 26501V1
(Revision H, 10/2020)
Original Instructions**



**ProTech® TPS
Total Protection System**

Manual 26501 consists of 2 volumes (26501V1 & 26501V2)

Volume 1—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

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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.



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

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Warnings and Notices

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.
Overspeed / Overtemperature / Overpressure	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	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:
Personal Protective Equipment	<ul style="list-style-type: none"> • Eye Protection • Hearing Protection • Hard Hat • Gloves • Safety Boots • Respirator <p>Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.</p>

! WARNING	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.
Start-up	

NOTICE**Battery Charging
Device**

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

Electrostatic Discharge Awareness

NOTICE**Electrostatic
Precautions**

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

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

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
 - Do not touch any part of the PCB except the edges.
 - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
 - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Regulatory Compliance

European Compliance for CE Marking

- 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)
- Low Voltage Directive:** Directive 2014/35/EU on the harmonisation 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
- ATEX – Potentially Explosive Atmospheres Directive:** Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
II 3 G, Ex nA IIC T4

Other European Compliance

Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:

- 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

- CSA:** Certified for Class I, Division 2, Groups A, B, C, and D, T4 at 60 °C Ambient for use in the United States and Canada.
Certificate 160584-2217246

Other International Compliance

- Australia (& New Zealand):** **RCM:** Compliance is limited to application for those units bearing the Regulatory Compliance Mark (RCM). *Only EMC is applicable in virtually all Woodward intended applications.* RCM on WWD products is very limited due to allowed exemptions from applying the RCM or having a DoC
EMC: Electromagnetic Compatibility (EMC) Declaration of Conformity (DoC) RCM requirements for the Australian (& New Zealand) Radiocommunications Act is a separate document only created for products applying the RCM to the label. Products with a RCM on the label have an EMC Declaration of Conformity available: Woodward products typically comply with at least CISPR11 Group1, Class A emissions limits, Electromagnetic Interference (EMI) testing, even if not marked with the RCM: *as long as the “CE mark” is on the label.*
- TÜV:** TÜV certified for SIL-3 per IEC 61508 Parts 1-7, Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems

**WARNING****The controller may only be installed in Class 2 Hazardous areas.**

Other Compliance

Gas Corrosion: IEC60068-2-60:1995 Part 2.60 Methods 1 and 4 (conformal coating)

Machinery Protection: API670, API612, & API-611 compliant

Special Conditions for Safe Use

This Equipment is Suitable for use in Class I, Division 2, Groups A, B, C, D or Non-Hazardous Locations Only.

This equipment is suitable for use in European Zone 2, Group IIC environments or Non-Hazardous Locations Only.

Wiring must be in accordance with North American Class I, Division 2, or European Zone 2, Category 3 wiring methods as applicable, and in accordance with the authority having jurisdiction.

A fixed wiring installation is required, and 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 and that is clearly marked as the disconnecting device for the equipment. The switch or circuit breaker shall not interrupt the protective earth conductor.

Protective Earth Grounding is required by the input PE terminal.

Field wiring must be rated at least 85 °C for operating ambient temperatures expected to exceed 50 °C.

For European ATEX compliance on panel mount models, this equipment must be installed in an area providing adequate protection against the entry of dust or water. A minimum ingress protection rating of IP54 is required for the enclosure.

Personnel must discharge their electrostatic build up to the cabinet ground point or use an ESD strap prior to touching the ProTech® interior surfaces if the engine/turbine is operational. The unit is designed to have one of three modules be removed during operation; however, ESD to the remaining operational modules may cause signal deviations. Signal deviations due to direct ESD may be large enough to result in the operational module to trip, shutting down the engine since two modules are in a tripped mode. Signal deviations were noted when ESD testing was done to the Speed pins, the IRIG-B pins, Service Port pins, and RS-232/RS-485 Modbus communications port pins.

**WARNING****Do not remove module unless module is de-energized, and all wire connections have been disconnected**

The Service Port (RS-232 communication) is not designed to remain connected during operation except at servicing & programming intervals. It should not have a cable connected to it other than during programming and servicing.

This device contains a single cell primary battery. This battery is not to be charged and is not customer replaceable.

Control is suitable for installation in pollution degree 2 environments.

**WARNING**

Measurement inputs are classified as permanently connected IEC measurement Category I and are designed to safely withstand occasional transient overvoltages up to 1260 Vpk. To avoid the danger of electric shock, do not use these inputs to make measurements within measurement categories II, III, or IV.

**WARNING**

Explosion Hazard—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

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

**AVERTISSEMENT**

Risque d'explosion—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

Safety Symbols



Both direct and alternating current



Alternating current



Direct current



Caution, risk of electrical shock



Caution, refer to accompanying documents



Protective conductor terminal



Frame or chassis terminal

Acronyms and Definitions

2oo3	2-out-of-3
Block Identifier	The identifier used for each logic block for configuration purposes (Chapter 9)
CAN	Controller Area Network
DC	Diagnostic Coverage
DCS	Distributed Control System
Module	Functionality contained within one of the three identical sections
MPU	Magnetic Pick-up
PC	Personal Computer or laptop with Windows operating system
PCT	Programming and Configuration Tool
PFD	Probability of Failure on Demand
PFH	Probability of dangerous Failure per Hour
PLC	Programmable Logic Controller
PROX	Proximity Probe
RTU	Remote Terminal Unit
Settings-File	A file that contains the configuration settings loaded with the ProTech Service Tool (.wset)
TPS	Total Protection System

Chapter 1.

General Information

Description

The ProTech® TPS (Total Protection System) is a safety system that provides specialized overspeed protection functions plus additional programmable logic and configurable inputs and outputs to address other safety critical functions.

The ProTech® TPS consists of three independent modules whose trip outputs are either independent or voted in a 2-out-of-3 configuration.

The ProTech® TPS includes Alarm, Event, and Trip log functions with timestamping. Indication that a test was active at the time of the event are provided on all logs and first-out indications are provided for Event and Trip logs. Trip response time monitoring and logging is also built into the ProTech® TPS.

The ProTech® TPS provides various pre-defined and user-definable test features including automated periodic tests.

There are several ways to interface with the ProTech® TPS. The front panel of allows the user to view current values and perform certain configuration and test functions. All the features and most of the information available from the front panel is also accessible via the Modbus® * interface. Finally, the Programming and Configuration Tool (PCT) is software that is run on a PC to define configurable inputs and programmable logic, download log files, and manage settings files.

*—Modbus is a trademark of Schneider Automation Inc.

This product is designed for critical applications and when installed correctly meets API-670, API-612, API-611, and IEC61508 (SIL-3) standards.

The following table shows the various hardware configurations (mounting options, power supplies, and trip relay options) available:

Table 1-1 Available ProTech® TPS Models

Part Number	Description
8237-1248	ProTech TPS, Bulkhead Mount, HV/LV, Indep Relay
8237-1371	ProTech TPS, Panel Mount, HV/LV, Indep Relay
8237-1249	ProTech TPS, Bulkhead Mount, HV/HV, Indep Relay
8237-1372	ProTech TPS, Panel Mount, HV/HV, Indep Relay
8237-1250	ProTech TPS, Bulkhead Mount, HV/LV, voted Relays
8237-1373	ProTech TPS, Panel Mount, HV/LV, voted Relays
8237-1251	ProTech TPS, Bulkhead Mount, HV/HV, voted Relays
8237-1374	ProTech TPS, Panel Mount, HV/HV, voted Relays
5437-1117	Spare Module for 8237-1248 Rev D or later, -1371 Rev B or later
5437-1118	Spare Module for 8237-1249 Rev D or later, -1372 Rev B or later
5437-1115	Spare Module for 8237-1250 Rev E or later, -1373 Rev B or later
5437-1116	Spare Module for 8237-1251 Rev E or later, -1374 Rev B or later
5437-1076	Spare Module for 8237-1248 Rev C or earlier, -1371 Rev A or earlier
5437-1077	Spare Module for 8237-1249 Rev C or earlier, -1372 Rev A or earlier
5437-1066	Spare Module for 8237-1250 Rev D or earlier, -1373 Rev A or earlier
5437-1075	Spare Module for 8237-1251 Rev D or earlier, -1374 Rev A or earlier

Applications

The ProTech® TPS is designed to be applied as a safety system for any size steam, gas, or hydro turbine, reciprocating engine, or plant process equipment. This safety PLC's fast (12 millisecond) response time, 0.5 to 32 000 rpm speed range, and integrated overspeed and acceleration detection/protection functionality, make it ideal for application on critical low-speed or high-speed rotating motors, compressor, turbines or engines. This standalone safety device accepts 10 discrete or analog inputs per module (30 total) and one speed (MPU or PROX) input (3 total). Each ProTech® TPS module provides 3 programmable relay outputs (9 total) and an analog speed output (3 total) in addition to the trip relay outputs. Configurable logic allows the customization required to meet specific application requirements to ensure plant protection.

The ProTech® TPS utilizes a triple modular redundant architecture and 2-out-of-3 voting logic to accurately determine unsafe conditions and ensure that no single-point failure will affect system reliability or availability. With this design, system failures (switches, transducers, modules) are detected, annunciated, and allowed to be repaired or replaced while the monitored system continues to operate on-line.

Alternatively, this standalone safety device can be configured to protect any plant system or device and report the system's device's status to the plant DCS. The ProTech® TPS control's versatile inputs, outputs, programming environment, and communications make it ideal as a safety protection device for use in small applications that could possibly reach an unsafe state or condition and that must communicate directly to the plant DCS. The ProTech® TPS is designed for critical applications where both personnel safety and unit availability (operation run time) is a concern or necessity.

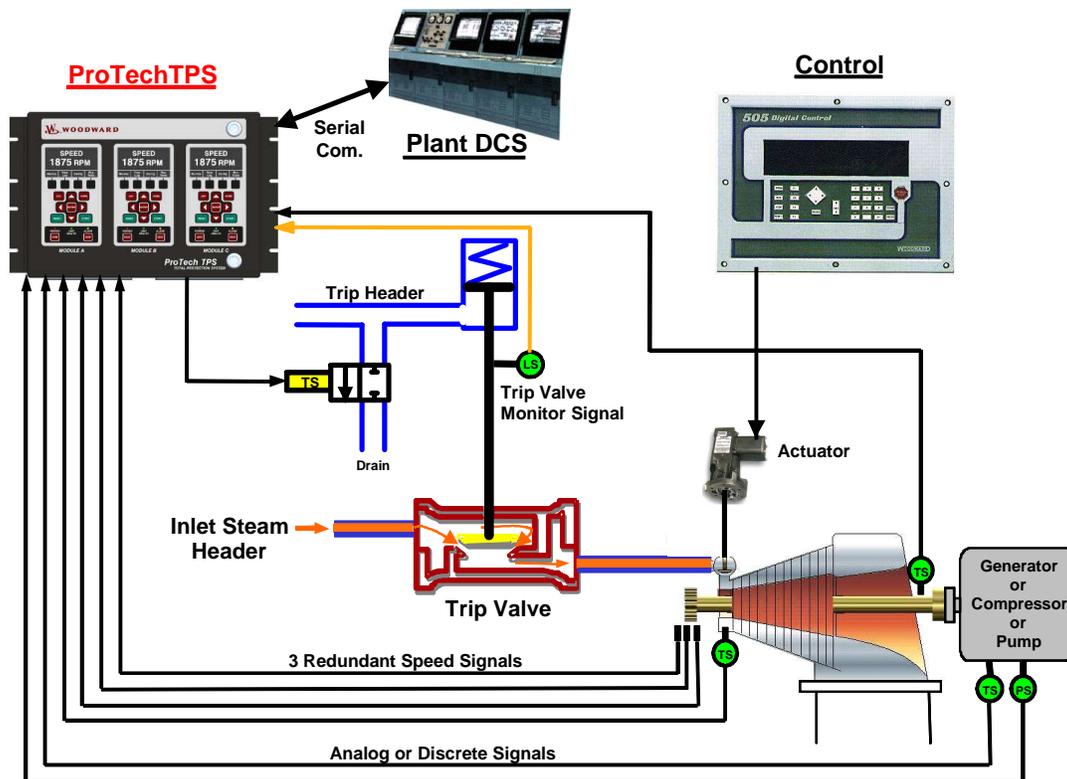


Figure 1-1. Typical ProTech® TPS Application (Voted Trip Relay Models)

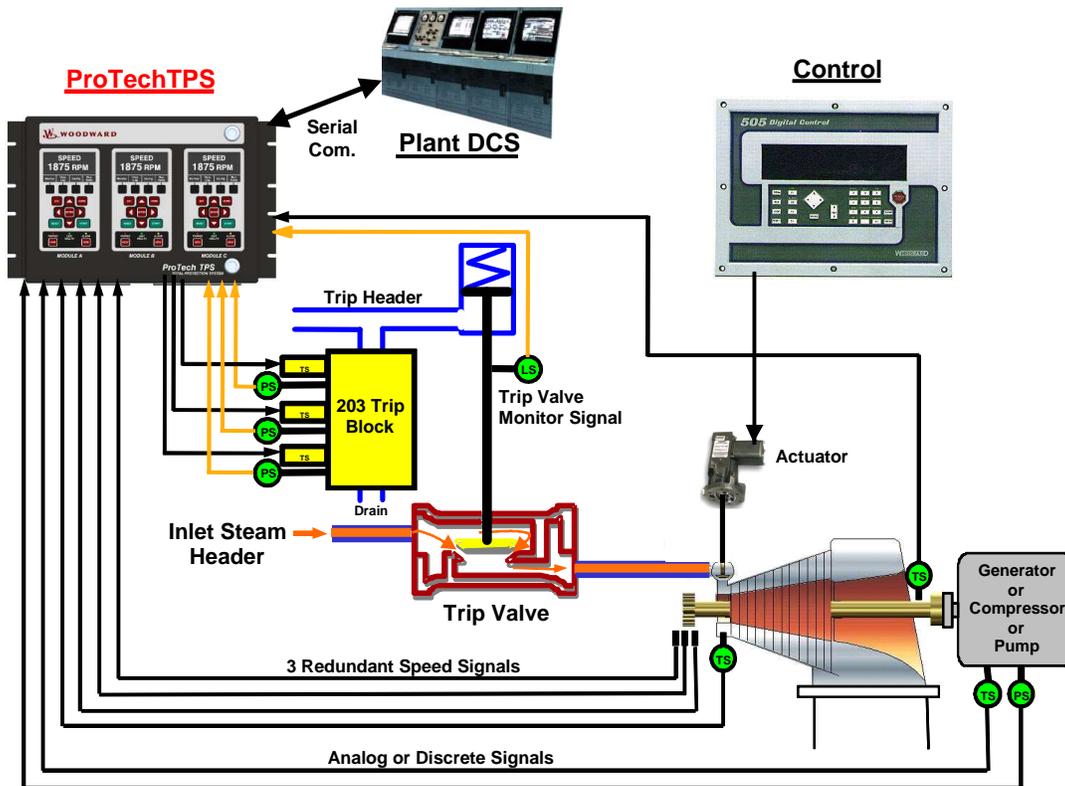


Figure 1-2. Typical ProTech® TPS Application (Independent Trip Relay Models)

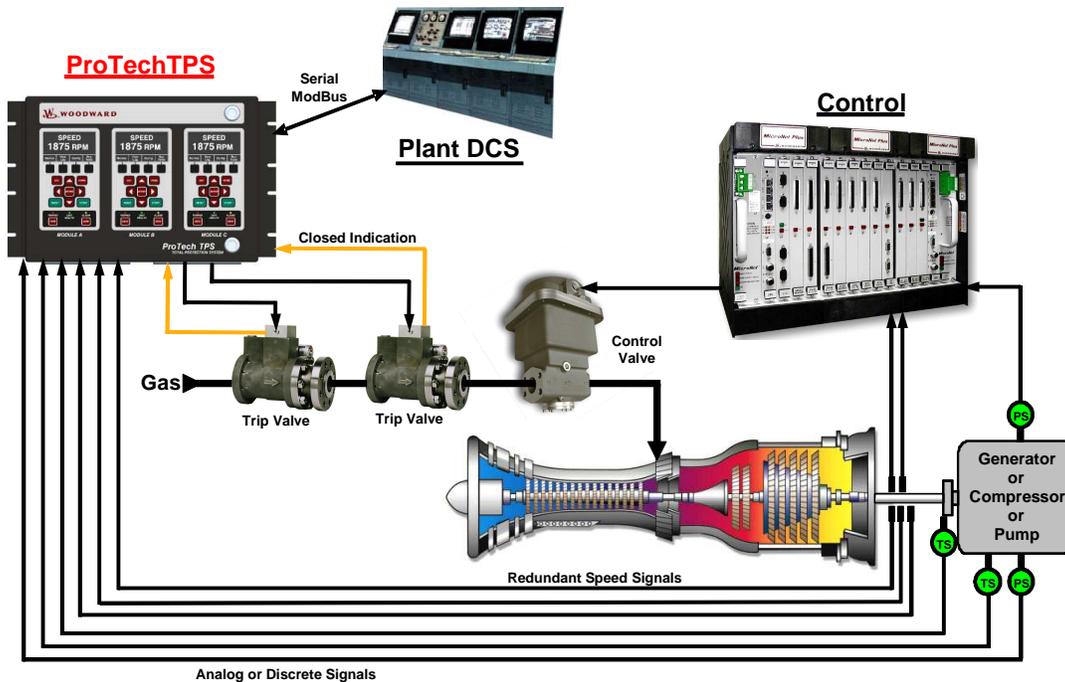


Figure 1-3. Typical Gas Turbine Application (Voted Trip Relay Models)

The ProTech® TPS is certified as an IEC61508 SIL-3 (Safety Integrity Level 3) safety device and can be applied as a stand-alone IEC61508-based device or within an IEC61511-based plant safety system.

AMMONIA REFRIGERATION VENT HEADER APPLICATION

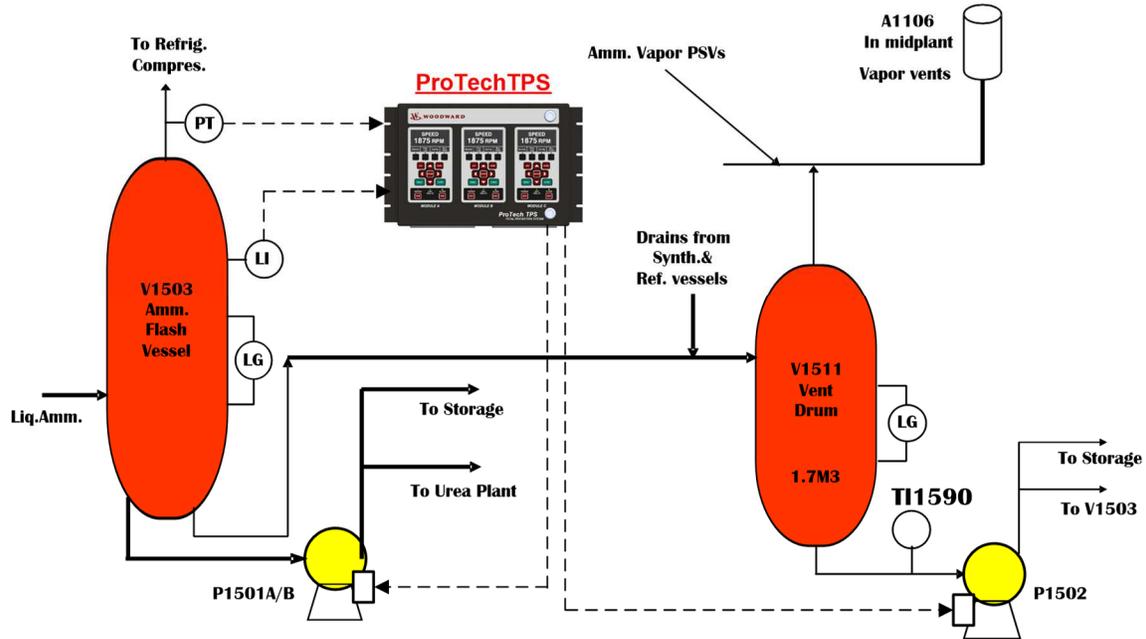


Figure 1-4. Typical Safety PLC Application (Voted Trip Relay Models)

Chapter 2. Installation

Introduction

This chapter provides instructions on how to mount and connect the ProTech® TPS into a system. Hardware dimensions, ratings, and jumper configurations are given to allow a customer to mount, wire, and configure the ProTech® TPS package to a specific application.

Electrical ratings, wiring requirements, and options are provided to allow a customer to fully install the ProTech® TPS into a new or existing application.

Unpacking

Before opening the shipping packaging, inspect the shipping container for damage and document any damage.

Be careful when opening & removing the shipping container. You may retain the original shipping container for unit storage or return shipping for suggested refurbishment. (See Asset Management chapter for storage details.)

Be careful when unpacking the ProTech® TPS system from the shipping container. The precautions called out in the Electrostatic Discharge Awareness section should be followed during unpacking, handling, installation, and operation during maintenance.

Once removed from the shipping packaging, check the device for signs of damage such as a bent or dented case and loose or broken parts. If damage is found, notify the shipper immediately.

System Installation Procedure

1. Review system manual to gain a complete understanding of the ProTech® TPS system.
2. Create a site-specific wiring diagram by referencing included wiring diagrams & constraints then perform mechanical and electrical installation following this chapter's instructions.
3. Visual inspection
 - a. Verify that all mounting hardware is tightened and that no wires are pinched.
 - b. Verify that no wiring insulation is nicked or abraded.
 - c. Verify that all terminal blocks are installed, and terminal screws are tight. (Follow control-wiring instructions for all terminal blocks.)
 - d. If used, verify that speed sensors have been correctly installed, and have the correct clearance from the speed gear (adjust if necessary). See manual 82510, Magnetic Pickups and Proximity Switches for Electronic Governors.
4. Apply power to each module (one at a time), and verify that each module boots up and its front panel screen displays turbine speed
5. If no special programming logic is used skip to step 11
6. If special programming logic is required install ProTech® TPS programming and configuration tool (PCT) from provided PCT Installation CD on to the desired computer and create system application program
7. Once the system application program is complete connect an extension (i.e. straight-through, not null-modem) RS-232 serial cable from the respective computer to any module's (A, B, C) service port, and download the program into the module
8. From the respective module's front panel copy downloaded program to other unit modules
9. From each module's front panel verify that the correct program has been installed in each module by comparing unit CRC codes.
10. From each module's front panel, enter the configuration mode and verify that each of the overspeed and over-acceleration settings are correct.
11. Enter the configuration mode and configure all settings to the specific application's requirements

12. Perform a full system checkout by verifying all system trips, alarms, and test routines function correctly before starting the machinery/system.
13. When ready, start the turbine/machinery following the equipment manufacturer's recommended starting procedure

Enclosures

NOTICE

Module identification is always from left to right, with module A on the left, module B in the center, and module C on the right. This applies to either the bulkhead-mount versions with the front cover open, or the panel-mount versions with the back cover removed.

Depending on the model purchased, the ProTech® TPS has either a bulkhead-mounted or a panel-mounted enclosure package.

The bulkhead-mounted enclosure models are designed to be mounted on a wall or skid next to the turbine and are rated for IP56-based environments. With these models, field-wiring access is through gland plates located on the bottom of the enclosure. Figures 2-1, 2-2, and 2-3 display the bulkhead mounted ProTech® TPS model's physical layout and mounting pattern.

The ProTech® TPS panel-mounted enclosure models are designed for installation within a control room panel or cabinet, and by itself, it cannot be bulkhead mounted. Once installed within an IP56 rated panel or cabinet, the ProTech® TPS panel-mounted models are rated for IP56-based environments. A gasket is attached to the rear side of the package's bezel to properly seal the ProTech® TPS control's faceplate & around the mounting studs to a panel. With these models, field-wiring access is located on the ProTech® TPS control's backside, and a back cover is included to protect wiring terminals after installation. Figures 2-4 and 2-5 display the Panel-Mount ProTech® TPS model's layout and mounting pattern.

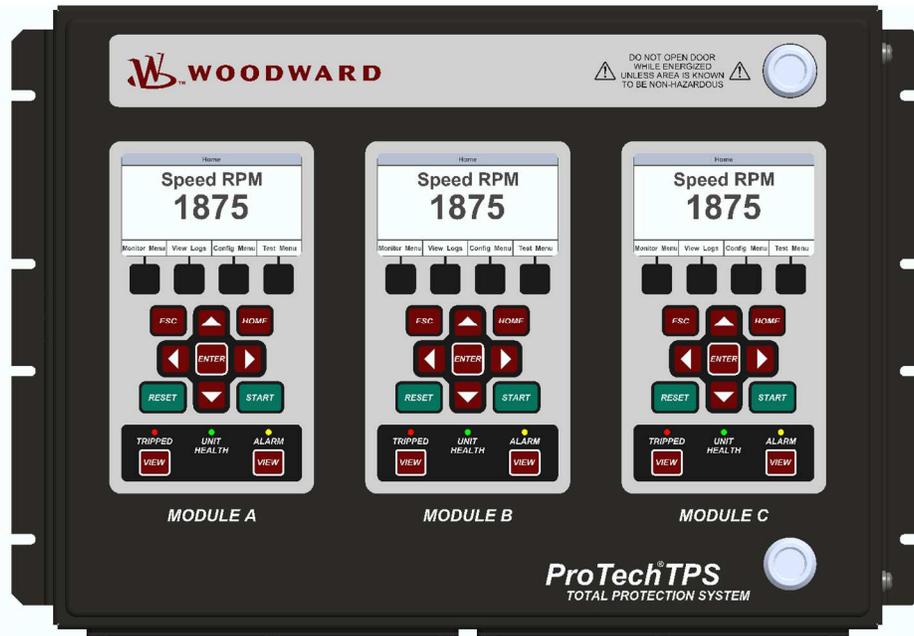


Figure 2-1. Typical ProTech® TPS Bulkhead Package—Front View



Figure 2-2a. Typical ProTech® TPS Bulkhead Package—Front Door Open

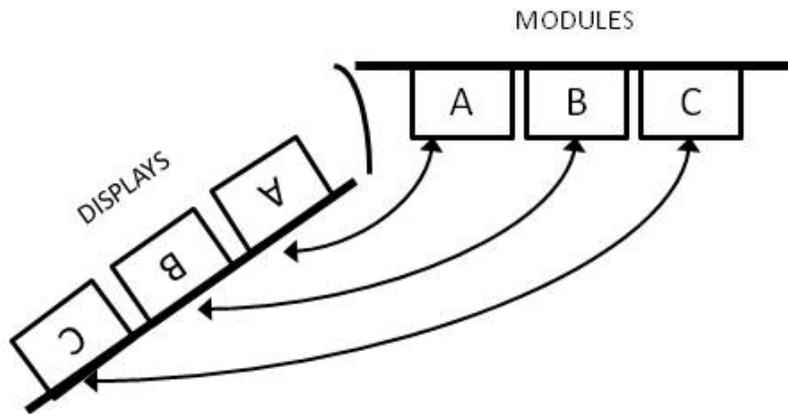


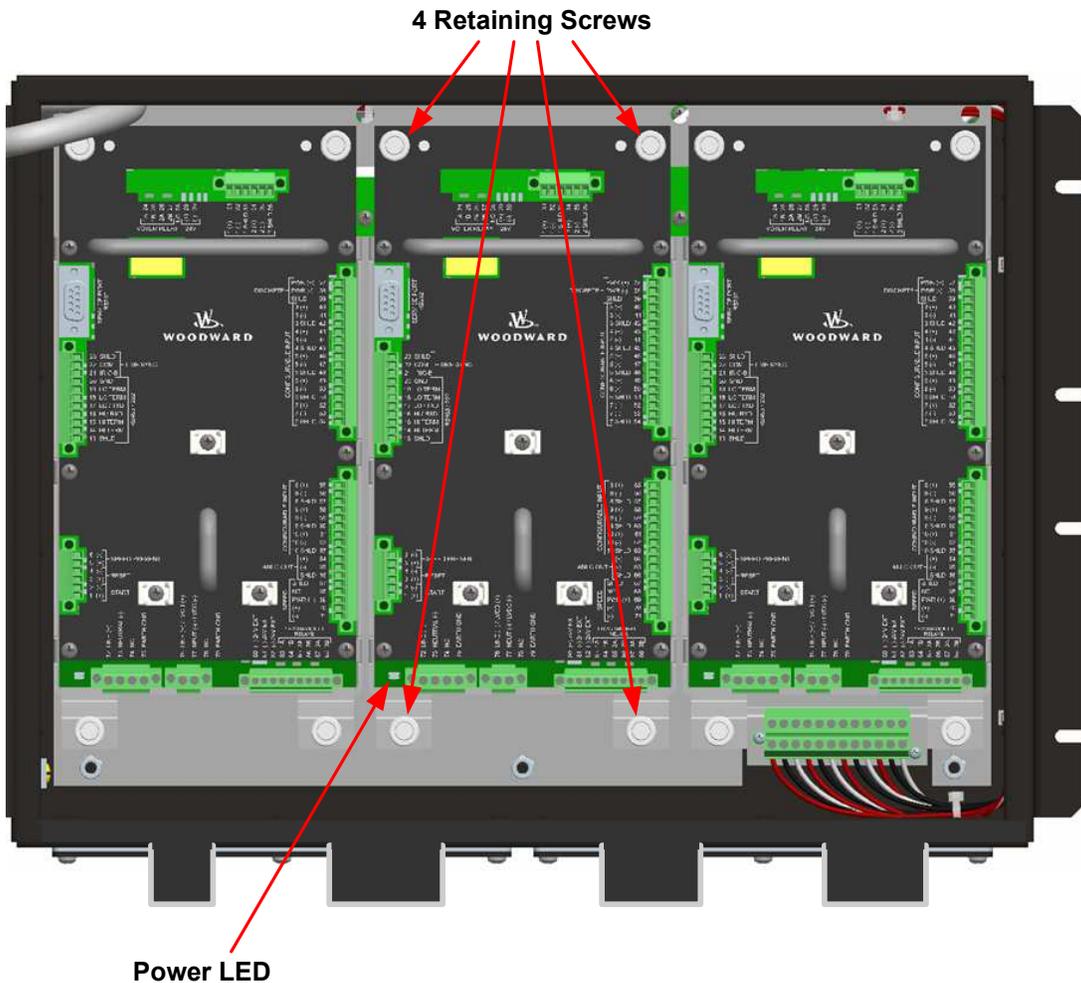
Figure 2-2b. Bulkhead Schematic Showing Front Panel A Connection to Module A and Front Panel C Connection to Module C—Top View

Module Removal and Installation—Bulkhead Mount Package

Follow this procedure for module removal and installation:

Removal:

1. Disconnect power from the module to be removed.
2. Verify power removed by observing power LED is OFF.
3. Remove terminal blocks from module terminals.
4. Loosen 4 module retention screws.
5. Remove module by pulling the two handles simultaneously.



Installation:

1. Insert module into slot by pressing firmly on handles. The module has guides to assist in location.
2. Tighten 4 module retention screws.
3. Install terminal blocks.
4. Apply power and observe that the power LED is ON.

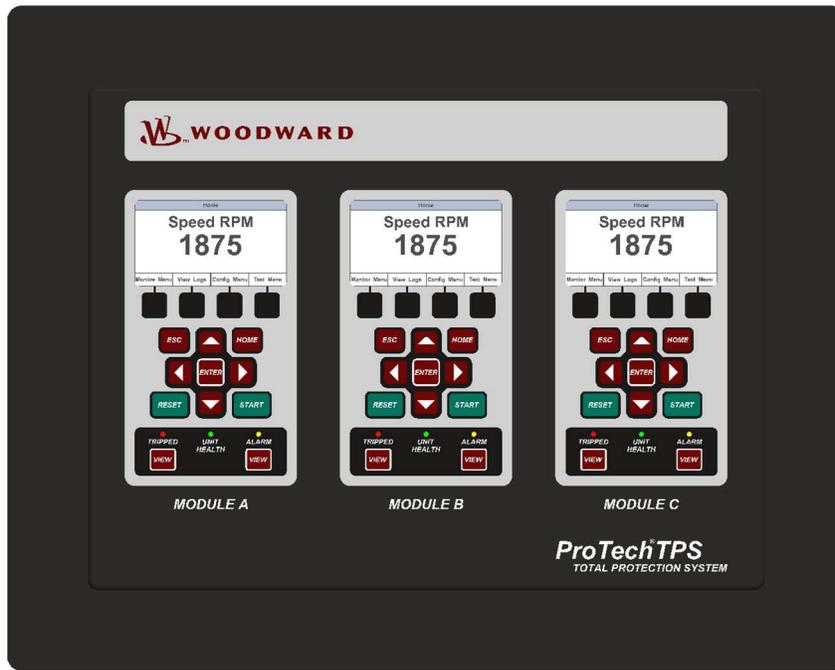


Figure 2-4a. Typical ProTech® TPS Panel Mount Package—Front View



Figure 2-4b. Typical ProTech® TPS Panel Mount Package—Rear View with Cover

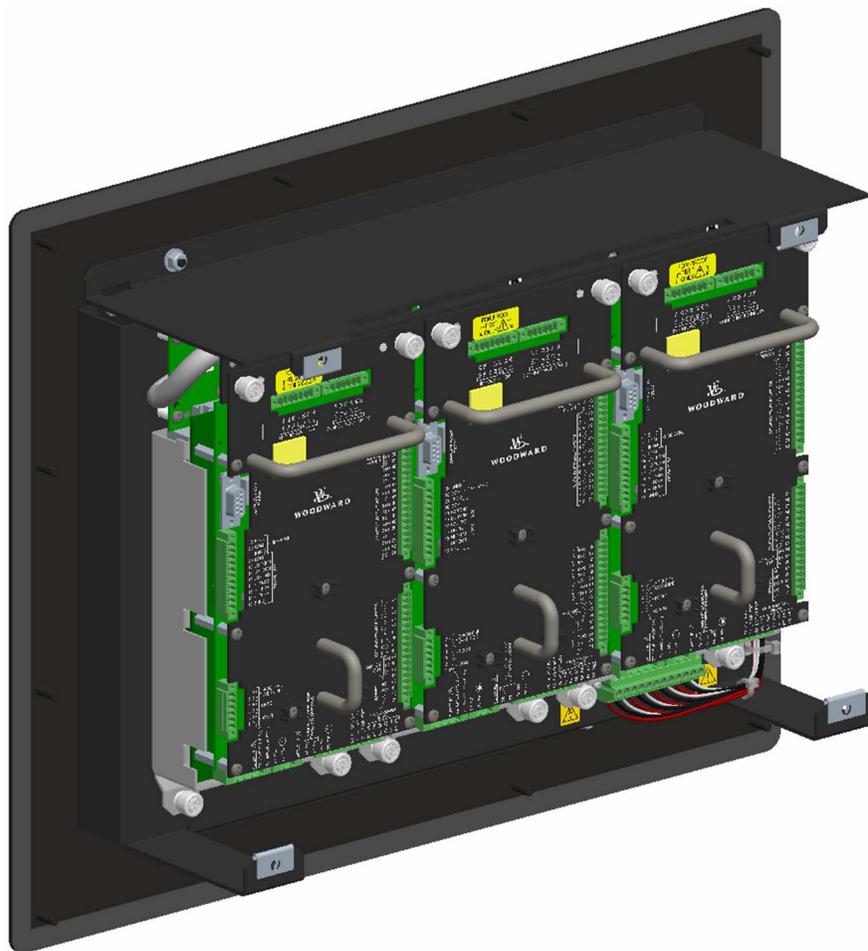


Figure 2-4c. Typical ProTech® TPS Panel Mount Package—Rear View without Cover

NOTICE

Module identification is always from left to right, with module A on the left, module B in the center, and module C on the right. This applies to either the bulkhead-mount versions with the front cover open, or the panel-mount versions with the back cover removed.

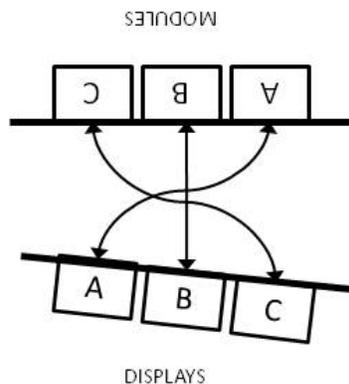


Figure 2-4d. Panel Mount Schematic Showing Front Panel A Connection to Module A and Front Panel C Connection to Module C—Top View

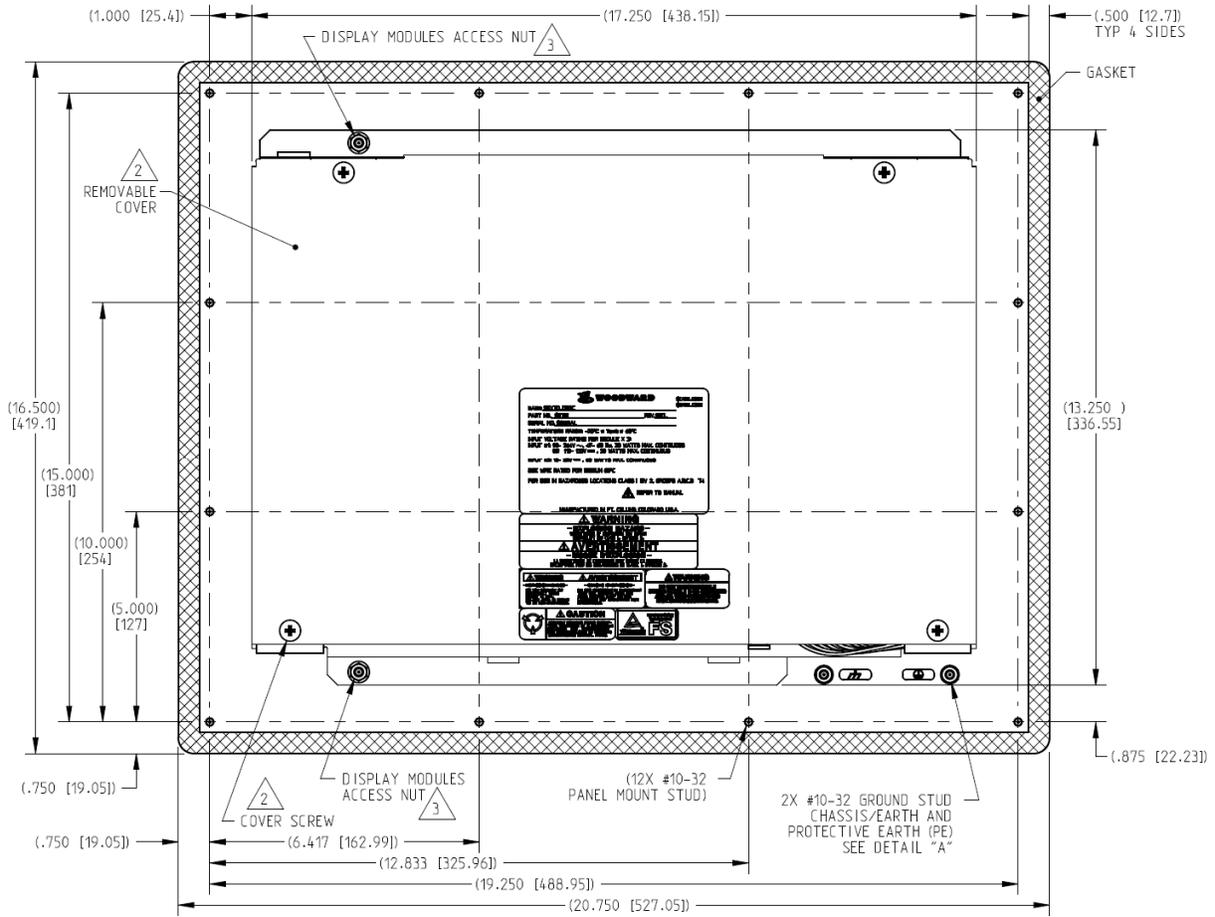


Figure 2-5a. Mounting Outline Diagram for Panel-Mount Models

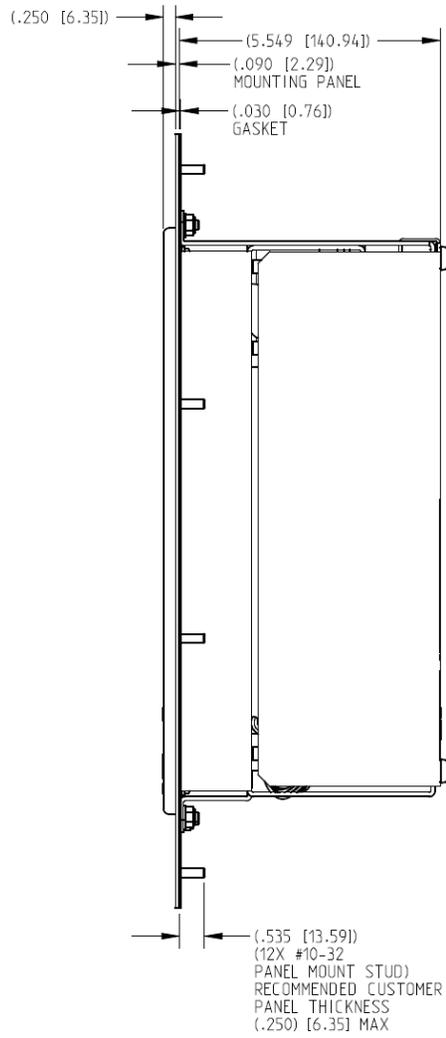


Figure 2-5b. Mounting Outline Diagram for Panel-Mount Models

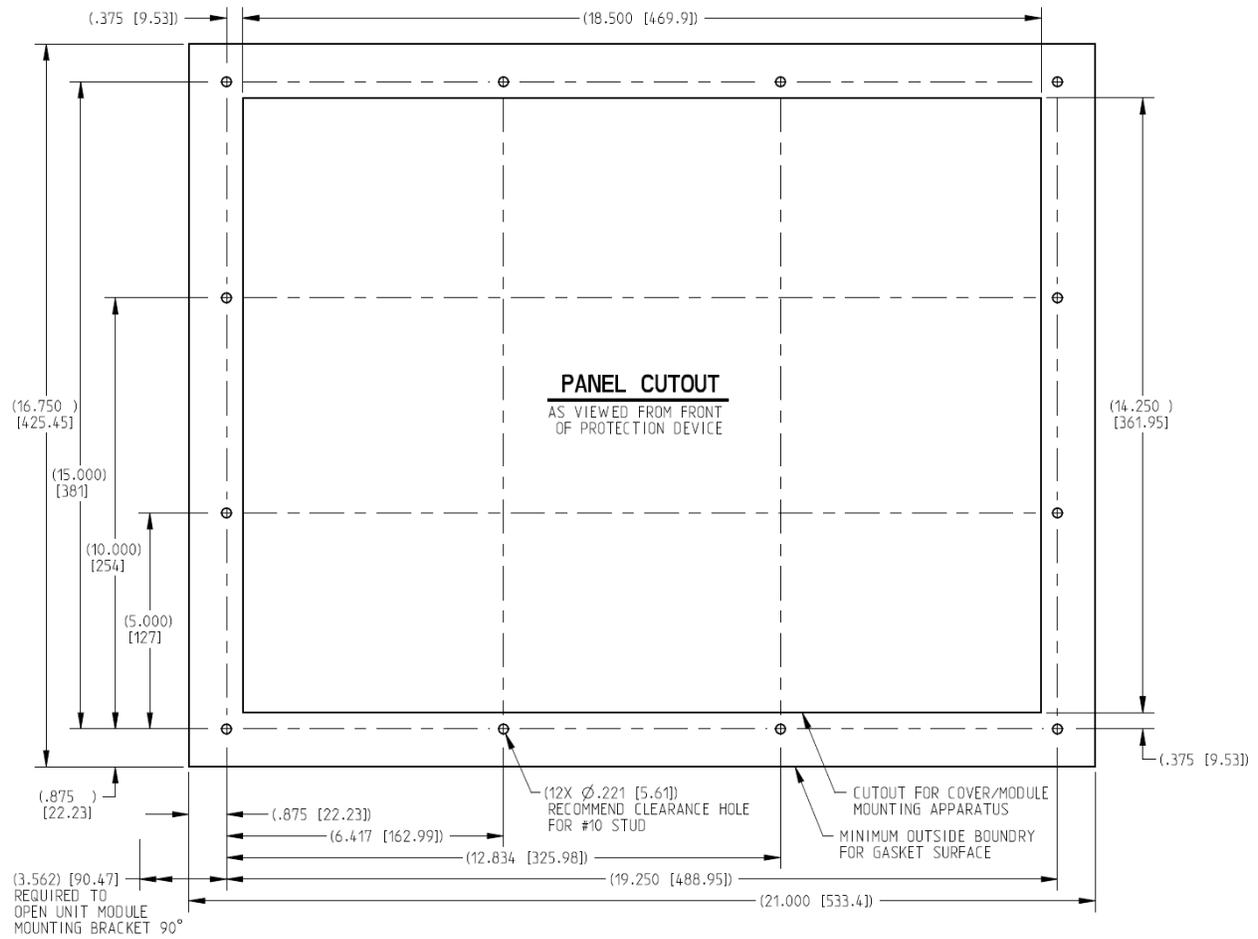


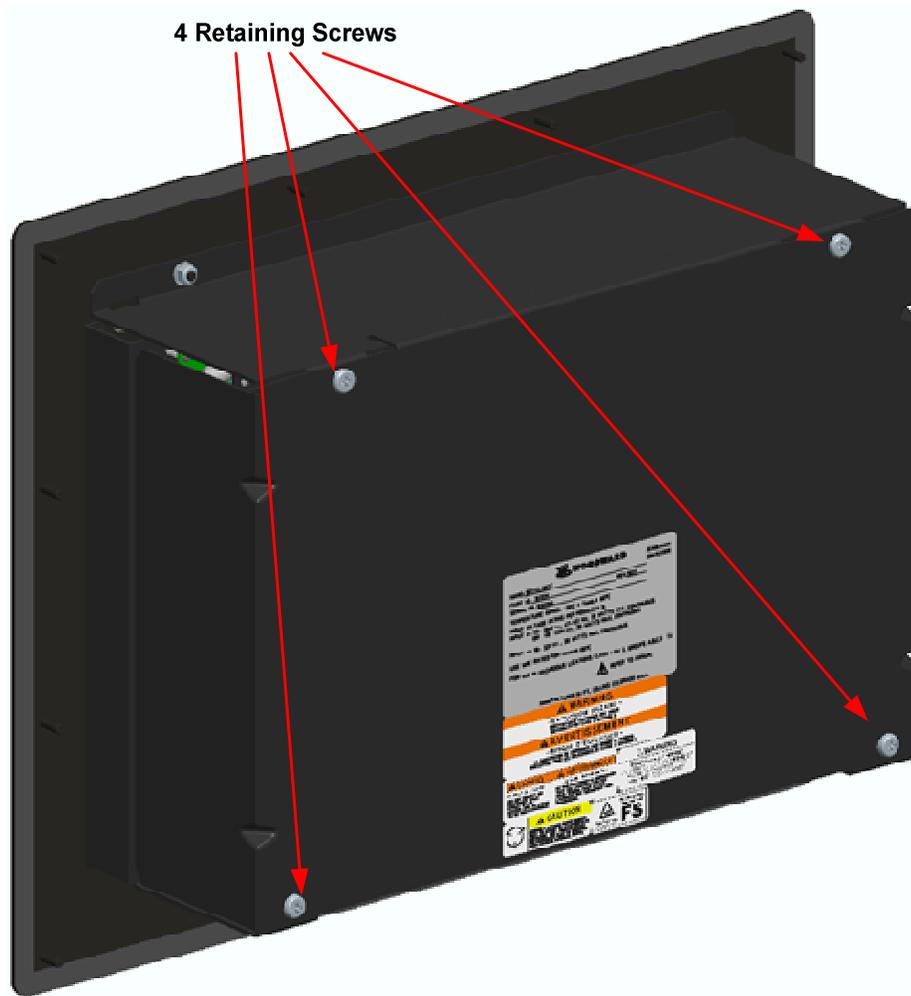
Figure 2-5c. Panel Cutout Diagram for Panel-Mount Models

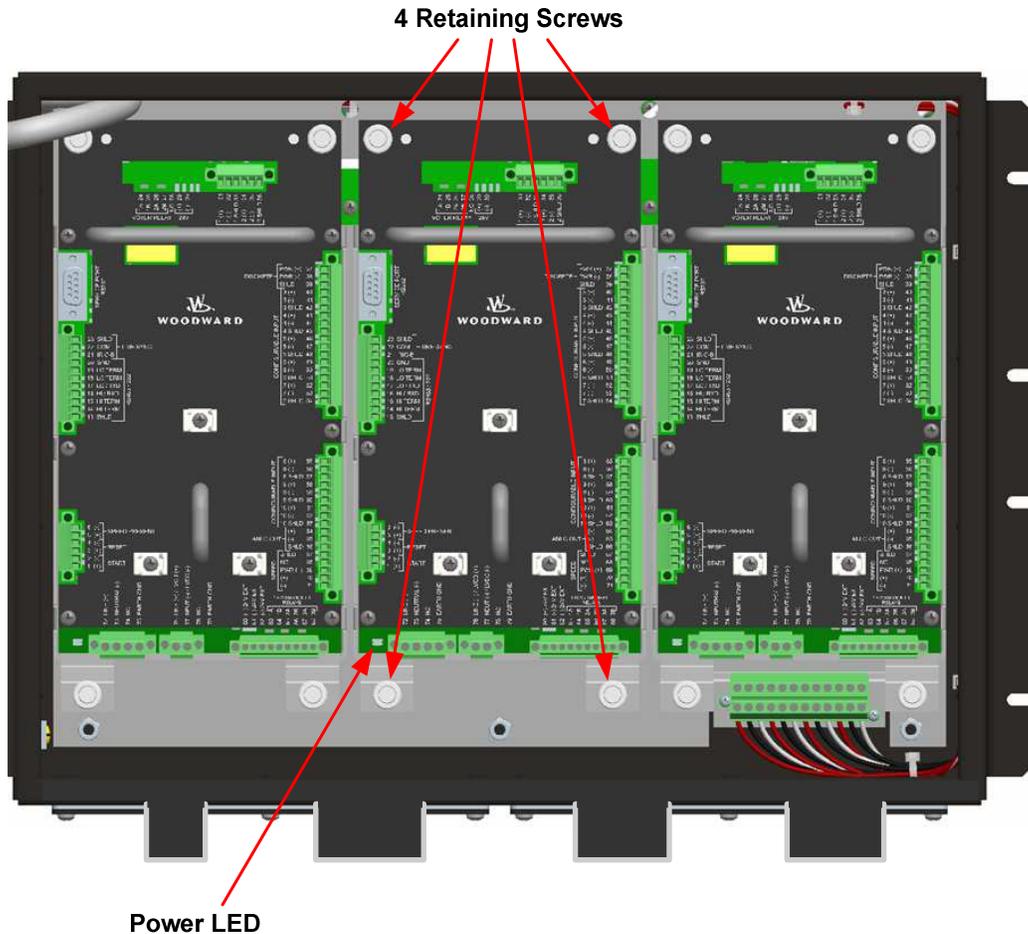
Module Removal and Installation—Panel Mount Package

Follow this procedure for module removal and installation:

Removal:

1. Disconnect power from the module to be removed.
2. Remove 4 back panel retaining screws.
3. Remove back panel.
4. Verify power removed by observing power LED is OFF.
5. Remove terminal blocks from module terminals.
6. Loosen 4 module retaining screws.
7. Remove module by pulling the two handles simultaneously.





Installation:

1. Insert module into slot by pressing firmly on handles. The module has guides to assist in location.
2. Tighten 4 module retaining screws.
3. Install back panel.
4. Install 4 retaining screws.
5. Install terminal blocks.
6. Apply power and observe that the power LED is ON.

Mounting Location Considerations

Consider the following general requirements when selecting the mounting location:

- Adequate ventilation for cooling
- A location that will provide an operating temperature range of -20 to $+60$ °C (-4 to $+140$ °F)
- The ProTech® TPS weighs approximately 12 kg (26.5 lb)
- Space for opening & servicing
- Space for installing & removing panel mount covers
- Space for installing cable strain relief as needed
- Vertical orientation of the unit
- Protection from direct exposure to sunlight, water, or to condensation-prone environments
- Protection from high-voltage or high-current devices which produce electromagnetic interference
- Avoidance of vibration
- A location that has H₂S and SO₂ gases at or below the levels classified in international standard IEC 721-3-3 1994 - environment Class 3C2
- Maximum purge pressure: 4 psi

Table 2-1. Environmental Specifications

Operating Temperature:	-20 to +60 °C (-4 to +140 °F)
Storage Temperature (nonoperational):	-20 to +65 °C (-4 to +158 °F)
Relative Humidity:	Up to 95% (non-condensing)
Vibration:	0.04 G ² /Hz, 1.04 Grms, 10 to 500 Hz
Shock:	30 G, 11 ms half-sine pulse
Altitude:	Up to 3000 meters above sea level
Enclosure (Bulkhead Mount Version):	IP56 (per IEC 60529)
Enclosure (Panel Mount Version):	IP56, installed in IP56 enclosure/cabinet
Weight (Bulkhead Mount Version):	Approximately 26 lb (12 kg)
Weight (Panel Mount Version):	Approximately 22 lb (10 kg)
Pollution Degree	2 (per IEC 60664-1)
Oversvoltage Category	II (per IEC 60664-1)

Power Supply Requirements

Each ProTech® TPS system consists of three separate internal modules (A, B, C), and each of these three modules accept two input power sources. Depending on the ProTech® TPS model purchased, the internal modules will accept either two high voltage (HV) input power sources or one HV input power source and one low voltage (LV) input power source.

HV / HV Models accept:

- Input #1: High Voltage Power Source (88–264 Vac/47–63 Hz; 100–150 Vdc) @ 90 W (30 W per module)
 - Nominally AC: 115 Vac / 240 Vac
 - Nominally 125 Vdc
- Input #2: High Voltage Power Source (88–264 Vac/47–63 Hz; 100–150 Vdc) @ 90 W (30 W per module)
 - Nominally 115 Vac / 240 Vac
 - Nominally 125 Vdc

HV / LV Models accept:

- Input #1: High Voltage Power Source (88–264 Vac/47–63 Hz; 100–150 Vdc) @ 90 W (30 W per module)
 - Nominally 115 Vac / 240 Vac
 - Nominally 125 Vdc
- Input #2: Low Voltage Power Supply (18–32 Vdc) @ 90 W (30 W per module)
 - Nominally 24 Vdc

Each ProTech® TPS module will function normally with power sourced to both or either power supply input independently, however Woodward recommends using both input power sources to improve system availability. Please refer to Table 1-1 for available ProTech® TPS models.

IMPORTANT

Since the ProTech® TPS is designed to detect a failure of either power supply input, a continuous “Power Supply Fault Alarm” will be issued if power-sources are not connected for both power supply inputs.

Each ProTech® TPS module requires a power source capable of a certain output voltage and current. In most cases, this power rating is stated in Volt-Amps (VA). Calculate the maximum VA of a source by taking the rated output voltage times the maximum output current at that voltage. This value should be greater than or equal to the VA requirement listed.

! WARNING

Each power source must be provided with an external disconnecting means that is identifiable to the specific power supply (A, B, or C).

NOTICE

A PE (Protective Earth) ground wire for each of the high voltage power supplies must be connected to PE ground. The PE ground connection wire must originate and be connected to PE at the power source. The PE ground wire must follow the power wires to the applicable power input connector PE Ground pin, so that each HV input has a PE ground. The PE ground wire gauge must be capable of handling the same current as the individual power wiring.

NOTICE

A PE (Protective Earth) ground wire for the enclosure must be provided and connected to PE Ground. At least one of the enclosure's PE labeled connection points must have a wire going from the enclosure to a building PE ground point. This wire must be of sufficient gauge to handle the rated current of all the interposing relay wires or 1.5 mm² (16 AWG), whichever is larger.

Shielded Wiring

All shielded cable must be twisted conductor pairs with either a foil or a braided shield. A braided shield is preferred and highly recommended. All analog & communication signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields as shown in the control wiring diagram (Figure 2-7). Wire exposed beyond the shield must not exceed 50 mm (2 inches). The shield termination should be done with the shield by opening the braid and pulling the wires through, not with an added wire. If a wire is used it must be the largest gauge accepted by the shield lug terminal. The other end of the shield must be left open or grounded through a capacitor and insulated from any other conductor. Do not run shielded signal wires with other wires carrying large currents or high voltages. See Woodward manual 50532, *EMI Control in Electronic Governing Systems*, for more information.

Installations with severe electromagnetic interference (EMI) may require relay and discrete input wiring to be shielded, conduits and/or double shielded wire may be needed, or other precautions may have to be taken. These additional precautions may be implemented in any installation. Contact Woodward for more information.

Control Wiring Guidelines

Electrical Connections

**WARNING**

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Figures 2-8 and 2-9 show the control wiring diagrams for the ProTech® TPS system. Refer to Figure 2-10 for proper routing and stress relief of field wiring entering the ProTech® TPS system. Wire tie-wrap fasteners are provided on each module to assist with I/O wire routing and installation.

Plug-in screw-type terminal blocks are used to connect field wiring to each ProTech® TPS module & to the trip (interposing) relay contacts.

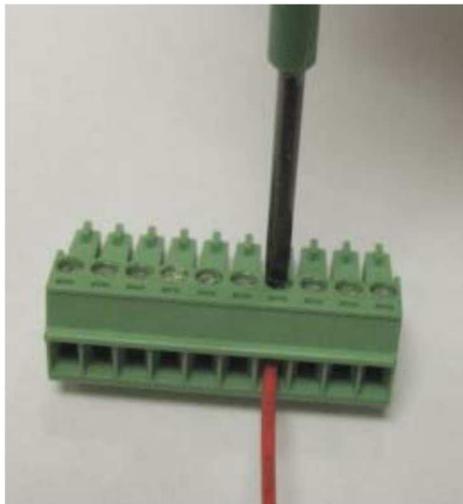
The size of the field wiring to the ProTech system should be between 1.5 and 6 mm² (16 and 10 AWG) for power supply wiring and between 0.3 and 4 mm² (22 and 12 AWG) for all other I/O wiring. Wires for the all the pluggable I/O terminal blocks should be stripped at 8 mm (0.3 inch). Torque and screwdriver requirements are listed below.

IMPORTANT

The screw lug terminal blocks are designed to flatten stranded wire. Do not tin (solder) the wire's strands that terminate at the ProTech Terminal Blocks. If the wire strands are soldered together, the solder will cold flow and shrink over time causing the connection to become intermittent or disconnected.

Woodward recommends the following for ProTech® TPS:

- Stranded bare copper wire (unless gaseous Sulfur compounds are present) at the wire ends
- Stranded copper wire with individually tin-plated strands at the wire ends
- Hollow ferrules at the wire ends
- Use single wire per terminal. There are enough terminals provided for all I/O wiring



Torque range for screws of Screw Connection Terminal Blocks:
0.22–0.25 N•m (1.95–2.21 lb-in).

Screwdriver blade:
0.4 X 2.5 mm (0.016 X 0.10 inch)
Screwdriver available as
Woodward PN 8992-005

Figure 2-6. Screw Connection Terminal Block

The ProTech® TPS control's terminal blocks are designed to be removed by hand.

With circuit power & trip (interposing) relay-controlled power disconnected, all terminal blocks can be removed, one at a time by unscrewing their terminal-locking screws and pulling them out of their sockets by hand.

NOTICE

When removing a terminal block, never pull on the wires connected to the terminal block.

Field wiring access for bulkhead mounted models is through gland plates located on the bottom of the enclosure. These gland plates allow users to bore multiple and different sized access holes for conduit entry, as required. Refer to Figure 2-3 for gland plate location and size.

For EMI (electromagnetic interference) reasons, Woodward recommends that all low-voltage field wiring be separated from all high-voltage field wiring by using separate conduit and conduit entries into the ProTech® TPS enclosure. Woodward also recommends that power wiring be segregated in the same manner, however LV & HV input power may be routed together.

Field wiring access for panel-mounted models is located on the back of the ProTech® TPS enclosure. To allow proper installation of the unit's back cover plate, Woodward recommends that all field wiring be routed from the bottom of the package. The unit's back cover must be installed. Refer to Figure 2-5 for field wiring access information.

For EMI (electromagnetic interference) reasons, Woodward recommends that all low-voltage field wiring be separated from all high-voltage field wiring where possible. Woodward also recommends that power wiring be segregated in the same manner, however LV & HV input power may be routed together.

**WARNING**

HIGH VOLTAGE—When wiring to interposing relays, be sure to wire both contacts with the same polarity. Failure to do so will create a potential shock hazard, which could cause injury or death.

IMPORTANT

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

All peripheral equipment must be suitable for the location in which it is being used.

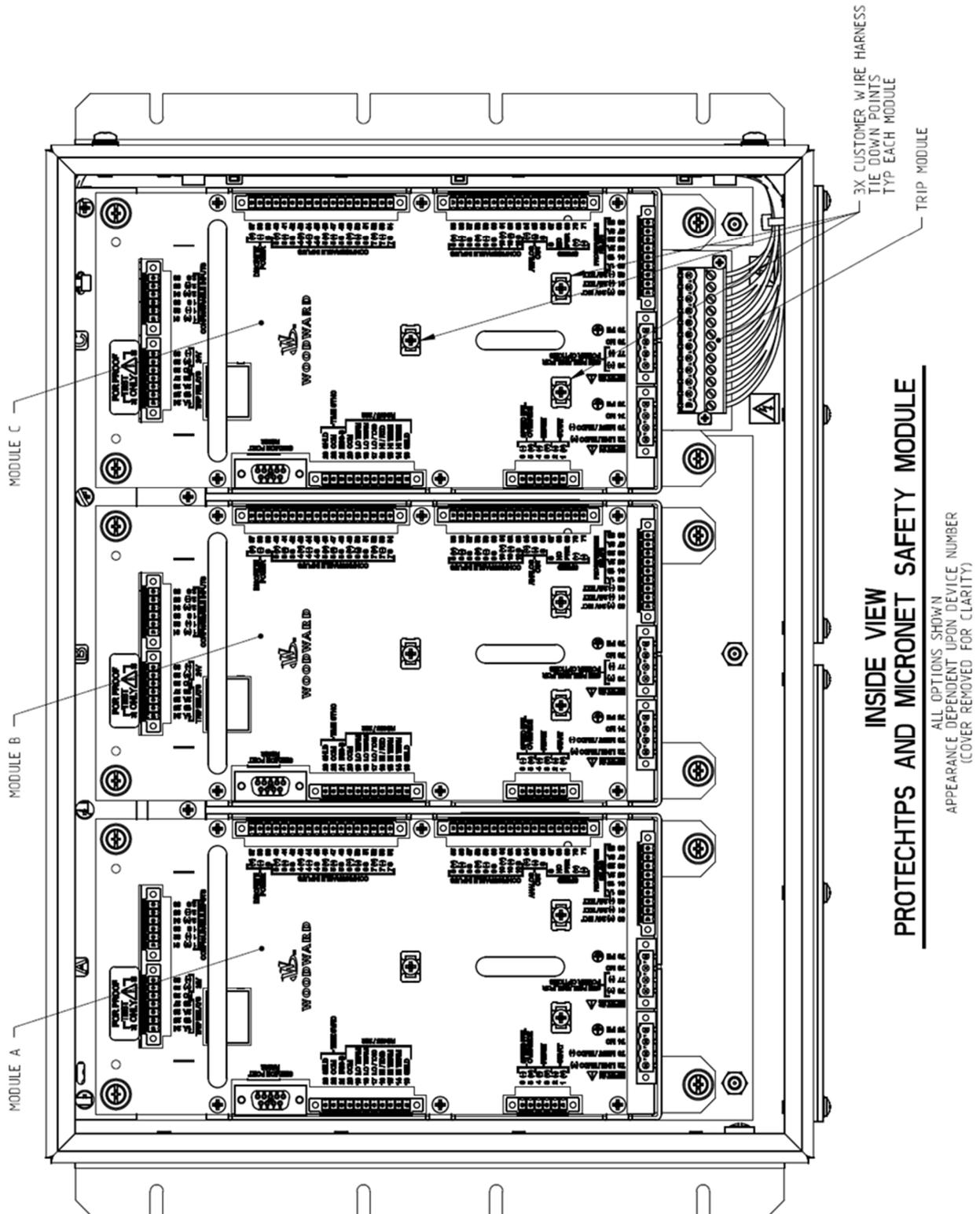


Figure 2-7. Inside View of ProTech® TPS

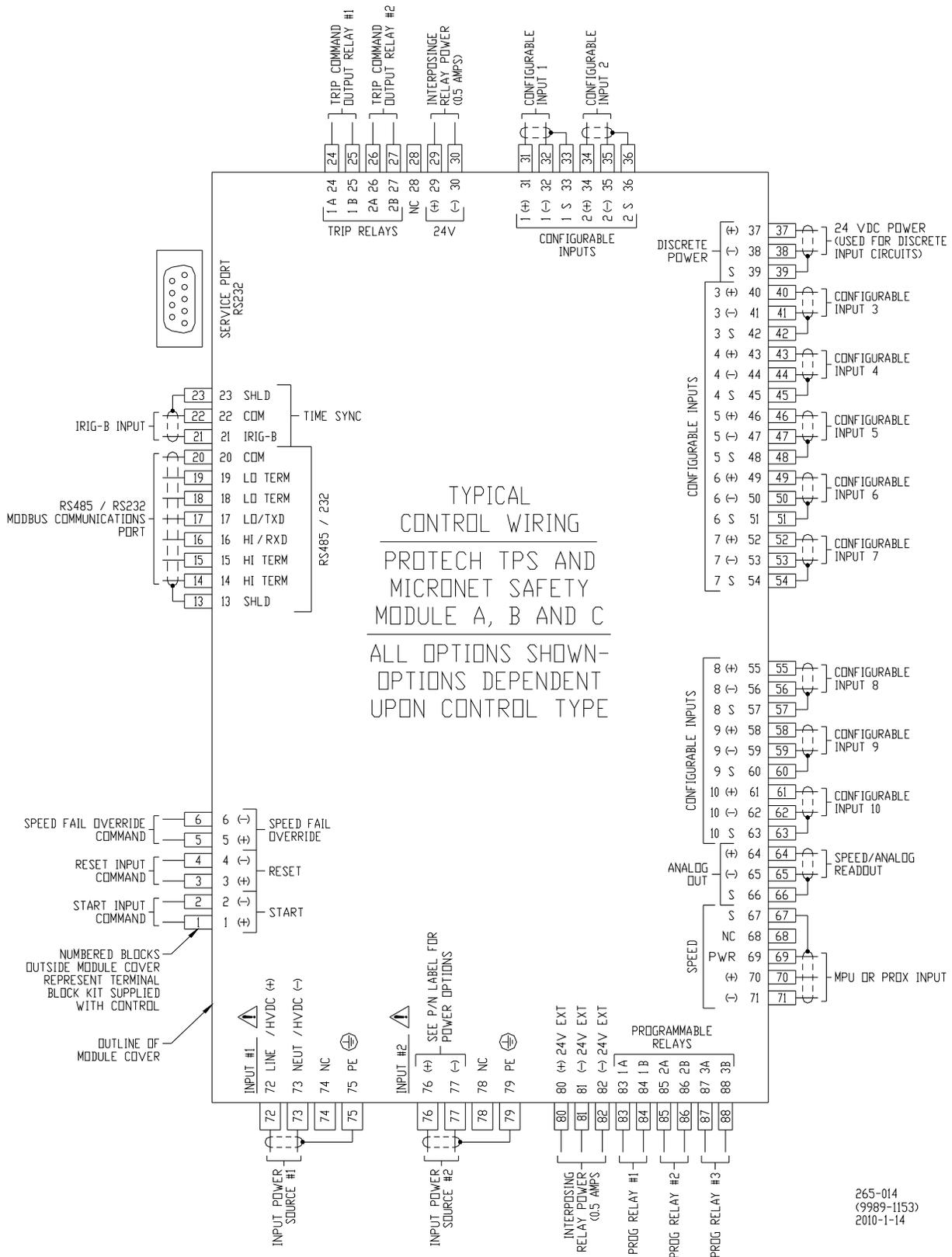


Figure 2-8. ProTech® TPS Control Wiring Diagram

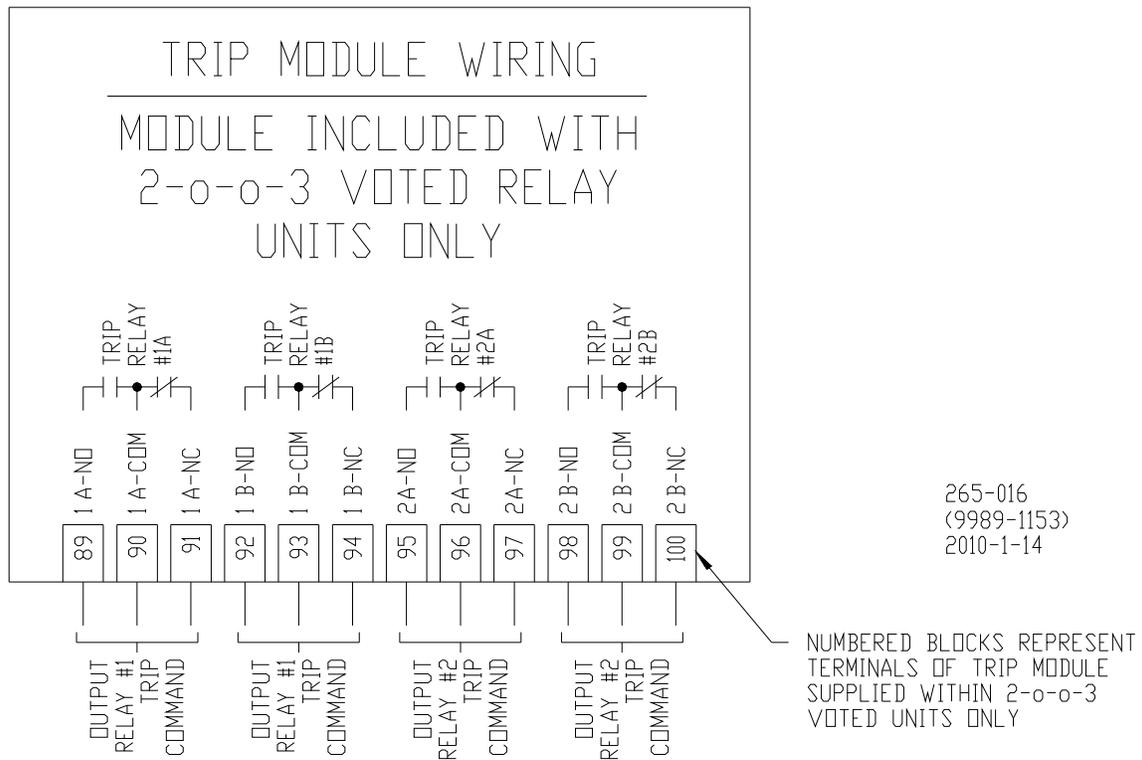


Figure 2-9. Trip Module – Included within Voted Trip Relay Units Only

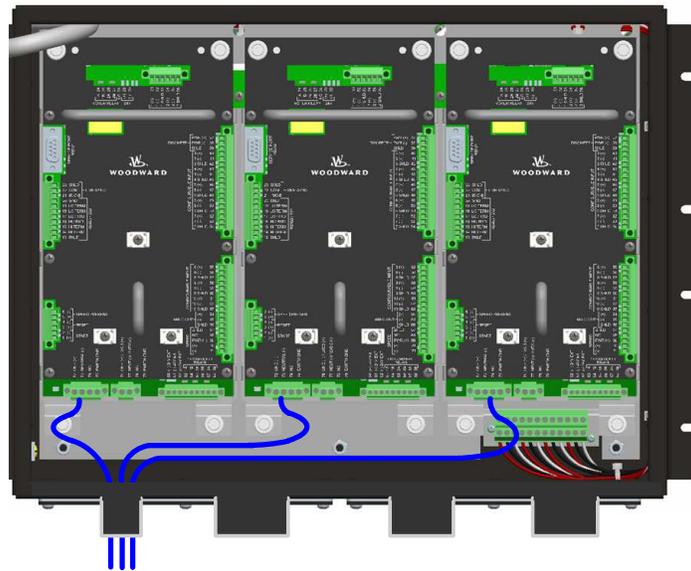


Figure 2-10a. Power Supply Field Wiring Routing & Stress Relief Diagram

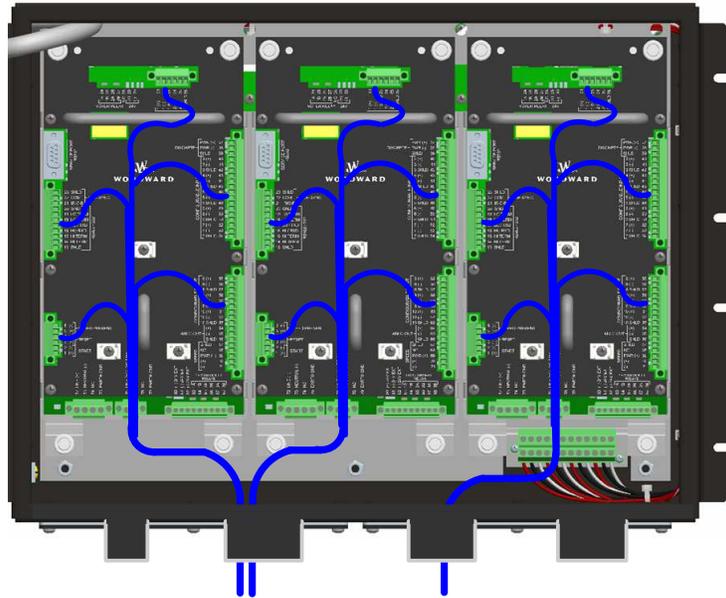


Figure 2-10b. Configurable I/O Wiring Routing & Stress Relief Diagram

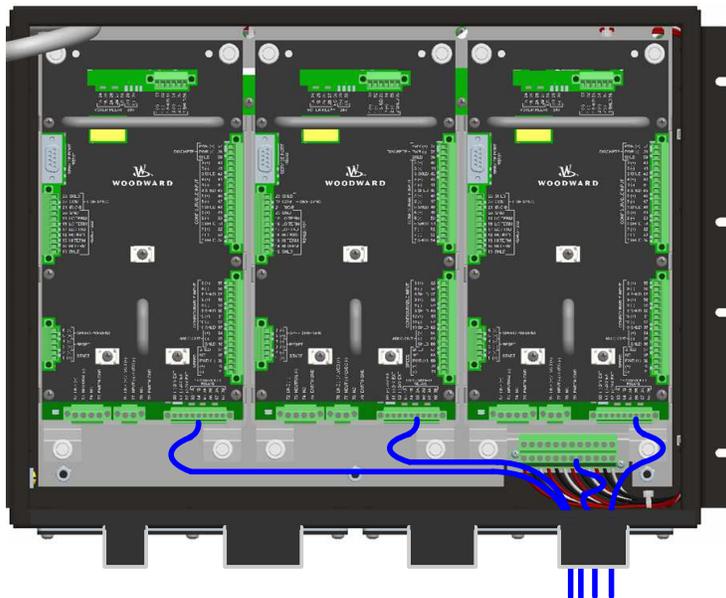


Figure 2-10c. Relay Output Field Wiring Routing & Stress Relief Diagram

Speed Sensor Inputs

To sense speed, each ProTech® TPS module (A, B, C) accepts a signal from a speed sensor mounted reading off of a gear connected or coupled to the turbine's rotor or engine's crank shaft. Speed sensors may be any of the following:

- Passive magnetic pickup unit (MPU)
- Active proximity probe
- Eddy current probe

A passive MPU provides a frequency output signal corresponding to turbine speed by sensing the movement of a gear's teeth past the MPU's pole piece. The closer the MPU's pole piece is to a gear's teeth and the faster the gear turns the higher a passive MPU's output amplitude will be. (Speed signal amplitude increase with both speed increase and distance decrease.) The ProTech® TPS must sense an MPU voltage of 1 to 35 Vrms for proper operation. With proper MPU, gear size, and MPU-to-gear clearance, speed measurement can range from 100 to 32 000 Hz. Standard MPU clearance is recommended to be 0.25 to 1.02 mm (0.010 to 0.040 inch) from tooth face to pole piece. For information on selecting the correct MPU or gear size please refer to Woodward manual 82510. Refer to Figure 2-11a for wiring information.

Proximity and eddy-current probes may be used to sense very low speeds to high speeds (0.5 to 25 000 Hz). The speed probe input voltage must be between 16 and 28 Vdc and output signal be between 16 and 28 V peak-to-peak for proper speed detection. The voltage for the speed probes must be from the provided voltage port or have its common referenced (connected) to the provided common pin for proper operation. See Figures 2-11b thru 2-11c for proximity and eddy-current probe wiring schematics.

An application may use the same or different types of speed probes (MPU, proximity, eddy-current), between the three different inputs depending on the specific application's requirements.

IMPORTANT

Woodward does **NOT** recommend that gears mounted on an auxiliary shaft that is coupled to the turbine rotor be used to sense turbine speed. Auxiliary shafts tend to turn slower than the turbine rotor (reducing speed-sensing resolution) and have coupling gear backlash, resulting in less than optimal speed sensing. For safety purposes, Woodward also does **NOT** recommend that the speed sensing device sense speed from a gear coupled to a generator or the mechanical drive side of a system's rotor coupling.

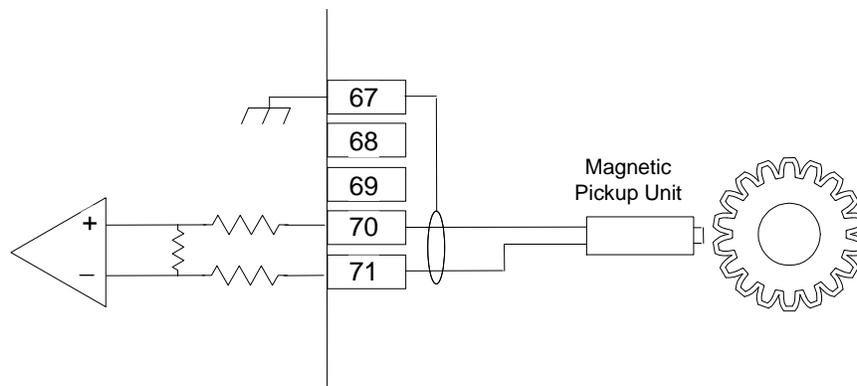


Figure 2-11a. Example MPU (Passive Magnetic Pickup Unit) Wiring

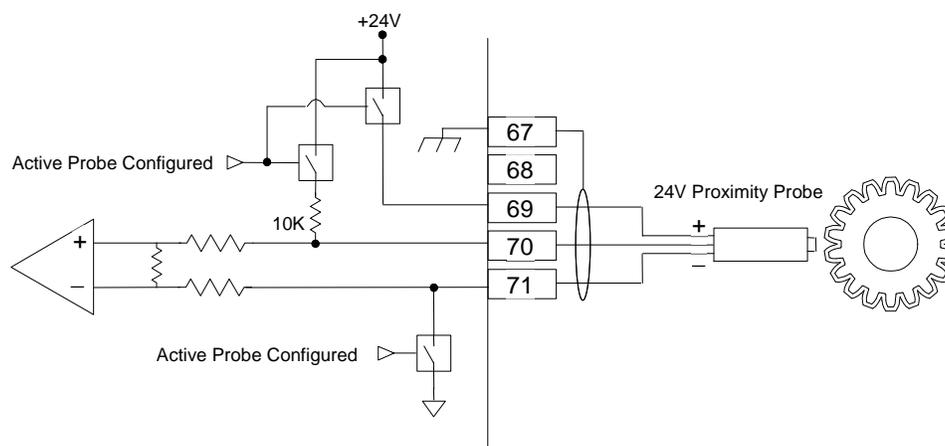


Figure 2-11b. Example Proximity Probe (Active Magnetic Pickup Unit) Wiring (Internal Power)

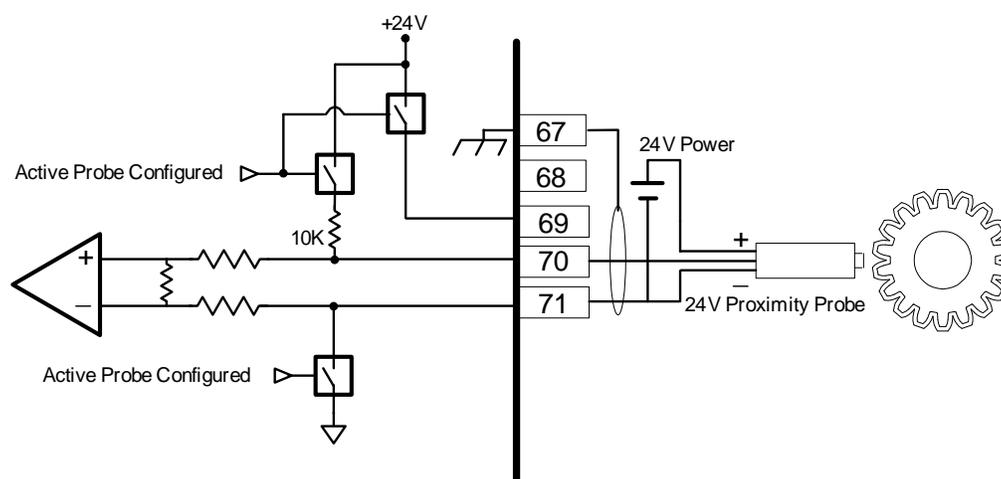


Figure 2-11c. Example Proximity Probe (Active Magnetic Pickup Unit) Wiring (External Power, Non-preferred)

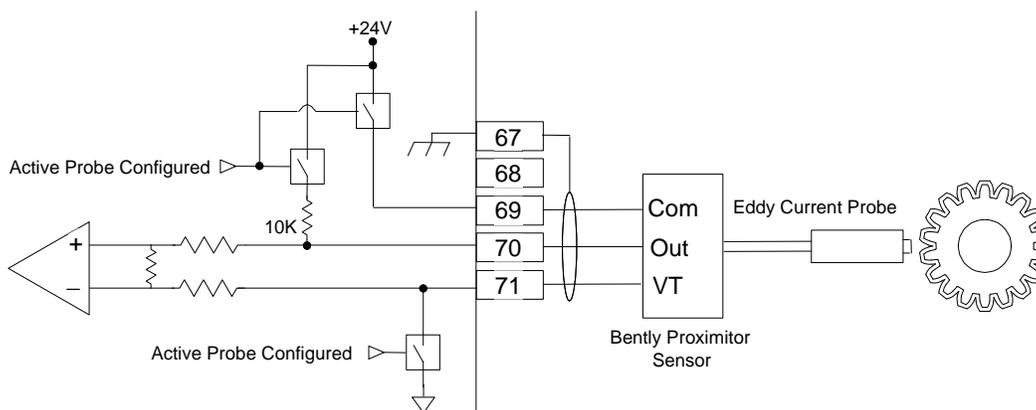


Figure 2-11d. Example Eddy Current Probe (Active Magnetic Pickup Unit) Wiring

Dedicated Discrete Inputs

Each ProTech® TPS model (A, B, C) accepts three dedicated discrete inputs. All discrete inputs accept dry contacts. Contact wetting voltage is available through terminals 1, 3, and 5 but an external +24 Vdc source can be used. Refer to Figure 2-12 for wiring information. In general, an input contact signal must change state for a minimum of 10 milliseconds for a ProTech® TPS module to sense and register a change in state. The Dedicated Discrete Inputs are Start, Reset and Speed-Fail-Override. Refer to Chapter 3 (Functionality) of this manual for information on each discrete input's functionality.

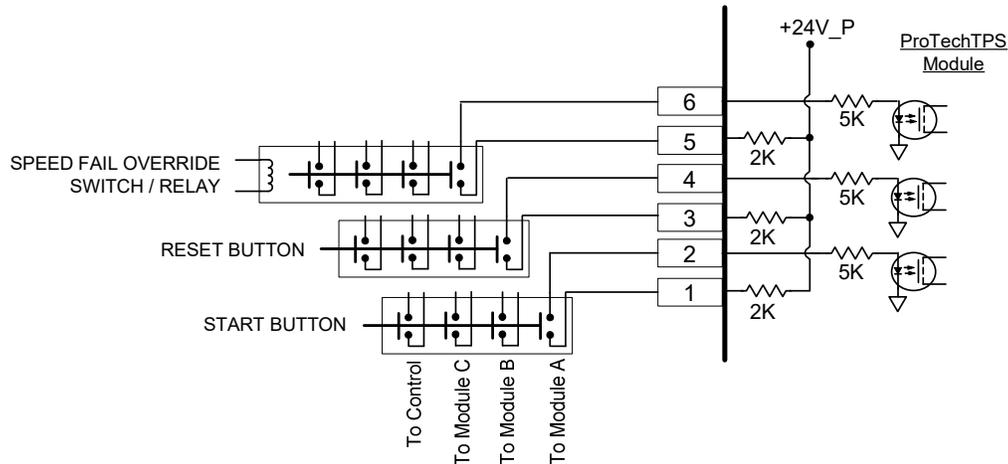


Figure 2-12a. Example Standard Discrete Input Wiring (Internal Power Option)

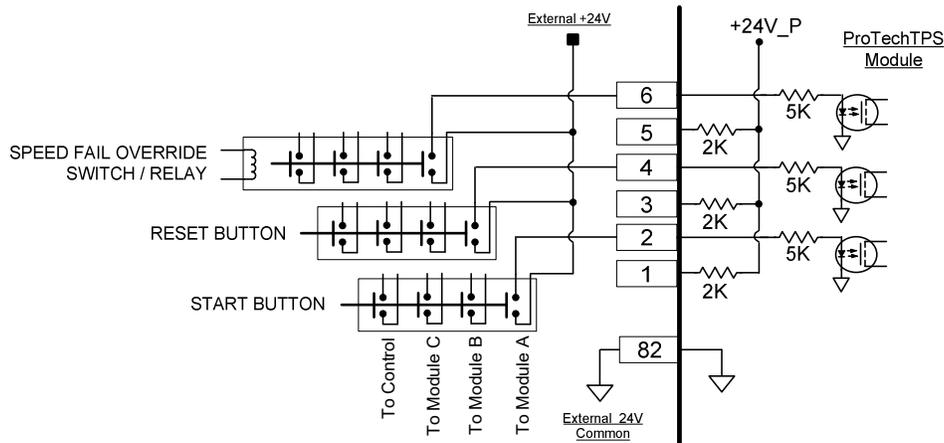


Figure 2-12b. Example Standard Discrete Input Wiring (External Power Option)

Configurable Discrete and Analog Inputs

Ten configurable inputs per module (A, B, C) are available to sense discrete contact input signals or 4–20 mA analog input signals. Depending on the application's needs, each input can be configured within the ProTech® TPS Programming and Configuration Tool (PCT) to function as discrete or analog input.

Configurable Discrete and Analog Inputs—Discrete Input Wiring

When an input is configured to function as a discrete input, it must be wired as shown in Figures 2-13a or 2-13b to function properly. Contact wetting voltage is available through terminal 37. Discrete input wires do not need to be shielded but may be shielded. If shielding is used, terminate shield as indicated on AI mode. If a shield is used, a common wire must be run with the signal wire for field powered DI's, and both power & common must run with the signal wire for ProTech® TPS powered DI's. Shielded DI's may be grouped with multiple signals & one common/power wire in a single shield. In general, an input contact signal must change state for a minimum of 4 milliseconds for a ProTech® TPS module to sense and register a change in state. Refer to Chapter 3 (Functionality) of this manual for information on how to program and use each discrete input in an application.

NOTICE

If total current draw through terminal 37 exceeds 50 mA, the power supply's internal breaker will open. Upon such a condition, all load must be removed from the specified terminals to allow this breaker to reset. The internal 24 V provides enough power to operate all 10 inputs in discrete mode.

NOTICE

For reliability reasons, Woodward recommends that input circuitry for each module (A, B, C) be fully isolated from the input circuitry of the other two modules. For example, the power source and wiring for module A should not be shared or connected in any way to modules B or C.

If desired, an external 18–26 Vdc power source can be used for the circuit-wetting voltage. In this case, terminal 38 (contact input common) must be connected to the external power source's common to establish a common reference point. Each contact input pulls 4.8 mA at 24 V when closed and requires at least 2.5 mA and 14 V to recognize a closure command. Refer to Figure 2-13b for wiring information.

IMPORTANT

Woodward recommends that separate input transducers be utilized for each ProTech® TPS module (A, B, C) to reduce nuisance trips, increase system availability, and simplify unit replacement.

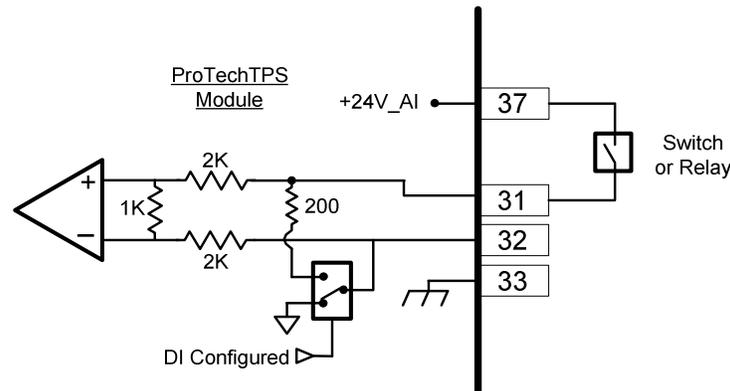


Figure 2-13a. Example Configurable Input Wiring—Discrete Input (Internal Power Option)

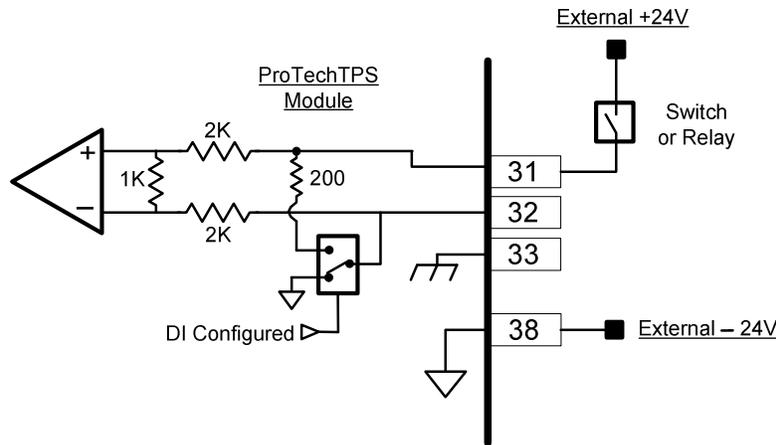


Figure 2-13b. Example Configurable Input Wiring—Discrete Input (External Power Option)

Configurable Discrete and Analog Inputs—Analog Input Wiring

When a configurable input is programmed to function as an analog input, it accepts a two-wire, ungrounded, loop-powered signal, and must be wired as shown in Figure 2-14 to function properly. The input impedance of the analog input circuit, as indicated in Figure 2-14, is 200 Ω . When configured as an AI, twisted shielded pair wiring must be used. Refer to Chapter 3 (Functionality) of this manual for information on how to program and use each analog input in an application. Refer to the Chapter 3 (Functionality) of this manual for applicable analog input specifications.

Because analog inputs are not fully isolated, take care in their application and maintenance to avoid “ground-loop” type problems. If interfacing to a non-isolated device with one of these inputs, the use of a loop isolator is recommended to break any return current paths, which could result in erroneous readings. Also, if a loop isolator is not used and the non-isolated field device has a signal (or power) reference to PE ground connection, damage may occur to the AI. Damage may occur during PE ground bounce or high current transient ground fault conditions due to large potential differences in the remote PE ground & the local PE ground.

NOTICE

For reliability reasons, Woodward recommends that input circuitry for each module (A, B, C) be fully isolated from the input circuitry of the other two modules. For example, the power source and wiring for module A should not be shared or connected in any way to modules B or C.

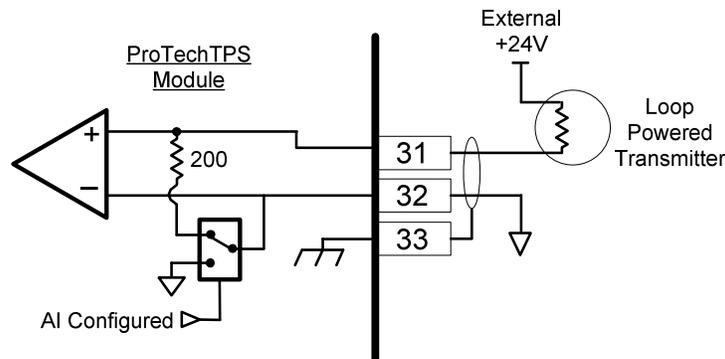


Figure 2-14. Example Configurable Input Wiring—Analog Input

Analog Output

One programmable 4–20 mA analog output per module (A, B, C) is available to drive a readout meter or interface with other controllers or plant DCS's (distributed control systems). This output is designed to drive into an impedance between 0 to 500 Ω . Twisted shielded pair wiring must be used. Refer to the Chapter 3 (Functionality) of this manual for applicable analog output specifications. Refer to Chapter 3 (Functionality) of this manual for information on how to program and use this analog output in an application.

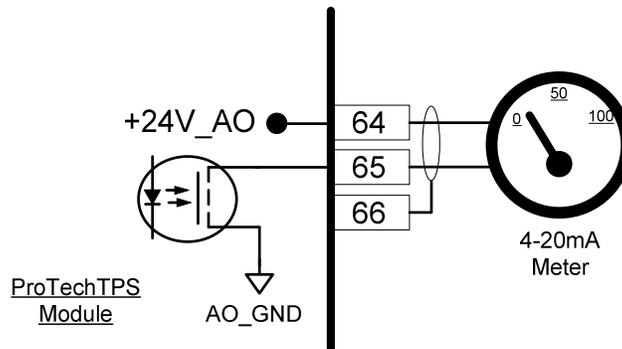


Figure 2-15. Example Analog Output Wiring

Relay Outputs

Two basic ProTech® TPS model variations are available depending on the required trip system architecture: the “Independent Trip Relay” model and the “Voted Trip Relay” model. Either version also has three programmable Relay Outputs per module. Refer to Figure 2-16a for the general locations for Trip Relay Output wiring in the two models.

IMPORTANT

Optionally all ProTech® TPS models can be configured for de-energize-to-trip or energize-to-trip functionality based on the application action required. However, de-energize to trip is a safer way to fail so that a total power loss to the control will trip a shut down.

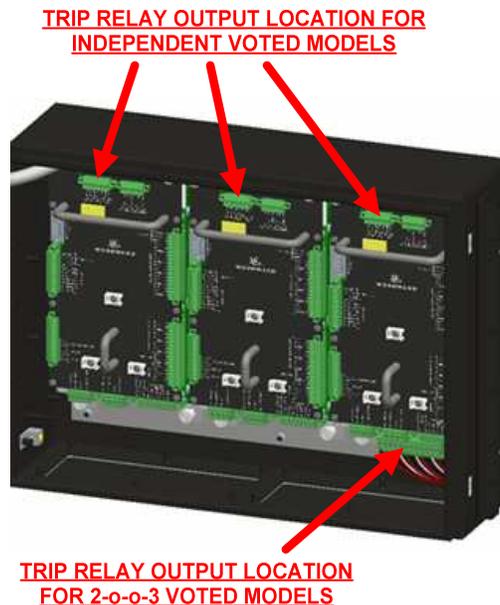


Figure 2-16a. Example Trip Relay Output Wiring

Refer to the Chapter 3 (Functionality) of this manual for all applicable relay output specifications. Refer to Chapter 3 (Functionality) of this manual for information on how to configure and use each programmable relay output in an application.

Relay Outputs (Independent Trip Relay)

Each ProTech® TPS “Independent Trip Relay” model has three independent modules (A, B, C), and each of these modules has five solid-state relay outputs. Each of the five solid-state relays have normally open type contacts and are rated for 24 Vdc @ 1 A. Two of these relay outputs are dedicated as redundant trip signal outputs, and the other three relay outputs are user-programmable which can be programmed to function independently as required. The Independent Trip Relay ProTech® TPS models are designed so each set of trip relays drive one of three external independent trip solenoids, typically used in 2-o-o-3 voted trip block assemblies. Refer to Figure 2-16a for relay terminal location and Figure 2-16b or c for wiring information.

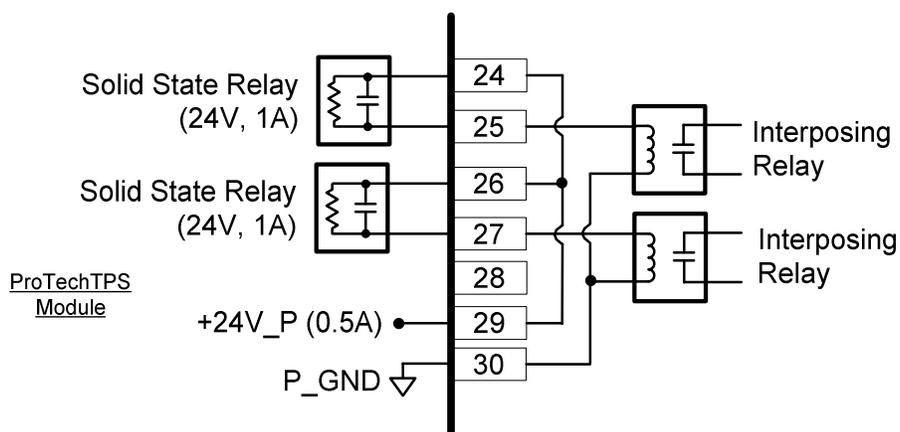


Figure 2-16b. Example Trip Relay Wiring (per Module) (Independent Trip Relay) (Internal Supply)

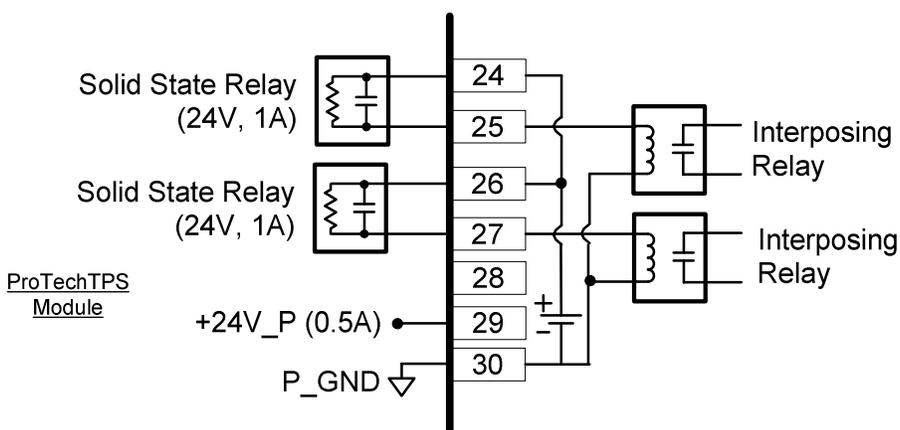


Figure 2-16c. Example Trip Relay Wiring (per Module) (Independent Trip Relay) (External Supply)

Relay Outputs (Voted Trip Relay)

Each “Voted Trip Relay” ProTech® TPS model has three independent modules (A, B, C), and each of these modules has five solid-state relay outputs. Each of the five solid-state relays have normally open type contacts and are rated for 24 Vdc @ 1 A. Two of these relay outputs are dedicated as redundant trip signal outputs, and the other three relay outputs are user-programmable which can be programmed to function independently as required. Note that with the “Voted Trip Relay” ProTech® TPS models, the two solid-state trip relays located on each module (A, B, C) are not available for use or connection. Each module’s trip signal relays are connected internally to the ProTech® TPS in a 2-o-o-3 voted fashion to drive two redundant Form-C trip relays. These two redundant have normally open and normally closed output contacts rated for 220 Vac @ 8 A or 24 Vdc @ 8 A. Refer to Figure 2-16a for relay terminal location and Figure 2-16d for wiring information.

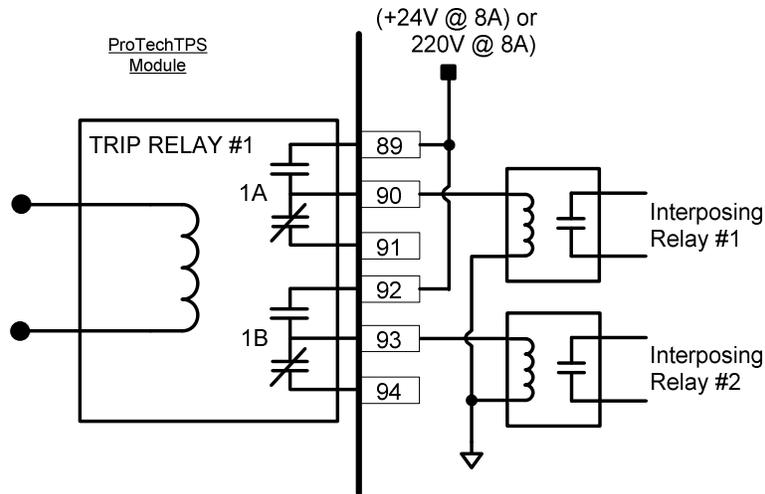


Figure 2-16d. Example Trip Relay Wiring (Voted Trip Relay Models)

Relay Outputs (Configurable)

In both the Independent & Voted Trip Relay versions, each of the three modules (A, B, C) also have three configurable solid-state relay outputs. These are user-programmable and can be programmed to function as required. The programmable relay outputs have normally open type contacts and are rated for 24 Vdc @ 1 A. Refer to Figure 2-16e or f for wiring information.

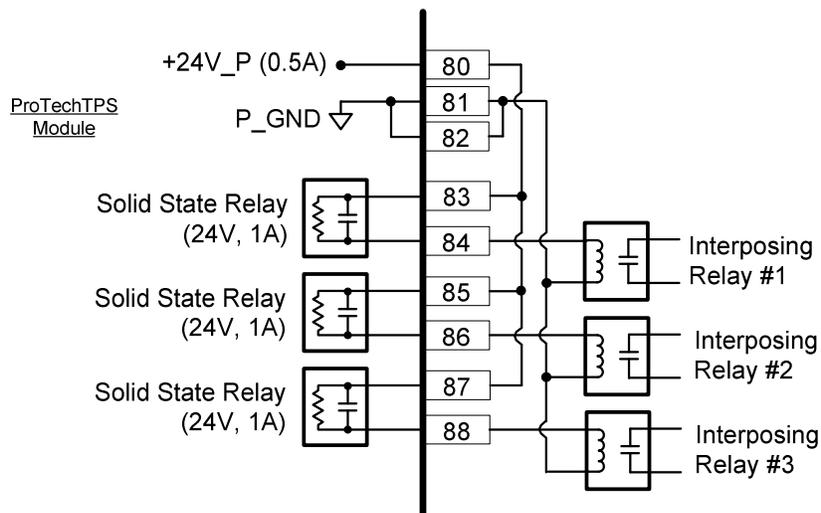


Figure 2-16e. Example Programmable Relay Wiring (Internal Supply)

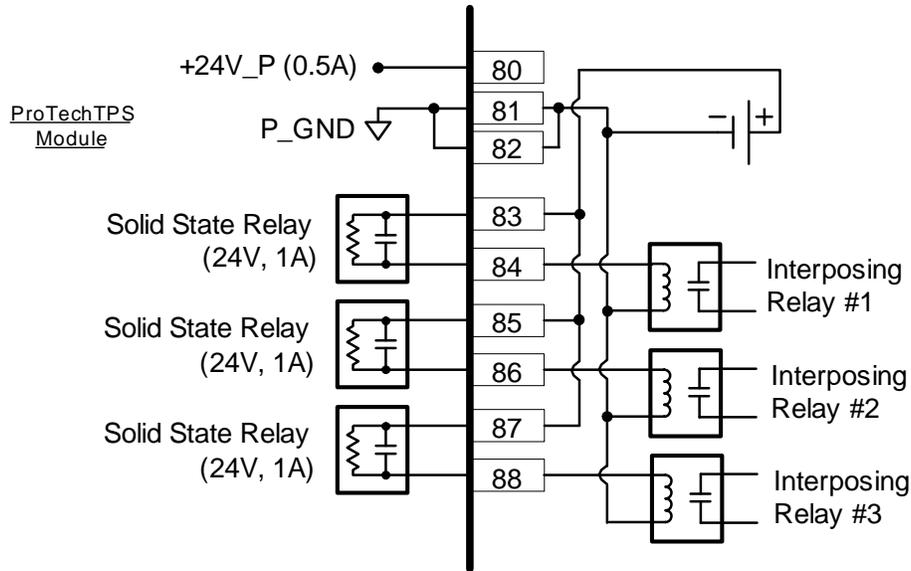


Figure 2-16f. Example Programmable Relay Wiring (External Supply)

Internal Power Supplies for Discrete Signals

Two internal 24 V power supplies are available within each ProTech® TPS module for Discrete I/O, one for driving external relay coils and one wetting voltage for configurable inputs (when used as discrete input circuits). Each power supply utilizes an internal circuit shutdown to protect the power supply from over-current conditions.

One power supply channel (+24 V_P) is capable of providing 24 Vdc $\pm 10\%$ @ 500 mA maximum output current, to power external relays. This supply is used for relay coils driven by the Independent Trip Relay signals and Programmable Relays. Independent Trip Relay signal connections can be made through terminals 29 and 30 with terminal 30 as common. Coil Voltage for Programmable Relays is on terminals 80, 81, and 82 with terminals 81 and 82 as the commons. Refer to Figure 2-17 for wiring information.

NOTICE

In the Independent Trip Relay models, if total current draw through terminals 30 and 80 exceeds 500 mA the power supply's internal breaker will open. Upon such a condition, all load must be removed from the specified terminals to allow this breaker to reset.
In Voted Trip Relay models, if the total current draw through Terminals 80 exceeds 500 mA the power supply's internal breaker will open. Upon such a condition, all load must be removed from the specified terminals to allow this breaker to reset.

If additional current capability is needed the Voter & Programmable relay connections points may be used as controlled switch contact connection points with an external power supply. An external supply may be used instead of the internal supply only for the independent trip relays or programmable relays as shown in figure 2-16f. The external supply should be referenced to terminal 80 or 81.

NOTICE

In the Independent Trip Relay models, if a customer provided external supply is used for coil voltage, it must not be the input power with a reference connection to the 24 V EXT supply or Discrete Supply. Referencing input power to DISCRETE PWR or 24 V EXT causes the internal supplies to respond more readily to transients on the power bus.

A second power supply channel (Discrete PWR) can provide 24 Vdc \pm 10% @ 50 mA maximum output current, to power the module's configurable input circuitry (configured as Discrete Inputs). Power connections can be made through terminal 37, with terminal 38 as the common. This power supply is sized to provide power for all ten discrete inputs. Refer to Figure 2-17 for information on the module's internal power supply relationship.

NOTICE

If total current draw through terminals 37 and 38 exceed 80 mA the power supply's internal breaker will open. Upon such a condition, all load must be removed from the specified terminals to allow this breaker to reset.

If additional current capability is needed, the DI wetting voltage may come from an external source. If an external supply is used it must be an isolated supply.

NOTICE

If DI wetting voltage is from an external supply, it must be an isolated, power supply. The module input power source of 24 Vdc may not be used. Tying the input power to the Discrete power causes bias offsets which make the supplies susceptible to transients. The supply must also be referenced correctly to Discrete PWR by connecting the two commons.

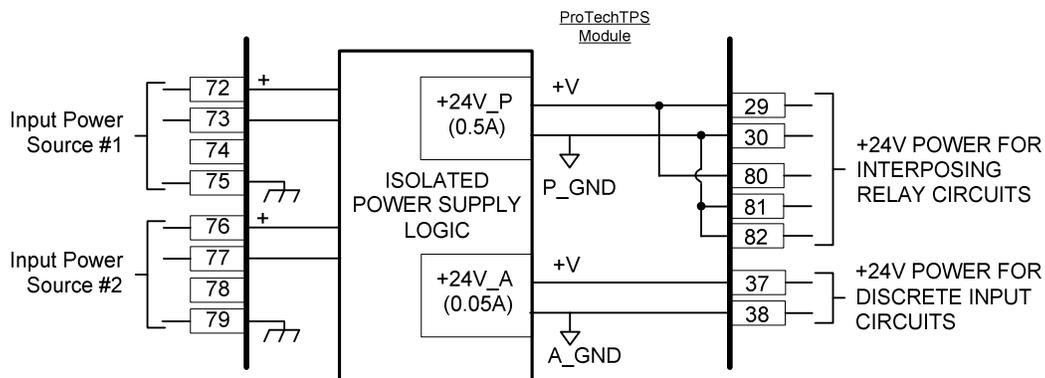


Figure 2-17. Power Supply Relationship Diagram

Serial Modbus Communications

One serial communications port per module (A, B, C) is available for Modbus communications to a plant DCS (distributed control system) or local HMI (human machine interface). This serial port can be wired and configured for RS-232 or RS-485 communications, depending on the specific application requirements. Refer to Figure 2-18a for RS-232 wiring information, and Figure 2-18b for RS-485 wiring information.

*—Modbus is a trademark of Schneider Automation Inc.

Note: only 2-Wire communications is supported.

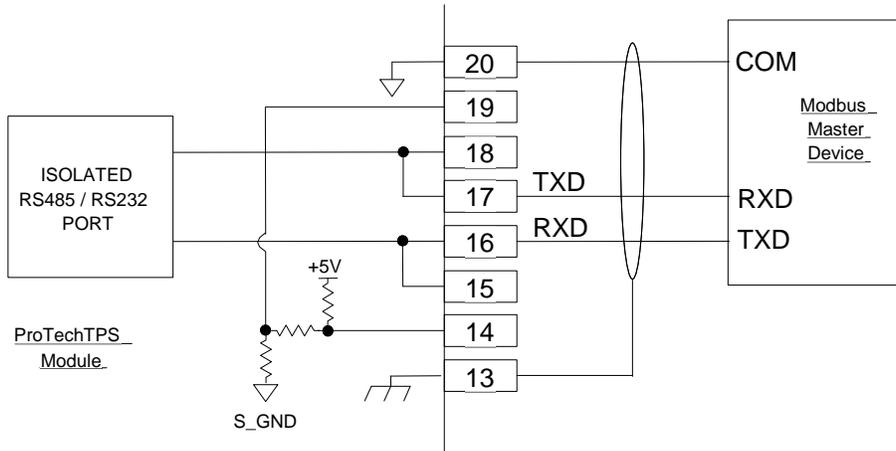


Figure 2-18a. Serial Port Interface Diagram—RS-232

Optional termination resistors for RS-485 communication networks are included within the ProTech® TPS control's internal circuitry, and only require terminal block wire jumper(s) for connection to a network, for applications requiring these termination resistors. Refer to Figure 2-18b for jumper connections.

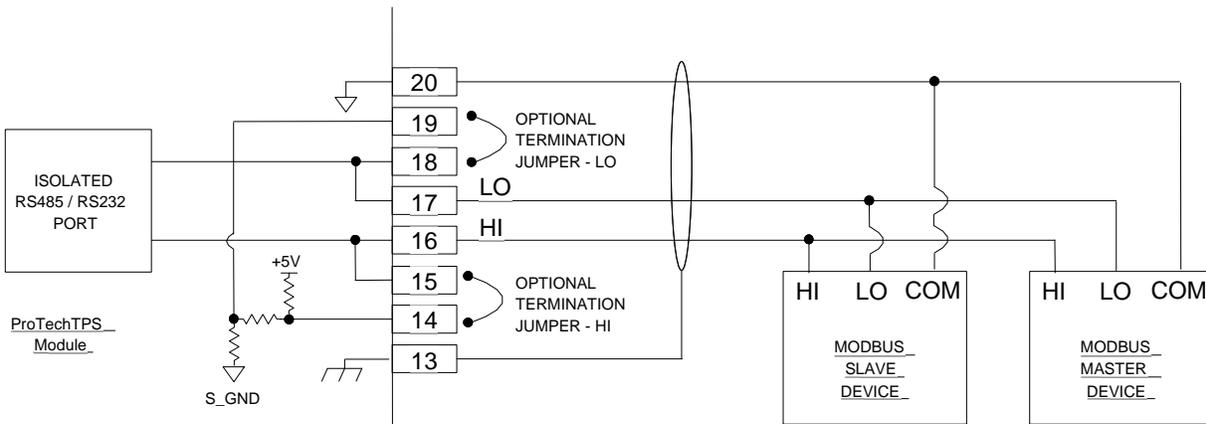


Figure 2-18b. Serial Com Port Interface Diagram—RS-485

Service Port Communications

One 9-pin Sub-D based service port per module (A, B, C) is available to interface with a computer for loading program settings into the ProTech and for reading stored log files from the ProTech using the Programming and Configuration Tool (PCT). This port is designed to communicate to the computer using a serial DB9 extension (straight-through) type of computer cable.

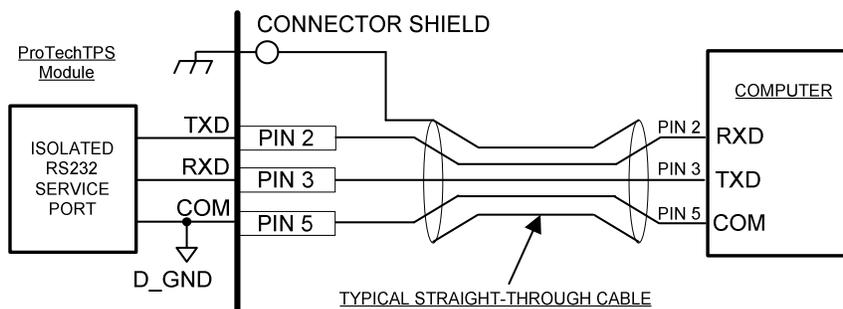


Figure 2-19. Service Tool Cable/Interface Diagram

IMPORTANT

The RS-232 serial cable must be disconnected when not in use. The port is a service port only, it is not designed for permanent connection.

Chapter 3. Functionality

The ProTech® TPS includes all the functionality of the original ProTech 203 Overspeed Protection system, but adds additional inputs, outputs, protection features, and configurable software to allow the ProTech® TPS to meet the requirements of a Total Protection System.

Features

Fault Tolerant Design

Each ProTech® TPS consists of three independent modules referred to as A, B and C. Each module accepts one speed input, ten configurable analog / discrete inputs, and three dedicated function discrete inputs. Each module also has three configurable relay outputs and one analog output for the sensed speed output.

The ProTech® TPS comes in two basic models – the “Independent Trip Relay” models and the “Voted Trip Relay” models. This relates to the trip signal configuration. The differences between these two models and their application are discussed in detail in the Product Models section of this chapter. Each of the three ProTech® TPS modules A, B, and C are fully fault isolated from each other, so that faults in one module do not affect other modules. The modules do not share input or output information, but each module is aware of the status of the others.

Normally, each module is configured to operate the same exact application program and with the same exact configuration settings. Monitoring logic is used to validate that all modules are running the same exact application program as the other modules, and the monitoring logic will issue an alarm if it detects that one or more of the modules are not running the exact same application program. Thus, if program changes are downloaded to a module, or a change to configuration setting is made to one module, while the ProTech® TPS is in normal operation and the turbine or equipment is on-line and operating normally, each module will issue an alarm. Once all application programs are the same again and all configuration settings are the same again, this alarm can be reset.

Some exceptions to this rule are permitted. The user-defined names can be different in each module to allow the specification of unique tag names. Since these may be different, this information is not checked by the Configuration Compare function and is not copied between modules by the Copy Configuration function. In special cases that require a different application to be installed in each module, the Configuration Compare alarm can be disabled.

The ProTech® TPS is a SIL-3 (according to IEC-61508) triple modular design that allows users to easily replace any of its modules (A, B, C) while the monitored equipment / turbine is on-line and operating normally. This is also referred to as ‘hot replacement’. The unit’s backplane plug-and-operate structure and its module-to-module program copying function enhance ease of replacement.

Programming/Configuring Overview

Each ProTech® TPS module includes preset overspeed, over-acceleration, alarm latch, and trip latch functionality and can be custom configured to meet a specific application through a module’s front panel or the provided Programming and Configuration Tool (PCT).

A custom application program is required for use of any of the ProTech® TPS configurable inputs, outputs and related functionality. A software based PCT is included with each ProTech® TPS that can be loaded onto a computer, and used to:

- Create and change custom application programs
- Change overspeed and over-acceleration functionality settings
- Save application and configuration settings to a file
- Download application and configuration settings to each ProTech® TPS module
- Upload application and configuration settings from a ProTech® TPS module
- Upload and view stored logged files from a ProTech® TPS module

Configuration and program logic changes are allowed while the service tool is connected (on-line) as long as the module is in a tripped state. Configuration and program logic changes can also be made off-line (service tool not connected) by editing a settings file that is loaded into the module later. Normally, each ProTech® TPS module is configured to operate the same exact application program and with the same exact configuration settings. Program differences between modules are detected and alarmed.

Although the overspeed and over-acceleration functionality can be programmed from either the PCT or a module's front panel, changes/additions to a custom application program can only be changed via the PCT. Entry of the correct "configuration" level password is required to perform any program changes or download a program into a module.

Refer to Chapters 9 and 10 of this manual for more information on performing program changes.

Security

The ProTech® TPS utilizes two password levels, a Test Level Password and a Config Level Password. The Programming and Configuration Tool (PCT) and Front Panel use the same passwords.

The Test Level Password is required to:

- Initiate tests
- Reset logs (except for the Peak Speed/Acceleration Log)
- Change the Test Level Password

The Config Level Password provides access to any function that requires the Test Level Password.

Additionally, the Config Level Password is required to:

- Change any program setting
- Download an application program file into a module
- Reset the Peak Speed/Acceleration Log.
- Change the Config Level Password

Each of these passwords meets NERC (North American Electric Reliability Corporation) cyber security requirements.

The default password for Test and Config Level is "AAAAAA".

Module-to-Module Communications

An isolated communications bus is used between modules to:

- Copy an application program from one module to another module
- Compare module application programs for differences
- Verify the health and state of the other modules before allowing a module test to be performed
- Pass a "module test token" between modules when performing a "Periodic Overspeed Test" routine

Product Models

Two basic ProTech® TPS models are available depending on the required system architecture and related output signal(s).

- The ProTech® TPS "Independent Trip Relay" models consist of three independent modules that each accept one speed input and ten configurable analog/discrete inputs, then output two redundant trip commands.
- The ProTech® TPS "Voted Trip Relay" models consist of three independent modules that each accept one speed input and 10 configurable analog/discrete inputs, and whose trip output commands are then voted in a 2-out-of-3 fashion to create the 2-out-of-3 trip output command.

Both of these models can be purchased with different mounting options (bulkhead mount or panel mount) and different input power supply options (two high-voltage power supply inputs or one high-voltage and one low-voltage power supply input). Each ProTech® TPS model can be configured to function for energize-to-trip and de-energize-to-trip applications. The de-energize-to-trip functionality is implemented such that a complete loss of power to the module results in a trip of that module. The energize-to-trip functionality is implemented such that a complete loss of power to the module does not result in a trip of that module.

IMPORTANT

Optionally all ProTech® TPS models can be configured for de-energize-to-trip or energize-to-trip functionality based on the application action required. However, de-energize to trip is a safer way to fail so that a total power loss to the control will trip a shut down.

ProTech® TPS with “Independent Trip Relay” Outputs

ProTech® TPS “Independent Trip Relay” models consist of three independent modules that each accept one speed input and ten configurable analog/discrete inputs, then output two redundant trip commands. The trip command outputs are electrically separated, allowing each module to actuate a separate external relay or trip solenoid. These models are typically used with special 2-out-of-3 voted trip block assemblies or 2-out-of-3 voted trip string relay logic.

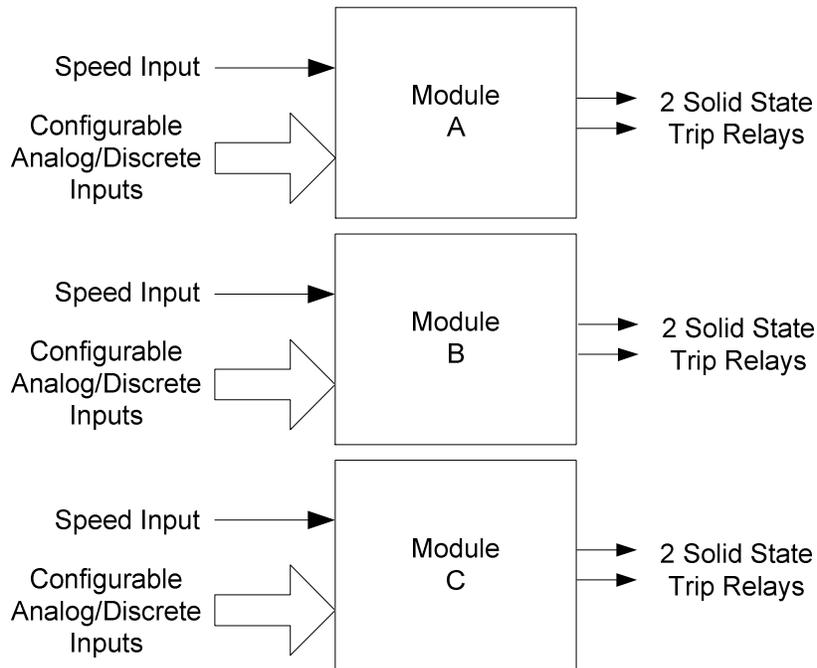


Figure 3-1. Basic Functional Overview of Independent Trip Relay Models

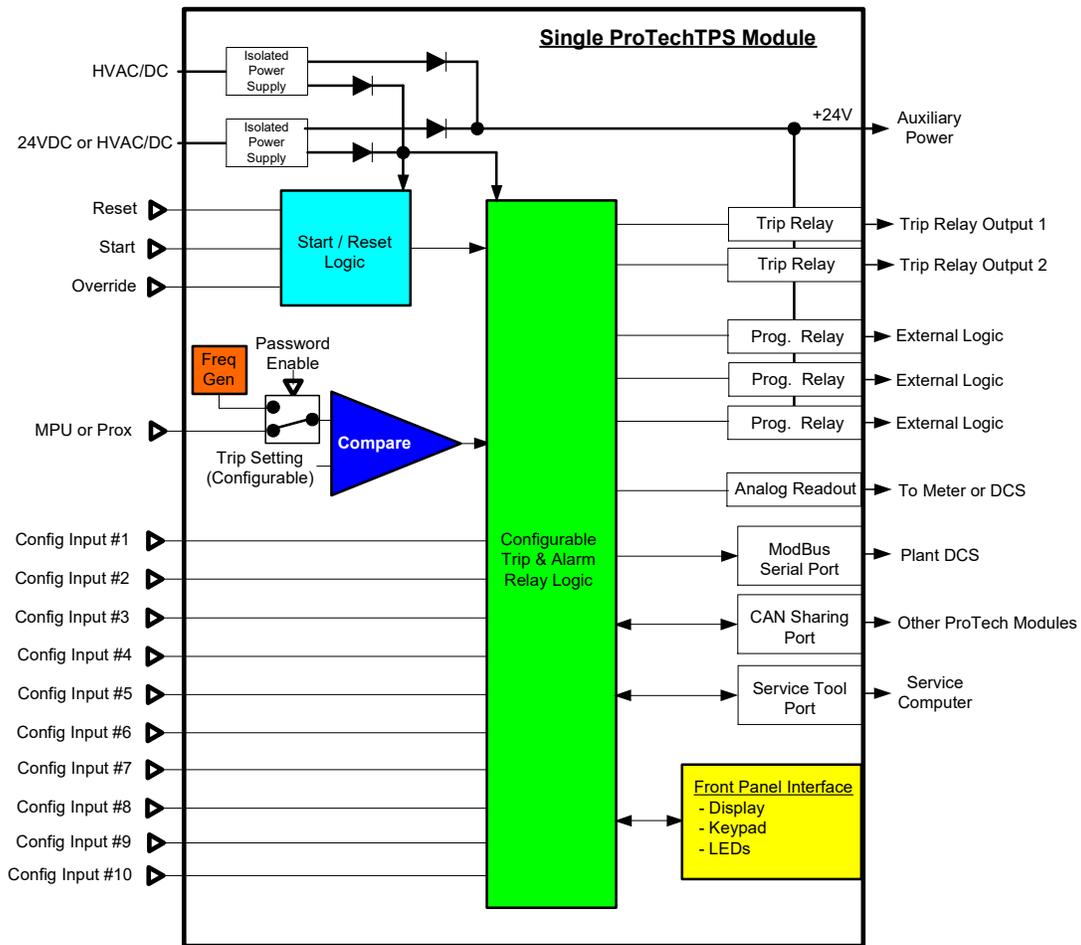


Figure 3-2. Functional Diagram of single ProTech® TPS module with Independent Trip Relay Outputs

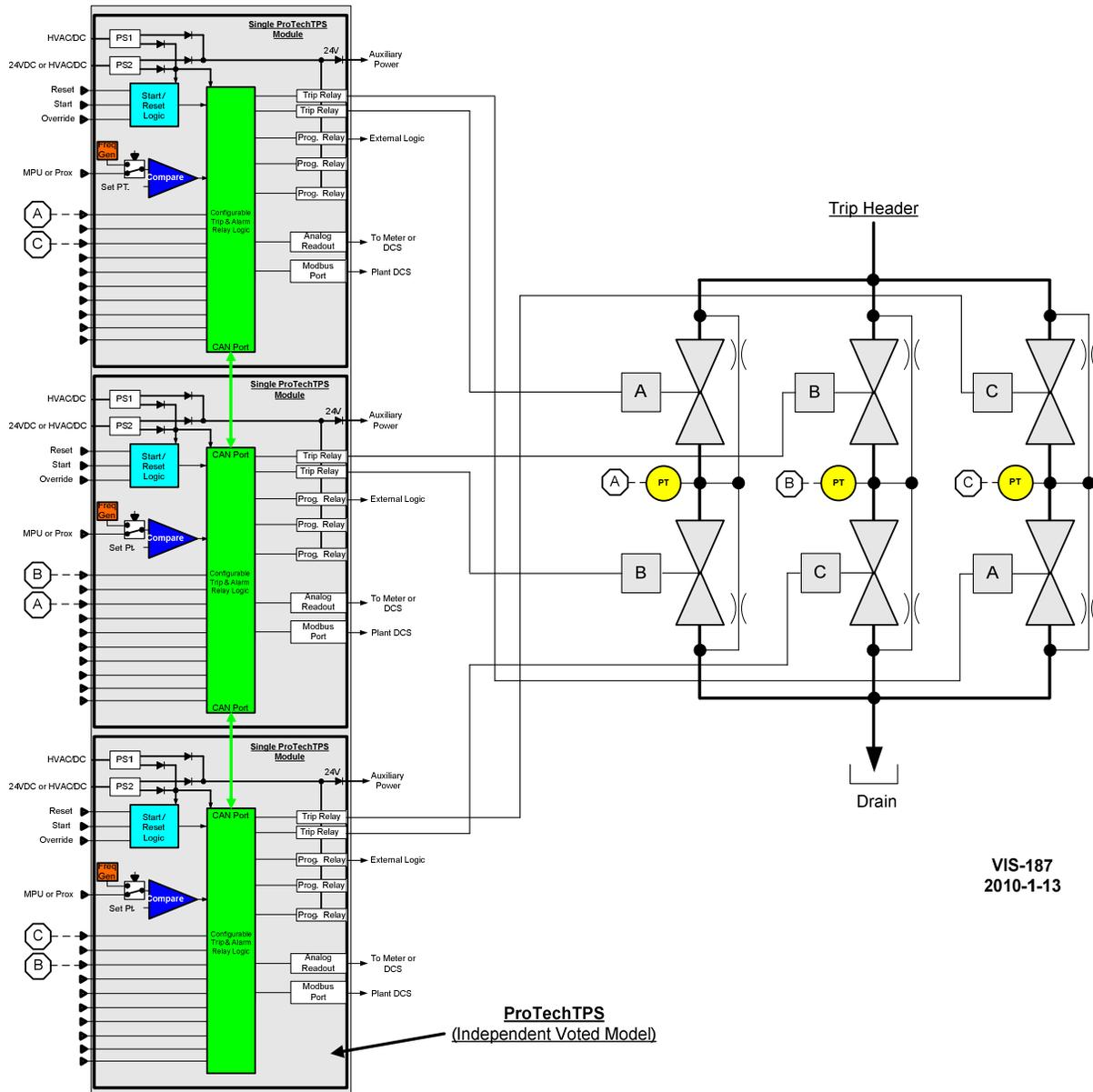


Figure 3-3. Example TMR Trip Block Assembly Interface

Table 3-1. Independent Trip Relay Output Specifications

Number of Channels	2 (actuated simultaneously)
Output Type	SPST Solid-state, Normally Open
Current Rating	1 A
Voltage Rating	24 V (32 V max)
Isolation	500 Vac from output to chassis and output to all other circuits
Signal Cable Length	Must be limited to 1000 ft / 305 m (low capacitance 16 AWG / 1.3 mm ² pair)

ProTech with Voted Trip Relay Output

ProTech® TPS “Voted Trip Relay” models consist of three independent modules that each accept one speed input and 10 configurable analog/discrete inputs, and whose trip output commands are then voted in a 2-out-of-3 (2oo3) fashion to create the 2oo3 trip output command. Two redundant “Form-C” 2oo3 voted relays are used in these models providing four isolated relay output signals with normally open and normally closed contacts.

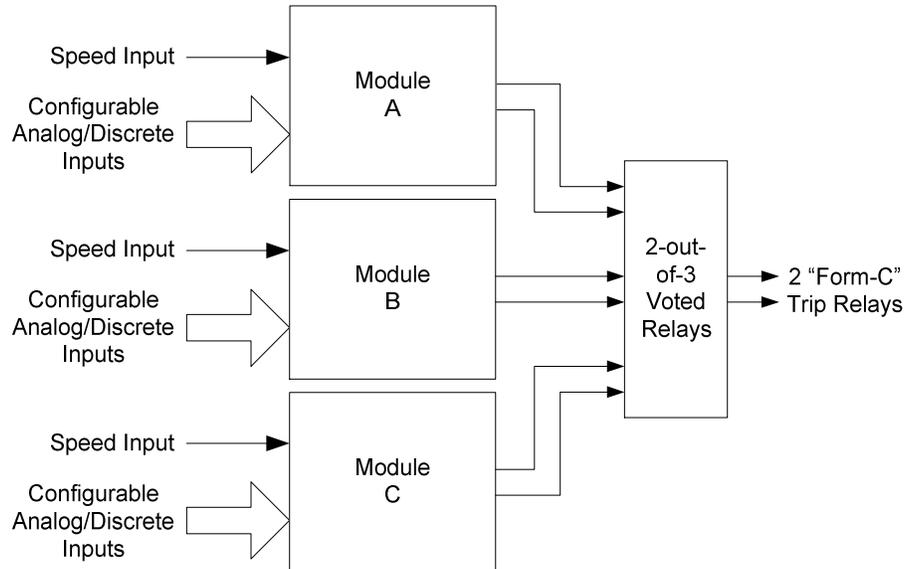


Figure 3-4. Basic Functional Overview of Voted Trip Relay Models

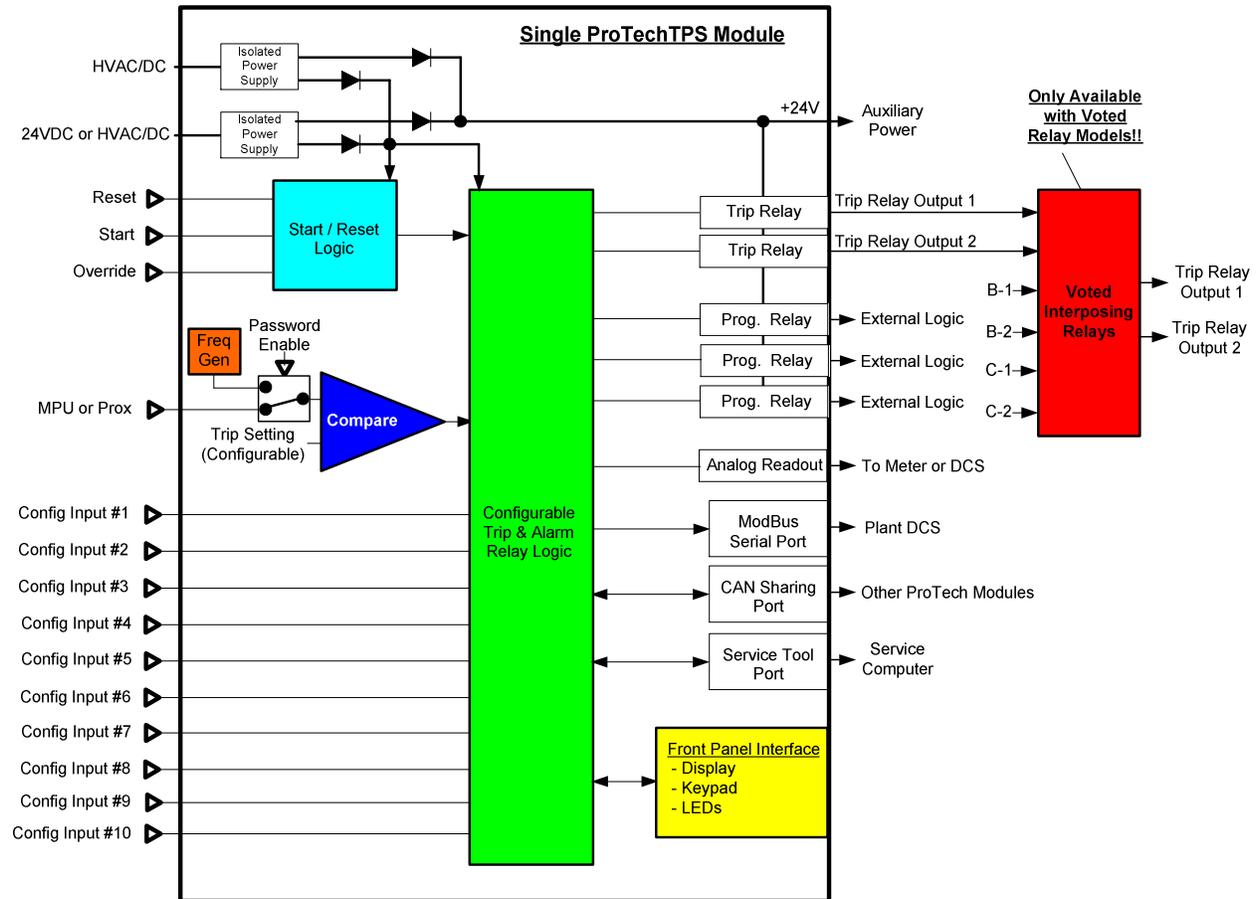


Figure 3-5. Functional Diagram of Single ProTech® TPS Module with Voted Trip Relay Outputs

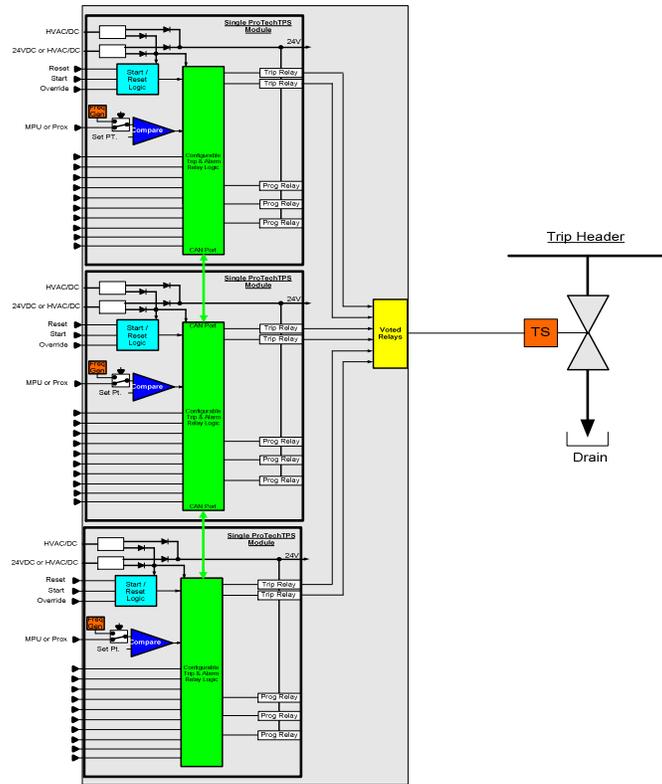


Figure 3-6. Simplex Trip Block Assembly

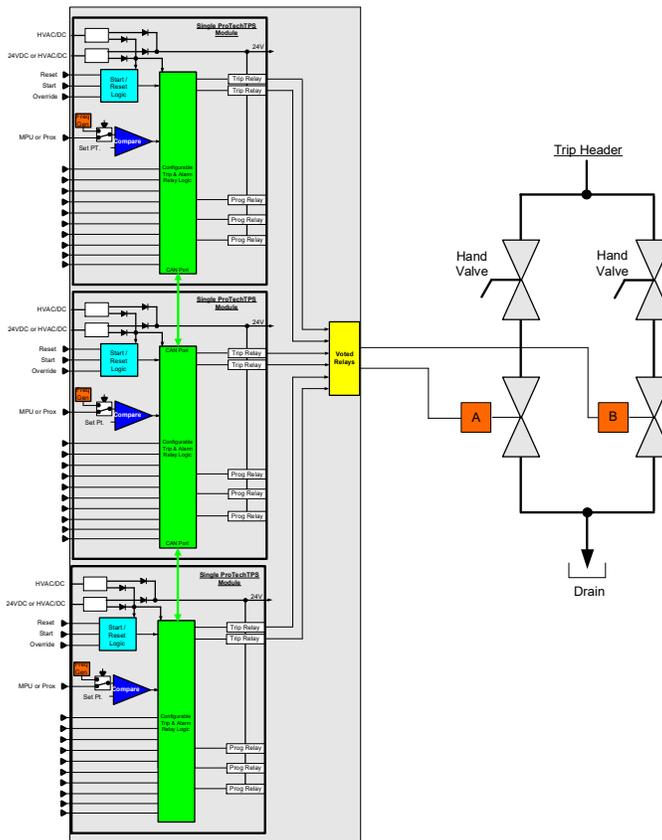


Figure 3-7. Dual Redundant Trip Block Assembly

Table 3-2. Voted Trip Relay Output Specifications

Number of Channels	2 (both channels actuated simultaneously), see wiring and installation
Output Type	Form C, dual SPDT
Contact Rating:	8 A @ 220 Vac / 8 A @ 24 Vdc
Max. Switching Voltage	220 Vac / 150 Vdc
Max. Switching Power	2000 VA / 192 W
Isolation	1500 Vac from contact to chassis and contacts to all other circuits

Power Supplies

Each ProTech® TPS system consists of three separate internal modules (A, B, C), and each of these three modules accept two input power sources (for redundancy). Depending on the ProTech® TPS model purchased, the internal modules will accept either two high-voltage (HV) input power sources or one HV input power source and one low-voltage (LV) input power source. For reliability purposes, each ProTech® TPS module will function normally with power sourced to both or either power supply input.

Table 3-3. Power Supply Specifications

Number of Inputs	2, Input range depends on model (see following tables): <ul style="list-style-type: none"> • 2 High Voltage Inputs OR • 1 High Voltage and 1 Low Voltage
Wiring Constraints	Each power supply input must be provided with its own breaker. This is to facilitate both on-line-removal of a module, and also to protect other power supplies from tripping while connected to a common input power circuit.

Table 3-4. High Voltage Input

Voltage Input Range	90 – 264 Vac, or 100 – 150 Vdc
Current Input Max (Note 1)	0.5 A @ 90 Vac 0.22 A @ 264 Vac
	0.25 Arms @ 110 Vdc 0.18 Arms @ 150 Vdc
Inrush Current	10 A at 115 Vac, 20 A @ 220 Vac
Reverse Polarity Protection	Yes, for dc connection
Interrupt Time	45 ms, when operating on one power supply only

Table 3-5. Low Voltage Input

Voltage Input Range	18 – 32 Vdc
Current Input Max (Note 1)	1.5 A @ 18 Vdc 1 A @ 32 Vdc
Inrush Current	0.05 A ² sec
Reverse Polarity Protection	Yes
Interrupt Time	3 ms, when operating on one power supply only

Note 1: The input current specifications are for 1 module, measured with the other power supply input disconnected. With both power supply inputs connected, input current will never exceed the maximum specification, however the two power supplies do not load share internally.

Internally Generated Limited Power Supplies

Table 3-6. Configurable Input Power Supply (24V_AI)

Output Voltage	24 Vdc \pm 10%
Current Limit	50 mA

IMPORTANT

Avoid using the Configurable Input Power Supply to power any analog input channels. It is intended for use with inputs that are configured for discrete mode only.

Table 3-7. Relay Output Power Supply (24V_P)

Output Voltage	24 Vdc \pm 10%
Current Limit	500 mA

Inputs and Outputs

Speed Sensor Inputs

Each module has one speed input which can be programmed to accept a passive MPU (magnetic pickup unit), or an active speed sensor (proximity probe signal or an eddy current probe signal).

When configured as an MPU signal input, special MPU open-wire detection circuitry is used to validate that the MPU is properly connected before turbine operation, and special loss-of-speed detection logic is used to validate speed sensor functionality during turbine operation. Depending on the module's program settings a loss of speed signal or open-wire detection will result in a trip or alarm condition.

IMPORTANT

MPU open-wire detection logic and associated trip/alarm action is only utilized when the speed input is configured a "passive" probe.

When configured as an MPU signal input, the speed sensor circuitry will sense MPU signals within the voltage range of 1—35 Vrms.

When configured as a proximity (active) probe input or eddy current probe input, a 24 V power supply is provided to power the probe, but an isolated external supply may be used instead, if referenced correctly.

The Number of Gear Teeth and Gear Ratio are configured to convert the frequency input from the speed probe to the unit speed.

WARNING

The Number of Gear Teeth and Gear Ratio must match the actual unit hardware or speed sensing and all associated protection and functionality will not work correctly.

Refer to Chapter 2 of this manual for related speed sensing input installation information.

Speed Input Specifications

Table 3-8. General Specifications

Number of Inputs	1, selectable as passive or active probe by front panel configuration
Speed Sensing Accuracy	Accuracy: \pm 0.04% of current speed over -20 to $+60$ °C ambient temperature
Acceleration Sensing Accuracy and Range	Accuracy: \pm 1% of current speed
Signal Cable Length	Detectable over-acceleration range: 0 to 25000 rpm/s
Internal Test Frequency Generator	Must be limited to 1500 ft / 457 m (low capacitance 16 AWG / 1.3 mm ²) 6 Hz to 32 kHz, selectable in different test modes, see Chapter 4, Configuration and Operation

Table 3-9. Passive Probe (MPU) Inputs

Input Frequency	Passive Probe (MPU): 100 Hz to 32 kHz
Input Amplitude	1 Vrms to 35 Vrms
Input Impedance	1.5 k Ω
Isolation	500 Vac from input to chassis and input to all other circuits
Open Wire Detection	MPU only > 7.5 k Ω

Table 3-10. Active Probe (Proximity, Eddy Current)

Input Frequency	Active Probe (Proximity, Eddy Current): 0.5 Hz to 25 kHz
Input Amplitude	Active Probe: 24 V probes
Probe Power	24 V \pm 10% @ 1 W, probe power switched on only in active probe mode.
Internal Pull-up Resistor	10 k Ω , input suitable for use with open collector probe outputs (Note 1)
Input Threshold (Vlow)	< 2 V
Input Threshold (Vhigh)	> 4 V
Isolation	500 Vac from input to chassis and input to all other circuits

WARNING

When Active Probes are used it is recommended to always enable (USED) the Speed Fail Trip function. Reference the Configuration Guidance section under the Troubleshooting Chapter for more detail.

IMPORTANT

Each speed input is designed to operate from its own speed probe. Do not connect a speed probe to more than one input. This will compromise the ability of the ProTech® TPS to sense open wire (passive mode only) and interfere with the minimum amplitude sensitivity and accuracy.

IMPORTANT

When using open collector probes, verify that the signal is being read properly at higher frequencies (>10 kHz). Long cable lengths can significantly reduce the signal strength at higher frequencies. In this case, add an external pull-up resistor of approximately 2 k Ω (0.25 W) from terminals 70 to 69 and verify that the signal is read properly by the ProTech® TPS.

IMPORTANT

Shielded cable is required when connecting to the speed input.

Dedicated Discrete Inputs

Each ProTech® TPS module (A, B, C) accepts three dedicated discrete inputs. The Preset Contact Inputs are Start, Reset and Speed-Fail-Override.

Start

This contact input is used as part of the Start Logic “Speed Fail Timeout Trip” function. When this function is Enabled, closing the Start contact will start the Speed Fail Timeout timer. This is an edge triggered signal and re-selecting Start will re-start this timer. Refer to the Start Logic section below for additional details.

Reset

This contact is used to clear module trips and alarms.

Speed-Fail-Override

This is used as part of the Start Logic “Speed Fail Trip” function. When this function is Enabled, closing the Speed-Fail-Override contact overrides the Speed Fail Trip. This is a level sensitive trigger so the contact must remain closed to prevent the Speed Fail Trip until speed is greater than the speed fail setpoint. Refer to the Start Logic section below for additional details.

Table 3-11. Dedicated Discrete Inputs Specifications

Number of Channels	3, (Start, Reset, Speed Fail Override)
Input Thresholds	<= 8 Vdc = “OFF” >= 16 Vdc = “ON”
Input Current	3 mA \pm 5% at 24 V (for externally power wiring, see, Chapter 2)
Wetting Current Supply	24 V at 2 W available (see installation diagrams, Chapter 2). This power supply is current limited.
Max Input Voltage	32 V (for externally power wiring, see, Chapter 2)
Isolation	500 Vac from output to chassis and output to all other circuits

Configurable Inputs

Each module has 10 configurable analog/discrete inputs. Each input can be configured as Not Used, Analog Input, or Discrete Input. User defined names can be associated with each input.

Discrete Input Configuration Example

When configured as a discrete Input, the channel accepts a 0 / 24 Vdc discrete input.

Note: <6 Vdc = FALSE, >12 Vdc = TRUE. The Boolean output associated with the Discrete input can be used in the user configured software.

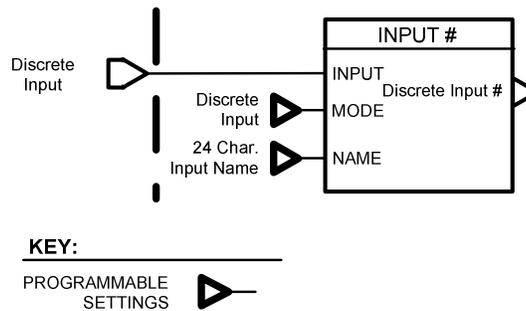


Figure 3-8. Discrete Input Example

Analog Input Configuration Example

When configured as an analog input, the channel accepts a 4–20 mA analog signal. The accuracy of the analog input is better than $\pm 0.5\%$ of 20 mA over the temperature range of the product. Engineering units and ranges are assigned to the 4–20 mA current input values. Additionally, low-low (LoLo), low (Lo), high (Hi), and high-high (HiHi) levels can be defined. The Boolean outputs associated with these levels for the analog input can be used in the user configured software. There is also a Range Error output to indicate that the Input is outside a 2–22 mA range.

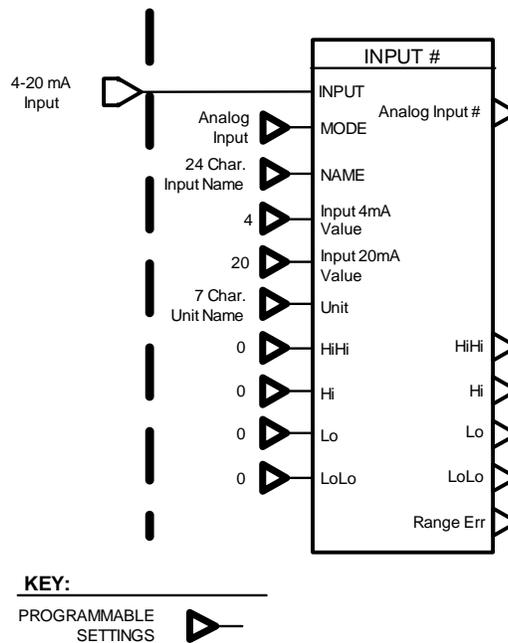


Figure 3-9. Analog Input Example



WARNING

The Analog scaling must match the actual unit hardware, or the signal sensing and all association protection and functionality will not work correctly.

Configurable Input Specifications

Table 3-12. General Specifications

Number of Channels	10, user configurable for individual analog or discrete input mode
Signal Cable Length	Must be limited to 1000 ft / 305 m (low capacitance 16 AWG / 1.3 mm ²)

Table 3-13. Analog Input Mode

Input Current Range	0 to 25 mA
Common Mode Rejection	45 dB at 60 Hz
Input Common Mode Range	±40 V
Input Impedance	200 Ω ±1%
Resolution	12 bit
Accuracy	±0.25% of 25 mA at 25 °C, (note 1) ±0.5% of 25 mA over-temperature
Analog Input Fail Thresholds	Fixed at 2 mA and 22 mA
Isolation	500 Vac from input to chassis and input to all other circuits, not galvanically isolated to other channels in analog mode. Faults or signals on one channel will not affect other channels.
Anti-aliasing Filter	2 poles at 500 Hz

- Loop power is not provided by the ProTech® TPS
 - Shielded twisted pair cable is required when connecting to the analog inputs.
- Note 1: +/- 0.25% represents the pk-pk noise of the input. The average accuracy is +/- 0.1% of 25 mA.

Table 3-14. Discrete Input Mode

Input Thresholds	<= 6 Vdc = "OFF" >= 12 Vdc = "ON"
Input Current	5 mA ±5% at 24 V (5 kΩ input impedance)
Wetting Current Supply	24 V at 2 W available (see installation diagrams, Chapter 2). This power supply is current limited.
Max Input Voltage	32 V
Isolation	500 Vac from input to chassis. In discrete mode, the discrete input shares a common internal ground with the other channels that are in discrete mode.

Configurable Relay Outputs

Each module has three configurable Relay Outputs. Each relay output can be configured to reflect the state of any Boolean value within the module. Each output can be configured to be inverting or non-inverting. If configured as non-inverting, the relay will energize when the configured input is true. The first configurable relay is defaulted to the output of the Alarm Latch.

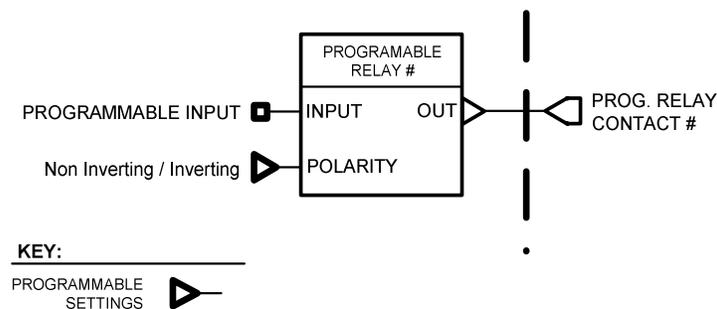


Figure 3-10. Programmable Relay Output Diagram

Table 3-15. Programmable Relay Output Specifications

Number of Channels	3
Output Type	SPST Solid-state, Normally Open
Current Rating	1 A
Voltage Rating	24 V (32 V max)
Isolation	500 Vac from output to chassis and output to all other circuits
Signal Cable Length	Must be limited to 1000 ft / 305 m (low capacitance 16 AWG / 1.3 mm ²)

Analog Output

A single 4–20 mA output is provided on each module to indicate the speed sensed by that module. The 4–20 mA range can be configured to any speed range desired. The accuracy of the analog output is better than $\pm 0.5\%$ of 20 mA over the temperature range of the product.

Table 3-16. Analog Output Specifications

Number of Channels	1
Output Type	4–20 mA, isolated
Max Current Output	25 mA
Accuracy	$\pm 0.1\%$ at 25 °C, $\pm 0.5\%$ over temperature
Resolution	12 bit
Response Time	< 2 ms (2 to 20 mA)
Min Current Output	0 mA
Min Resistive	0 Ω
Max Resistive Load	500 Ω at 25 mA
Isolation	500 Vac from output to chassis and output to all other circuits
Signal Cable Length	Must be limited to 1000 ft / 305 m (low capacitance 16 AWG / 1.3 mm ²)

Shielded twisted pair cable is required when connecting to the analog outputs.

Overspeed and Over-Acceleration Detection and Trip

Each ProTech® TPS includes overspeed and over-acceleration functionality and can be custom configured/set to meet specific application overspeed and over-acceleration requirements. No custom application program is required to be loaded for this functionality to operate normally.

The ProTech® TPS senses speed and then compares the sensed speed to its programmed overspeed trip setpoint to detect an overspeed condition and generate a trip command.

NOTICE

For process-safety-based applications where speed is not sensed or used, the speed input can be disabled by putting a jumper across the sensor input terminals and disabling the ProTech® TPS control's internal start logic.

The ProTech® TPS derives acceleration from the sensed speed and then compares the sensed acceleration to its programmed over-acceleration trip setpoint to detect an over-acceleration condition and generate a trip command. The ProTech® TPS control's acceleration detection function can be configured to be enabled or disabled, or only enabled above a certain speed setpoint, depending on the specific application's requirements. The over-acceleration trip range is configurable from 0 to 25 000 RPM/s.

Peak speed and peak acceleration are tracked and logged for every overspeed and over-acceleration occurrence, the last 20 occurrences logged and can be viewed from a front panel or loaded to a computer via the ProTech® TPS Programming and Configuration Tool (PCT).

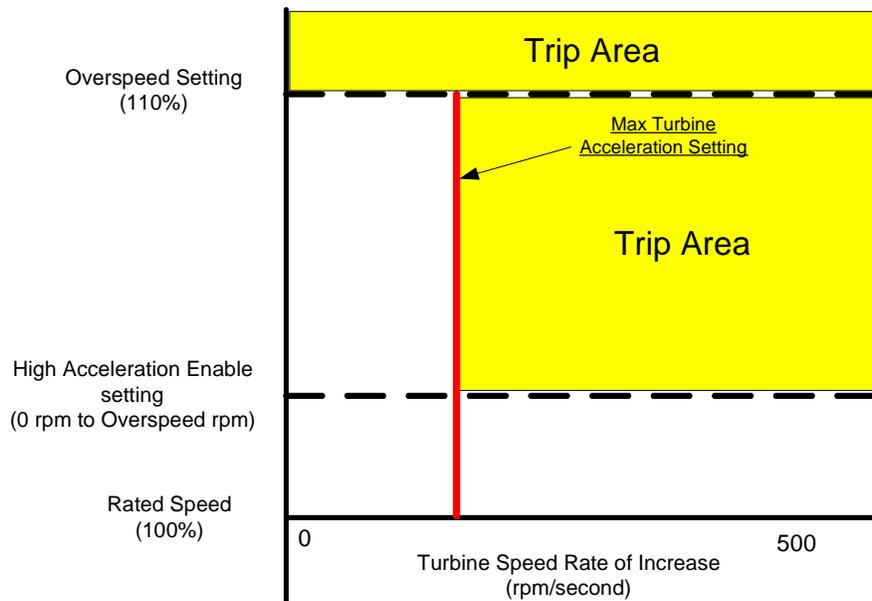


Figure 3-11. Over-Acceleration Enabling Diagram

Start Logic

The ProTech® TPS control's failed speed signal detection logic is used to sense no/zero speed and issue a trip command. However, before a prime mover is started and as its speed gear begins to turn, magnetic speed probes output a zero rpm signal until the speed exceeds the probe's minimum frequency. Two different start logic functions are available to use within the ProTech® TPS to override failed speed signal detection logic and allow the prime mover to be started. Either, both, or neither of these methods can be selected. There is also an alarm that can be enabled to indicate any time the Speed is below the Speed Fail Setpoint.

Speed Fail Trip

If the "Speed Fail Trip" is Enabled, the Speed-Fail-Override is used to override the speed fail trip logic. When the contact is open, the sensed speed must exceed the Speed Fail Setpoint, otherwise a Speed Fail Trip occurs.

For example, if there is a failure in the speed probe before the contact is opened, the Speed Fail Trip function will detect the missing speed signal and trip the module.

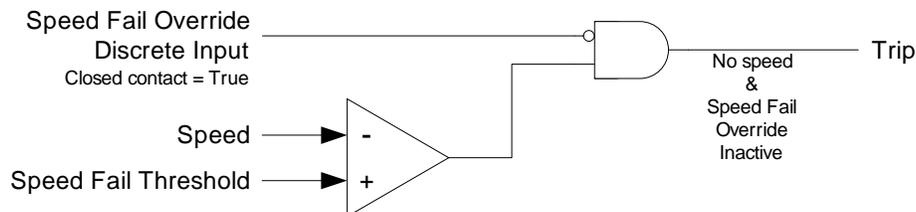


Figure 3-12. Speed Fail Trip Diagram



Speed Fail Trip should be utilized whenever possible. See Configuration Guidance section under the Troubleshooting Chapter for more detail.

Speed Fail Timeout Trip

If the “Speed Fail Timeout Trip” is Enabled, the sensed speed must exceed the Speed Fail Setpoint within the Speed Fail Timeout Time after a Start signal occurs, otherwise a Speed Fail Timeout Trip occurs.

IMPORTANT

The Speed Fail Timeout trip is cleared by the reset function (the trip and alarm reset function, not the reset input to the timer in the diagram below), even if speed is still below the Speed Fail Setpoint.

The start signal is generated by selecting the START button on the front panel of a module or by closing the predefined Start contact input. The start signal is edge triggered and re-selecting Start will reset the timer.

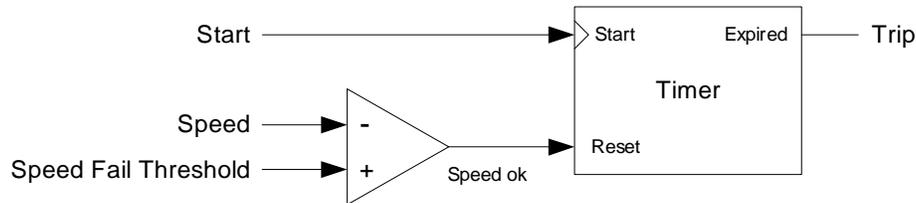


Figure 3-13. Speed Fail Timeout Trip Diagram

Start Example with Speed Fail Timeout Trip

First, any trips or alarms are cleared by issuing a reset command either by pressing the reset key, or by momentarily closing the reset contact, or by issuing the Reset command via Modbus.

When the turbine is ready to be started, the Speed fail timer is started by pressing the start key, or by momentarily closing the start discrete input. The timer expires when it reaches the Speed fail timeout value. If speed does not exceed the Speed fail set point before the timer expires, the unit trips.

If the unit is being restarted after a normal rolldown (that is, there was no trip), the unit does not require a reset. The Speed fail trip is overridden because the Speed fail timer is cleared whenever speed exceeds the Speed fail set point. The Speed fail timer should be started by the operator when the turbine is ready to be started again.

NOTICE

For the speed fail timeout trip function to provide the intended fault detection, Start must be selected when the turbine is to be started.

The timer can only be started when speed is below the Speed Fail Setpoint. Selecting Start has no effect if speed is above the Speed Fail Setpoint.

Configurable Logic

The ProTech® TPS provides configurable, or user-definable, logic to implement custom safety/protection and test programs. This can be used in conjunction with the configurable inputs and user-definable alarms and trips to monitor values such as lube oil pressure, vibration, trip manifold status, and provide parameter monitoring functions. Configurable logic is also used to implement the user-defined test functionality. It is possible to generate (and reset) module trips, alarms, or events and to use the associated logs and trip cycle time monitoring as part of the safety system test validation.

The logic unit provides configurable logic that allows the user to define how the input signals are used in detecting an unsafe condition and generating a trip signal.

The configurable logic provides the following functions:

- Analog comparators
- Boolean combinatorial logic (AND, OR, NOT, etc.)
- Boolean latches
- Delays
- Timers

The user is responsible to validate that the configured logic unit's input-to-output behavior performs as expected, with the intent of confirming the following:

- Verify that the logic unit was configured as intended;
- Verify that the documentation for the logic unit has been correctly understood and applied;
- Verify that the information presented to the user by the Programming and Configuration Tool (PCT) is correct.

Functional Examples

IMPORTANT

For robust programming and reliability system fault response, it is recommended that the programming features are used to sense out of range conditions. For example, when using a configurable input in analog mode, this can be done by using the Lo, LoLo, Hi and HiHi setpoints.

Process Parameter Monitoring and Trip

The logic unit has inputs to measure process parameters (continuous or discrete signals). These signals might represent such values as lube oil pressure, thrust, vibration, system hydraulic pressure, valve position, additional trip inputs, or other values significant to the safety system. Comparators, Boolean logic, and timers can be used to implement relatively sophisticated algorithms including, noise suppression, test functions, alarming, and trip functions based on these signals.

Trip System Testing

The system can be programmed to implement the user-defined tests to activate relay outputs (or even generate a trip from the module) to actuate a part of a trip system. The user-configurable inputs can be defined to monitor and log the test results. This might include monitoring a change of pressure or a limit switch to confirm the functionality of the system tested. After the test is completed, or after some time delay if there is a test failure, the trip test sequence can re-store the system to the normal state. When the normal state of the system is confirmed the user-defined test can be reset. The event latch might be used to confirm the progress and success or failure of the test steps.

Test Routines

Each ProTech® TPS module provides a variety of test routines to support common test requirements. The ProTech® TPS also supports 3 User-defined Tests.

In general, a test may not be started if any other module is tripped or in test or if the current module is tripped or in test. Also, tests will be aborted if another module trips. One exception to these rules is the Temporary Overspeed Trip Setpoint which can be applied to multiple modules or if another module is tripped. The other is the Lamp Test which can be applied to any module at any time without a password. If a test is not permitted, or aborted, messages displayed on the front panel explain the cause.

NOTICE

The Test Mode Interlock can be disabled in the configurable software.

Any test may be initiated (or cancelled) from the ProTech® TPS Front Panel. Modbus provides commands to initiate the Auto Speed Test or any of the User-defined Tests. User-defined Tests can be started through configurable logic – so a discrete input might be defined to initiate a test. Finally, there is a Periodic Overspeed Test function that will automatically run tests at a user-defined interval.

NOTICE

For Modbus commands, a start confirmation is required and an abort is also provided.

Temporary Overspeed Setpoint

This feature temporarily replaces the Overspeed Trip setpoint with a different value for testing. This test mode can be applied to all three modules simultaneously. The Temporary Overspeed Setpoint can be higher or lower than the normal overspeed trip setting.

NOTICE

When the Temporary Overspeed Setpoint is set above the normal overspeed trip, it should not be set above the maximum speed allowed for the unit.

The Temporary Overspeed Setpoint is designed to allow users to easily test the module's overspeed function at level lower than the normal overspeed setting or to test the overspeed function of a mechanical bolt or other overspeed protection system at a higher speed than the normal overspeed trip setting.

An alarm is generated when this test is enabled. Also, there is a Temporary Overspeed Trip Timeout feature that prevents an operator from "forgetting" to disable this test. The timeout can be configured from 0 to 30 minutes. When the test is enabled the timer starts, if it reaches the timeout value, the test is automatically aborted.

Once the module is in its tripped state, this test is disabled and the module's overspeed setpoint is returned to its normal setting.

Simulated Speed Tests

There are three tests that use an internally generated speed signal to test a modules overspeed trip setpoint and trip output function. The ProTech® TPS is defaulted to use the Test Mode Interlock so that a module cannot be placed in test while any other unit is tripped or in test. If it is desired to test a unit trip by tripping multiple modules through these simulated speed tests, the Test Mode Interlock can be disabled.

Manual Simulated Speed Test

This allows the user to manually increase/decrease a modules' internal frequency generator to perform a test of the overspeed trip function of that module. This test can only be performed from the front panel of the ProTech® TPS.

When the test is initiated, the frequency generator automatically starts at 100 rpm below the overspeed setpoint. Then the operator can adjust the simulated speed up or down from the front panel of the ProTech® TPS.

When the overspeed trip occurs, it is logged in the modules' trip log and noted as a test.

An alarm is generated while this test is enabled. Also, there is a Simulated Speed Timeout feature that prevents an operator from "forgetting" to disable this test. The timeout can be configured from 0 to 30 minutes. When the test is enabled the timer starts, if it reaches the timeout value, the test is automatically aborted. The operator can abort the test at any time.

Auto Simulated Speed Test

This test allows users to easily test the module's overspeed trip function by having the module's frequency generator automatically ramp up to and above the module's overspeed set point. This can be initiated from the front panel or via Modbus. The auto test starts at 100 rpm below setpoint. Then the frequency generator ramps up at approximately 10 rpm/s until the overspeed trip occurs.

When the overspeed trip occurs, it is logged in the modules' trip log and noted as a test.

To initiate the Auto Simulated Speed Test via Modbus, the Initiate Auto Speed Test command (Modbus address 0:0102) must be followed by the Confirm Auto Speed Test (Modbus address 0:0101) within 10 seconds. The intent of the confirmation is to prevent an erroneous signal from initiating a test. The test can be aborted from either the front panel or via Modbus.

Periodic Overspeed Test

This test is similar to the Auto Simulated Speed Test but allows the ProTech® TPS to perform the test automatically on each module on a regular basis. The Test Interval can be configured from 1 to 999 days. The test can be manually initiated from the front panel, and then the test will be automatically repeated at the specified test interval.

This automated test is applied to all three modules. First, the test will be performed on the A module, and when the overspeed trip occurs, it is logged in the modules trip log and noted as a test. Then, the A module is automatically reset and the B module is tested. When the B module test is completed, the C module is tested. In this way, periodic testing is performed automatically on a regular basis with no operator intervention.

The operator can disable the periodic test from the front panel of the module. When the Periodic test is Disabled, or if any module is in trip or test, the Time Remaining Until Next Test will be prevented from counting below 1 hour. If the timer is already below 1 hour it will be increased to 1 hour. When Enable Periodic Test is selected and no modules are tripped or in test, this function is removed.

Configuration and Management of the Periodic Overspeed Test can only be done through Module A only.

User-defined Test

Each module supports three user-defined test latches in the configurable logic. These latches allow the users to configure custom test routines as needed to test their system.

These user-defined tests are intended to support automated tests of such systems as trip manifolds, parameter monitoring functions, or other user-specific systems. The associated logic may be simple or complex depending on the nature of the system to be tested.

These tests may include tripping a single module and checking the performance of a single channel in a trip manifold using the trip cycle time monitoring functions, and then resetting the module.

All the test logic must be programmed with the configurable logic. The User-defined Test latches are intended to initiate the tests, to provide the handshaking between modules, and to signify and manage the end of the test including an aborted test.

NOTICE

The logic behind the User-defined Test must be validated by the user for all possible modes of operation including normal test, test failure(s), or test abort.

These latches share some of the same properties as the implemented test routines. A test cannot be initiated if any other module is tripped or any other test routine is active. User-defined tests can be initiated from the front panel (with password), via Modbus (with confirmation), or through configurable logic (which allows connection to any Boolean value including Discrete Inputs).

An alarm is associated with each test latch. Additionally, there is a Timeout feature associated with each User-defined Test latch that prevents an operator from “forgetting” to disable this test. The timeout can be configured from 0 to 30 minutes (1800 seconds) with 1 second resolution. When the test is enabled, the timer starts—if it reaches the timeout value, the test latch is automatically reset. The test latches can be reset from the configurable logic, or the front panel, or via Modbus.

Alarm, Trip, and Event Latches

The ProTech® TPS provides pre-defined, user-configurable, and user-defined alarms and trips. This makes it easy to utilize common functions but allows great flexibility to customize the ProTech® TPS to meet a user's specific needs. The fully configurable Event latches make it possible to record additional information such as test results or to provide more detail on alarm or trip events.

Reset Function

The Reset Function is associated with all of the following latches. A Reset can be generated by pressing the reset key on the front panel, from the pre-defined reset contact input, via Modbus, or from the user-defined “Configurable Reset Source”.

It is possible to configure one Discrete Input to function as a Resettable Trip input where the Reset Function will clear the associated trip even if the contact is still open. This is used in cases where the ProTech® TPS trip must be cleared to reset a trip system which feeds back a trip status that trips the ProTech® TPS.

Alarm Latch

An “alarm” refers to an action of the ProTech® TPS module to bring some condition to the attention to the user. When any of the Alarm Latch inputs becomes true, the output of the alarm latch is set TRUE. The yellow ALARM light is illuminated on the front panel. By default, the Configurable Relay #1 is connected to the Alarm latch (but this can be changed with the Programming and Configuration Tool (PCT) software). Each Alarm Input is individually latched, and those latched outputs are available on Modbus. The individual latches are reset by the trip reset function if the input is false. The alarm latch output remains TRUE until the reset function occurs, and all inputs are false.

Here is the complete list of possible Alarm Latch inputs:

- Configuration Mismatch (if configured)
- Speed Fail (if configured)
- Internal Fault Alarm
- Power Supply 1 Fault
- Power Supply 2 Fault
- Tmp Ovrspd Setpoint On
- Manual Sim. Speed Test
- Auto Sim. Speed Test
- User Test 1 Active (if configured)
- User Test 2 Active (if configured)
- User Test 3 Active (if configured)
- Trip Cycle Time Mon 1 (if configured)
- Trip Cycle Time Mon 2 (if configured)
- User configurable Alarms 1-50 (if configured)

Note: The user can define the Name associated with each user-defined Alarm.

Trip Latch

In almost every case, the ProTech® TPS and associated trip system will be designed such that two modules must be issuing a trip command before the unit will be tripped. This is referred to a 2-out-of-3 (2-o-o-3) trip scheme. In the “Independent Trip Relay” version of the ProTech® TPS, the trip action of each module may put part of the trip system into a tripped state and at least two modules must be tripped to trip the unit. In the “Voted Trip Relay” version of the ProTech® TPS, at least two modules would have to be in the tripped state for the voter relay to go to its tripped state.

A "trip" of the module refers to the action of the ProTech® TPS module changing the state of its Trip output. When any of the Trip Latch inputs becomes true, the output of the trip latch is set TRUE. The red TRIPPED light is illuminated on the front panel. The module trip relays are put in the trip state (which could be configured as energized or de-energized). Each Trip Input is individually latched, and those latched outputs are available on Modbus. The individual latches are reset by the reset function if the input is false. The first input to set the Trip latch, or First Out (FO), is also latched. This first out indication is available in the trip log and on the Modbus. The Trip latch output remains TRUE and the First Out indication remains unchanged until the reset function occurs, and all inputs are false.

IMPORTANT

When configured as de-energize-to-trip, the modules power up in the tripped state. When configured as energize-to-trip, the modules power up such that they do not enter the tripped state unless a trip condition is present.

IMPORTANT

The logic unit requires that it be in the tripped state in order to change the configuration.

The user can reset a trip by pressing a button on the unit's front panel, or by activating a discrete input that is dedicated to the reset function.

Here is the complete list of possible trips:

- Power Up Trip
- Configuration Trip
- Parameter Error Trip
- Internal Fault Trip
- Overspeed Trip
- Over-Acceleration Trip (if configured)
- Speed Probe Open Wire (if configured)
- Speed Lost Trip (if configured)
- Speed Fail Trip (if configured)
- Speed Fail Timeout Trip (if configured)
- Resettable Trip Input Trip (if configured)
- User configurable Trips 1-25 (if configured)

Note: The user can define the Name associated with each user-defined Trip

Event Latches

In each module, three Event Latches are provided. These are to be used in conjunction with the user-defined software and can be used to log any desired event. The latch is structured like the Trip Latch.

For a given Event Latch, when any of the Event Latch inputs becomes true, the output of the Event latch is set TRUE. Each Event Input is individually latched, and those latched outputs are available on the Modbus. The individual latches are reset by the reset function if the input is false. The first input to set the Event latch, or First Out (FO), is also latched. This First Out indication is available in the Event log and on Modbus. The Event latch output remains TRUE and the First Out indication remains constant until the reset function occurs and all inputs are false.

Each event latch provides 25 user-configurable Inputs. The user can define the Name associated with each user-defined Event.

System Logs

Each Module in the ProTech® TPS logs (saves to memory) all trips, alarms, events, trip cycle times, and overspeed events. Peak speed and acceleration are also logged. The logs can be viewed from the front panel of the ProTech® TPS or from the PCT tool. With PCT tool, the Configuration Error Log can also be viewed. The logs can be exported from the PCT tool.

The logs are stored in non-volatile memory so loss of power to the ProTech® TPS will not affect this information. The log functions use scrolling buffers that keep the most recent data. The individual log sizes are described in the following descriptions. Logs can be cleared from the front panel with the appropriate password. The Test Level Password is needed to Reset All Logs except of the Peak Speed/Acceleration Log. The Config Level Password is required to Reset the Peak Speed/Acceleration Log.

Overspeed/Acceleration Log

Any time an overspeed or over-acceleration event occurs, the date and time of the trip, the speed and acceleration values at the trip time, and the maximum speed and acceleration will be recorded. If the trip occurred during testing, this will also be noted in the log. The log will save the last 20 overspeed or over-acceleration events.

Trip Log

The module logs the last 50 trips. The log holds the trip description, the date and time of the trip, whether it was the “first out” trip, and whether the module was performing a test when the trip occurred.

Alarm Log

The Alarm Log stores the last 50 alarms. The log holds the alarm description, the date and time of the alarm, and whether the module was performing a test when the alarm occurred.

Trip Cycle Time Log

If Trip Cycle Time monitoring is configured, the module logs the trip cycle times for the last 20 trips. Whenever a module trip occurs, two trip cycle time monitors can be configured to monitor the milliseconds from the trip until a user-defined Trip Indicator Input is true. The Trip indicator could be configured to be a limit switch which indicates a trip valve has closed, or a pressure comparison that indicates that the system or part of the trip system has actuated. The Trip Cycle Time Monitors are designed to monitor the performance of the trip system and detect any degradation of its response time to warn the user before a potentially dangerous condition exists.

The Maximum Cycle Time for each event can be specified as 1 to 60 000 ms. If this time is exceeded, an alarm will be generated. If the event has not occurred in 10x this maximum cycle time (up to a maximum of 60 seconds), then the trip cycle time will be set to 60 seconds.

Event Logs

Three event logs are provided. Each log records events seen by Event Latches 1, 2, and 3, respectively. The last 50 events on each Event Latch are logged. Each Event Latch has 25 inputs. Event Latches inputs can be configured to record any Boolean variable and associate a 24-character user-defined name with that event.

Peak Speed/Acceleration Log

The maximum speed and acceleration detected by the module will be logged. This includes values generated by internal simulation testing. As this is intended to be a maximum value capture, no date or time information is associated with these values. This can be reset from the front panel with the Config Level Password.

Response Time Performance

Independent Trip Relay

The response time is less than 12 ms (**Note 1**) measured from detection of overspeed or out-of-range process to assertion of the trip relays.

Voted Trip Relay

The response time is less than 20 ms (Note 1) measured from detection of overspeed or out-of-range process to assertion of the trip relays.

No operator intervention via the operator interface is required for the logic unit to perform the safety functions.

Note 1: See the following charts for measured response time. The response time specifications are valid for measured frequencies of 2 kHz and higher. For this reason, it is highly recommended that the user use speed wheel gearing that provides the ProTech with a frequency of at least 3 kHz for the normal operating speed. The internal frequency is calculated from rpm and number of gear teeth:

$$\text{Frequency} = (\text{rpm}) * (\text{number of teeth}) / 60$$

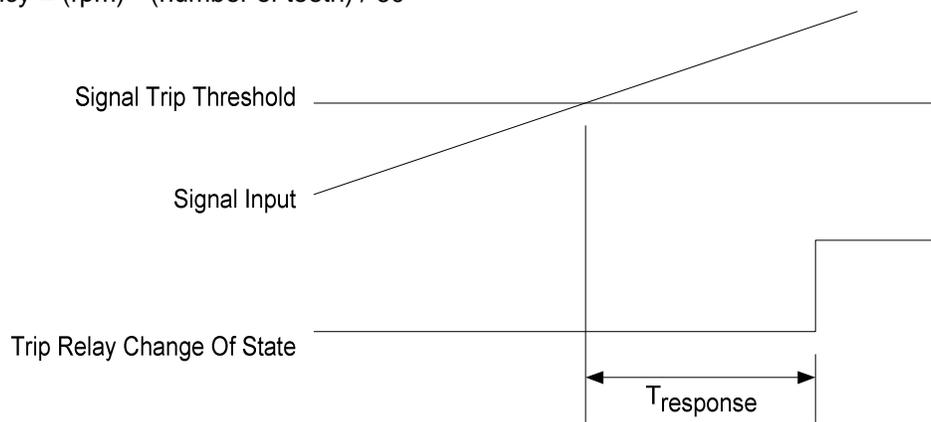


Figure 3-14. Response Time Definition

Analog Output

The response time of the analog output is less than 10 ms measured from a change in speed to a change in the output current.

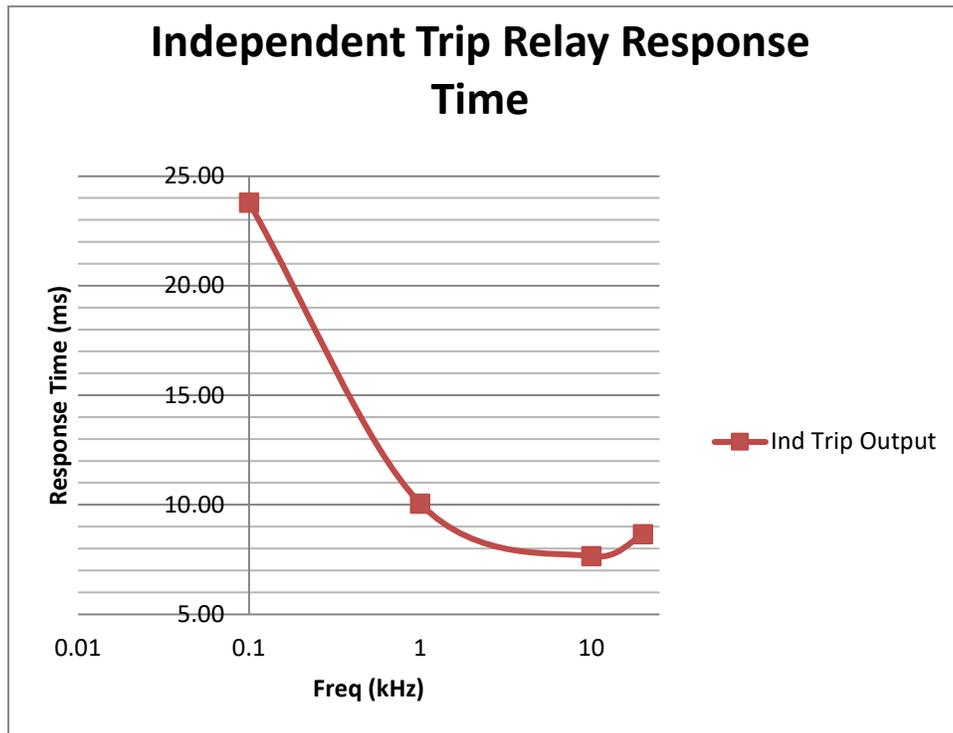


Figure 3-15. Independent Trip Relay Response Time (Typical) Graph

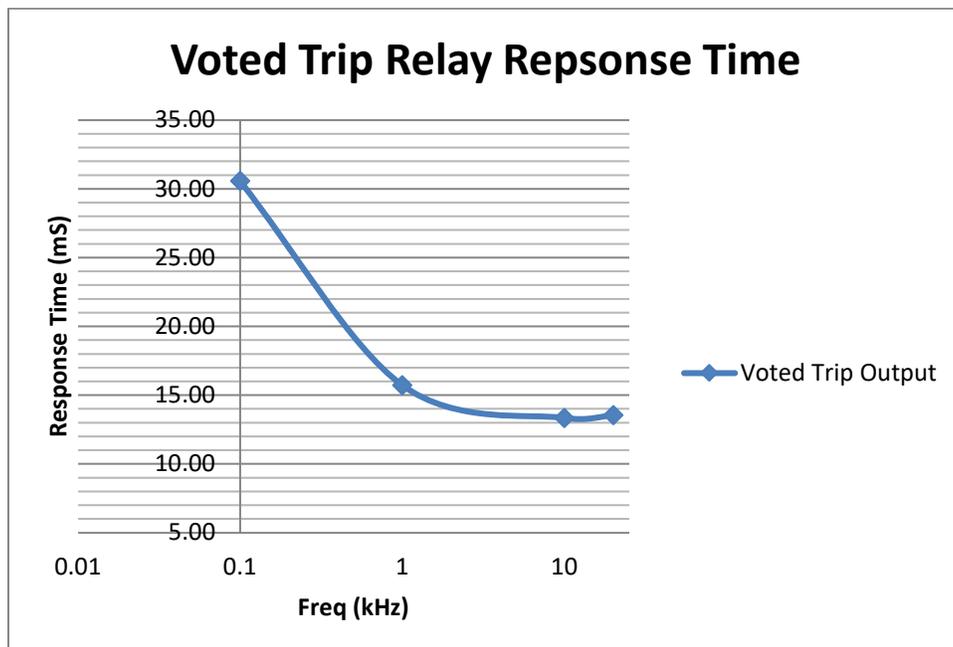


Figure 3-16. Voted Trip Relay Response Time (Typical) Graph

Chapter 4.

Modbus Communications

Modbus Communications

The ProTech® TPS can communicate with plant distributed control systems and/or CRT based operator control panels through three Modbus communication ports (one port per module). Each of the three modules (A, B, & C) has a serial port for Modbus communications. These ports support RS-232 or RS-485 communications using a standard Remote Terminal Unit (RTU) Modbus transmission protocol. Modbus utilizes a master/slave protocol. This protocol determines how a communication network's master and slave devices establish and break contact, how a sender is identified, how messages are exchanged, and how errors are detected.

Since each module has its own Modbus port, and since each module is fully isolated from the other modules, each Modbus port provides its module's sensed information only (speed, analog inputs, etc.).

Table 4-1. Serial Communication Port (RS-232/RS-485) Specifications

Number of Ports	1
Comm Type	RS-232/RS-485, user selectable (2-Wire Only)
Termination Resistor	RS-485 on board, terminal block selectable
Isolation	500 Vac from output to chassis and output to all other circuits
Signal Cable Length	Must be limited to 1500 ft / 305 m (low capacitance 16 AWG / 1.3 mm ²)

Monitor Only

Each of the three Modbus communication ports is designed to continually output all Boolean and analog read information and can be configured to accept or ignore "write" commands, depending on the specific application's requirements. This allows the ProTech® TPS to be monitored but not controlled from any external device.

Once a Modbus port's "Enable Write Commands" setting is configured "No", the respective ProTech® TPS module will not accept "write" commands from an external master device (DCS, etc.). For security purposes, the option to ignore "write" commands can only be enabled or disabled with a configuration-level password.

Monitor and Control

Once a Modbus port's "Enable Write Commands" setting is configured "Yes", the respective ProTech® TPS module will accept "write" commands from an external master device (DCS, etc.). This allows a Modbus compatible device to monitor all read registers and issue "Reset" and "Start/Abort Test Routines" commands only. Modbus ports are independent of each other and can be used simultaneously.

To ensure that a Modbus based test command is valid, both "Initiate Test" and "Confirm Test" commands must be received to initiate a test routine. A Confirm must be received within 10 seconds or the sequence must be re-initiated. The ProTech® TPS is designed to allow only one module to be tested at a time. Thus, a module will only accept an Initiate Test command and perform the requested test if all three modules are healthy, not tripped, and not in a test mode.

Modbus Communication

Each ProTech® TPS Modbus communications port is designed to function as a slave device on a Modbus network using the industry-standard Modbus RTU (remote terminal unit) transmission protocol. For more information on Modbus networks and the RTU transmission protocol, refer to Modbus Protocol Reference Guide PI-MBUS-300 Rev. J.

A Modbus function code tells the addressed slaves what function to perform. The Table 4-2 lists the function codes supported by the ProTech® TPS:

Table 4-2. Supported Modbus Function Codes

Code	Definition	Reference Address
02	Boolean Read Registers (Status of Alarms/Shutdowns, Discrete input/outputs)	1XXXX
04	Analog Read Registers (Speed, Acceleration, etc.)	3XXXX
05	Boolean Write Registers (Reset and Test Initiate Commands)	0XXXX

As a slave Modbus device, the ProTech® TPS is not responsible to sense or annunciate Modbus link communication errors. However, for troubleshooting purposes, the ProTech® TPS will display a “Link Error” message in its “Monitor Modbus” screen if a Modbus transaction request is not received within its five-second time-out period. This error message is automatically cleared when Modbus communications are re-established.

Port Adjustments

Before the ProTech® TPS can communicate with the master device, the communication parameters must be verified to match the master device’s protocol settings. For security purposes, these parameters can only be set in the module’s Configuration mode.

Table 4-3. Modbus Communication Port Settings

Parameter	Range
Mode:	RS-232 or RS-485
Baud Rate:	19200 TO 115200
Comm Parity:	NONE, ODD or EVEN
Slave Address:	1 - 247
Enable Write Commands:	Yes or No

ProTech® TPS Parameter Addresses

Each available read or write parameter has a unique Modbus address. A complete list of the available parameters and their addresses is located at the end of this chapter. This list consists of Boolean Write, Boolean Read, and Analog Read parameters. Analog write parameters are not used or available with this device.

All values that can be addressed by Modbus are considered discrete and numeric. The discrete values are a 1-bit binary on or off value, and the numeric values are 16-bit values. Discrete values are sometimes referred to as coils or digitals, and numeric values are referred to as registers or analogs. All read/write registers are interpreted by the ProTech® TPS as signed 16-bit integer values.

Since Modbus can only handle integers, values that require a decimal point in the Modbus Master Device are multiplied by a scaling constant before being sent by ProTech® TPS. See the Modbus list for the scaling used on each analog parameter.

Boolean Writes (Code 05)

Boolean Write registers are used by an external master device (plant DCS, etc.) to issue Boolean commands to a ProTech® TPS module. The available write commands are listed in Table 4-2.

Once a Modbus port’s “Enable Write Commands” setting is configured “Yes”, the respective ProTech® TPS module will accept “write” commands from an external master device (DCS, etc.).

Note: All write commands are edge-triggered.

Initiating a test mode

Only one test mode can be active at a time. Attempts to start a test are ignored when another test mode is active or another module is tripped or in a test mode.

Speed/user tests must be requested by first setting the Initiate bit, followed by a setting the confirm bit. If the Confirm bit is not set within 10 seconds after the initiate bit is set, then the test will not be requested.

Note: the confirm-initiate addresses are in reverse order so that an initiate followed by a confirm cannot be executed by a single write command. Both bits must be set to 0 before starting the initiate-confirm sequence.

If an Abort command is set to 1, an initiate-confirm sequence shall be ignored.

Boolean Reads (Code 02)

Boolean Read registers are used by an external master device (plant DCS, etc.) to read the status of internal ProTech® TPS module signals (hardware inputs, logic blocks, hardware outputs, etc.). A Boolean read register will have the value 1 if the status of the monitored signal is true and a 0 if false. The available Boolean read registers are listed in Table 4-3.

Analog Reads (Code 04)

Analog Read registers are used by an external master device (plant DCS, etc.) to read the value of internal ProTech® TPS module signals (hardware inputs, logic blocks, hardware outputs, etc.). An example of an analog read value would be actual speed.

With the Modbus protocol, analog values are transmitted as 16-bit integer values ranging from -32767 to +32767 (if signed) or 0 to 65535 (if unsigned). Since Modbus can only handle integers, values that have a decimal point are multiplied by a constant before being sent by Modbus. For example, these input registers may be listed as the Modbus value 'x100' within the listed parameter table. Some values, like the Timer values, are sent using more than one register. The available Analog read registers, units (scaling), and range are listed in Table 4-3.

Heartbeat indication (1:1300)

The Heartbeat indication provides an indication that toggles every 1 second between logic 1 and logic 0.

Last Trip time and date indication (3:0701 - 707)

Last Trip Date/Time represents the Date/Time of the most recent first out trip.

Unit Health indication (3:0801)

The unit health status indicates the state of the internal fault trip (if known) as follows:

0 = internal fault trip is TRUE (Unit Health LED is green)

1 = internal fault trip is FALSE (Unit Health LED is amber)

2 = state of the internal fault trip is unknown because of a communication fault (Unit Health LED is off)

Table 4-3. Boolean Write Addresses (Code 05)

ADDRESS	DESCRIPTION
0:0001	Reset
0:0101	Confirm Auto Speed Test
0:0102	Initiate Auto Speed Test
0:0103	Abort Auto Speed Test
0:0201	Confirm User Defined Test 1
0:0202	Initiate User Defined Test 1
0:0203	Abort User Test 1
0:0301	Confirm User Defined Test 2
0:0302	Initiate User Defined Test 2
0:0303	Abort User Test 2
0:0401	Confirm User Defined Test 3
0:0402	Initiate User Defined Test 3
0:0403	Abort User Test 3

Table 4-4. Boolean Read Addresses (Code 02)

ADDRESS	DESCRIPTION
1:0001	Internal Fault Trip
1:0002	Power Up Trip
1:0003	Module Config Trip
1:0004	Parameter Error Trip
1:0005	Over Speed Trip
1:0006	Over Accel Trip
1:0007	Open Wire Detected Trip
1:0008	Speed Lost Trip
1:0009	Speed Fail Trip
1:0010	Speed Fail Timeout Trip
1:0011	Resettable Trip Input Trip
1:0012 to 36	User Configurable Trips 1 to 25
1:0101 to 134	Trip Latch First Out Registers 1-34
1:0201	Internal Fault Alarm
1:0202	Module Config Mismatch Alarm
1:0203	Power Supply 1 Fault Alarm
1:0204	Power Supply 2 Fault Alarm
1:0205	Speed Fail Alarm
1:0206	Speed Lost Alarm
1:0207	Temp Overspeed SP is Active Alarm
1:0208	Simulated Speed Test in Progress Alarm
1:0209	Auto Speed Test Active Alarm
1:0210	Periodic OvrSpd Test Active Alarm
1:0211	User Test 1 Active Alarm
1:0212	User Test 2 Active Alarm
1:0213	User Test 3 Active Alarm
1:0214	Trip Cycle Time Mon 1 Alarm
1:0215	Trip Cycle Time Mon 2 Alarm
1:0216 to 265	User Configurable Alarms 1 to 50
1:0401 to 425	Event 1 Latched Inputs 1 to 25
1:0501 to 525	Event 1 Latch First Outs 1 to 25
1:0601 to 625	Event 2 Latched Inputs 1 to 25
1:0701 to 725	Event 2 Latch First Outs 1 to 25
1:0801 to 825	Event 3 Latched Inputs 1 to 25
1:0901 to 925	Event 3 Latch First Outs 1 to 25
1:1001	Speed Fail Override
1:1002	Overspeed Trip Non-Latched
1:1003	Overacceleration Trip Non-Latched
1:1004	Speed Fail Trip Non-Latched
1:1005	Reserved (Do not use)
1:1006	Speed Lost Alarm Non-Latched
1:1007	Speed Lost Trip Non-Latched
1:1008	Speed Probe Open Wire Non-Latched
1:1009	Tmp Ovrspd Setpoint On
1:1010	Simulated Speed Active
1:1011	Auto Test Speed Active
1:1012	Periodic OvrSpd Test Active
1:1013	User Defined Test 1
1:1014	User Defined Test 2
1:1015	User Defined Test 3
1:1016	Configuration Mismatch Non-Latched
1:1017	Speed Fail Alarm Non-Latched
1:1018	Trip
1:1019	Alarm
1:1020	Event Latch 1
1:1021	Event Latch 2
1:1022	Event Latch 3
1:1023	Analog Input 1 HiHi
1:1024	Analog Input 1 Hi
1:1025	Analog Input 1 Lo
1:1026	Analog Input 1 LoLo

ADDRESS	DESCRIPTION
1:1027	Analog In 1 Range Err
1:1028	Discrete Input 1
1:1029	Analog Input 2 HiHi
1:1030	Analog Input 2 Hi
1:1031	Analog Input 2 Lo
1:1032	Analog Input 2 LoLo
1:1033	Analog In 2 Range Err
1:1034	Discrete Input 2
1:1035	Analog Input 3 HiHi
1:1036	Analog Input 3 Hi
1:1037	Analog Input 3 Lo
1:1038	Analog Input 3 LoLo
1:1039	Analog In 3 Range Err
1:1040	Discrete Input 3
1:1041	Analog Input 4 HiHi
1:1042	Analog Input 4 Hi
1:1043	Analog Input 4 Lo
1:1044	Analog Input 4 LoLo
1:1045	Analog In 4 Range Err
1:1046	Discrete Input 4
1:1047	Analog Input 5 HiHi
1:1048	Analog Input 5 Hi
1:1049	Analog Input 5 Lo
1:1050	Analog Input 5 LoLo
1:1051	Analog In 5 Range Err
1:1052	Discrete Input 5
1:1053	Analog Input 6 HiHi
1:1054	Analog Input 6 Hi
1:1055	Analog Input 6 Lo
1:1056	Analog Input 6 LoLo
1:1057	Analog In 6 Range Err
1:1058	Discrete Input 6
1:1059	Analog Input 7 HiHi
1:1060	Analog Input 7 Hi
1:1061	Analog Input 7 Lo
1:1062	Analog Input 7 LoLo
1:1063	Analog In 7 Range Err
1:1064	Discrete Input 7
1:1065	Analog Input 8 HiHi
1:1066	Analog Input 8 Hi
1:1067	Analog Input 8 Lo
1:1068	Analog Input 8 LoLo
1:1069	Analog In 8 Range Err
1:1070	Discrete Input 8
1:1071	Analog Input 9 HiHi
1:1072	Analog Input 9 Hi
1:1073	Analog Input 9 Lo
1:1074	Analog Input 9 LoLo
1:1075	Analog In 9 Range Err
1:1076	Discrete Input 9
1:1077	Analog Input 10 HiHi
1:1078	Analog Input 10 Hi
1:1079	Analog Input 10 Lo
1:1080	Analog Input 10 LoLo
1:1081	Analog In 10 Range Err
1:1082	Discrete Input 10
1:1083	Analog Comparator 1
1:1084	Analog Comparator 2
1:1085	Analog Comparator 3
1:1086	Analog Comparator 4
1:1087	Analog Comparator 5

Table 4-3 (continued). Boolean Read Addresses (Code 02)

ADDRESS	DESCRIPTION	ADDRESS	DESCRIPTION
1:1088	Analog Comparator 6	1:1153	Delay 1
1:1089	Analog Comparator 7	1:1154	Delay 2
1:1090	Analog Comparator 8	1:1155	Delay 3
1:1091	Analog Comparator 9	1:1156	Delay 4
1:1092	Analog Comparator 10	1:1157	Delay 5
1:1093	Logic Gate 1	1:1158	Delay 6
1:1094	Logic Gate 2	1:1159	Delay 7
1:1095	Logic Gate 3	1:1160	Delay 8
1:1096	Logic Gate 4	1:1161	Delay 9
1:1097	Logic Gate 5	1:1162	Delay 10
1:1098	Logic Gate 6	1:1163	Delay 11
1:1099	Logic Gate 7	1:1164	Delay 12
1:1100	Logic Gate 8	1:1165	Delay 13
1:1101	Logic Gate 9	1:1166	Delay 14
1:1102	Logic Gate 10	1:1167	Delay 15
1:1103	Logic Gate 11	1:1168	Timer 1 HiHi
1:1104	Logic Gate 12	1:1169	Timer 1 Hi
1:1105	Logic Gate 13	1:1170	Timer 2 HiHi
1:1106	Logic Gate 14	1:1171	Timer 2 Hi
1:1107	Logic Gate 15	1:1172	Timer 3 HiHi
1:1108	Logic Gate 16	1:1173	Timer 3 Hi
1:1109	Logic Gate 17	1:1174	Timer 4 HiHi
1:1110	Logic Gate 18	1:1175	Timer 4 Hi
1:1111	Logic Gate 19	1:1176	Timer 5 HiHi
1:1112	Logic Gate 20	1:1177	Timer 5 Hi
1:1113	Logic Gate 21	1:1178	Timer 6 HiHi
1:1114	Logic Gate 22	1:1179	Timer 6 Hi
1:1115	Logic Gate 23	1:1180	Timer 7 HiHi
1:1116	Logic Gate 24	1:1181	Timer 7 Hi
1:1117	Logic Gate 25	1:1182	Timer 8 HiHi
1:1118	Logic Gate 26	1:1183	Timer 8 Hi
1:1119	Logic Gate 27	1:1184	Timer 9 HiHi
1:1120	Logic Gate 28	1:1185	Timer 9 Hi
1:1121	Logic Gate 29	1:1186	Timer 10 HiHi
1:1122	Logic Gate 30	1:1187	Timer 10 Hi
1:1123	Logic Gate 31	1:1188	Timer 11 HiHi
1:1124	Logic Gate 32	1:1189	Timer 11 Hi
1:1125	Logic Gate 33	1:1190	Timer 12 HiHi
1:1126	Logic Gate 34	1:1191	Timer 12 Hi
1:1127	Logic Gate 35	1:1192	Timer 13 HiHi
1:1128	Logic Gate 36	1:1193	Timer 13 Hi
1:1129	Logic Gate 37	1:1194	Timer 14 HiHi
1:1130	Logic Gate 38	1:1195	Timer 14 Hi
1:1131	Logic Gate 39	1:1196	Timer 15 HiHi
1:1132	Logic Gate 40	1:1197	Timer 15 Hi
1:1133	Logic Gate 41	1:1198	Unit Delay 1
1:1134	Logic Gate 42	1:1199	Unit Delay 2
1:1135	Logic Gate 43	1:1200	Unit Delay 3
1:1136	Logic Gate 44	1:1201	Unit Delay 4
1:1137	Logic Gate 45	1:1202	Unit Delay 5
1:1138	Logic Gate 46	1:1203	Unit Delay 6
1:1139	Logic Gate 47	1:1204	Unit Delay 7
1:1140	Logic Gate 48	1:1205	Unit Delay 8
1:1141	Logic Gate 49	1:1206	Unit Delay 9
1:1142	Logic Gate 50	1:1207	Unit Delay 10
1:1143	Latch 1	1:1208	Reserved (Do not use)
1:1144	Latch 2	1:1209	Reserved (Do not use)
1:1145	Latch 3	1:1210	Reserved (Do not use)
1:1146	Latch 4	1:1211	Internal Fault Trip Non-Latched
1:1147	Latch 5	1:1212	Internal Fault Alarm Non-Latched
1:1148	Latch 6	1:1213	Configuration Trip Non-Latched
1:1149	Latch 7	1:1214	Resettable Trip Non-Latched
1:1150	Latch 8	1:1215	Power Supply 1 Alarm Non-Latched
1:1151	Latch 9	1:1216	Power Supply 2 Alarm Non-Latched
1:1152	Latch 10	1:1217	Parameter Error Trip Non-Latched
		1:1301	Heartbeat

Table 4-4. Analog Read Addresses (Code 04)

ADDRESS	DESCRIPTION	UNITS	RANGE
3:0001	Speed	RPM	0-30000
3:0002	Acceleration	RPM/Sec	-32768 - 32767
3:0101	Analog Input 1	mA x 100	0-2400
3:0102	Analog Input 2	mA x 100	0-2400
3:0103	Analog Input 3	mA x 100	0-2400
3:0104	Analog Input 4	mA x 100	0-2400
3:0105	Analog Input 5	mA x 100	0-2400
3:0106	Analog Input 6	mA x 100	0-2400
3:0107	Analog Input 7	mA x 100	0-2400
3:0108	Analog Input 8	mA x 100	0-2400
3:0109	Analog Input 9	mA x 100	0-2400
3:0110	Analog Input 10	mA x 100	0-2400
3:0201	Trip Cycle Time 1	milliseconds	0-65535
3:0202	Trip Cycle Time 2	milliseconds	0-65535
3:0301	Test Mode Time Remaining	seconds	0-65535
3:0401	Speed Fail Time Remaining	seconds	0-65535
3:0501	Timer 1 Seconds Value	seconds	0-65535
3:0502	Timer 1 Milliseconds Value	milliseconds	0-999
3:0503	Timer 2 Seconds Value	seconds	0-65535
3:0504	Timer 2 Milliseconds Value	milliseconds	0-999
3:0505	Timer 3 Seconds Value	seconds	0-65535
3:0506	Timer 3 Milliseconds Value	milliseconds	0-999
3:0507	Timer 4 Seconds Value	seconds	0-65535
3:0508	Timer 4 Milliseconds Value	milliseconds	0-999
3:0509	Timer 5 Seconds Value	seconds	0-65535
3:0510	Timer 5 Milliseconds Value	milliseconds	0-999
3:0511	Timer 6 Seconds Value	seconds	0-65535
3:0512	Timer 7 Milliseconds Value	milliseconds	0-999
3:0513	Timer 8 Seconds Value	seconds	0-65535
3:0514	Timer 8 Milliseconds Value	milliseconds	0-999
3:0515	Timer 9 Seconds Value	seconds	0-65535
3:0516	Timer 9 Milliseconds Value	milliseconds	0-999
3:0517	Timer 10 Seconds Value	seconds	0-65535
3:0518	Timer 10 Milliseconds Value	milliseconds	0-999
3:0519	Timer 11 Seconds Value	seconds	0-65535
3:0520	Timer 11 Milliseconds Value	milliseconds	0-999
3:0521	Timer 12 Seconds Value	seconds	0-65535
3:0522	Timer 12 Milliseconds Value	milliseconds	0-999
3:0521	Timer 13 Seconds Value	seconds	0-65535
3:0522	Timer 13 Milliseconds Value	milliseconds	0-999
3:0521	Timer 14 Seconds Value	seconds	0-65535
3:0522	Timer 14 Milliseconds Value	milliseconds	0-999
3:0521	Timer 15 Seconds Value	seconds	0-65535
3:0522	Timer 15 Milliseconds Value	milliseconds	0-999
3:0601	Temp Overspeed SetPoint	RPM	0-65535
3:0602	Simulated Speed RPM	RPM	0-65535
3:0701	Last Trip Month	Months	1-12
3:0702	Last Trip Day	Days	1-31
3:0703	Last Trip Year	Years	2000-2099
3:0704	Last Trip Hour	Hours	0-23
3:0705	Last Trip Minute	Minutes	0-59
3:0706	Last Trip Second	seconds	0-59
3:0707	Last Trip Milli-Second	milliseconds	0-999
3:0801	Unit Health Status	Enum	0-2

Chapter 5. Troubleshooting

Many troubleshooting features are available from the front panel of each module. In general, the following high-level approach can be used to troubleshoot the ProTech® TPS control.

Check the front panel LEDs

View the trip and alarm logs by pressing the corresponding view buttons on the front panel

Use the messages in the trip and alarm logs to assist in troubleshooting. The messages are summarized in the tables below.

Use the Monitor Menu from the front panel to trace and branch to potential I/O, configuration, and programming problems.

For more in depth help, use the service tool provided with the ProTech® TPS.

The entry point for troubleshooting the ProTech® TPS is the state of the three LEDs on lower part of the front panel. The Trip Log and the Alarm Log can also be viewed from the front panel. The service tool also provides more detailed information in the log pages.

UNIT HEALTH LED

The UNIT HEALTH LED indicates module health status.

Green – Unit OK and functioning properly.

Red – Safety Functionality is not running/internal fault trip is present.

Unlit – Status unknown because of a communication fault with the front panel or the module is not powered.

TRIPPED LED

The TRIPPED LED indicates the state of the trip latch.

Unlit - Unit not tripped or the module is not powered.

Red – unit tripped, press VIEW button below the LED to see the trip log log or navigate to the Monitor Trip Latch screen to see the active status on each trip input.

ALARM LED

The ALARM LED indicates the state of the alarm latch.

Unlit – no alarms or the module is not powered.

Yellow – active alarms, press VIEW button below LED to see the alarm log or navigate to the Monitor Alarm Latch screen to see the active status on each alarm input.

I/O Troubleshooting

Problem or diagnostic indication	Possible Cause	Suggested Actions
Power Supply Inputs not working properly. Power supply input alarm present.	Wiring fault, terminal block loose.	Verify wiring and terminal block connections.
	Power source breaker or fuse open.	Verify breaker or fuse.
	Only one power supply is connected.	On the front panel, press the VIEW button under the ALARM LED and check for Power Supply 1 or 2 Fault.
	Power supply input out of range or insufficient rating.	Check input voltage level and verify it is within acceptable range per electrical specifications. Also check that power supply has appropriate rating to power the ProTech® TPS.
Speed Input not working	Wiring fault, terminal block loose.	Verify wiring and terminal block connections.
	Configuration.	On the front panel, check the Speed Input Configure Menu and verify that all proper configuration options are selected.
	Alarms and Faults.	Verify that there are no alarms or faults that may indicate a setup problem (open wire trip, speed lost, speed fail, etc.)
	Signal level.	Verify that the input signal levels are within the electrical specifications. Also verify shield connections.
	Active Probe Power.	If using an active probe, verify probe power is correct by disconnecting the probe and measuring from terminals 69 to 71. The voltage should be 24 V \pm 10%. Attach probe and measure again to verify that the probe is not overloading the voltage provided by the ProTech® TPS.
Dedicated discrete input not working (Start, Reset or Speed Fail Override)	Wiring fault, terminal block loose.	Verify wiring and terminal block connections.
	Configuration.	On the front panel, check the Dedicated Discrete Inputs Monitor Menu and verify logic state is correct.
	Signal source not working correctly or not within acceptable electrical specifications.	Check signal level and verify it is within acceptable range per electrical specifications.
	Internally supplied wetting voltage fault.	Measure voltage from terminal 1 to terminal 81 and verify it is 23 V \pm 2 V. If out of range, return unit to Woodward.

Problem or diagnostic indication	Possible Cause	Suggested Actions
Configurable Input - Discrete input not working	Wiring fault, terminal block loose.	Verify wiring and terminal block connections.
	Configuration.	On the front panel, check the Configurable Inputs Monitor Menu and verify logic state is correct. Using the PCT, verify that the input is configured as discrete input.
	Signal source not working correctly or not within acceptable electrical specifications.	Check signal level and verify it is within acceptable range per electrical specifications.
	Internally supplied wetting voltage fault.	Measure voltage from terminal 37 to terminal 38 and verify it is 24 V \pm 10%. If out of range, remove wiring and measure again to verify that the voltage source is not being overloaded..
Configurable Input – Analog Input not working	Wiring fault, terminal block loose.	Verify wiring and terminal block connections.
	Configuration.	On the front panel, check the Configurable Inputs Monitor Menu and verify the correct analog input level is displayed. A “signal out of range” indicates the input is less than 2 mA or greater than 22 mA. Using the PCT, verify that the input is configured as analog input and the Lo, LoLo, Hi, HiHi limits are set correctly..
	Signal source not working correctly or not within acceptable electrical specifications.	Check signal level and verify it is within acceptable range per electrical specifications. Verify shield connection.
Trip relays not working	Wiring fault, terminal block loose.	Verify wiring and terminal block connections.
	Configuration.	Using the service tool or front panel, check to see that the trip configuration is set correctly. Energize to trip vs. de-energize to trip will invert the polarity on the relays.
	External supplies.	Check the power supplies that provide voltage to the relay output. If using the 24 V EXT available from the ProTech® TPS, measure voltage between terminals 80, 81 and verify 24 V \pm 10%. If it is not, remove the wiring from the 24 V EXT to unload the output and measure again to verify the voltage is not being overloaded.

Problem or diagnostic indication	Possible Cause	Suggested Actions
Programmable relay output not working	Wiring fault, terminal block loose.	Verify wiring and terminal block connections.
	Configuration.	Using the PCT, check to see that the polarity is set correctly, and the correct internal signal is selected to drive the output.
	External supplies.	Check the power supplies that provide voltage to the relay output. If using the 24 V EXT available from the ProTech® TPS, measure voltage between terminals 80, 81 and verify 24 V \pm 10%. If it is not, remove the wiring from the 24 V EXT to unload the output and measure again to verify the voltage is not being overloaded.
Analog Output not working	Wiring fault, terminal block loose.	Verify wiring and terminal block connections. On the front panel, check the Monitor Analog Output Menu and verify that the analog output is reading an expected output value. Measure the current from terminal 64 and verify that it corresponds to the previous step. Verify the load on the analog output is within the electrical specifications.
	Configuration.	Using the PCT or front panel, verify that the scaling is correct.
	MODBUS not working	Wiring fault, terminal block loose.
Service Tool not working	Configuration.	Using the PCT or front panel, verify that the correct settings are selected.
	Wiring and connection.	Verify cable that is plugged into DB9 port is not a crossover. A straight-through cable is required.
	COM Port.	Check that there is power applied to the ProTech® TPS module that the service tool is connected. Verify the correct COM port is selected when establishing communications and that Auto Detection BAUD rate is selected.

Trip Indications

Problem or diagnostic indication	Description	Possible Cause	Suggested Actions
Internal Fault trip	The module tripped on an internal fault.	Various.	<p>Connect the PCT and view the Module Faults Log. This log expands the Internal Fault annunciation.</p> <p>In general, it is not possible to fix internal faults without returning the unit to Woodward.</p>
Power Up Trip	The module has lost power and has been restored.	Power source fault or breaker reset.	Verify power source, breaker, fuse and wiring integrity. The Reset function will reset the module.
Configuration Trip	Trip is issued internally to keep the module in tripped state while the module is actively saving a configuration.	The module is actively saving a configuration.	Wait for module to finish saving configuration. Reset function will reset the module.
Parameter Error	An error has been detected in the internally stored parameters. Internally stored parameters are constantly checked for data integrity.	Non-volatile memory hardware fault or internal fault.	<p>Reload configuration settings using the PCT. Cycle input power.</p> <p>If Parameter Error persists return unit to Woodward according to the instructions in Chapter 8 of this manual.</p>
Overspeed Trip	The module tripped on an overspeed event.	<p>Turbine overspeed.</p> <p>Configuration.</p>	<p>Check trip system prior to operating turbine, including ProTech® TPS built-in simulated speed tests to verify ProTech® TPS functionality.</p> <p>Using the PCT or front panel, verify that the correct settings are selected.</p>
Overacceleration Trip	The module tripped on an overacceleration event.	<p>Rapid turbine acceleration.</p> <p>Configuration.</p>	<p>Check trip system prior to operating turbine, including ProTech® TPS built-in simulated speed tests to verify ProTech® TPS functionality.</p> <p>Using the PCT or front panel, verify that the correct settings are selected.</p>

Problem or diagnostic indication	Description	Possible Cause	Suggested Actions
Speed Probe Open Wire	The module has detected an open wire condition on the speed probe (Passive, or MPU probe only).	Wiring fault or probe fault.	Check wiring continuity and probe integrity.
Speed Lost Trip	Sudden Speed Loss is configured as Trip and the module has detected a sudden speed loss.	Wiring fault or probe fault.	Check wiring continuity and probe integrity.
Speed Fail Trip	Start logic – Speed Fail Trip is enabled and the module has detected the Speed Fail Override contact input is open while speed is below the user configured Speed Fail Setpoint.	Wiring fault, speed probe fault. Speed Fail Override contact input operation not correct. Incorrect speed fail setpoint configured.	Check wiring continuity and probe integrity. Check contact and wiring operation. See manual for description of function. Use PCT to verify proper configuration settings.
Speed Fail Timeout	Start logic - the module has not detected speed within the time set by the Speed Fail Timeout setting.	Wiring fault, speed probe fault. Incorrect speed fail timeout time configured.	Check wiring continuity and probe integrity. See manual for description of function. Use PCT to verify proper configuration settings.

Alarm Indications

Problem or diagnostic indication	Description	Possible Cause	Suggested Actions
Internal Fault Alarm	The module has an internal fault that is announced an alarm and not a trip.	Various.	Connect the service tool and view the Trip And Alarm Log. This log expands the Internal Fault Alarm annunciation.
Configuration Mismatch	Configuration data does not match between modules.	Different settings loaded than in one or both of the other two modules.	Copy configurations between modules using Configuration Management in the Config Menu, or load settings from service tool.
Power Supply 1 Fault	The module has detected a fault on Power Supply 1.	Power supply input 1 is either faulted or the power is disconnected.	Check the power source, breaker, fuse and connections. Note the module will continue to operate normally on power supply 2.
Power Supply 2 Fault	The module has detected a fault on Power Supply 2.	Power supply input 2 is either faulted or the power is disconnected.	Check the power source, breaker, fuse and connections. Note the module will continue to operate normally on power supply 1.
Speed Fail Alarm	Start logic – Speed Fail Alarm is enabled, and the module has detected the Speed Fail Override contact input is open while speed is below the user configured Speed Fail Setpoint.	Wiring fault, speed probe fault. Speed Fail Override contact input operation not correct. Incorrect speed fail setpoint configured.	Check wiring continuity and probe integrity. Check contact and wiring operation. See manual for description of function. Use PCT or front panel to verify proper configuration settings.
Speed Lost Alarm	Sudden Speed Loss is configured as Alarm and the module has detected a sudden speed loss.	Wiring fault or probe fault.	Check wiring continuity and probe integrity.
Tmp Overspd Setpoint On	Indicates the temporary overspeed setpoint has been activated.	User initiated temporary setpoint test.	See manual for description and limitations. Use PCT or front panel to verify settings.
Manual Sim. Speed Test	Indicates the manual simulated overspeed test has been activated.	User initiated simulated speed test.	See manual for description and limitations.
Auto Sim. Speed Test	Indicates the automated simulated overspeed test has been activated.	User initiated simulated speed test.	See manual for description and limitations.

Problem or diagnostic indication	Description	Possible Cause	Suggested Actions
Periodic Overspd Test	Indicates the automated Periodic Overspeed Test has been activated.	User enabled the simulated speed test or test interval time expired and test started.	See manual for description and limitations. Use PCT or Module A front panel to verify settings.
User Defined Test 1	Indicates the User Defined Test 1 has been activated.	User enabled the User Defined Test or the configured Set Input was true.	Connect PCT and verify settings. Check the set and reset functions are correct. Note specifically the effect of the timeout setting.
User Defined Test 2	Indicates the User Defined Test 2 has been activated.	User enabled the User Defined Test or the configured Set Input was true.	Connect PCT and verify settings. Check the set and reset functions are correct. Note specifically the effect of the timeout setting.
User Defined Test 3	Indicates the User Defined Test 3 has been activated.	User enabled the User Defined Test or the configured Set Input was true.	Connect PCT and verify settings. Check the set and reset functions are correct. Note specifically the effect of the timeout setting.
Trip Cycle Time Mon 1 Alarm	Indicates the Trip Cycle Monitor Time 1 Alarm has been set.	Trip Cycle Monitor Time 1 Alarm is set when the maximum cycle time has been exceeded during a trip cycle time test.	Check the Trip Cycle Time Monitor Menu and note the trip cycle time to see if the cycle time indicator signal is reaching the ProTech® TPS. Connect PCT and verify settings. Verify the trip indicator input is from the correct source and the max cycle time setting is correct. Check external system by following the trip signal around the loop until it returns back to the ProTech® TPS input that is designated as the trip indicator input.

Problem or diagnostic indication	Description	Possible Cause	Suggested Actions
Trip Cycle Time Mon 2 Alarm	Indicates the Trip Cycle Monitor Time 2 Alarm has been set.	Trip Cycle Monitor Time 2 Alarm is set when the maximum cycle time has been exceeded during a trip cycle time test.	<p>Check the Trip Cycle Time Monitor Menu and note the trip cycle time to see if the cycle time indicator signal is reaching the ProTech® TPS.</p> <p>Connect PCT and verify settings. Verify the trip indicator input is from the correct source and the max cycle time setting is correct.</p> <p>Check external system by following the trip signal around the loop until it returns back to the ProTech® TPS input that is designated as the trip indicator input.</p>

Configuration Guidance

The ProTech® TPS is a fault tolerant safety control device that is fully configured by customers for each unique site application. These products have many functional options available and the system is designed to continually provide its primary function, even when one fault occurs anywhere in the ProTech system.

It has come to our attention that some user configurations of these products, may not react as expected when a second fault occurs in the ProTech® TPS system.

These safety products are all configurable by the user, so it is important to emphasize the following points:

- On any configurable device – it is possible to have a valid configuration that may not do all that is expected, verification of customer and installers requirements and unit testing at site commissioning is required to ensure the appropriate response to faults in the system.
- On any fault tolerant system, a single fault should be investigated and addressed. Depending on the configuration, running the system in a prolonged mode with an active alarm, leaves it in a state where a second fault could cause a trip or prevent the unit from performing its primary function.

If your configuration settings are using Active probes (not MPU's) and your configuration has Speed Fail Trip set to "NOT USED" your configuration may be at risk in the event of a second fault.

Configure Speed Input		AND		Configure Start Logic	
Probe Type	ACTIVE			Speed Fail Setpoint	100 RPM
Nr of Gear Teeth	60			Speed Fail Trip	NOT USED
Gear Ratio	1.0000			Speed Fail Alarm	NOT USED
Overspeed Trip	4100.0 RPM			Speed Fail Timeout Trip	USED
Sudden Speed Loss	TRIP			Speed Fail Timeout Time	00:00:30 hh:mm:ss
Speed Loss Threshold	200.0 RPM				
Press ENTER to edit value				Press ENTER to edit value	
Monitor Menu	View Logs	Config Menu	Test Menu	Monitor Menu	View Logs
				Config Menu	Test Menu

Figure 5-1. Configuration Guide - Front Panel Interface with Active Probe

It is recommended that on ProTech® TPS products, the option Speed Fail Trip always be set to “USED” whenever the configuration of the speed input probe type is “Active”.

This can be complete using the Front Panel Interface as shown above or can be completed using the PCT (Programming and Configuration Tool) as shown below:

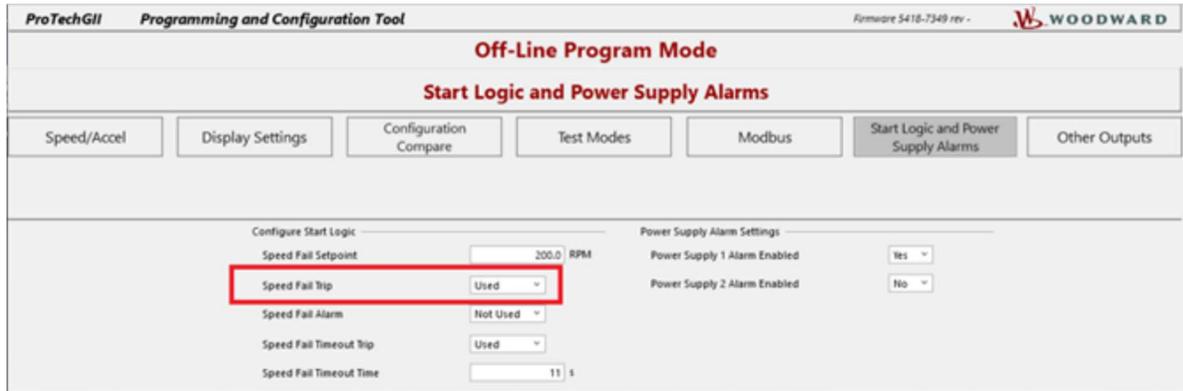
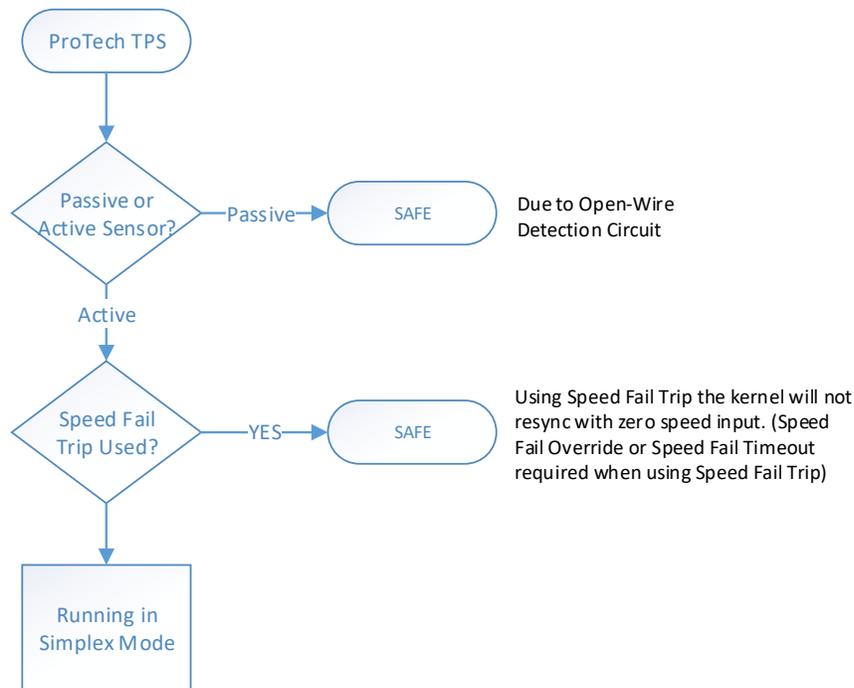


Figure 5-2. Speed Fail Trip Using PCT

To determine the recommended configuration settings for detecting failed speed probes in systems that utilize Active Speed probes, reference the flowchart in Figure 5-3 below:



- Turn Speed Fail Trip to USED.
- If Speed Fail Trip cannot be used, then enable Speed Failure Alarm – will give notification of an issue but will not trip.
- Customer should verify speed on the modules before and after reset.
- Using Reset then issuing Start will validate the speed input and will trip if not above Speed Set point by end of start command.

Figure 5-3. Configuration Guidance Flowchart

Chapter 6. Safety Management

Product Variations Certified

The functional safety requirement in this manual applies to all ProTech® TPS variations.

These products are certified for use in applications up to SIL3 according to IEC61508.

Safe State

The ProTech® TPS is designed so that the safe state can be configured for either de-energize or energize to trip. De-energize to trip will place trip relays into their unpowered, normally open state.

The de-energize-to-trip functionality is implemented such that a complete loss of power to the module results in a trip of that module. The energize-to-trip functionality is implemented such that a complete loss of power to the module does not result in a trip of that module.

When configured as de-energize-to-trip, the modules power up in the tripped state. When configured as energize-to-trip, the modules power up such that they do not enter the tripped state unless a trip condition is present.

Table 6-1. Configuration and Module Power Loss/Power Up State

Configuration	Module Power Loss State	Module Power Up State
De-energize to trip	Tripped	Tripped
Energize to trip	Not Tripped	Not Tripped, unless trip condition present.

SIL Specifications

PFD and PFH calculations have been performed on the ProTech® TPS according IEC61508. For SIL3, IEC states the following requirements.

Table 6-2. SIL3 IEC Requirements

Type	SIL 3 Value
PFH	10^{-8} to 10^{-7}
PFD	10^{-4} to 10^{-3}
SFF	> 90%

Table 6-3. SIL3 Specifications

PFH	
7.8E-8 1/h	
PFD	
PFD	Proof Test Interval
3.7E-5	6 month
5.6E-5	9 month
7.5E-5	1year
Safe Failure Fraction	
SFF > 90%	
Diagnostic Coverage	
DC > 90%	

Failure Rate Data

The Mean Time to Failure (MTTF) is a measure of time between failures that cause a complete process shutdown. In determining this number, IEC61508 evaluation takes into account safe failure and dangerous detected failures that cause a module trip.

Table 6-4. MTTF Value

MTTF	
	> 54 000 years

Because of the nature of the 2-o-o-3 voting structure, a single module trip does not shut down the process.

Response time data

The response time for a safety system must be less than the process safety time. The system integrator must determine the process safety time and the response time of all elements (sensors, ProTech® TPS, actuators, etc.) that make up the total process safety time. For this purpose, the ProTech® TPS response time is given below.

Table 6-5. ProTech® TPS Response Time

Response Time	
Independent Trip Relay Versions	< 12 ms
Voted Trip Relay Versions	< 20 ms

The response time of the ProTech® TPS is the time from when a signal is received at the ProTech® TPS terminal blocks that is out of a range as defined by the programming (i.e. speed, analog input) to the point where the trip relays have changed state.

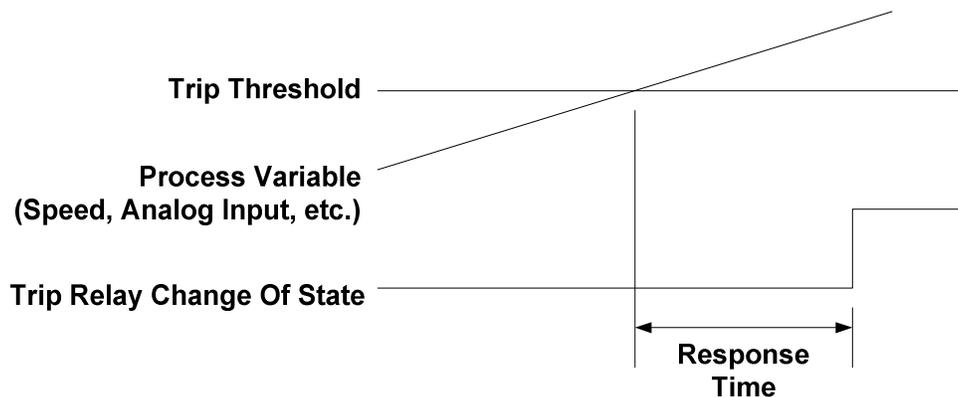


Figure 6-1. Illustration of Response Time Calculations

Limitations

When proper installation, maintenance, proof testing, and environmental limitations are observed, the product life of the ProTech® TPS is 20 years.

Table 6-6. Environmental Specifications:

Operating Temperature	-20 to +60 °C
Storage Temperature (Non-operational)	-20 to +65 °C
Relative humidity	up to 95% non-condensing
Vibration	2 hrs/axis, 1.04 Grms, 10–500 Hz, three axis
Shock:	±3 pulses, 30 G, 11 ms half sine shock, three axis
IP rating	56
Altitude	up to 3000 meters above sea level
Electromagnetic Compatibility	Emissions: EN61000-6-4 Immunity: EN61000-6-2

Management of Functional Safety

The ProTech® TPS is intended for use according the requirements of a safety lifecycle management process such as IEC61508 or IEC61511. The safety performance numbers in this chapter can be used for the evaluation of the overall safety lifecycle.

Restrictions

The user must complete a full functional check of the ProTech® TPS after initial installation, and after any modification of the programming or configuration of the device. This functional check should include as much of the safety system as possible, such as sensors, transmitters, actuators and trip blocks. The ProTech® TPS has programming capability to facilitate the automatic checkout and periodic maintenance of the safety system. For help on programming, see the chapters on functionality, configuration and the example applications.

The ProTech® TPS must be used within the published specification in this manual.

Competence of Personnel

All persons involved in the initial design or modification of the programmable software, installation and maintenance must have appropriate training. Training and guidance materials include this manual, the ProTech® TPS service tool, and training programs available at Woodward. See Chapter 8 (Service Options) for more information.

Operation and Maintenance Practice

A periodic proof (functional) test of the ProTech® TPS is required to verify that no dangerous faults not detected by internal run-time diagnostics remain undetected. More information is in the “Proof Test” section of this chapter. The frequency of the proof test is determined by the overall safety system design, of which the ProTech® TPS is part of the safety system. The safety numbers are given in the following sections to help the system integrator determine the appropriate test interval. This will require password access to the front panel menus.

Installation and Site Acceptance Testing

Installation and use of the ProTech® TPS must conform to the guidelines and restrictions included in this manual. No other information is needed for installation, programming, and maintenance. This will require password access to the front panel menus.

Functional Testing after Initial Installation

A functional test of the ProTech® TPS is required prior to use as a safety system. This should be done as part of the overall safety system installation check and should include all I/O interfaces to and from the ProTech® TPS that are part of the safety system. For guidance on the functional test, see the proof test procedure below. This will require password access to the front panel menus.

Functional Testing after Changes

A functional test of the ProTech® TPS is required after making any changes that affect the safety system. Although there are functions in the ProTech® TPS that are not directly safety related, it is recommended that a functional test is performed after any change. This will require password access to the front panel menus.

Proof Testing (Functional Test)

The ProTech® TPS must be periodically proof tested to ensure there are no dangerous faults present that are not detected by on-line diagnostics. Because of the 2-o-o-3 configuration of the ProTech® TPS, it is possible to perform the proof test while the ProTech® TPS is on-line. Many built-in test modes are included. The test procedure will set the trip outputs on the module under test into a trip state (de-energized for a de-energize-to-trip configuration and energized in an energized to trip configuration). It is possible to automate several steps of the proof test procedure shown below using the programmability and test mode configurability of the ProTech® TPS, but the intent of the steps below must be met.

With the procedure below, the user can expect 99% test coverage of the dangerous failures that are not tested by online diagnostics.

Functional Verification (Proof) Test Procedure (module level):

This procedure requires a digital multimeter for resistance and voltage measurement. This will require password access to the front panel menus.

1. Cycle Power on the module and verify there are no internal faults on the Alarm Latch page of the monitor menu.
2. Remove power from one power supply input (power supply input 1 or 2) at a time and verify the correct fault is read on the Alarm Latch page of the monitor menu.
3. Measure external 24 V EXT (terminals 80 – 81; 23 ± 1 V).
4. Verify proper Discrete Input voltage (terminals 37 – 38; 23 ± 1 V).
5. Measure SPEED PWR (terminals 69 – 71). Insure active probe mode is selected in Speed Configuration Menu, make the measurement, and insure probe type is in original configuration (23 ± 1 V).
6. Test Speed input by using one of the internal speed test modes in the Test Menu. Resistance measurement of each of the voter outputs is required. Verify as follows:
 - a. With module not tripped, resistance measurement from 1A – 1B, or 2A – 2B must be less than 100Ω .
 - b. With module tripped, resistance measurement from 1A – 1B, or 2A – 2B must be greater than $1 M\Omega$.
7. Test any configurable inputs that are set to analog mode to make sure that all inputs are operational. The analog signal must be varied from a steady state value. Verify the proper signal by monitoring the respective input on the Monitor Menu\Configurable Input page of the front panel.
8. Test any configurable inputs that are set to discrete mode to make sure that all inputs are operational and not stuck in the ON or OFF state. Inputs must be cycled from ON to OFF and OFF to ON. Verify the proper signal by monitoring the respective input on the Monitor Menu\Configurable Input page of the front panel.
9. Test Programmable Outputs if used as part of the safety system.
10. Cycle dedicated inputs and verify the proper signal by monitoring the respective input on the Monitor Menu/Dedicated Discrete Input page of the front panel.
11. If possible, compare external speed with measured speed-reading on the ProTech® TPS display.

12. If used as part of the safety system, verify the analog output. Measure this output by performing an automated overspeed trip test as described in step 6.
13. Chassis isolation checks using resistance measurement. Measure from terminals 39, 66, 67 to a point on the ProTech® TPS chassis (the grounding braid is a good place for this measurement): $< 1 \Omega$.
14. Perform a lamp test from front panel Test Menu.

Chapter 7. Asset Management

Product Storage Recommendations

The unit may be stored in its original shipping container until it is ready for installation. Protect the device from weather and from extreme humidity or temperature fluctuations during storage. This product is designed for continuous storage in IP56 rated locations with an ambient temperature range of: –20 to +65 °C.

To ensure product shelf life, Woodward recommends that a stored ProTech® TPS be powered up (power source applied to each module) for five minutes every 24–36 months. This procedure re-establishes an electrical charge into the product's electrolytic capacitors, extending their shelf life. (See the Unpacking section in the chapter on Installation for unpacking.)

Refurbishment Period Recommendation

This product is designed 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, Woodward recommends that your product be sent back to Woodward or to a Woodward authorized service facility after every five to ten years of continuous service for inspection and component upgrades. Please refer to the service programs in the following chapter.



EXPLOSION HAZARD—Substitution of components may impair suitability for Class I, Division 2.

Chapter 8.

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 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.

Modbus Ethernet Gateway Information

Introduction

For customers who want to use Modbus Ethernet communications or put the ProTech® on the plant network, Woodward recommends the following Ethernet-to-Serial Gateways:

B&B Electronics –

Model: MESR901
 Serial: RS-232, RS-485, or RS-422
 Power Input: 10–48 Vdc

B&B Electronics Mfg. Co.
 707 Dayton Road
 P.O. Box 1040
 Ottawa, IL 61350
 USA

Phone: (815) 433-5100 (8-5:00 CST, M-F)
 Email: orders@bb-elec.com
 Web: www.bb-elec.com



Lantronix –

Model: UDS100-Xpress DR IAP
 Serial: RS-232, RS-485, or RS-422
 Power Input: 9–30 Vdc, 9–24 Vac

Lantronix
 15353 Barranca Parkway
 Irvine, CA 92618
 USA

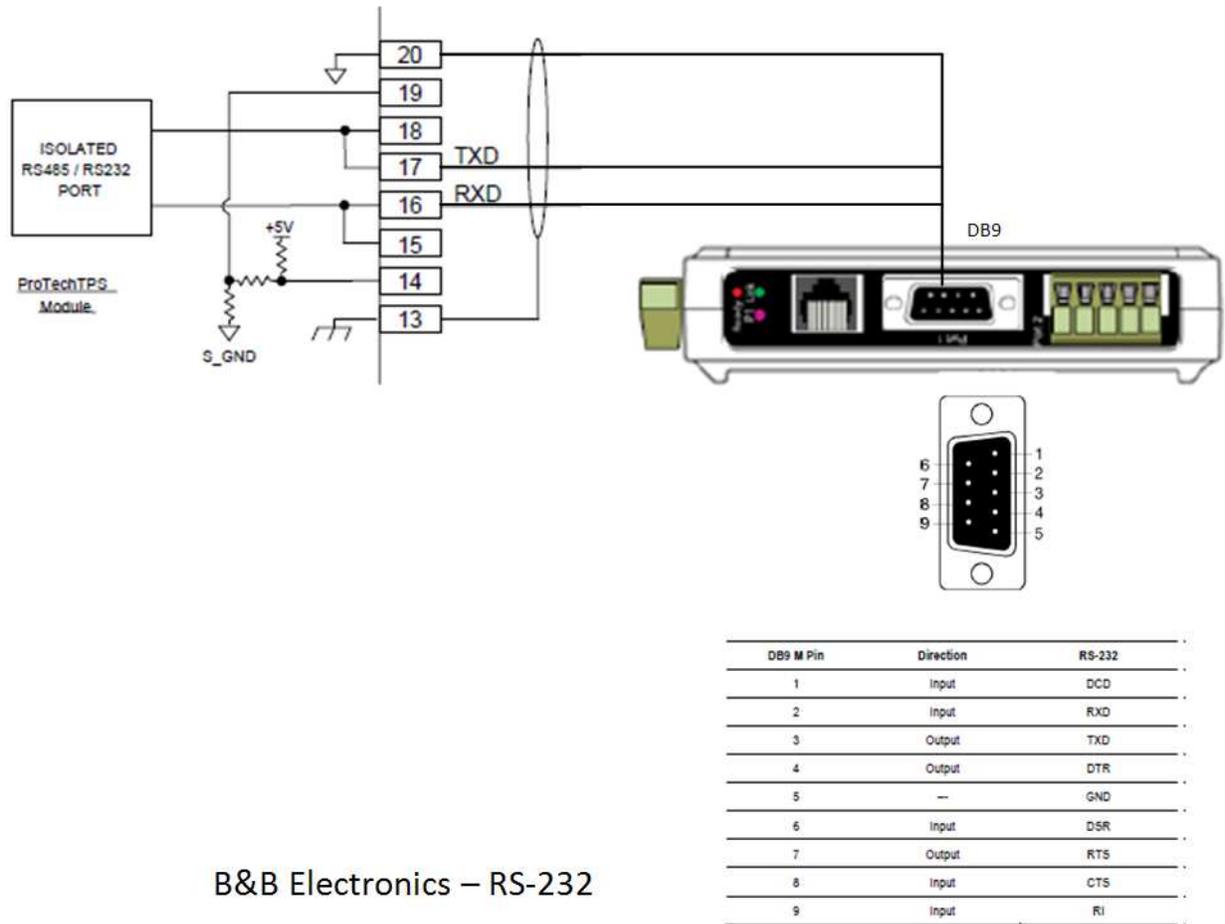
Phone: 1-800-422-7055
 Email: sales@lantronix.com
 Web: www.lantronix.com



B&B Electronics Setup

Below you will find the wiring setup and software configuration for the MESR901. Remember that the pictures below are for reference—you will need to set up the serial configuration to match the settings you chose in the ProTech. When multi-dropping the 3 modules together using RS-485/422, you will need to assign each module a unique node address, which can be found in the Modbus configuration screen on the ProTech.

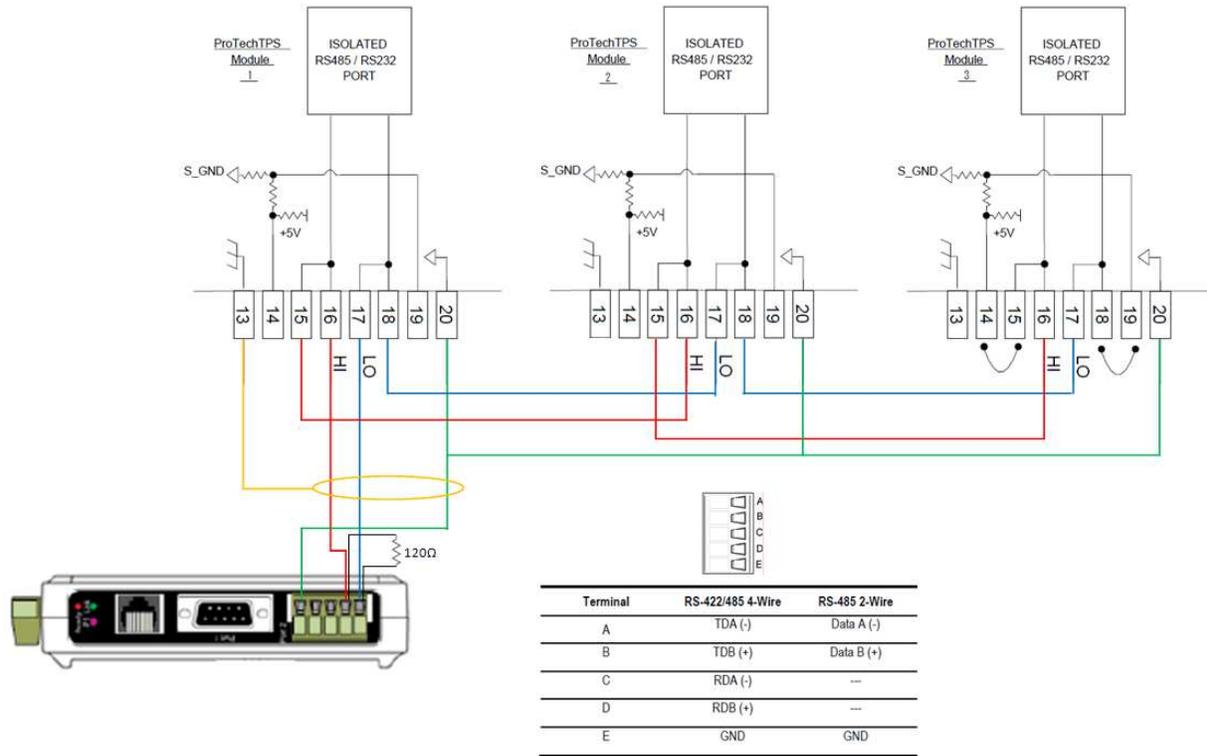
Wiring



B&B Electronics – RS-232

Figure A-1. RS-232

Note: The Serial DB9 connection is used for RS-232 communication only.



B&B Electronics – RS-485 Multi-drop Connection

Figure A-2.RS-485 2-wire

Note: Use the terminal block for wiring of RS-485 communications.

When configuring for RS-485, termination resistors (120 Ω) are needed at each end of the network. Note the location of the resistor on the device. The ProTech has the termination resistor built into the module, jumpers are necessary between terminals 14 – 15 and 18 – 19 to activate the termination.

Configuration –

Configuration of the MESR901 is done through Vlinx Modbus Gateway Manager. The configuration software is provided with the device.

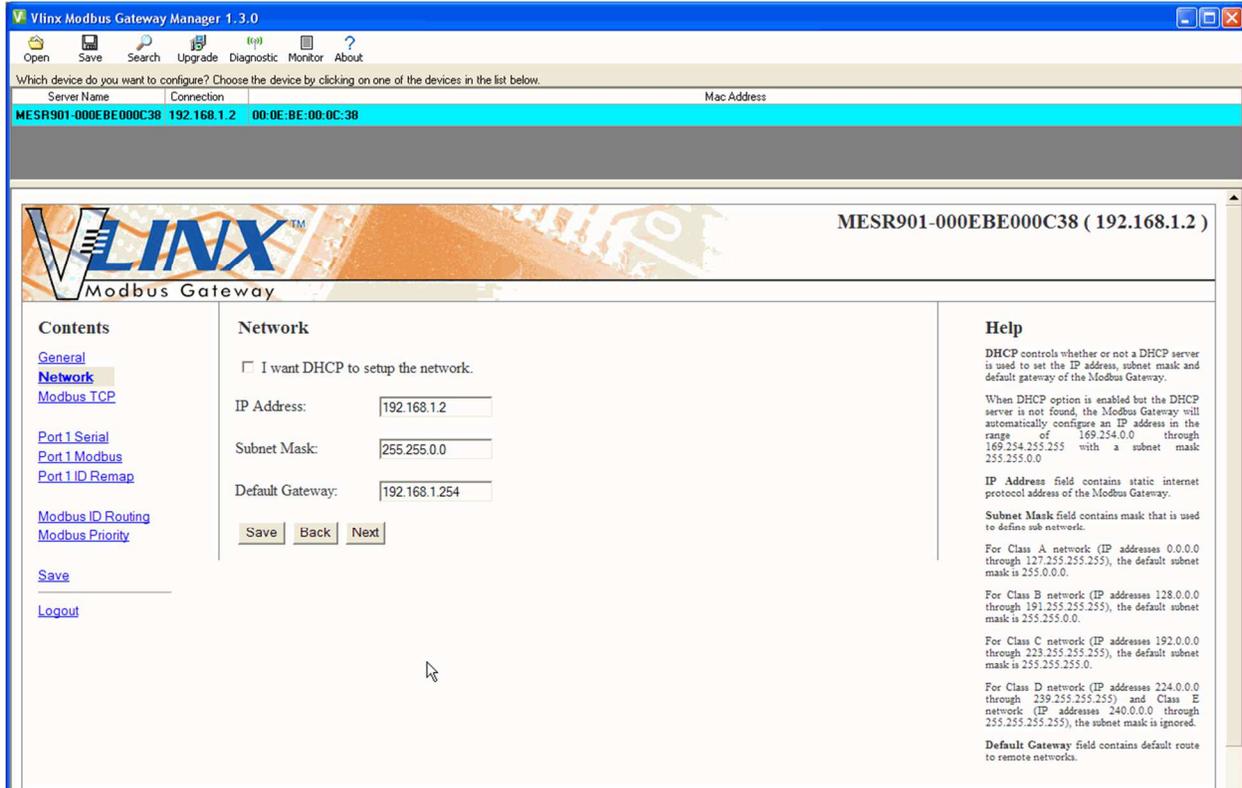


Figure A-3. Network Settings

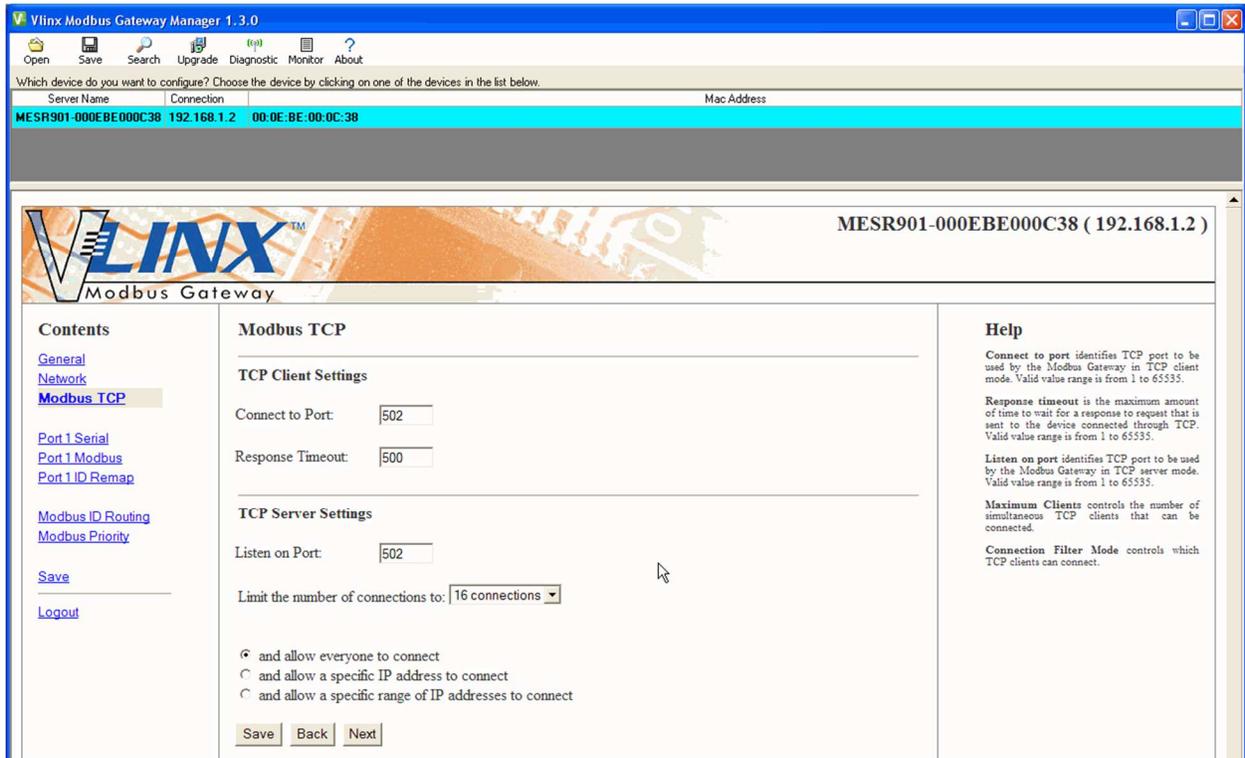


Figure A-4. Modbus TCP Settings

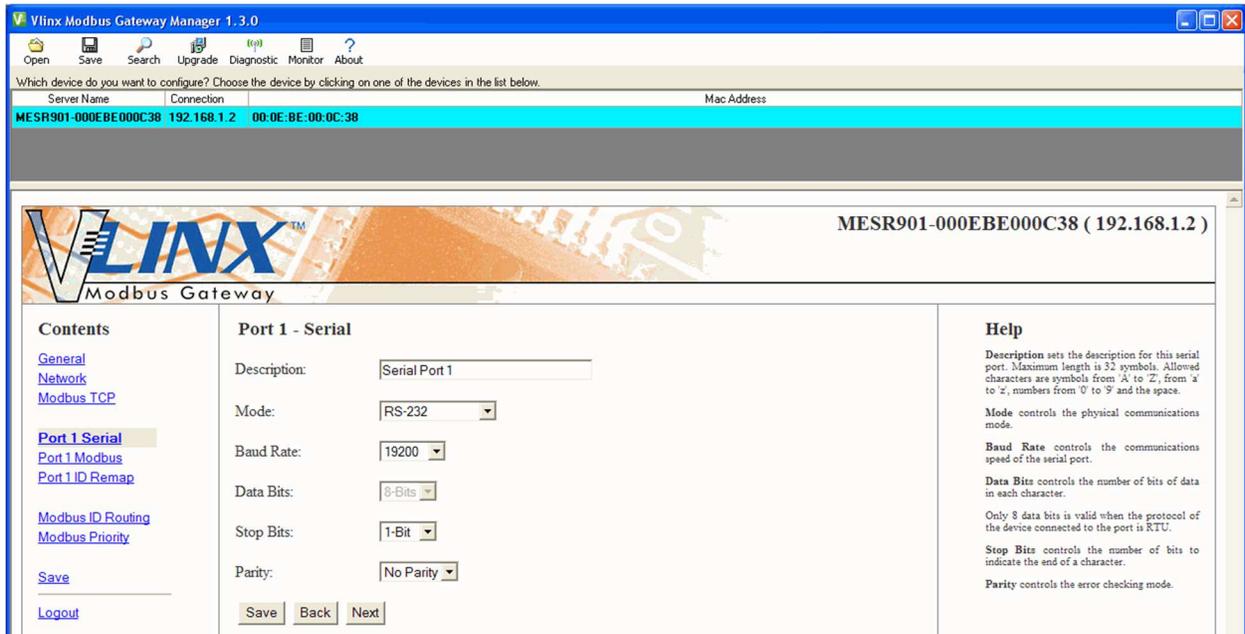


Figure A-5. Serial Communication Settings

Note: For RS-485 communication, select RS-485 under Mode, and use the terminal block connections. The DB9 port is for RS-232 communications only.

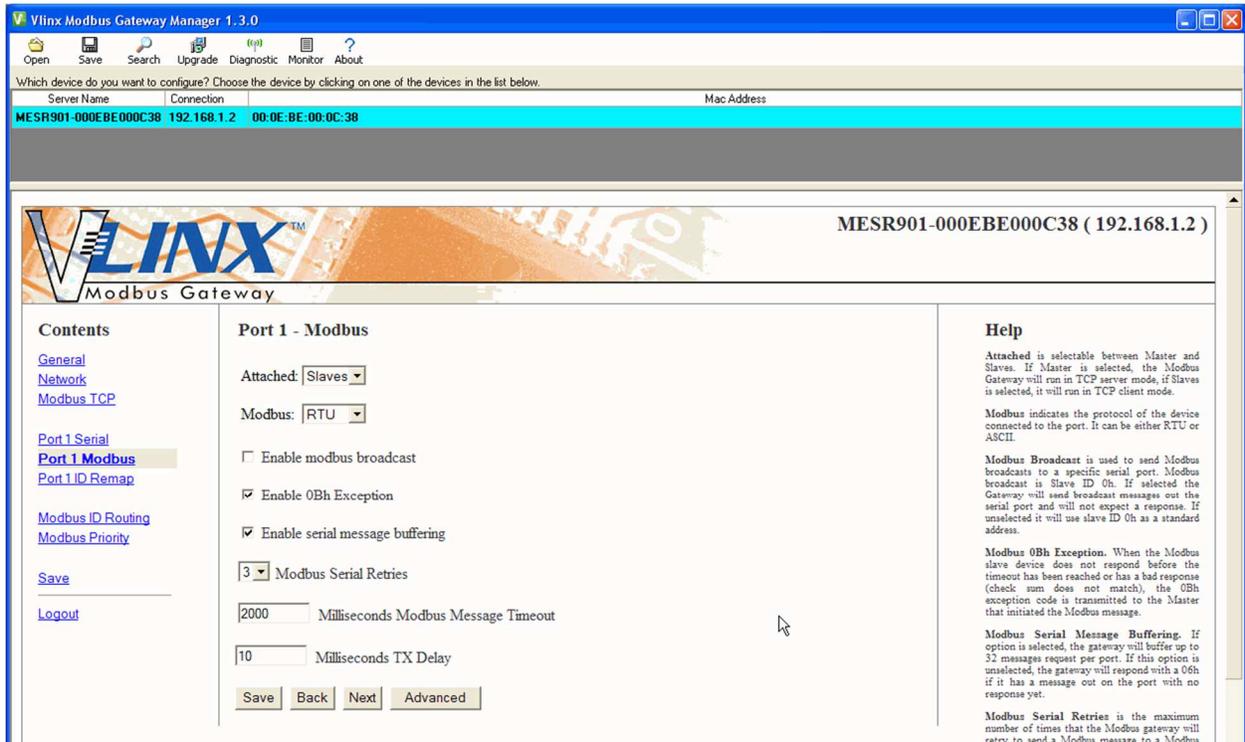
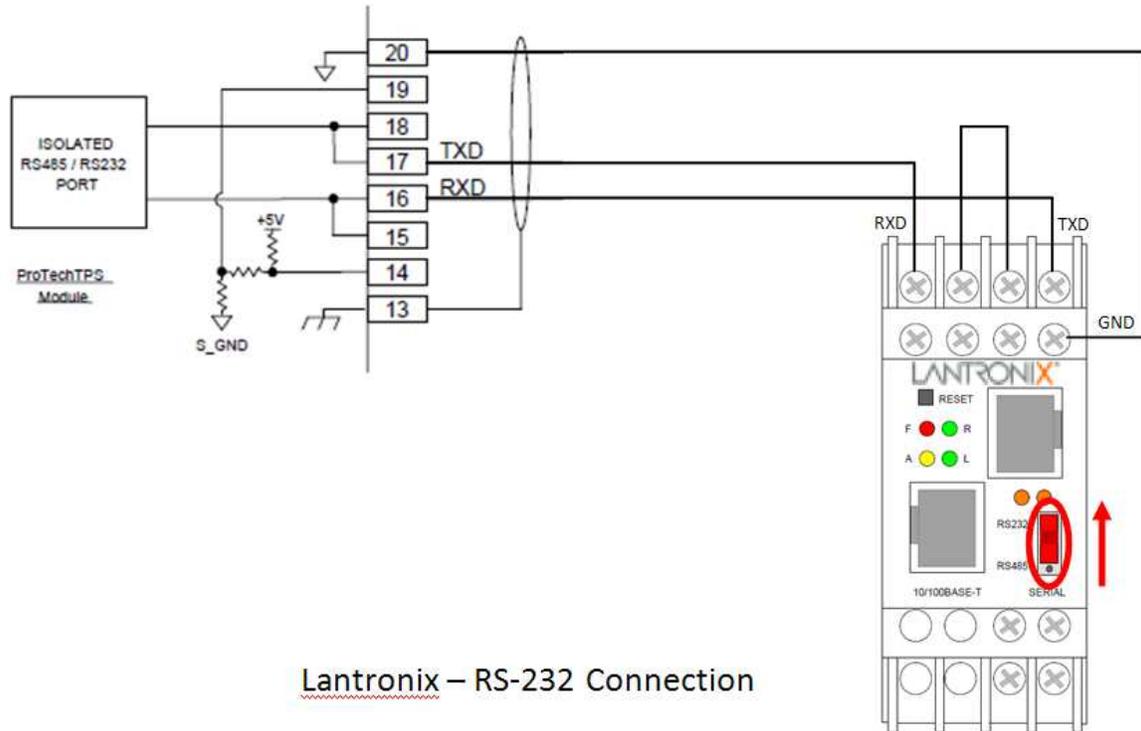


Figure A-6. Serial Modbus Settings

Lantronix Setup

Below you will find the wiring setup and software configuration for the UDS100-Xpress DR IAP. Remember that the pictures below are for reference, you will need to setup the serial configuration to match the settings you chose in the ProTech. When multi-dropping the 3 modules together using RS-485/422, you will need to assign each module a unique node address, which can be found in the Modbus configuration screen on the ProTech.

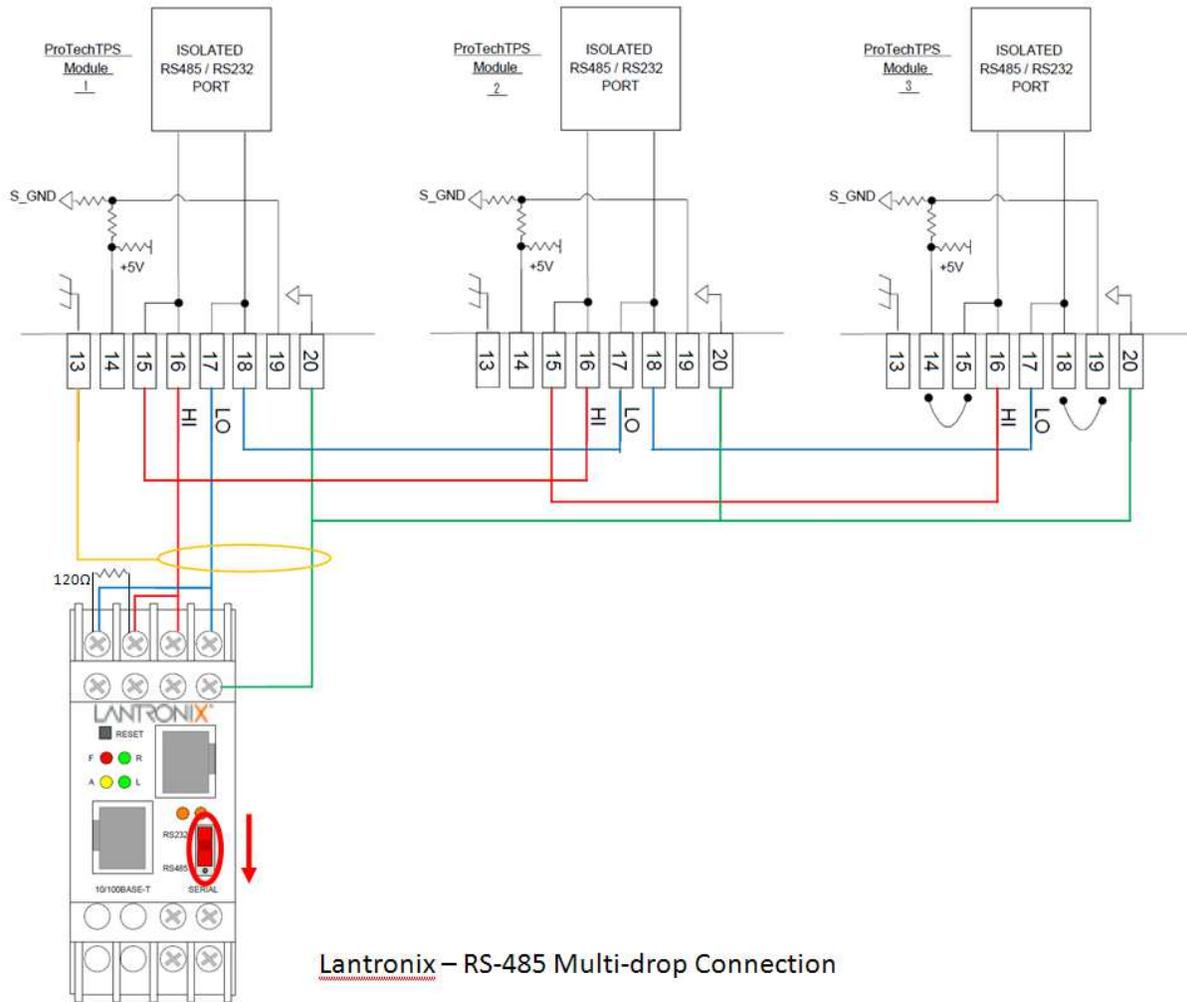
Wiring



Lantronix – RS-232 Connection

Figure A-7. Lantronix RS-232

Verify that the dip switch on the front of the device is in the up position, indicating RS-232 communications.



Lantronix – RS-485 Multi-drop Connection

Figure A-8 Lantronix RS-485 2-wire

Verify that the dip switch on the front of the device is in the down position, indicating RS-485 communications. When configuring for RS-485, termination resistors (120 Ω) are needed at each end of the network. Note the location of the resistor on the device. The ProTech has the termination resistor built into the module, jumpers are necessary between terminals 14 – 15 and 18 – 19 to activate the termination.

Configuration

Configuration of the UDS100-Xpress DR IAP is done through DeviceInstaller. The configuration software is provided with the device.

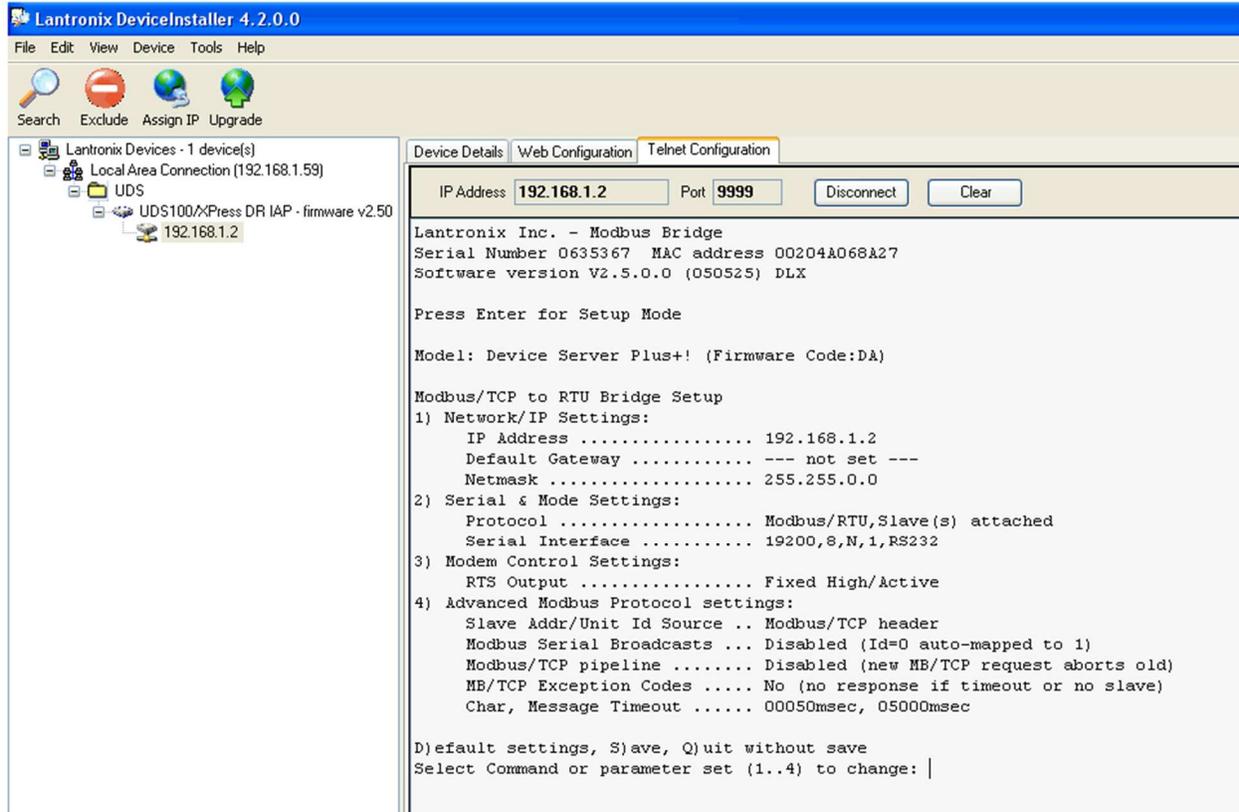


Figure A-9. Overview Screen

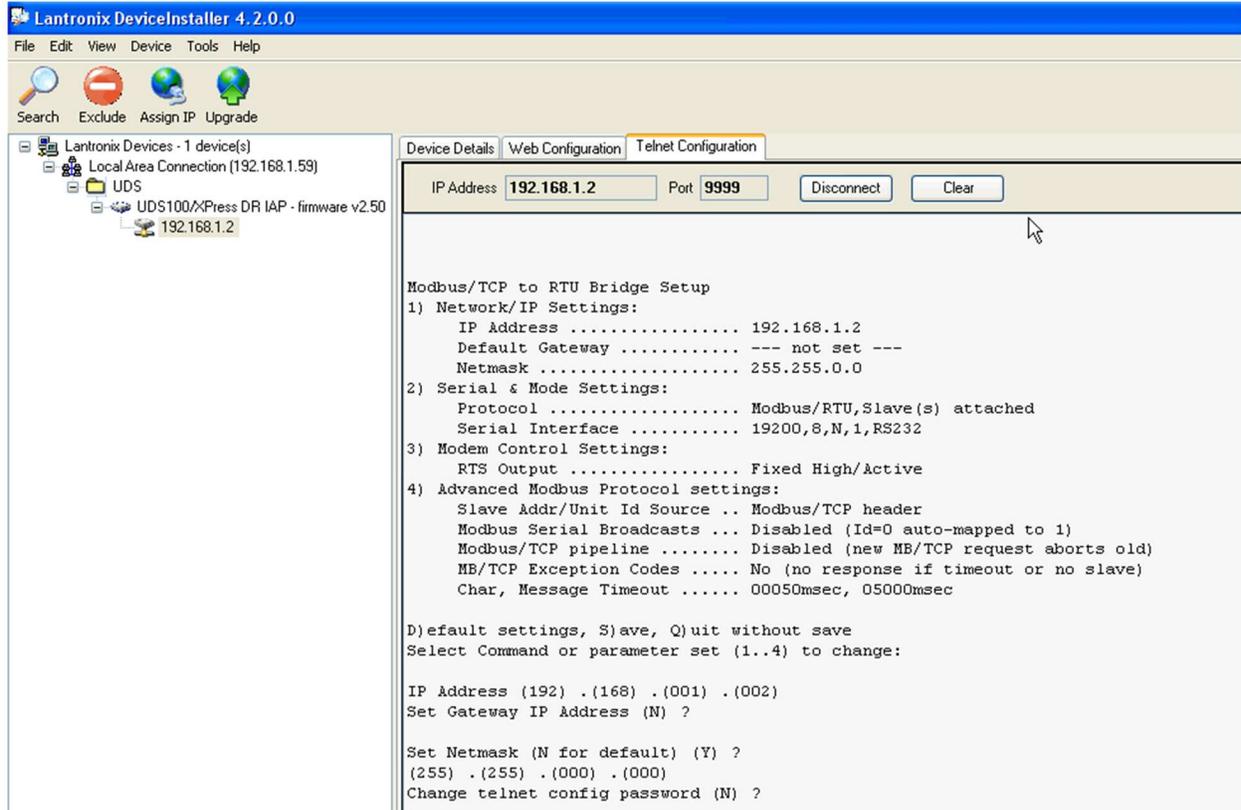


Figure A-10. Network Menu Screen

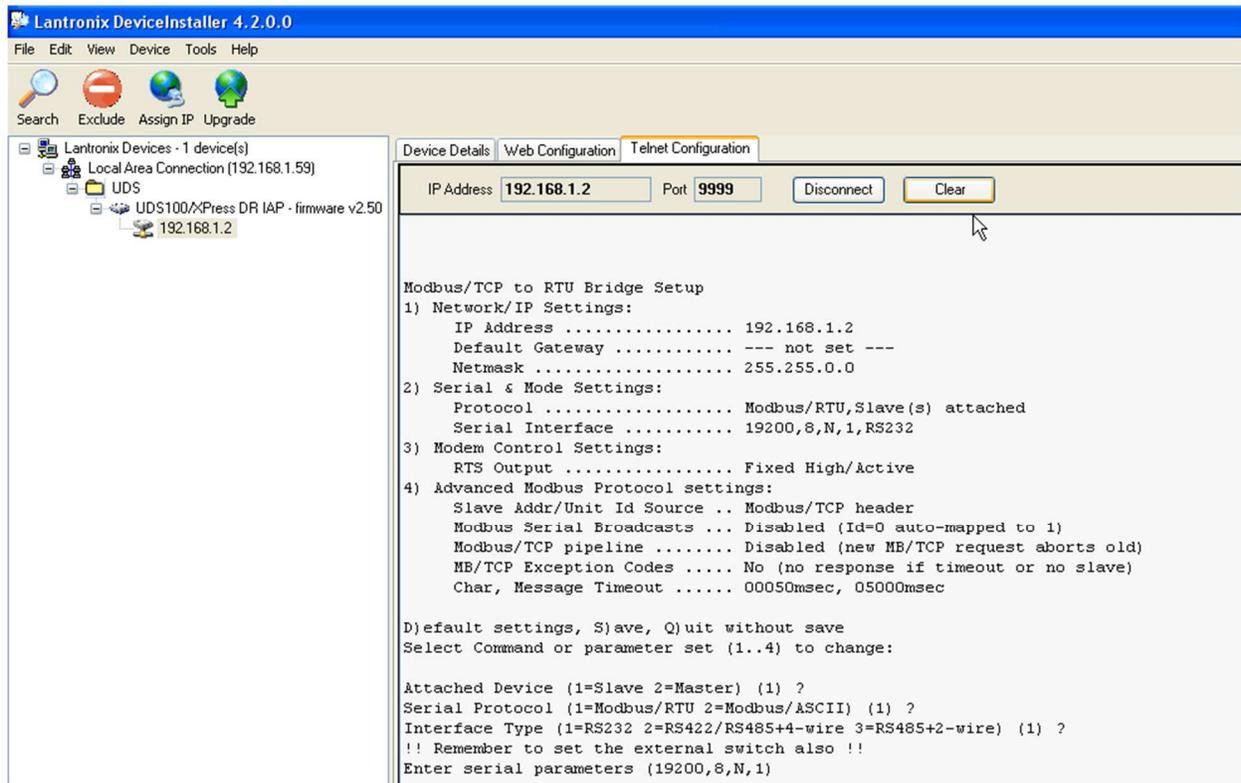


Figure A-11. Serial Settings Menu

Note: For RS-485 communications, choose option 3 under interface type and do not forget to set the dip switch on the front of the device.

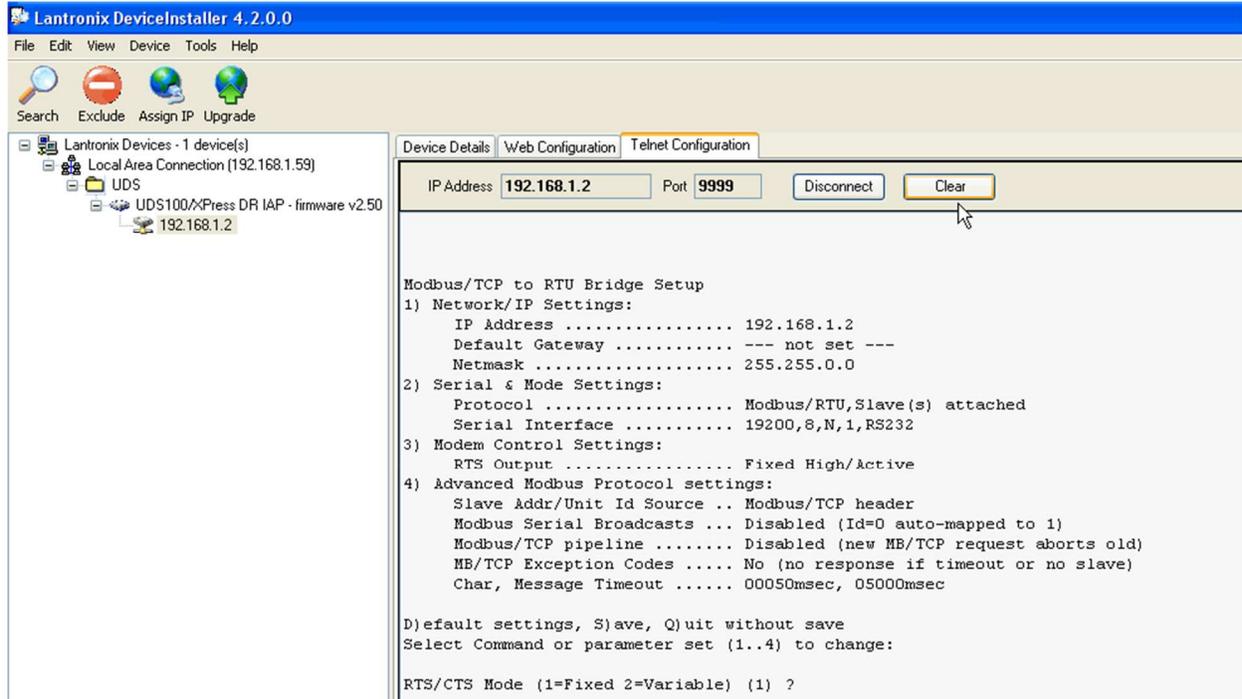


Figure A-12. Modem Control Menu

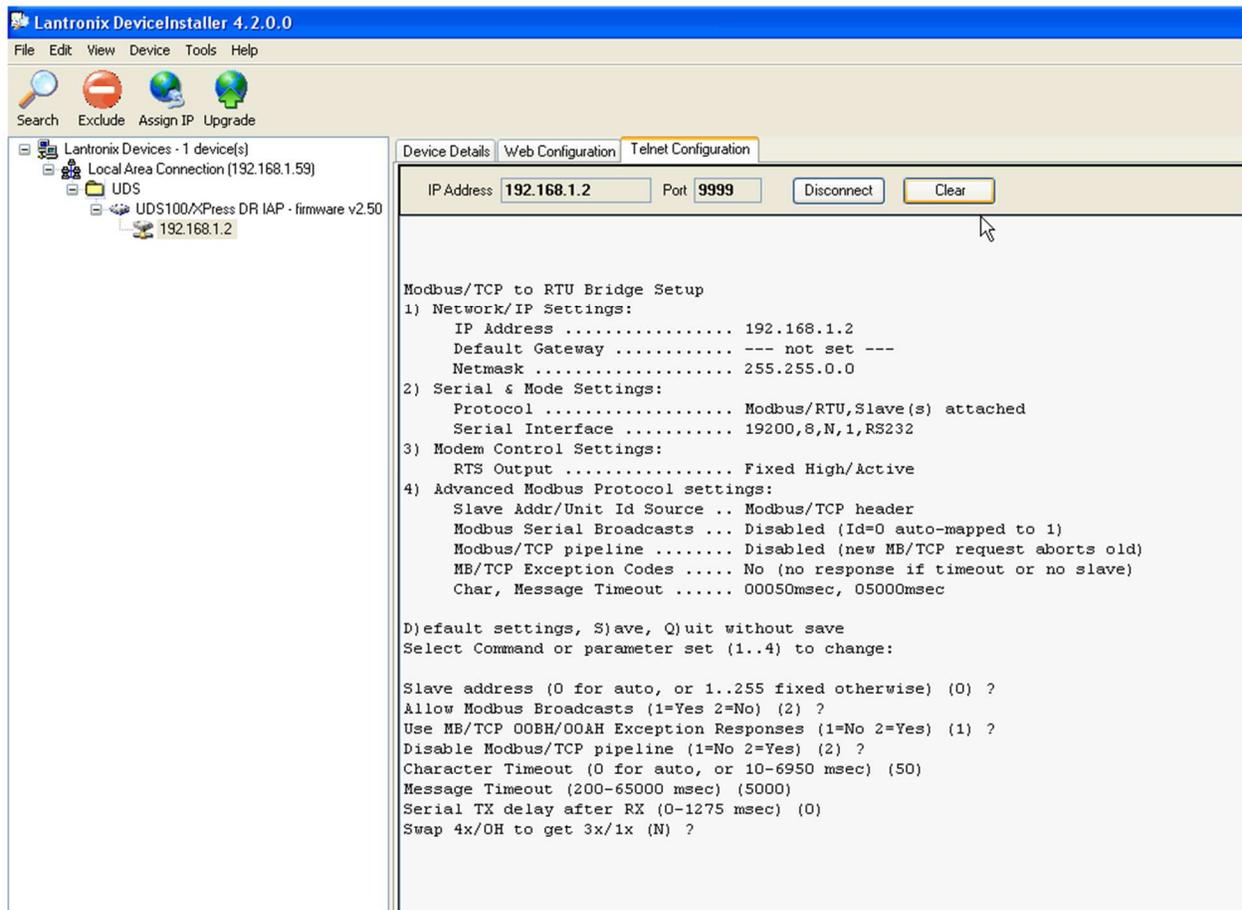


Figure A-13. Advanced Menu

Revision History

Changes in Revision H—

- Added note to Serial Modbus Communication section in Chapter 2
- Added two new Warning boxes to Chapter 3
- Added “(2-Wire Only)” to Table 4-1
- Added Configuration Guidance section to Chapter 5

Changes in Revision G—

- Removed WEEE, EuP, and C-Tick Directives from the Regulatory Compliance section
- Edited ATEX and RoHS Directives in the Regulatory Compliance section
- Added Australia (& New Zealand) RCM & EMC Compliance to Regulatory Compliance section

Changes in Revision F—

- Changes to Regulatory and Compliance Section
- Updated Declarations

Changes in Revision E—

- Added new warning required by GOST R

Changes in Revision D—

- Updated manual to reflect changes to MPU input threshold and impedance
- Added GOST R information to Regulatory Compliance section

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.: 00396-04-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): ProTech®-GII, ProTech® TPS, and the MicroNet® Safety Module
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation: Directive 2014/34/EU on the harmonisation 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)
 Directive 2014/35/EU on the harmonisation 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
Markings in addition to CE marking:  Category 3 Group II G, Ex nA IIC T4 X
Applicable Standards: EN61000-6-2:2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
 EN61000-6-4:2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments
 EN60079-15, 2010: Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection 'n'
 EN60079-0, 2012/A11:2013: Electrical apparatus for explosive gas atmospheres – Part 0: General requirements
 EN61010-1, 2001: Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General Requirements
Last two digits of the year in which the CE marking was affixed for the first time: 10

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

Christopher Perkins

Full Name

Engineering Manager

Position

Woodward, Fort Collins, CO, USA

Place

13-JUL-2016

Date

5-09-1183 Rev 26

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication **26501V1**.



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PO Box 1519, Fort Collins CO 80522-1519, USA
1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

Email and Website—www.woodward.com

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