WOODWARD

Product Manual 35027
(Revision A, 3/2017)
Original Instructions

Turbine Protection Monitoring System

Installation and Operation Manual

General Precautions	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

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

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 Out-of-date translations are marked with ⚠.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

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

Contents

Illustrations and Tables

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

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

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

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

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

The Woodward Turbine Protection Monitoring System does not have any certifications as a whole. However, the hardware components have the following listings:

European Compliance for CE Marking:
The cRIO-9068 Controller is CE marked for the following:

EMC Directive	Declared to 2004/108/EC
Low Voltage Directive:	Declared to 2006/95/EC
ATEX – Potentially Explosive Atmospheres:	Declared to 94/9/EC Demko 12ATEX1202658X Zone 2, Category 3 Group II G Ex nA IIC T4 Gc Special conditions for safe use below.

North American Compliance:
These listings are limited only to those cRIO units bearing the UL identification:

UL:	UL Listed for Class I, Zone 2, AEx nA IIC T4 and Ex nA IIC T4 in United States and Canada per UL E208190
UL:	UL Listed as Measuring, Testing, and Signal-generation Equipment in United States and Canada per UL E183728

Other International Compliance:
Marked controller and modules are separately certified.

Korean EMC:	Registered with National Radio Research Agency under the Radio Waves Act. Each marked component type has its own KCC Registration Certificate.
IECEx:	Certified for use in explosive atmospheres per Certificate IECEx UL 14.0089X Ex nA IIC T4 Gc

Conditions of Use for IECEx and ATEX:

- You must make sure that the transient disturbances do not exceed 140% of the rated voltage.
- The system shall be mounted in an IECEx certified enclosure with a minimum ingress protection rating of at least IP54 as defined in IEC 60079-15.
- The system shall only be used in an area of not more than Pollution Degree 2, as defined in IEC 60664-1.
- The enclosure must have a door or cover accessible only by the use of a tool.
- The devices shall be used with ATEX/IECEx certified Chassis for Group IIC and rated in accordance with the modules.

Marine Compliance:
Controller and modules only

Lloyd's Register Type Approval Certificate LR 05/60002(E7)
Expires 12-Feb-2020
Conditions on Certificate:
To meet electromagnetic compatibility (EMC) requirements, install the product in a shielded enclosure with shielded and/or filtered power and input/output ports. Power supply and module cables shall be separated on opposite sides of the enclosures, and enter/exit through opposing enclosure walls.

Chapter 1.
General Information

System Overview

Speed Condition Monitoring

- Monitors the speed of the Gas Generator and the Power Turbine independently
- Provides trip outputs when Gas Generator or the Power Turbine overspeed
- Supports redundancy of MPU signals; two MPU input channels for the Gas Generator and two for the Power Turbine
- Each MPU input is monitored for signal faults
- Fault detection logic will trip the generator if all of the gas generator MPU's or all of the power turbine MPU's are faulted (MPU fault trip can be turned on/off)
- The MPU fault can be inhibited by an discrete input

Vibration Signal Conditioning

- Signal conditioning of the Gas Generator vibration and the Power Turbine vibration are independent
- Supports redundant vibration signals, two for Gas Generator and two for Power Turbine
- Requires acceleration to be input as velocity signal
- Tracking filter extracts only the vibration signals that are induced by the generator and outputs (4-20 mA) the amplitude of the tracked vibration
- Wideband filter passes all vibration signals within a defined frequency range and outputs (4-20 mA) the highest amplitude of vibration detected within the defined range
- Outputs can be configured to be a measurement of velocity or displacement

FSOV (Fuel Shut-Off Valves) Condition Monitoring

- Monitors the current through the solenoid-operated fuel shut off valve
- Provides trip outputs for overcurrent/undercurrent event.
- Inputs allow for simultaneous monitoring of up to 4 fuel shut off valves
- The FSOV over/under-current trip can be inhibited by an external switch or controller to temporarily disable FSOV trips
- Provides configurable delay time for trip

Chapter 2
System Description

The Woodward Turbine Protection Monitoring (TPM) system is a control and signal-processing unit that provides independent turbine protection and signal conditioning of gas turbine units.

The three major areas of protection and monitoring covered by the TPM system are:
1. Independent overspeed protection
2. Vibration signal conditioning
3. Independent FSOV over/under-current protection

Figure 2-1 displays the inputs and outputs that are associated with each area of protection and monitoring.

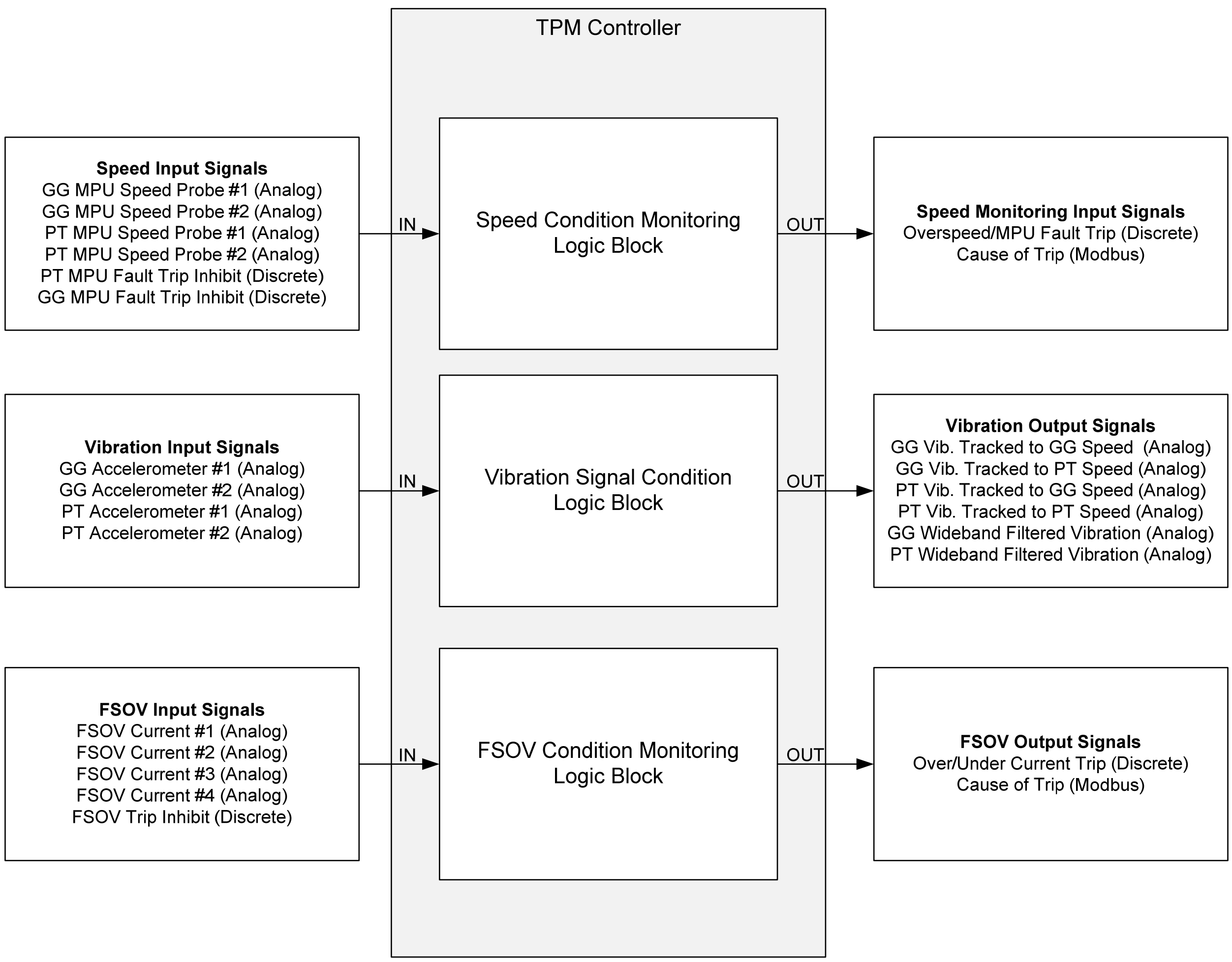


Figure 2-1. Control Overview

This chapter covers the details of the three major control areas of the TPM system.

System Trips

The TPM system will open the trip outputs anytime it detects a condition defined in table 1 below.

Extended definitions and details about the different trip cases are available in the Speed Condition Monitoring and FSOV Monitoring section of this chapter.

Table 2-1. List of all system defined turbine protection trips

Trip Cause	Area	Description
GG Overspeed	Speed Condition Monitoring	At least one MPU indicates that the Gas Generator speed exceeds the overspeed setpoint
PT Overspeed	Speed Condition Monitoring	At least one MPU indicates that the Power Turbine speed exceeds the overspeed setpoint
GG MPU Faults (Selectable)	Speed Condition Monitoring	All Gas Generator MPU's indicate a faulted signal or are indicating a speed below the minimum speed setpoint
PT MPU Faults (Selectable)	Speed Condition Monitoring	All Power Turbine MPU's indicate a faulted signal or are indicating a speed below the minimum speed setpoint
FSOV 1-4 Overcurrent	FSOV Condition Monitoring	The measured current through the Fuel Shut Off Valve exceeds the overcurrent setpoint for a time greater than the configured delay time.
FSOV 1-4 Undercurrent	FSOV Condition Monitoring	The measured current through the Fuel Shut Off Valve is less than the undercurrent setpoint for a time greater than the configured delay time.

When a trip condition has been detected, the Turbine Protection Monitoring system will trip the generator by disrupting power to the fuel shut off valves.

The TPM system accomplishes this by opening the output relay which should be connected in series with the current sense output of FSOV driver (5432-039) of the fuel shut off valves as part of the “Trip String”, as shown in Figure 2-2.

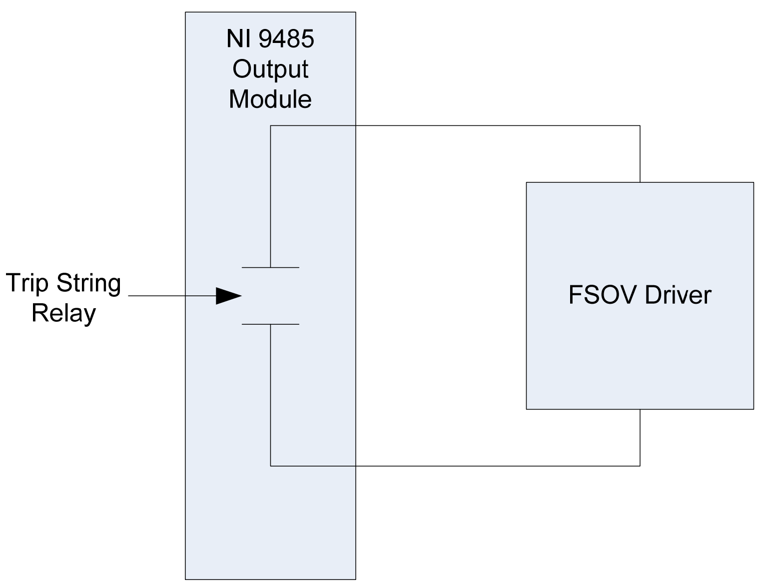


Figure 2-2. FSOV Trip String

Detecting the Cause of a Trip

When a system-defined trip occurs, a first out alarm will activate in the TPM control unit, indicating the cause of the trip.

The status of the first out alarms is available over Modbus communication. Table 2-2 defines the First-Out Alarm Modbus registers. Refer to *Chapter 5*
Modbus Communication for detailed information about the Modbus mapping.

Table 2-2. Modbus Registers for First Out Alarms

Function Code	Register	Access	Length	Signal Description
2	10011	R	1 Word	Cause of Trip: GG MPU1 Overspeed Trip
2	10012	R	1 Word	Cause of Trip: GG MPU2 Overspeed Trip
2	10013	R	1 Word	Cause of Trip: PT MPU1 Overspeed Trip
2	10014	R	1 Word	Cause of Trip: PT MPU2 Overspeed Trip
2	10019	R	1 Word	Cause of Trip: GG MPU Fault Trip
2	10020	R	1 Word	Cause of Trip: PT MPU Fault Trip
2	10025	R	1 Word	Cause of Trip: FSOV input #1 Undercurrent
2	10026	R	1 Word	Cause of Trip: FSOV input #2 Undercurrent
2	10027	R	1 Word	Cause of Trip: FSOV input #3 Undercurrent
2	10028	R	1 Word	Cause of Trip: FSOV input #4 Undercurrent
2	10029	R	1 Word	Cause of Trip: FSOV input #1 Overcurrent
2	10030	R	1 Word	Cause of Trip: FSOV input #2 Overcurrent
2	10031	R	1 Word	Cause of Trip: FSOV input #3 Overcurrent
2	10032	R	1 Word	Cause of Trip: FSOV input #4 Overcurrent

The status of the first out alarms can also be viewed through the TPM service tool. Digital LED indicators display the status of the first out trip alarms. The LED indicators will appear red when the associated trip is active.

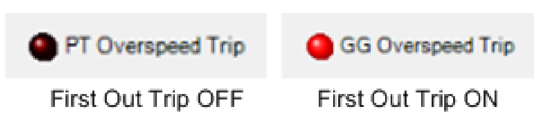


Figure 2-3. A GG Overspeed Trip First Out Indication

Resetting the System after a Trip

The trip string relay remains' open until the condition that caused the trip has been fixed and the first out alarm has been reset.

Reset the alarm over through the discrete input IO module, the Modbus communication, or the service tool. When resetting the alarm through the hardwired or Modbus input, the command must be pulsed. If the input holds true, the system may not respond to other resets.

When resetting the alarm through the service tool, press the button twice because it is a latching output. The button's normal state is off; never leave it on.

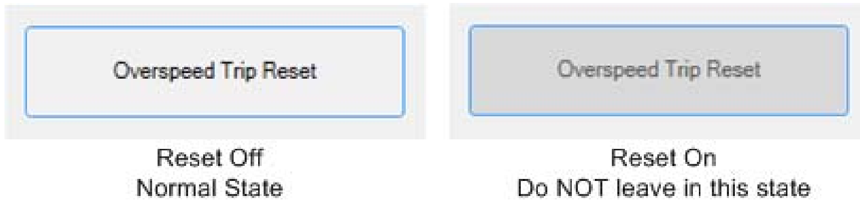


Figure 2-4. Trip Reset Buttons

Refer to *Chapter 4*
System Configuration for more information about resetting the alarms through the service tool.

Trip Inhibits

The TPM system has a trip inhibit digital input channel for the following trip conditions:

- Gas Generator MPU Fault Trip
- Power Turbine MPU Fault Trip
- FSOV Over/Under Current Trip (Inhibits all FSOV trips for all active FSOV channels)

NOTICE **The trip inhibits do not override the overspeed protection.**

The trip inhibit input channels are on the NI 9421 Digital Input Module assigned to slot 5 of the TPM Chassis. The 24 VDC input connect to an electrical switch or an output from a third party controller. The state of the inhibit inputs are available over Modbus.

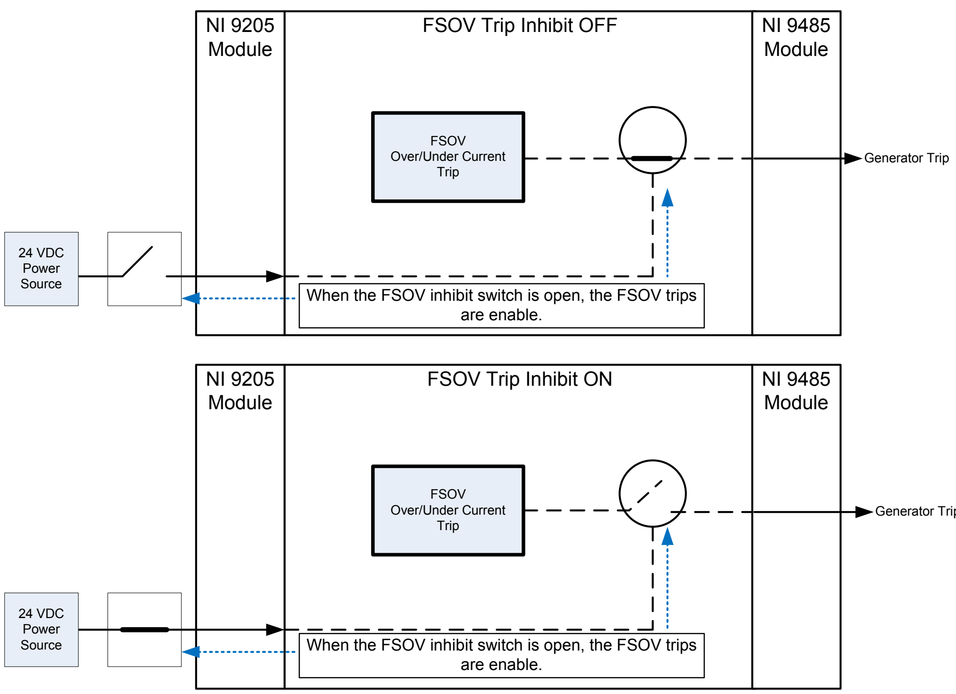


Figure 2-5. Trip Inhibit Example

The trip inhibits are allow system users to temporarily disable the MPU fault trip from an external switch or control. Typically the inhibit switch is used to prevent the TPM system from tripping the generator during controlled shutdowns, maintenance routines or any other situations where an MPU fault or FSOV can undesirably interrupt the process.

WARNING **Trip inhibits disable protection for the gas turbine. Trip inhibit should only be used when specified by the manufacturer to prevent erroneous trips.**

Speed Condition Monitoring

The Woodward TPM system monitors the speed of the Gas Generator and the Power Turbine independently to ensure that the unit is operating within the configured limits.

The following areas of the speed condition monitoring will be covered in this section of the manual:

- Managing redundant MPU inputs
- Overspeed protection trip
- MPU Fault detection, alarms and trip
- MPU Fault Trip inhibit switch

Refer to Figure 2-6 below for an overview of the speed monitoring logic for the power turbine. The logic for the gas generator is identical.

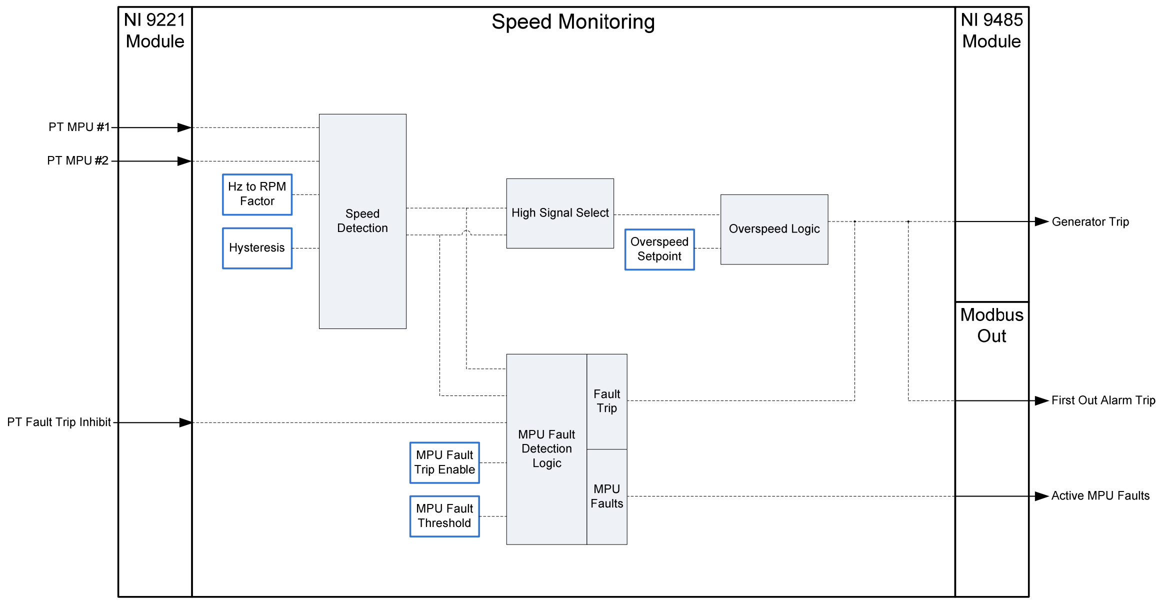


Figure 2-6. Overview of TPM Speed Monitoring control logic (Power Turbine)

Inputs

The system has redundant input channels for the MPU Speed Probe both the gas generator and the power turbine (see *Chapter 3 System Hardware*).

Table 2-3. MPU Speed Probe Input Channels

Inputs
Gas Generator MPU #1
Gas Generator MPU #2 (Redundant)
Power Turbine MPU #1
Power Turbine MPU #2 (Redundant)
Power Turbine MPU Fault Trip Inhibit Switch

Gas Generator MPU Fault Trip Inhibit Switch

In order to provide maximum protection to the equipment from a generator overspeed condition, the system selects the high signal from the redundant pair to be the monitored speed of the generating unit. This means that the system will only execute the speed protection logic based the MPU signal with the greater measured value.

For information about the input requirements and specifications, refer to the section *NI 9221 Analog Input Module* of this manual.

Overspeed Protection

The TPM control unit will independently trip the generating unit if the operating speed of the gas generator or the power turbine exceeds its respected overspeed setpoint.

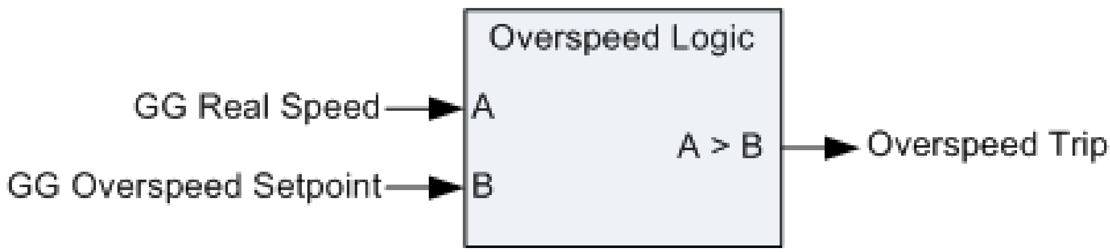


Figure 7: Overspeed Logic Example

The overspeed setpoint is the maximum acceptable speed as specified by the engine manufacturer. The setpoint is can be configured through the TPM Service Tool.

NOTICE	**When configuring the overspeed setpoint, the limit should comply with the generators manufacturer's specification for tolerable operating speeds.**

Refer to the *Speed Monitoring Settings* section for details on the configuring the overspeed setpoint.

The generator trip for Gas Generator or Power Turbine overspeed is an instantaneous trip. Example:

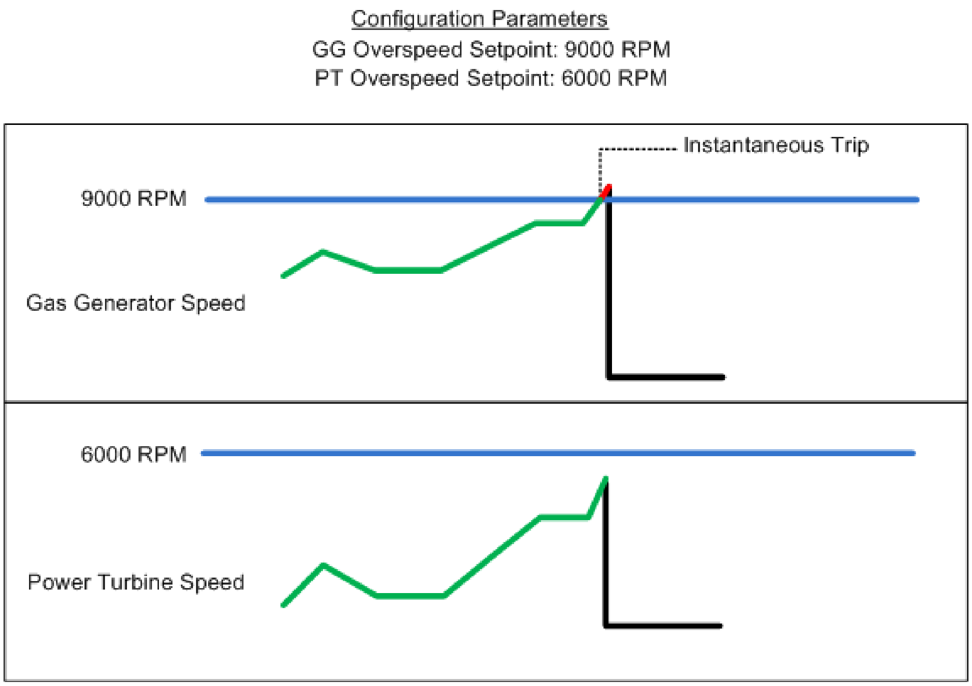


Figure 2-8. GG Overspeed Trip Example

MPU Fault Detection/Trip

If enabled, the TPM system will trip the generating unit if the MPU signal is faulted.

The system will detect an MPU fault when the measured speed from the MPU signal is below the configured minimum speed setpoint. For instructions on how to configure this setpoint, see the *Speed Monitoring Settings* section.

When detecting a signal fault, the measured value from the MPU input signal defaults to zero in the system.

Fault detection is handled on a per input channel basis, meaning that each individual input will be monitored for fault detection. A trip will not occur unless both signals belonging to a redundant pair fail.

Vibration Signal Conditioning

The Turbine Protection Monitoring system has accelerometer input signal channels to monitor vibration levels on the gas generator and the power turbine.

The TPM internally filters the accelerometer signal using one of two (or both) types of filtering options:

1. Tracking Filter
2. Wideband Filter

The TPM only outputs filtered vibration levels to a higher-level control. The TPM will not perform any actions based on vibration levels.

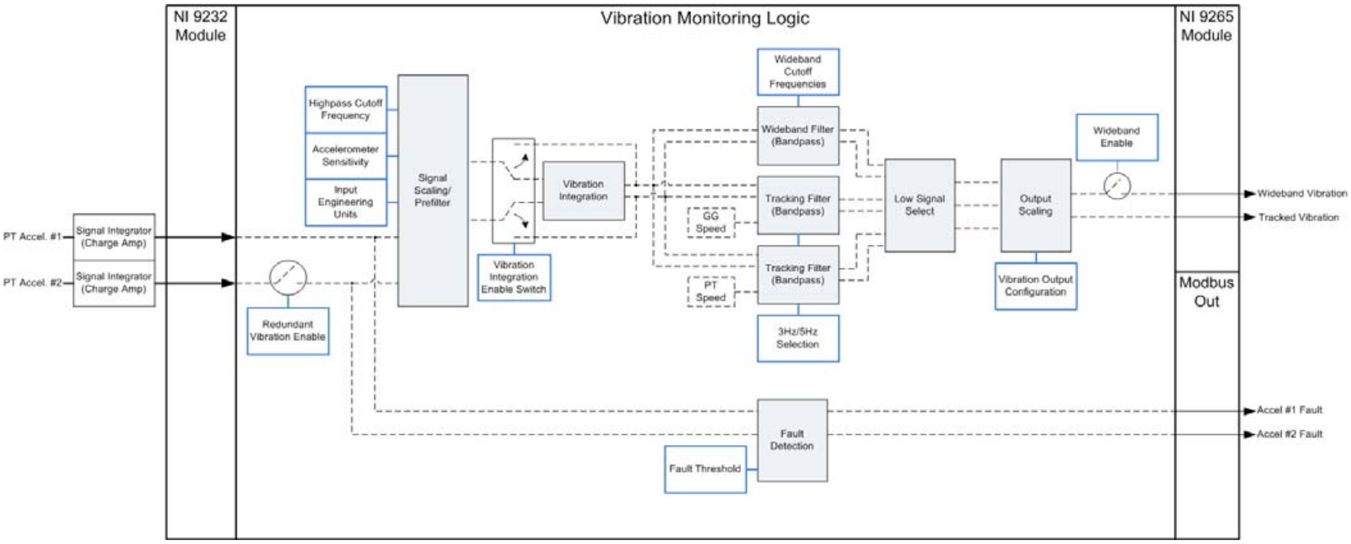


Figure 2-8. Overview of TPM Vibration Signal Conditioning control logic

NOTICE	**Any trips or preventative measures in response to undesirable vibration levels must be done by a higher-level control.**

Inputs/Outputs

For information about the input connections and specifications, refer to section *NI 9232 Analog Input Module* in this manual.

The TPM can support redundant accelerometer inputs from the gas generator and the power turbine, for (maximum of four) accelerometer input channels.

Table 2-4. Redundant Accelerometer Inputs

Inputs
Gas Generator Accelerometer #1
Gas Generator Accelerometer #2 (Optional)
Power Turbine Accelerometer #1
Power Turbine Accelerometer #2 (Optional)

The signals from the accelerometers must be integrated to represent a measurement of velocity before being connected to the TPM system. This is typically accomplished with a charge amplifier.

IMPORTANT	**The system does not integrate acceleration to velocity and will not function properly if the vibration input signal is not a measurement of velocity.**

There are six analog outputs associated with TPM vibration monitoring. Unlike other areas of turbine protection monitoring, there are no system trips associated with vibration monitoring.

Table 2-5. Analog Outputs Associated with TPM Vibration Monitoring

Outputs
Gas Generator Vibration Tracked to Gas Generator Speed
Gas Generator Vibration Tracked to Power Turbine Speed

Power Turbine Vibration Tracked to Gas Generator Speed
Power Turbine Vibration Tracked to Power Turbine Speed
Gas Generator Wideband Vibration (Optional)
Power Turbine Wideband Vibration (Optional)

All outputs signals are derived from the signal processing and filtering logic executed by the TPM on the input signal from the accelerometers. The units of measurement from the filtered vibration outputs can vary depending on the configuration settings.

Table 2-6. Vibration Outputs Units of Measurement

Output Signal Type	System of Units	Units
Velocity	Metric	mm/s (Peak)
Velocity	Imperial	in/s (Peak)
Displacement	Metric	mm (Peak to Peak)
Displacement	Imperial	mils (Peak to Peak)

Prefilter

The purpose of prefilter is to reject unwanted signals with frequencies that are below the minimum frequency of the total frequency range required for measurement.

The prefilter is a single high pass filter with a static cutoff frequency. The system engineer assigns this cutoff frequency. It typically is set to the minimum frequency of the desired frequency range of vibration monitoring specific to the system.

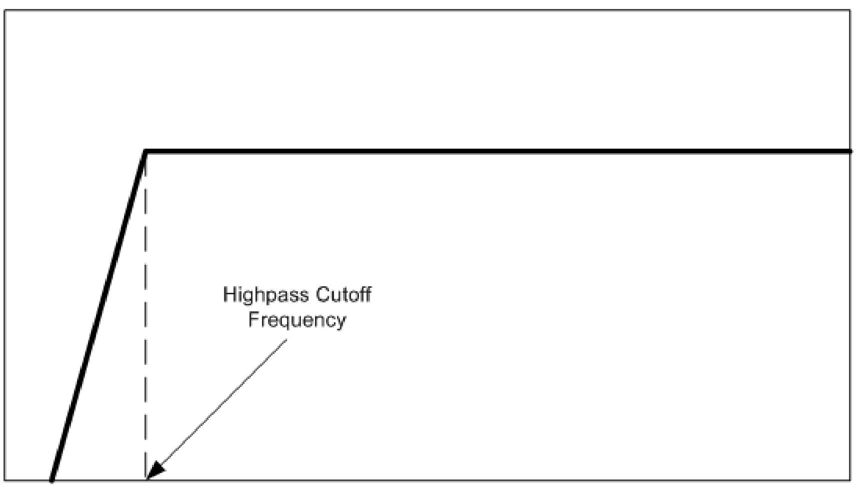


Figure 2-10. The Prefilter of the TPM is a High Pass Filter

As seen in

Figure 2-8 from the vibration monitoring overview page, the input signals pass through the prefilter prior to any other signal processing of vibration monitoring. This functions so that signals that passing to the tracking and wideband filters are trimmed to include only the signals that are within the desired frequency range of vibration analysis. This increases the accuracy and response of the tracking and wideband filters.

IMPORTANT	**Configure the prefilter cutoff frequency below the minimum frequency of interest for the tracking and wideband filters.**

Tracking Filter

The purpose of the tracking filter is to monitor vibration induced by the generating unit. This type of filtering can reveal system defects such as mechanical stress (worn bearings), turbine misalignment, unbalanced rotors, and other issues that can put the safety of the site's equipment and people at risk.

The tracking filter is a dynamic band-pass filter in which the center frequency will always tune itself to the frequency of the measured unit's rotational speed. The bandwidth of the tracking filter can be 3 Hz (+/-1.5 Hz from center frequency) **or** 5 Hz (+/- 2.5 Hz from center frequency). The system engineer should assign the tracking filters bandwidth.

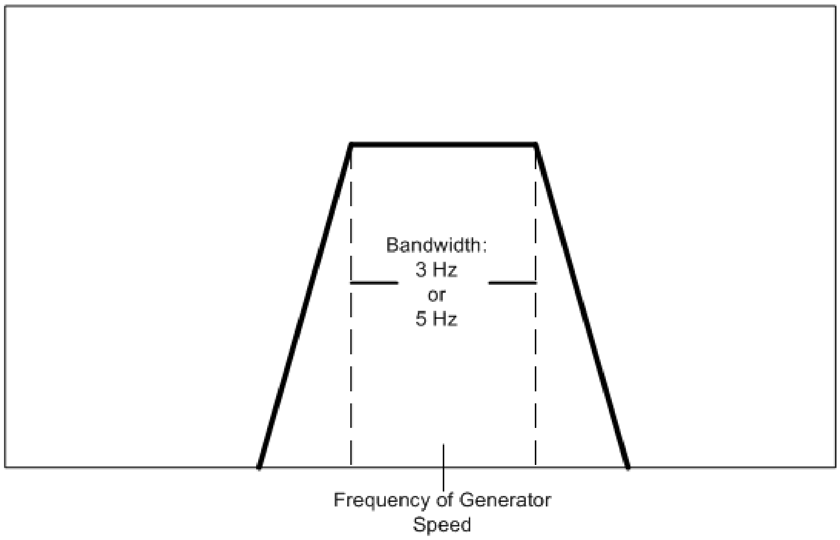


Figure 2-9. Tracking filter with center frequency tracked to generator speed

Refer to the section *Vibration Monitoring Settings* in this manual for instructions on how to configure the bandwidth setting.

The tracking filter has a very small bandwidth so that the only signals that pass through the filter are the ones with frequencies equal to the frequency of the signal driver. This ensures that the signal passing through the filter is only generator-induced vibration.

The filtered signal is available to external control units through a 4-20mA output. The output signal will either be a measurement of displacement or velocity, depending on the vibration integration settings. The 4-20mA output scales based on the user configured output scaling.

Wideband Filter

The purpose of the wideband filter is to monitor the amplitude of vibration across a broad frequency range. This filtering can detect vibration caused by forces external to the rotational equipment of the generating unit.

The system engineer assigns wideband output is a band pass filter with a broad frequency range.

IMPORTANT	**The high pass cutoff frequency should not be less than the high pass cutoff frequency of the prefilter.**

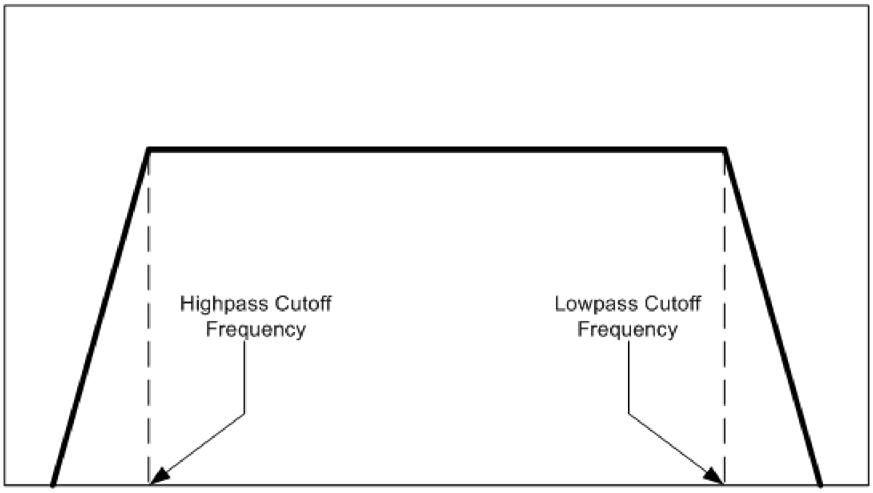


Figure 2-10. Wideband Filter

Wideband output: The signal with the greatest measured amplitude of vibration passes to a 4-20mA output as a measurement in mil p-p.

> **IMPORTANT**
> **Disable wideband filtering in the system settings through the TPM service tool. If you are not using the wideband-filtered output and slot 8 does not contain a NI9265 module, then disable wideband filtering.**

Accelerometer Fault Detection

The accelerometers used for measuring vibration of the rotors should be designed with a DC voltage bias for the purposes of fault detection. When the TPM system measures a DC voltage that is not within a defined threshold of the expected DC bias, the unit can assume that the instrument is faulted. When a fault has been detected, the system will disregard any signals on the input.

When a fault is detected, the system will trigger a system warning alarm indicating which accelerometer input is faulted. These alarms are visible from the service tool interface and are also available over the Modbus communicated data.

> **NOTICE**
> **Under no circumstances will the TPM trip the generator as a direct result to one or more accelerometer faults.**

FSOV Condition Monitoring

The TPM monitors the current drawn by the Fuel Shut-Off Valves (FSOV) to ensure that the valves are operating within the configured limits. There are four enablable/disable able available inputs for FSOV signals.

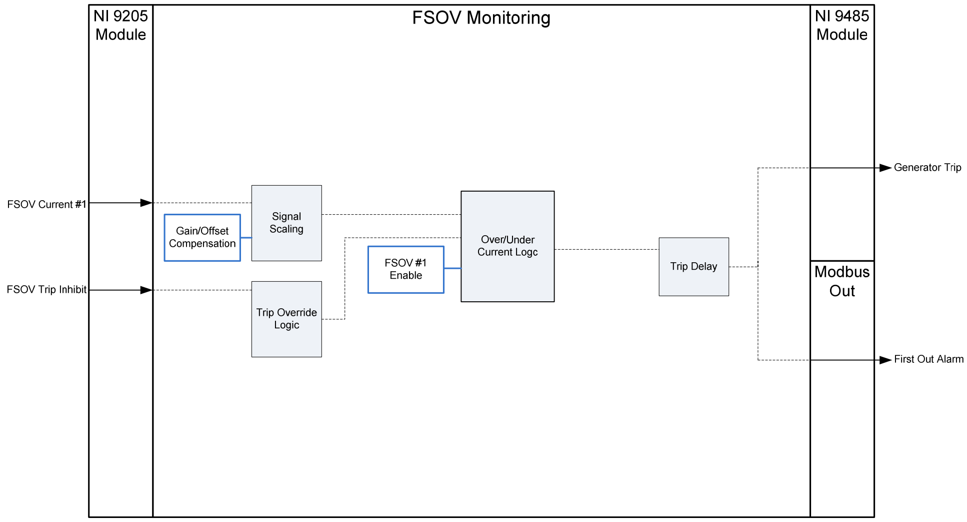


Figure 2-11. FSOV Condition Monitoring Logic Overview

Overcurrent/Undercurrent Trips

The TPM system monitors a voltage representative of the electric current through the solenoid-operated fuel shut off valve. If the measured voltage exceeds the overcurrent/undercurrent limits, the TPM system will open trip output relay.

The turbine protection trips of FSOV current monitoring are:

1. Overcurrent trip
2. Undercurrent trip

When an overcurrent trip occurs, the overcurrent first out alarm will become active and remain active until an FSOV trip reset command issues from a higher-level control or through the service tool.

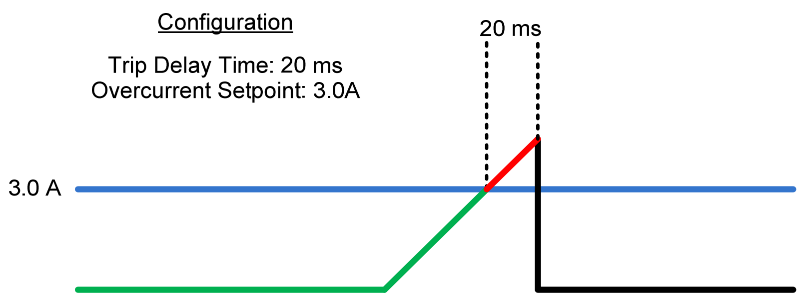


Figure 2-12. FSOV Trip Example

Similarly, if the TPM system detects a current less than the undercurrent limit, the system will issue an undercurrent trip to the generator. When an undercurrent trip occurs, the undercurrent first out alarm will become active and remain active until an FSOV trip reset command issued from a higher-level control or through the service tool.

Chapter 3
System Hardware

The hardware of the Turbine Protection Monitoring control unit consist of a chassis housing with eight I/O modules and an embedded controller for communicating and processing.

This chapter will describe in detail the hardware composition and I/O requirements of the Turbine Protection Monitoring system.

Control Module

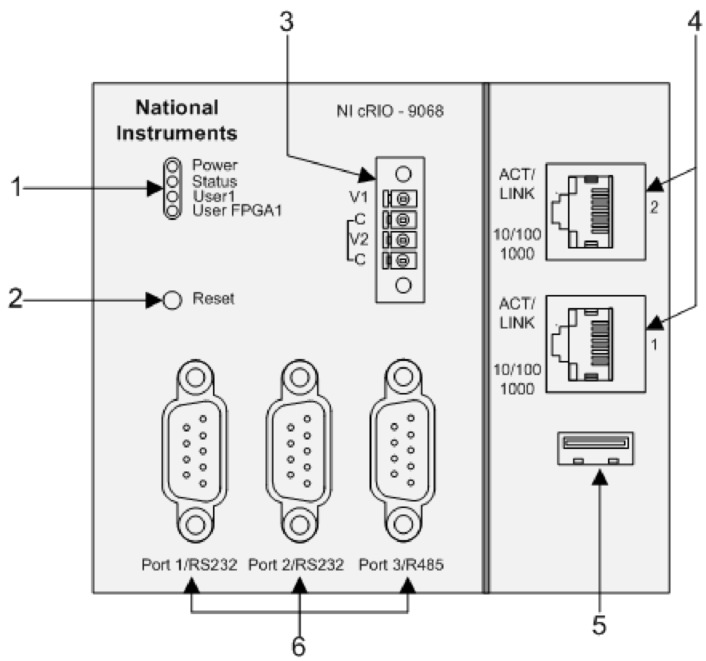


Figure 13 Control Module Overview

1. LED’s
2. Reset Switch
3. Power Connector
4. RJ-45 Ethernet Ports
5. USB Port (Unused)
6. Serial Ports (Unused)

Input Power
The TPM system requires a connection to an external power supply that meets the following power requirements:

Voltage input range	9 to 30 V
Maximum power input	25 W
Maximum power consumption	25 W

The control module filters and regulates the supplied power and distributes power to all of the I/O modules. The chassis has one layer of reverse-voltage protection. The power input is not isolated. If isolation is desired, a DC-DC converter must be used to supply power to the chassis.

IMPORTANT **The power input is not isolated. If isolation is desired, a DC-DC converter must be used to supply power to the chassis, separately from the NI 9265 analog outputs.**

Connecting Power

The power connection on the TPM unit has two inputs for connecting redundant (separate) power supplies.

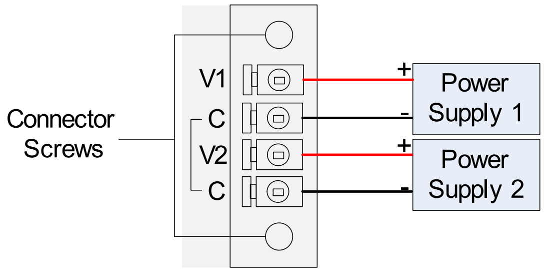


Figure 3-2. Module Input Power

1. Remove the connector by unscrewing the connector screws and open the input terminals by unscrewing the terminal screws.
2. Connect the positive lead of the primary power supply to the V1 terminal and tighten the terminal screw. If you are using redundant supplies, connect the positive lead of the secondary power supply to the V2 terminal.
3. Connect the negative of the primary power supply to the C terminal that is paired with V1 and tighten the terminal screw. If you are using redundant supplies, connect the negative lead of the secondary supply to the C terminal that is paired with V2. NOTE: The C terminals are internally connected to each other.
4. Reconnect the connector by reinserting it to the control module and tightening the connector screws.

Mounting the Chassis

In order to obtain the best possible environmental conditions and maximum shock and vibration tolerance, the chassis should be mounted horizontally on a flat, vertical, rigid (ideally metallic) surface.

IMPORTANT **The chassis may also be mounted vertically on a variety of surfaces such as a non-metallic surface (i.e. a wall or panel), a 35 mm DIN rail, a desktop, or in a rack. These orientations don't provide the same environmental or shock/vibration tolerance.**

When mounting the chassis, allow 2 inches (50.8 mm) of vacant space between the top and bottom of the mounted chassis for maximum air circulation. In addition, allow 2 inches (50.8 mm) in front of modules for cabling clearance for common connectors.

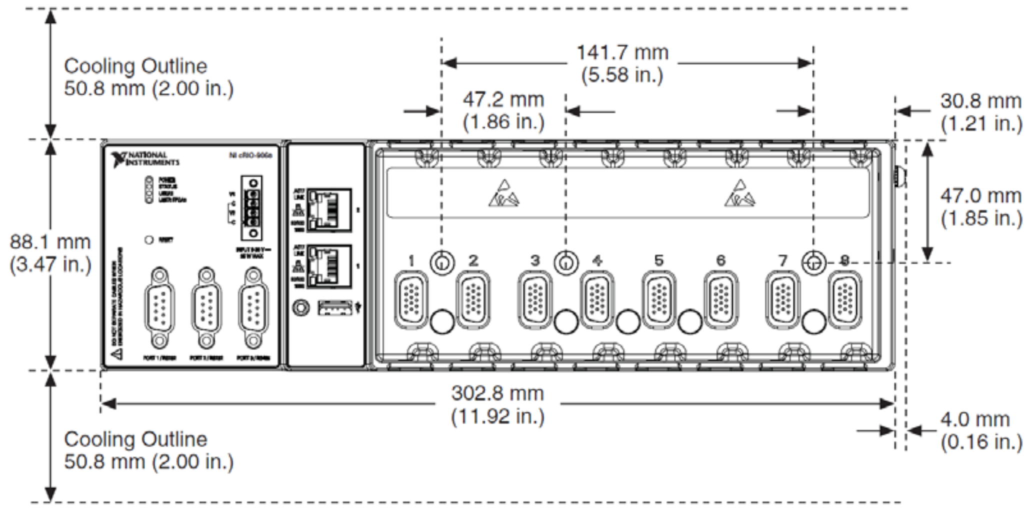


Figure 3-3. TPM Chassis Dimensions

The TPM chassis has three mounting holes on the backplane to securely mount the chassis to a flat surface. Use the dimensions of the figure above to prepare the mounting surface such as a panel.

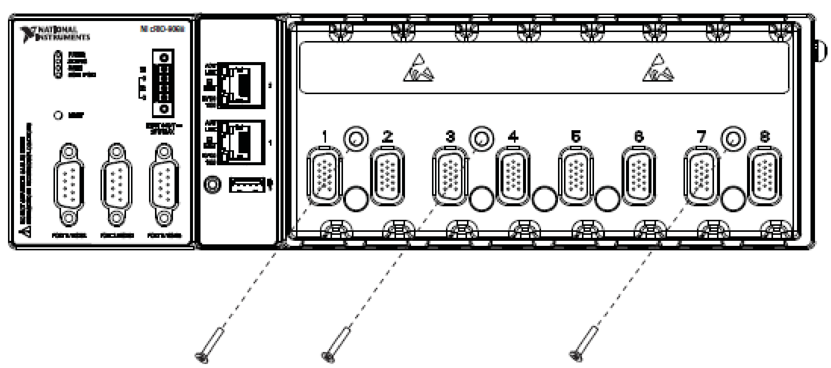


Figure 3-4. Chassis Mounting Holes

The screws used for mounting should be M4 or number 8 and must be longer than 19 mm (0.75 in.) to pass all the way through the chassis.

NOTICE	**When mounting the unit, all of the I/O module slots should be empty. Install modules until the unit has been securely mounted to the mounting surface.**

Grounding the Chassis

Ground the chassis to grounding system of the facility where the TPM unit is installed.

1. Attach one end of a 14 AWG or larger wire to the grounding electrode system of the facility and attach the other end to a ring lug.

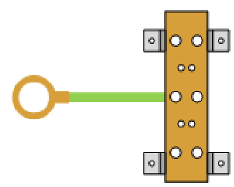


Figure 3-5. Connecting Grounding Cable

2. Remove the grounding screw from the grounding terminal on the right side of the chassis.

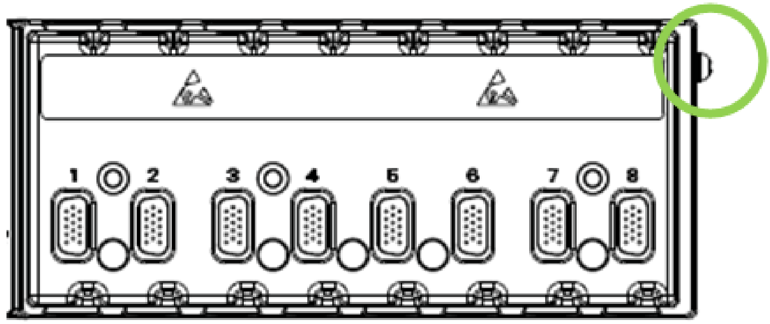


Figure 3-6. Grounding Screw

3. Attach the ring lug to the grounding terminal and tighten the grounding screw.

NOTICE	**If you use shielded cabling to connect to an I/O module with a plastic connector, you must attach the cable shield to the chassis grounding terminal using 16 AWG or larger wire. Attach a ring lug to the wire and attach the wire to the chassis grounding terminal. Solder the other end of the wire to the cable shield. Use shorter wire for better EMC performance**

Safety Guidelines for Hazardous Locations

The cRIO-9068 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class 1, Zone 2, AEx nC IIC T4 and Ex nL IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the cRIO-9068 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.

WARNING

When installing the cRIO-9068 in a hazardous location:

- **Do not disconnect the power supply wires and connectors from the controller unless power has been switched off.**
- **Substitution of components may impair suitability for Class I, Division 2.**
- **For Zone 2 applications, install the CompactRIO system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60529.**
- **The USB port requires the NI Industrial USB Extender Cable, NI part number 152166-xx. The cable must pass through conduit or cable gland to a nonhazardous location. Do not disconnect the cable unless the cRIO-9068 is powered off or the area is known to be nonhazardous.**

Special Conditions for Hazardous Locations Use in Europe

Some chassis have been evaluated as Ex nA IIC T4 Gc equipment under DEMKO Certificate No. 12 ATEX 1202658X. Each such chassis is marked Ex II 3G and is suitable for use in Zone 2 hazardous locations, in ambient temperatures of -40 ≤ Ta ≤ 70 °C.

⚠WARNING

- **You must make sure that transient disturbances do not exceed 140% of the**
- **The system shall be mounted in an ATEX certified enclosure with a minimum ingress protection rating of at least IP 54 as defined in IEC/EN 60529 and used in an environment of not more than Pollution Degree 2.**
- **The enclosure must have a door or cover accessible only by the use of a tool.**

Communication Interfaces

The RJ-45 ports are the only communication interfaces on the device that are enabled. This means that any online connections between a device and the TPM unit must be through the RJ-45 ports. The USB Port and the Serial Ports are not enabled for communicating to third party control networks or devices.

Table 3-1. RJ-45 Ports Default IP Addresses

Port	IP Address	Subnet Mask
1	190.14.98.170	255.255.255.0
2	162.168.128.40	255.255.255.0

The TPM device is a Modbus Slave and therefore it can communicate to a Modbus master device of a third party system. For instructions on establishing a Modbus connection, refer to *Chapter 5 Modbus Communication* of this manual.

The RJ-45 ports must be used for downloading or changing system settings through the TPM Service Tool. For instructions on connecting to a computer installed with the TPM Service Tool, refer to *Chapter 4 System Configuration*.

I/O Modules and Assignments

The input and output hardware of the Turbine Protection Monitoring system is modular, meaning the different I/O types belong to individual, removable modules.

This section will describe the features, I/O assignments and signal requirements of each module.

Overview

Each module slot on the TPM chassis is reserved for a specific module type. If a module is placed in slot that is configured for a different module type, the control unit will enter I/O Lock Mode. Refer to *Chapter 6 Troubleshooting and Diagnostics* for more information about I/O Lock.

Use Figure and Table 3-2 as references for the correct module-slot assignment of the TPM system.

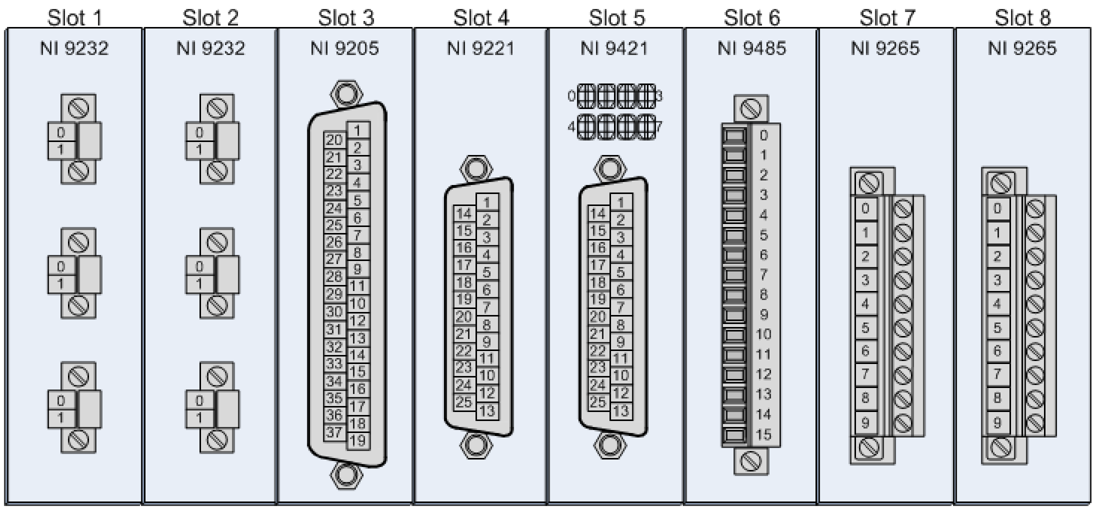


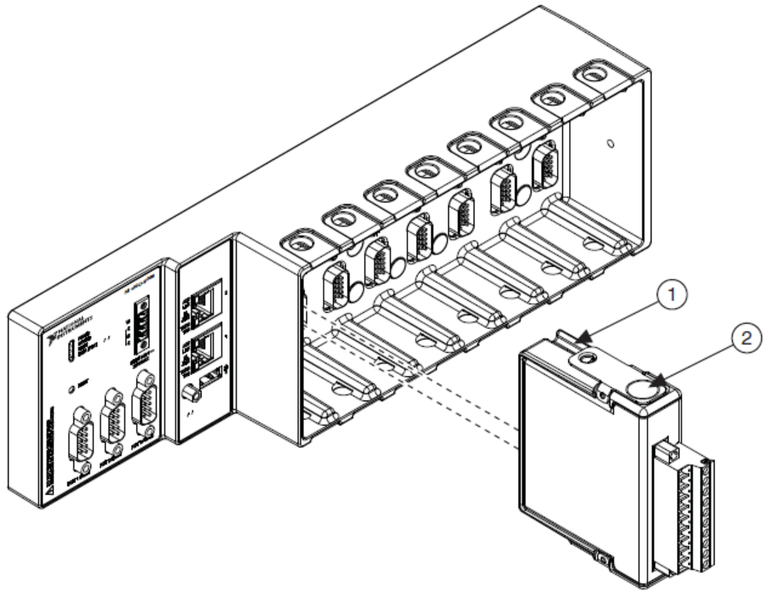
Figure 3-7. TPM Module-Slot Assignments

Table 3-2. TPM I/O Module Overview

Slot	Module	I/O Signals	TPM Functionality
1	NI 9232 Analog Input Module	GG and PT Accelerometers	Measuring/Filtering Generator Vibration
2	NI 9232 Analog Input Module	Redundant PT Accelerometer	Measuring/Filtering Generator Vibration
3	NI 9205 Analog Input Module	Output from FSOV Driver	Measuring/Monitoring Current Through the Fuel Shut Off Valves
4	NI 9221 Analog Input Module	GG and PT MPUs	Measuring/Monitoring GG and PT speed
5	NI 9421 Digital Input Module	Trip Inhibits Alarm Reset	Detect Status Trip Inhibit Switches/Bypass Trip Logic When Active
6	NI 9485 Digital Output Module	Trip Outputs	Open Relay Output When Logic Issues a Trip
Slot	**Module**	**I/O Signals**	**TPM Functionality**
7	NI 9265 4-20 mA Output Module	PT and GG Tracked Vibration	Output the maximum amplitude of vibration at frequencies equal to generator speed
8	NI 9265 4-20 mA Output Module	PT and GG Wideband Vibration	Output the maximum amplitude of vibration across all frequencies within the wideband limits

Inserting and Removing I/O Modules

Make sure that no I/O-side power is connected to the I/O module. If the system is in a non-hazardous location, the chassis power can be on when you install I/O modules.



1 Insertion Groove	2 Latch

Figure 3-8. Inserting a Module

Squeeze the latches and insert the I/O module into the module slot.
Press firmly on the connector side of the I/O module until the latches lock the I/O module into place.

Filler Modules

Filler modules (1751-6707) can be used to in place of modules whose respective system features are disabled.

The following table lists what slots can be filled with filler modules by disabling the associated features:

Table 3-3. Slots Filled with Filler Modules

Slot	Disabled Feature
Slot 2	Redundant Accelerometer Inputs are disabled
Slot 3	All FSOV Inputs are disabled
Slot 8	Wideband Vibration Disabled

NOTICE

If a slot's system feature is disabled, the slot must either have its required IO module or it must have a filler module. The unused slot cannot be left vacant.

NI 9232 Analog Input Module

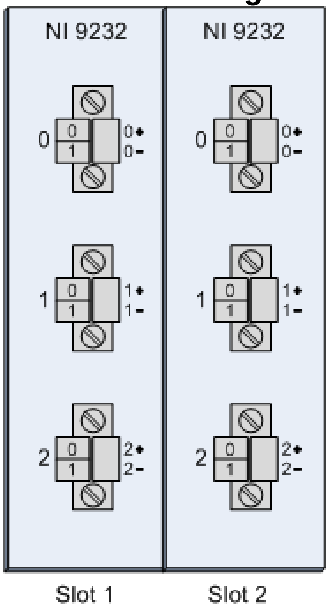
3 Channel, ±30V AC/DC Analog Input Channel

The NI 9232 module is used in Woodward's Turbine Protection Monitoring System to measure and filter the conditioned accelerometer input signals from the gas generator and the power turbine.

Slot 1 and 2 on the TPM chassis are reserved for the NI 9232 modules only.

There are a total of four available input channels between the two NI 9232 modules for vibration monitoring. Two (redundant) input channels for the gas generator accelerometer signals and two (redundant) input channels for the power turbine accelerometer signals.

NI 9232 I/O Assignment



Slot	Channel	Signal
1	**0**	Gas Generator Accelerometer
1	**1**	Power Turbine Accelerometer
1	**2**	Gas Generator Redundant Accelerometer
2	**0**	Power Turbine Redundant Accelerometer
2	**1**	Not Used
2	**2**	Not Used

Figure 3-9. NI 9232 Vibration Input Channel Assignments

The input channels that are not assigned are not spare channels. These channels are not configured for sampling and therefore will not process any signals that are connected.

NOTICE

If redundant vibration is not enable, a 9232 module is not required in slot 2, however, a filler module must be used. The slot cannot be left empty.

Connecting Inputs

The input channels are two terminal screw-terminal inputs rated for 16 AWG to 28 AWG copper conductor wire.

The terminal blocks can be removed by unscrewing the outer most screws of the input channel. The terminals can be opened by unscrewing the inner screws of the input channels.

The signal shields must be connected to the chassis ground and the input wires must be have a clamp-on ferrite bead (Woodward PN: 1692-1062) installed. The ferrite bead should be installed as close to the module as possible.

Input Requirements

The input signals from the field must be an analog measurement of velocity. For this reason, it is typical for the accelerometer signal to pass through a charge amplifier (or equivalent converter) that is external to the TPM system.

The input signals must have a DC voltage bias for fault detection. Without a DC Bias, the system will not accept the AC signal as a valid signal if the DC bias is not within the configured threshold. See *Chapter 4 System Configuration* for instructions on how to configure the DC Bias threshold.

The redundant input channels are not required to be used. The monitoring of these channels can be enabled/disabled through the TPM service tool.

If you are not using redundancy for vibration monitoring, you do not need an NI 9232 module placed in slot 2.

Table 3-4. NI 9232 I/O Specifications

Woodward Component Number	1751-6701
Channels	3 Analog Inputs
ADC Resolution	24 bits
Voltage Input Range	±30 V

NI 9205 Analog Input Module

32 Channel, ±200 mV to ±10 V, 16-Bit Analog Input Module

The NI 9205 module is used in Woodward's Turbine Protection Monitoring System to measure and monitor the current from the FSOV driver.

Slot 3 on the TPM chassis is reserved only for the NI 9205 module.

NI 9205 I/O Assignment

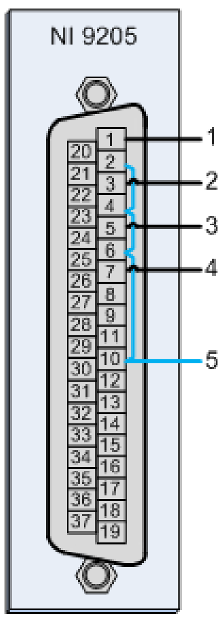


Figure #	Signal	Pin
1	FSOV Current #1 Input	1
(5)	Jumper From COM	2
2	FSOV Current #2 Input	3
(5)	Jumper From COM	4
3	FSOV Current #3 Input	5
(5)	Jumper From COM	6
4	FSOV Current #4 Input	7
(5)	Jumper From COM	8
5	COM	10

Figure 3-10. NI 9205 FSOV Monitoring Input Assignments

The channels that are not assigned are not configured and should not be treated as spare channels.

⚠WARNING

Each FSOV signal input terminal is paired with an input terminal that is jumped to the signal common. Connect these inputs to COM for proper measurement on the FSOV Current inputs.

Connecting Inputs

If the generator has less than four fuel shut off valves, the unused channels should be disabled through the TPM service tool. If these channels are not disabled the system will trip on undercurrent from the unused channels.

The NI 9205 module requires a 37-pin DSUB connector. The input channels are rated for 18 AWG to 28 AWG copper conductor wire.

For each single ended input that is enabled, the next terminal should be electrically jumped to the COM channel. This is necessary to ground any residual voltage between samples. The COM jumpers to the paired pins of the channels you are using must be connected. For FSOV current channels not being used, then the COM pair to the unused inputs can be left open.

Input Requirements

The real current of the FSOV signal should be converted proportionally to a 0-5V analog signal through a Woodward Solenoid Driver (PN#: 5432-039) or equivalent device. Any known offsets or gains between the real current and the converted voltage should be configured through the TPM service tool.

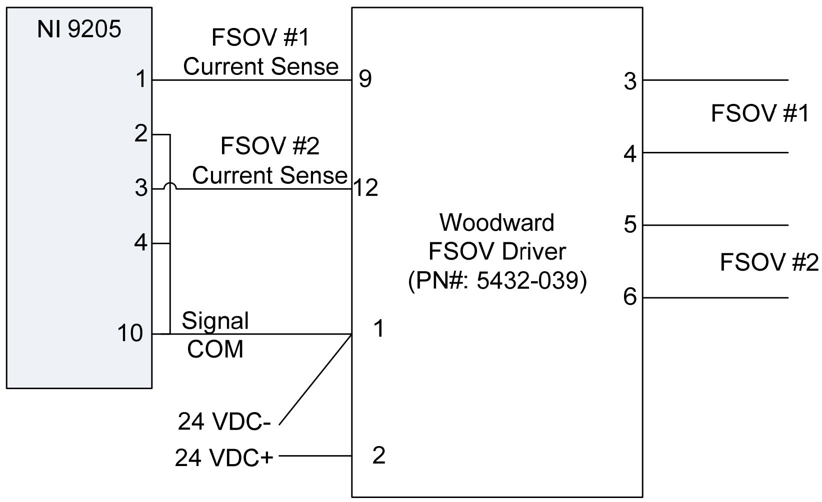


Figure 3-11. Typical wiring for connecting FSOV Driver to NI 9205 Module

Table 3-5. NI 9205 I/O Specifications

Woodward Component Number	1751-6702
Channels	32 single-ended analog input channels
ADC Resolution	16 bits
Input coupling	DC
Nominal input ranges	0-5 V
Maximum working voltage for analog inputs (signal + common mode)	Each channel must remain within ±10.4 V of Common

NI 9221 Analog Input Module

8 Channel, 12-Bit Analog Input Channel

The module is used in Woodward's Turbine Protection Monitoring System to monitor and measure the speed of the gas generator and the power turbine.

Slot 4 on the TPM chassis is reserved only for the NI 9221 module.

NI 9221 I/O Assignment

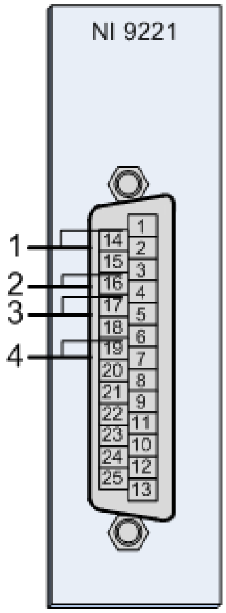


Figure #	Signal	Terminal
1	Gas Generator MPU #1	14 (+)
		1 (-)
2	Power Turbine MPU #1	16 (+)
		3 (-)
3	Gas Generator MPU #2	17 (+)
		4 (-)
4	Power Turbine MPU #2	19 (+)
		6 (-)

Figure 3-12. NI 9221 MPU Input Channel Assignments

The channels that are not specified in the figure above are non-configured channels that do not have any functionality. They should not be treated as spare channels.

Connecting Inputs

There are four inputs on the NI 9221 module configured for speed monitoring. Two (redundant) input channels for the gas generator MPU speed probe signals and two (redundant) input channels for the power turbine MPU speed probe signals.

The NI 9221 requires a 25-pin DSUB connector. The input channels are rated for 12 AWG to 24 AWG copper conductor wire.

Input Requirements

The maximum voltage range of the NI 9221 input channels is ±60 volts. It is possible for an MPU signal to exceed this range during normal turbine operation. A MPU transformer should be used for isolation and limiting the maximum voltage. Woodward has two MPU isolation transformers available for this, a 1:1 transformer (Woodward P/N 1751-6058) and a 3:1 transformer (Woodward P/N 1751-147).

⚠WARNING	**The HZ to RPM MPU signal conversion factor setting in the TPM configuration settings must match the factor specified by engine manufacturer. If the conversion factor in the TPM settings does not align with MPU factor then the measured speed of the generating unit will not be accurate.**

The maximum frequency from the MPU signal that can be processed by the TPM is 10 kHz. Therefore the overspeed setpoint (set in RPM) must be less than 10 kHz based on the Hz to RPM conversion factor. See Table 3-6 below for examples of maximum overspeed set points of different RPM to Hz factors based on a maximum input signal frequency of 10000 Hz.

Table 3-6. Maximum Overspeed Set Points of Different RPM

RPM to Hz Factor	Maximum Overspeed SP
0.5 Hz/RPM	20000 RPM
1 Hz/RPM	10000 RPM
2 Hz/RPM	5000 RPM

The TPM system checks the overspeed setpoint against the RPM to Hz factor during its boot sequence. If the configured overspeed setpoint is greater than 10000 Hz when converted from RPM based on the RPM to Hz factor, the system will enter IO Lock mode.

MPU Hysteresis

The TPM provides a configurable MPU hysteresis. This feature allows improved speed measurement on noisy MPU signals. The MPU signal must exceed the +Hysteresis voltage level, followed by going below the –Hysteresis level, before a rising zero crossing is detected. This is shown in Figure .

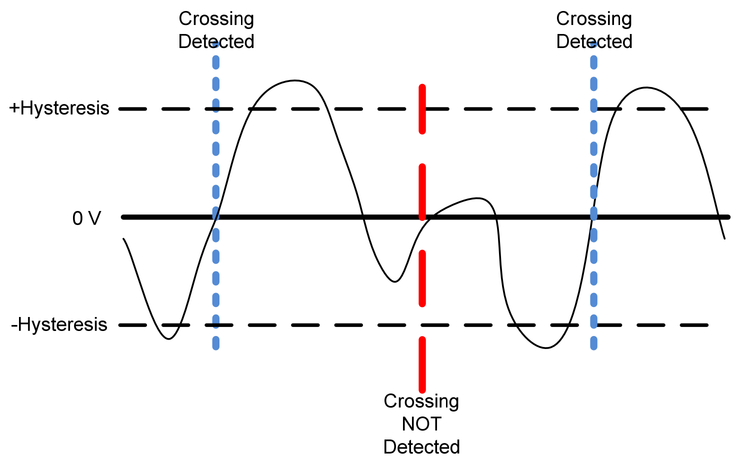


Figure 3-13. MPU Hysteresis

Table 3-7. NI 9221 I/O Specifications

Woodward Component Number	1751-6703
Channels	8 Analog Input Channels
ADC Resolution	12 bits
Nominal input ranges	±60 V
Maximum Input Frequency	10 kHz

NI 9421 Digital Input Module

8 Channel Sinking Digital Input Modules

The NI 9421 module is used in Woodward's Turbine Protection Monitoring System to allow external supervisory trip inhibits and by pass the associated logic when active.

Slot 5 on the TPM chassis is reserved only for the NI 9421 module.

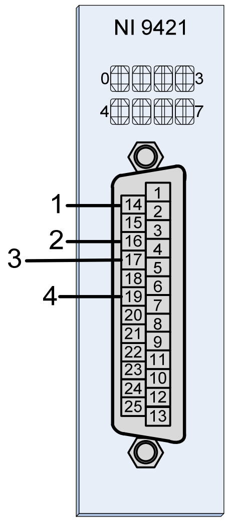


Figure #	Signal	Pin Assignment
1	FSOV Monitor Trip Inhibit	14
2	PT MPU Fault Trip Inhibit	16
3	GG MPU Fault Trip Inhibit	17
4	Alarm Trip Reset	19
	COM	1,3,4,6

Figure 14: NI 9421 Discrete Input Channel Assignments

Connecting Inputs

Each channel of the NI 9421 pin to which you can connect 24VDC signals. The module has a signal COM that is internally connected to the isolated ground reference of the module.

If you are connecting more than one wire to a single terminal, you must use a 2-wire ferrules to create a secure connection.

Each channel has an LED that turns on and off to indicate the state of that channel. When a channel LED is lit, the channel is on. When the LED is dark, the channel is off.

Input Requirements

The NI 9421 has sinking inputs, meaning that when the external device drives current or applies voltage to the DI terminal or pin, DI provides a path to COM for the current or voltage. The NI 9421 internally limits current signals connected to DI.

Table 3-8. NI 9421 Specifications

Woodward Component Number:	1751-6706
Channels:	8 Digital Input Channels
Digital States	
OFF State – Input Voltage:	≤5 V
ON State – Input Voltage:	11-30 V
I/O Protection – Input Voltage:	40 V max
Reverse-Biased Voltage:	-30 V max
Input Current:	7 mA max, internally limited

NI 9485 Digital Output Module
8 Channel Solid State Relay Digital Output Module

The NI 9485 module is an 8 channel solid-state relay digital output module. The module is used in Woodward's Turbine Protection Monitoring System to trip the generator by disrupting power to the fuel shut off valves.

Slot 6 on the TPM chassis is reserved only for the NI 9485 module.

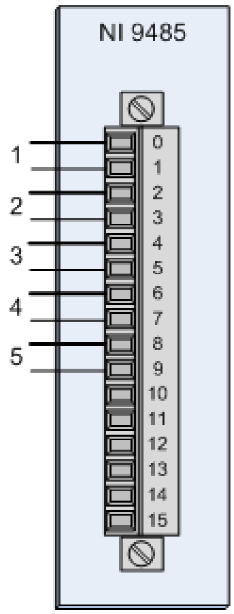


Figure #	Signal	Terminal Assignment
1	Relay 1	0 (+)
		1 (-)
2	Relay 2	2 (+)
		3 (-)
3	Relay 3	4 (+)
		5 (-)
4	Relay 4	6 (+)
		7 (-)
5	Relay 5	8 (+)
		9 (-)

Figure 15: NI 9485 Relay Output Channel Assignments

The channels that are not specified in the figure above are non-configured channels that don't have any functionality. They should not be treated as spare channels.

Output States
There are five outputs configured on the NI 9485 module to accommodate up to four Fuel Shut-Off Valves with one spare relay.

During normal operation, the relays are held closed. When the system issues a generator trip, all of the relays will open and will remain open until the TPM trip alarms have been reset/cleared.

All five relays will open synchronously when a generator trip has been triggered in the TPM logic. The following trips will open all five outputs:

- Gas Generator Overspeed Trip
- Power Turbine Overspeed Trip
- Gas Generator MPU Fault Trip
- Power Turbine MPU Fault Trip
- FSOV (1-4) Overcurrent Trip
- FSOV (1-4) Undercurrent Trip
-

For additional information about the TPM generator trips and their settings, refer to the *System Trips* section in *Chapter 2*
System Description of this manual.

Connecting Outputs

Each Fuel Shut-Off Valve from the generator should be assigned to an NI 9421 generator trip output. When connecting to a trip relay, the connection should be made in series with the FSOV trip string from an FSOV driver (Woodward PN# 5432-039) or equivalent device.

The Woodward FSOV driver is supports up to two FSOV connections. Figure 16 below shows how to connect the FSOV trip string from the FSOV driver.

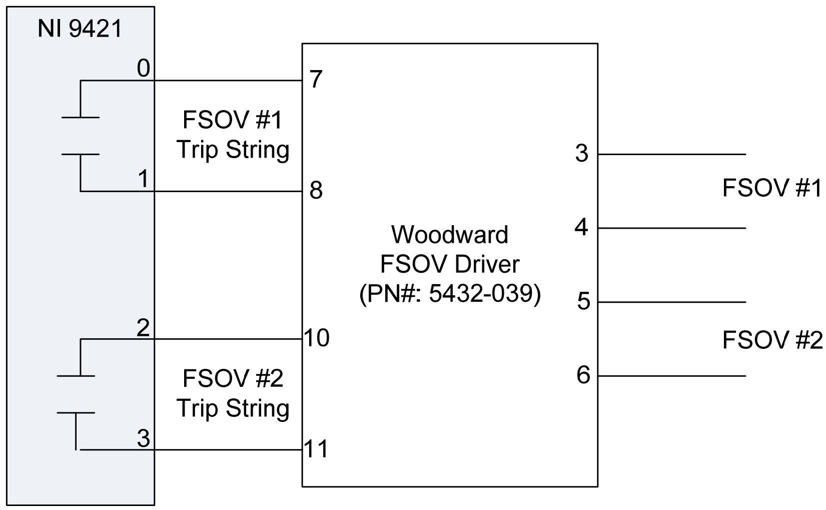


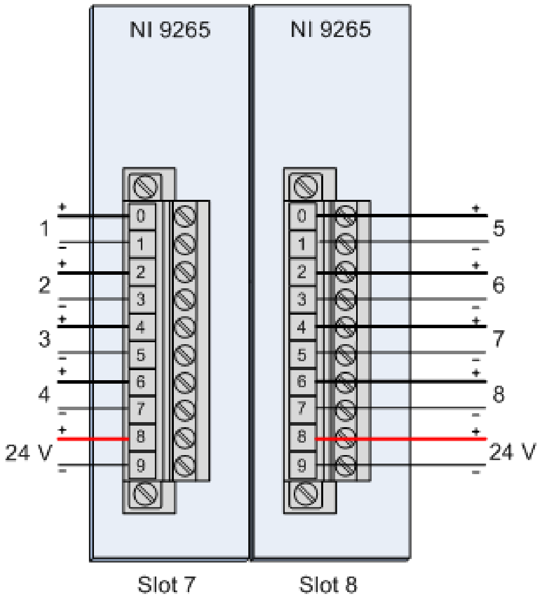
Figure 16: Connecting FSOV Trip String

Table 3-9. NI 9485 Specifications:

Woodward Component Number:	1751-6706
Channels:	8 Digital Output Channels
Relay Type:	Normally Open Solid State
Switching Voltage:	60 VDC max
Switching Current, per channel:	1.2 A

NI 9265 Analog Output Module

4 Channel, 4-20 mA, 16 Bit Analog Current Output Module



Slot	Channel	Signal
1	0 (+), 1 (-)	GG Vibration Tracked To GG Speed
2	2 (+), 3 (-)	GG Vibration Tracked To PT Speed
3	4 (+), 5 (-)	PT Vibration Tracked To GG Speed
4	6 (+), 7 (-)	PT Vibration Tracked To PT Speed
5	0 (+), 1 (-)	GG Wideband Output
6	2 (+), 3 (-)	PT Wideband Output
7	4 (+), 5 (-)	Not Used
8	6 (+), 7 (-)	Not Used

Figure 17: NI 9265 Analog Output Channel Assignments

The NI 9265 modules are used to output a 4-20mA signal proportional to measured vibration level. *Table 2-6. Vibration Outputs Units of Measurement* provides the assignments of type of measured vibration to NI 9265 output. The outputs can represent velocity or displacement, based on the configuration. Please see *Chapter 4*
System Configuration for details on system configuration. The NI 9265 modules require an external 24 VDC power supply. The NI 9265 is isolated, in order to maintain this isolation, a DC-DC converter should be used between the chassis power and the NI 9265 power.

NOTICE	**If wideband vibration is not enable, a 9265 module is not required in slot 8. However, a filler module must be used. The slot cannot be left empty.**

Table 3-10. NI 9265 Specifications

Woodward Component Number:	1751-6704
Channels:	4 Analog Outputs
Output Type:	4-20 mA
External Power Voltage:	9-36 VDC
External Power Consumption:	1.4 W

Chapter 4
System Configuration

Connecting To the Device

The following items are required to establish a connection to the TPM device:

- Computer installed with ToolKit 4.7.3 or later
- A copy of the TPM Service Tool utility file (".wstool" file)
- A CAT-5 twisted pair Ethernet cable

IMPORTANT	**Running the TPM service tool requires a computer installed with Woodward's ToolKit AND the TPM Service Tool utility file.**

ToolKit

ToolKit is a generic Woodward HMI platform for interfacing with controls and is required to run the TPM Service Tool. Refer to the Woodward software web page below to download a ToolKit installation:

http://www.woodward.com/software.aspx

You must have a Woodward online account to download any software. If you do not already have a login, you can create one at no cost when you on initial login. Search for "ToolKit" on the software page and click the download icon on that is linked with the product name *ToolKit X.X.X* where X.X.X is the current software version available for download.

After downloading the latest ToolKit installer, proceed with the installation and follow the directions of the installer.

TPM Service Tool

Users must have the TPM Service Tool file to connect to the TPM device through ToolKit. Refer to the Woodward software web page below to download the TPM Service Tool:

http://www.woodward.com/software.aspx

The ToolKit TPM Service Tool allows users to connect and interface with the TPM device. Through the service tool, users can:

- View the system status and health
- View Real-Time I/O Values
- View the configuration settings of the device
- Change the configuration settings of the device
- Reset active alarms and trips

Launching the Service Tool

1. Configure your computer's IP address to be in the same network as the port you are connecting to on the device.
2. Connect the CAT-5 twisted pair Ethernet cable between your computer and the port you want to connect to on the TPM device.
3. Start ToolKit on your computer

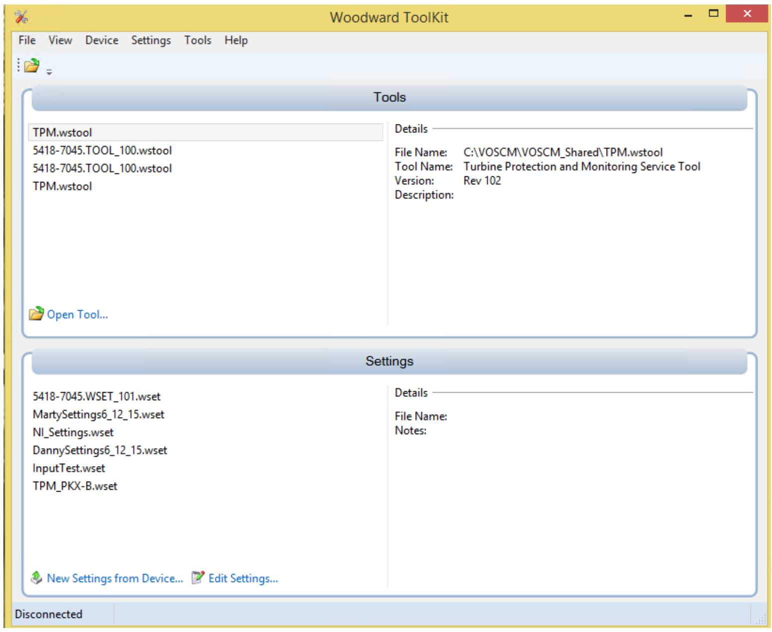


Figure 4-1. ToolKit File System

4. Open the TPM Tool by clicking *File* → *Open Tool* and navigate to the TPM Tool *.wstool file.

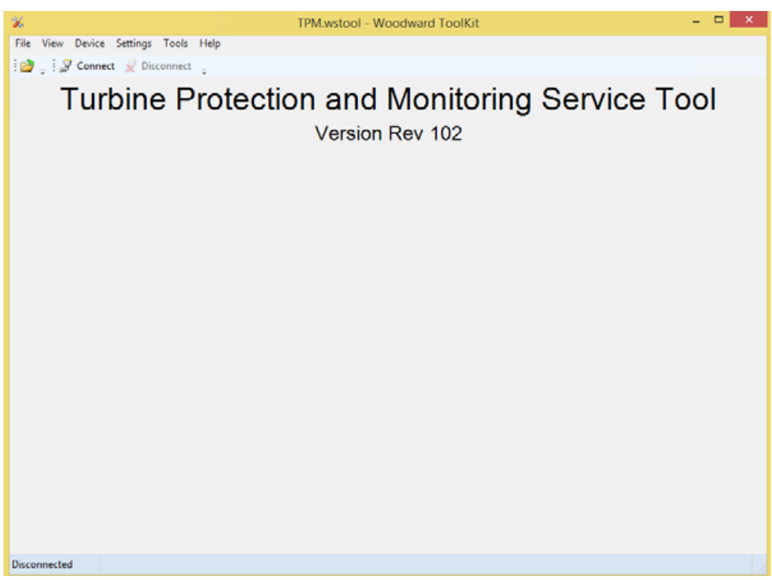


Figure 4-2. TPM Tool Opening Page

5. Start the connection by pressing the *Connect* button located in the upper left portion of the screen.
6. From the connection setup dialog box:
   a. Select TCP/IP under the "Select a network" box
   b. Select Servlink from the "Protocol" drop down menu
   c. Enter the device IP address under the "Host Name/Address" entry box and then press add
   d. Press the *Connect* button at the bottom of the dialog

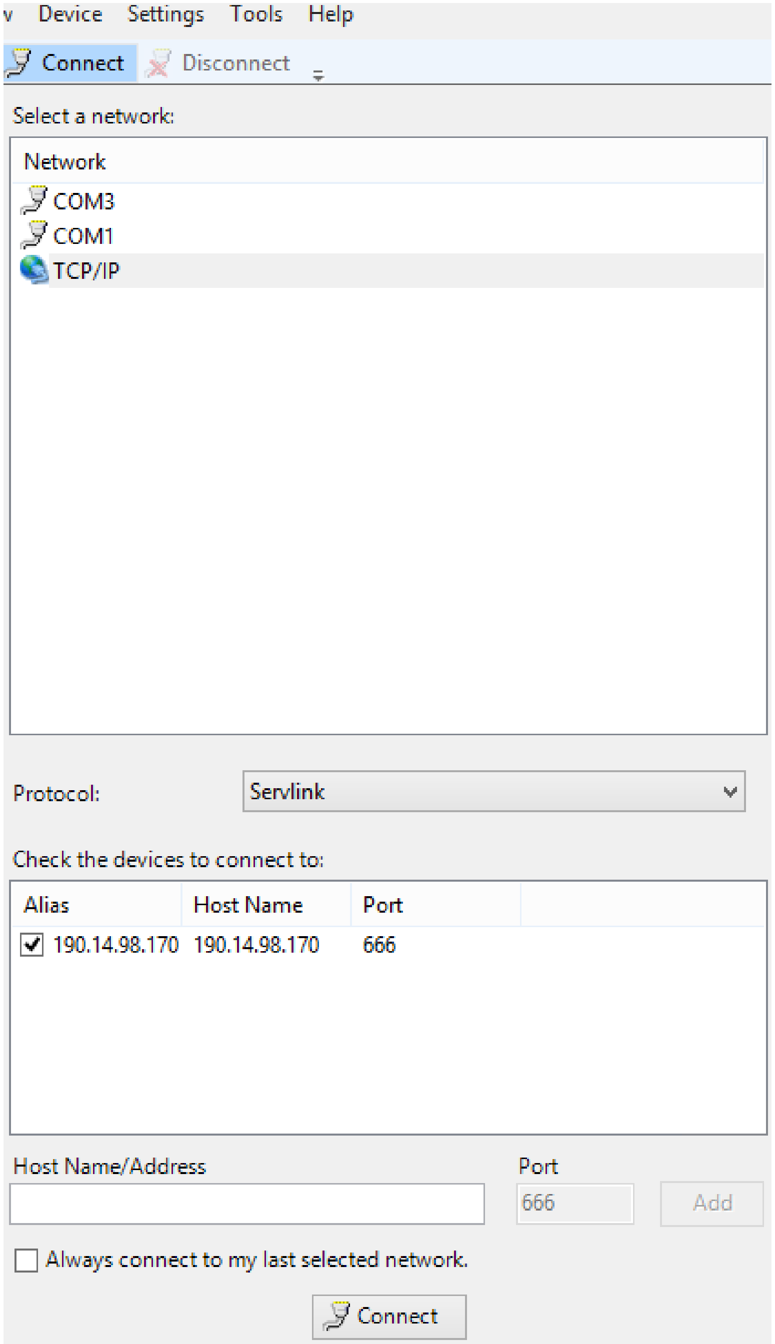


Figure 4-3. ToolKit Connection Setup Dialog Box

7. Connection established!

NOTICE **If you are unable to connect, check your firewall settings. If your firewall is blocking the connection, you may have to temporarily disable it to successfully establish and maintain a connection.**

Service Tool Interface

The following pages are available from the service tool:

1. Home
2. Diagnostics
3. Vibration
4. Speed
5. FSOV (Fuel Shut Off Valves)

Navigating

You can navigate through the service tool pages by using the navigation tools in the menu bar at the top of your window.

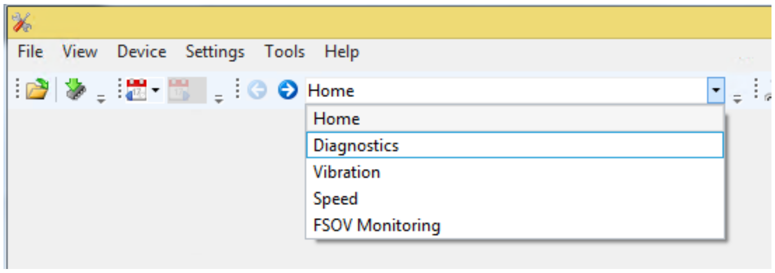


Figure 4-4. Navigation Tools

- Click the right blue arrow to go the next page
- Click the left blue arrow to go back to the previous
- Jump to any page by expanding the drop down menu and selecting a page
-

Home

The first screen you will see when you log on is the home screen. The home screen should have the name of the service tool and the version number of the tool:

Figure 4-5. Home Screen

Diagnostics

The diagnostics screen displays important information about the health and status of the system:

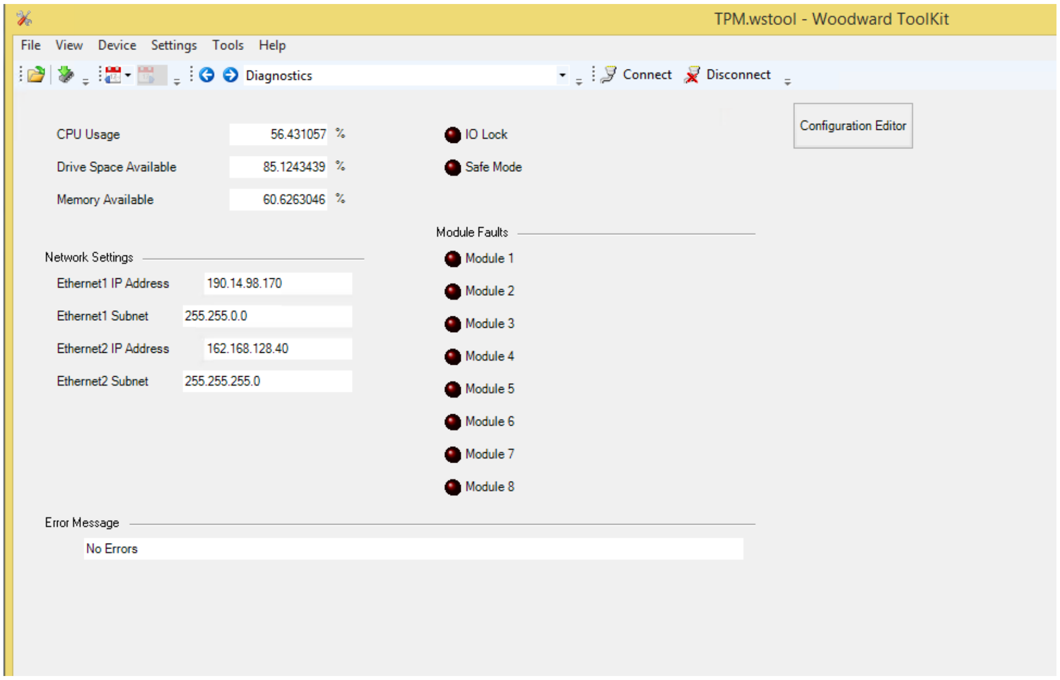


Figure 18 Diagnostics Screen

System information includes:

Table 4-1. Definitions of Diagnostics Screen Interface

Display Text:	Description
CPU Usage	The total amount in percentage of the CPU's load. Contact a system representative if the CPU usage is often greater than 70%
Drive Space Available	The total amount in percentage of unused hard disk space. Contact a system representative if at the space available is less than 20%.
Memory Available	The total amount in percentage of available RAM. Contact a system representative if at the space available is less than 10%.
Ethernet1 IP Address	The IP address of Ethernet port #1 on the TPM chassis.
Ethernet1 Subnet	The IP subnet of Ethernet port #1 on the TPM chassis.
Ethernet2 IP Address	The IP address of Ethernet port #2 on the TPM chassis.
Ethernet2 Subnet	The IP subnet of Ethernet port #2 on the TPM chassis.
Error Messages	When a system error occurs, the error message will display an error code and a brief description
IO Lock	When the system enters IO Lock, the LED will appear bright red. See Chapter 6 for information about IO Lock Mode.
Safe Mode	When the system enters Safe Mode, the LED will appear bright red. See Chapter 6 for information about Safe Mode.
Module Faults	If the control module loses communication to one of the modules, the LED indication of the respective module appear to be on in a bright red color

Settings Configuration

This section provides instructions on how to configure the settings of the TPM system though the TPM Service Tool. For instructions on how to connect to the device through the TPM Service Tool, refer to the previous section of this manual, *Connecting To the Device*.

⚠DANGER	**Changing configuration will force the system to reboot. Changes to the TPM should only be made when the generator is shut down and in a safe state.**

Download Existing Settings from the Device

1. Start an online session by connecting to the device. Refer to the section "Launching the Service Tool" from Chapter 4 for instructions.
2. From the menu bar, select Settings → Save from Device to File

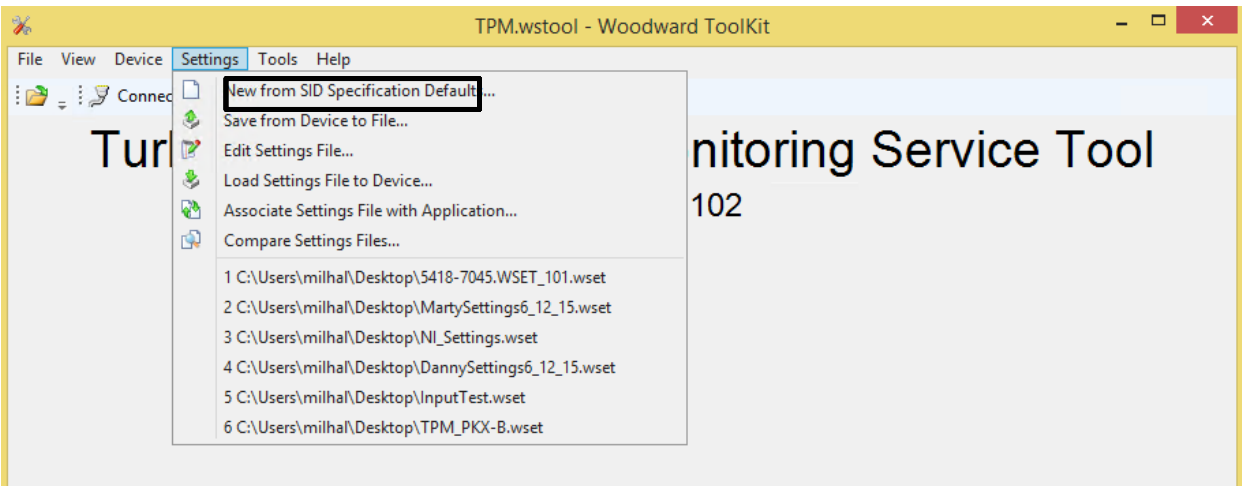


Figure 4-6. ToolKit Settings Menu

3. Select a target directory and assign a name of your desire to save the settings file to (Note: Browse opens explorer. You can navigate to the directory of your choosing and type a name of your desire for the file to be saved as). Click next when done.
4. Select your device from the device list showing the status as connected and click next.
5. Enter any notes you want and click next.
6. Click close when notified that the save has been completed.

IMPORTANT	**It is best practices to save a backup of the settings file on the device before making any changes.**

Configuring System Settings

Every page that contains configuration parameters has a button titled "Configuration Editor" in the upper right hand side of the page.

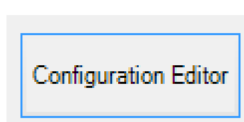


Figure 4-7. Configuration Editor Button

Pressing this button will open the configuration editor window. This window contains writeable entries for changing settings. There is one editor page for every main page.

Speed Monitoring Settings

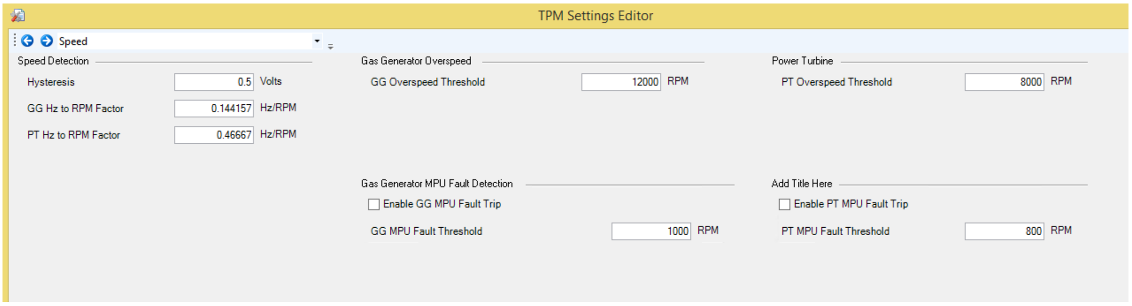


Figure 4-8. Configuration Editor Window

Table4-2. Definitions of Speed Screen Interface

Setting	Description	Min	Max	Units
Hysteresis	The minimum peak voltage the MPU signal must go above (0 volts+Hysteresis) and below (0 volts–Hysteresis), for the detection of the MPU frequency. This parameter is used to increase speed measurement for noisy MPU signals.	0	50	Volts
GG Hz to RPM Factor	The gear ratio between the Gas Generator revolutions to MPU revolutions.	0.01	10	Hz/RPM
PT Hz to RPM Factor	The gear ratio between the Power Turbine revolutions to MPU revolutions.	0.01	10	Hz/RPM
GG Overspeed Threshold	The maximum speed tolerated for power turbine operation. When the MPU measures a speed greater than this setpoint, an overspeed alarm is triggered and the TPM system will trip the generator. **NOTE:** This value should be determined by the generator manufacturer.	0	50000	RPM
Enable GG MPU Fault Trip	Toggle switch to enable/disabled a generator trip due to a GG MPU fault. Checking this box enables the generator trip setting, meaning the TPM system trip the generator if a GG MPU fault is detected on both inputs. When the box is not checked the GG MPU fault trip is disabled, meaning the TPM system will not trip the generator when both GG MPU faults are detected. **NOTE:** This setting only enables/disables a PT MPU fault trip. It has no effect on an overspeed trip. **NOTE:** If the external PT Fault Trip Inhibit switch is active the TPM will not issue a trip on a fault detection.	No Check = Disable	Check = Enable	(On/Off Switch)
GG MPU Fault Threshold	The minimum speed measured by the MPU for the signal to be considered healthy by the TPM system. When the measured speed from the MPU is below this setpoint, the signal will be considered faulted by the TPM system	0	10000	RPM

Setting	Description	Min	Max	Units
PT Overspeed Threshold	The maximum speed tolerated for power turbine operation. When the MPU measures a speed greater than this setpoint, an overspeed alarm is triggered and the TPM system will trip the generator. **Note:** This value should be determined by the generator manufacturer.	0	50000	RPM
Enable PT MPU Fault Trip	Toggle switch to enable/disabled a PT MPU generator trip due to a PT MPU fault. Checking this box enables the generator trip setting, meaning the TPM system trip the generator if an MPU fault is detected. When the box is not checked the PT MPU fault trip is disabled, meaning the TPM system will not trip the generator when both PT MPU faults are detected. **Note:** This setting only enables/disables a PT MPU fault trip. It has no effect on an overspeed trip. **Note:** If the external PT Fault Trip Inhibit switch is active the TPM will not issue a trip on a fault detection.	No Check = Disable	Check = Enable	(On/Off Switch)
PT MPU Fault Threshold	The minimum speed measured by the MPU for the signal to be considered healthy by the TPM system. When the measured speed from the MPU is below this setpoint, the signal will be considered faulted by the TPM system.	0	10000	RPM
Enable DI Reset	Toggle switch to enable/disable the discrete input (DI) reset functionality. This DI can be used instead of using the reset over Modbus. This reset is shared between overspeed and FSOV monitoring.	No Check = Disable	Check = Enable	(On/Off Switch)

Vibration Monitoring Settings

Open the vibration configuration page by navigating to the vibration page and pressing the *Configuration Editor* button.

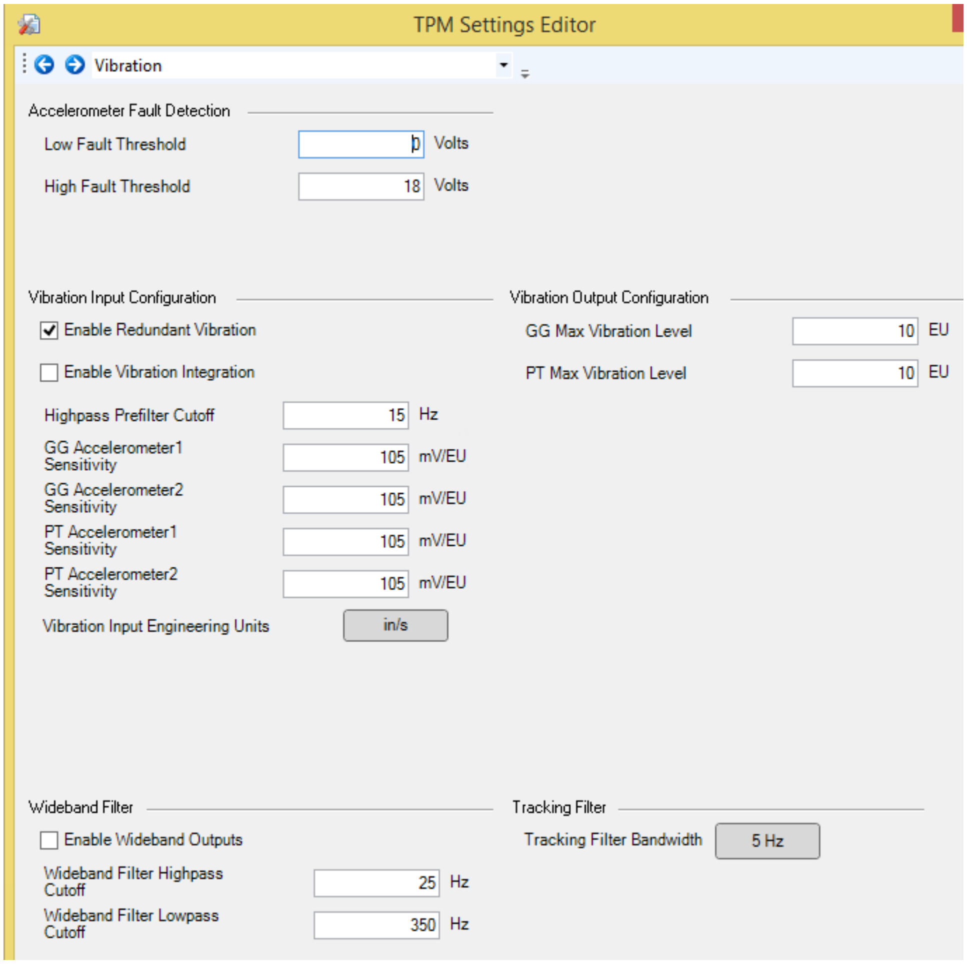


Figure 4-9. Vibration Configuration Page

Unless specified, the settings defined in the table below are attributed to all accelerometer for all inputs.

Table 3: Definitions of Vibration Screen Interface

Setting	Description	Min	Max	Unit
Low Fault Threshold	The minimum voltage (DC bias) detected from the accelerometer that can be considered healthy. If an accelerometer's DC voltage bias is below this value, the accelerometer will be considered faulted.	-30	30	Volts
High Fault Threshold	The maximum voltage (DC bias) detected from the accelerometer that can be considered healthy. If an accelerometer's DC voltage bias is below this value, the accelerometer will be considered faulted.	-30	30	Volts
Enable Redundant Vibration	Checking this box turns ON vibration monitoring/filtering on the redundant accelerometer input channels (both PT and GG). This feature requires a NI 9232 module in slot 2.	No Check = Disable	Check = Enable	(On/Off Switch)
Enable Vibration Integration	Checking this box turns ON signal integration. When integration is turned on, vibration will be analyzed as and output as a measurement of displacement. When vibration integration is turned off, vibration will be analyzed and output as a measurement of velocity.	No Check = Disable	Check = Enable	(On/Off Switch)
Highpass Prefilter Cutoff	The prefilter's high pass frequency setpoint. Signals that are at frequencies below this setpoint will be attenuated and signals that are at frequencies above this setpoint will be passed on for additional processing. This filter applies to all vibration measurements (tracking and wideband).	10	30	Hz
Accelerometer sensitivity	Set the millivolts to engineering unit's ratio. This value should be set according to the accelerometers specifications.	0	2000	mV/EU
Vibration Input Engineering Units	Pressing the button will toggle between the engineering units of measurement between metric and imperial.	mm/s, mm	in/s, mils	(Toggle Switch)
Enable Wideband Outputs	Checking this box turns on the wideband filtered output. This feature requires a NI 9265 in slot 8.	No Check = Disable	Check = Enable	(On/Off Switch)
Wideband Filter Highpass Cutoff	The high pass cutoff frequency setpoint for the wideband filter. This value should be set minimum frequency of the desired frequency range for vibration monitoring. Signals below this frequency will be greatly attenuated. This should be set above the "Highpass Prefilter Cutoff".	0	500	Hz
Wideband Filter Lowpass Cutoff	The low pass cutoff frequency setpoint for the wideband filter. This value should be set maximum frequency of the desired frequency range for vibration monitoring. Signals below this frequency will be greatly attenuated.	0	1000	Hz
GG and PT Max Vibration Level	Maximum value in engineering units to scale to the 4-20mA outputs. This value is shared common to both the wideband and tracking filter outputs.	1	500	EU
Tracking Filter Bandwidth	Toggle switch with a 3 Hz or a 5 Hz bandwidth	3 Hz	5 Hz	(Toggle Switch)

FSOV Current Monitoring Settings

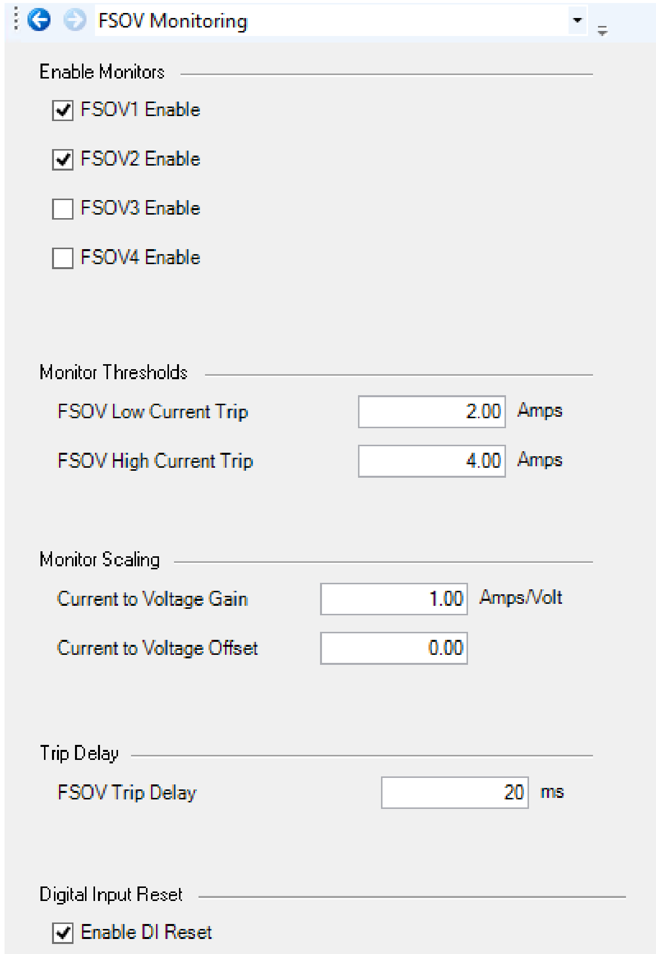


Figure 4-10. FSOV Current Settings Page

Table 4: Definitions of FSOV Monitoring Screen Interface

Setting	Description	Min	Max	Unit
FSOV (1-4) Enable	Checking this box enables FSOV monitoring to its respective FSOV input. If FSOV monitoring is not being used, all FSOV inputs must be disabled (uncheck selection).	No Check = Disable	Check = Enable	(On/Off Switch)
FSOV Low Current Trip	The setpoint to trigger an undercurrent trip. When the measured FSOV current is less than this value, the system will trip the generator.	0	5	Amps
FSOV High Current Trip	The setpoint to trigger an overcurrent trip. When the measured FSOV current is greater than this value, the system will trip the generator.	0	5	Amps
Current To Voltage Gain	The gain of the FSOV current signal when converted to a voltage. This value represents a factor (multiplier) of **amps per volts** of the converted signal. If there is no gain (unity gain) the voltage and amperage of the converted signal, this value should be set to 1. If the converted voltage is two times greater than the amperage, then this value should be 0.5. If the converted voltage is half the value of the amperage, then this value should be 2.	0.1	5	Amps/Volts
Current To Voltage Offset	The offset of the FSOV current signal when converted to a voltage. This value represents a difference between the amperage and voltage of the converted signal. If there is no difference in value between the voltage and amperage of the converted signal, this value should be set to 0. If the voltage of the converted signal is greater than the amperage by a value of 1, this value should be set to 1. If the voltage of the converted signal is less than the amperage by a value of 1, this value should be set to -1.	-5	5	
FSOV Trip Delay	The amount of time that an over/under-current event must remain before the TPM system will trip the generator. If an undercurrent or overcurrent condition occurs for a time period less than the configured delay time, then the TPM will not trip the generator.	0	5000	ms
Enable DI Reset	Toggle switch to enable/disable the discrete input (DI) reset functionality. This DI can be used instead of using the reset over Modbus. This reset is shared between overspeed and FSOV monitoring.	No Check = Disable	Check = Enable	(On/Off Switch)

Chapter 5
Modbus Communication

The Turbine Protection Monitoring System uses Modbus communication protocol to communicate system data and information, such as first out alarms, system diagnostics, and I/O status, over Modbus TCP-IP.

The TPM control unit is a Modbus slave and therefore can only establish connections with Modbus masters.

Connecting to a Modbus Network

The TPM control unit has two Ethernet ports for establishing redundant master-slave Modbus TCP-IP connections. The ports act independently from one another and therefore will respond to any request from a master device as long as the connection is healthy.

Follow the instructions below for connecting to the Modbus Slave. Repeat the steps for setting up a redundant connection.

1. Connect one end of a standard Category 5 (CAT-5), twisted pair Ethernet cable a device in the Modbus network (i.e. switch) or directly to Modbus master device.
2. Connect the other end of the cable to port 1 of the TPM chassis to the Modbus network.
3. Configure your Modbus master to connect to a Modbus slave through port 502 using the slave's IP address.
4. If a Slave ID/Number is required in addition to the IP address in your master configuration, use slave number 1.
5. Configure the Modbus master to request only the registers of the function codes that are defined in the Modbus map below. Requesting registers that are not defined will result in a Modbus exception error.
6. Master-slave connection is ready to be established.

Modbus Map

The Modbus map of the Turbine Protection Monitoring system consists of 40 discrete read registers (function code 1) and 4 discrete write registers (function code 5).

Table 5-1 Modbus Map Read Registers A

Function Code	Register	Access	Length	Signal Description	Interpretation
2	10001	R	1 Word	Safe Mode State	0=Safe Mode Not Active 1=Safe Mode Active
2	10002	R	1 Word	IO Lock State	0=IO Lock Not Active 1=IO Lock Active
2	10003	R	1 Word	Module 1 Fault	0=No Fault 1=Fault
2	10004	R	1 Word	Module 2 Fault	0=No Fault 1=Fault
2	10005	R	1 Word	Module 3 Fault	0=No Fault 1=Fault
2	10006	R	1 Word	Module 4 Fault	0=No Fault 1=Fault
2	10007	R	1 Word	Module 5 Fault	0=No Fault 1=Fault
2	10008	R	1 Word	Module 6 Fault	0=No Fault 1=Fault
2	10009	R	1 Word	Module 7 Fault	0=No Fault 1=Fault
2	10010	R	1 Word	Module 8 Fault	0=No Fault 1=Fault
2	10011	R	1 Word	Cause of Trip: GG MPU1 Overspeed Trip	0=No Trip 1=Overspeed Trip
2	10012	R	1 Word	Cause of Trip: GG MPU2 Overspeed Trip	0=No Trip 1=Overspeed Trip
2	10013	R	1 Word	Cause of Trip: PT MPU1 Overspeed Trip	0=No Trip 1=Overspeed Trip
2	10014	R	1 Word	Cause of Trip: PT MPU2 Overspeed Trip	0=No Trip 1=Overspeed Trip
2	10015	R	1 Word	GG MPU Input #1 Fault	0=No Fault 1=GG MPU #1 Fault
2	10016	R	1 Word	GG MPU input #2 Fault	0=No Fault 1=GG MPU #2 Fault
2	10017	R	1 Word	PT MPU input #1 Fault	0=No Fault 1=PT MPU #1 Fault
2	10018	R	1 Word	PT MPU input #2 Fault	0=No Fault 1=PT MPU #2 Fault
2	10019	R	1 Word	Cause of Trip: GG MPU Fault Trip	0=No Trip 1=GG MPU Fault Trip
2	10020	R	1 Word	Cause of Trip: PT MPU Fault Trip	0=No Trip 1=PT MPU Fault Trip
2	10021	R	1 Word	PT MPU Fault Trip Inhibit State	0=Trip Inhibit Inactive 1=Trip Inhibit Active

Function Code	Register	Access	Length	Signal Description	Interpretation
2	10022	R	1 Word	GG MPU Fault Trip Inhibit State	0=Trip Inhibit Inactive 1=Trip Inhibit Active
2	10023	R	1 Word	Trip Output	0=No Trip 1=TPM Tripped
2	10024	R	1 Word	FSOV Trip Inhibit State	0=Trip Inhibit Inactive 1=Trip Inhibit Active
2	10025	R	1 Word	Cause of Trip: FSOV input #1 Undercurrent	0=No Trip 1=FSOV #1 Undercurrent Trip
2	10026	R	1 Word	Cause of Trip: FSOV input #2 Undercurrent	0=No Trip 1=FSOV #2 Undercurrent Trip
2	10027	R	1 Word	Cause of Trip: FSOV input #3 Undercurrent	0=No Trip 1=FSOV #3 Undercurrent Trip
2	10028	R	1 Word	Cause of Trip: FSOV input #4 Undercurrent	0=No Trip 1=FSOV #4 Undercurrent Trip
2	10029	R	1 Word	Cause of Trip: FSOV input #1 Overcurrent	0=No Trip 1=FSOV #1 Overcurrent Trip
2	10030	R	1 Word	Cause of Trip: FSOV input #2 Overcurrent	0=No Trip 1=FSOV #2 Overcurrent Trip
2	10031	R	1 Word	Cause of Trip: FSOV input #3 Overcurrent	0=No Trip 1=FSOV #3 Overcurrent Trip
2	10032	R	1 Word	Cause of Trip: FSOV input #4 Overcurrent	0=No Trip 1=FSOV #4 Overcurrent Trip
2	10033	R	1 Word	Spare	
2	10034	R	1 Word	Spare	
2	10035	R	1 Word	GG Accelerometer1 Fault	0=No Fault 1=GG Accel. #1 Fault
2	10036	R	1 Word	GG Accelerometer2 Fault	0=No Fault 1=GG Accel. #2 Fault
2	10037	R	1 Word	PT Accelerometer1 Fault	0=No Fault 1=PT Accel. #1 Fault
2	10038	R	1 Word	PT Accelerometer2 Fault	0=No Fault 1=PT Accel. #2 Fault
2	10039	R	1 Word	Spare	
2	10040	R	1 Word	Spare	

Table 5-2. Modbus Map Write Registers

Function Code	Register	Access	Length	Signal Description	Interpretation
1	00001	W	1 Word	Trip Reset	0=Idle 1=Reset Trip
1	00002	W	1 Word	Spare	
1	00003	W	1 Word	Spare	
1	00004	W	1 Word	Spare	

Table 5-3. Modbus Map Write Registers B

Function Code	Register	Access	Length	Signal Description	Interpretation
4	30001	R	1 Word	FSOV 1 CURRENT X10	AMPS
4	30002	R	1 Word	FSOV 2 CURRENT X10	AMPS
4	30003	R	1 Word	FSOV 3 CURRENT X10	AMPS
4	30004	R	1 Word	FSOV 4 CURRENT X10	AMPS

Chapter 6
Troubleshooting and Diagnostics

LED Indications

Power LED
The POWER LED is lit while the cRIO-9068 is powered on. This LED indicates that the power supply connected to the chassis is adequate.

Status LED
During power on, this LED is normally solid orange. It will turn off after the system is running normally. Contact your system representative if the status LED is blinking.

User 1 LED
The user 1 LED has three possible states which include:
1. Off – System is normal
2. Flashing Green – System is in IO Lock
3. Solid Green – System is in Safe Mode

IO Lock and Safe Mode indicate that a critical system fault is active and immediate action should be taken.

Error codes and system information can be retrieved through diagnostics screen of the TPM Service Tool. The information on the Diagnostics page can assist in troubleshooting the cause of an IO Lock or Safe Mode.

If the problem cannot be resolved, contact your system representative.

IO Lock
IO Lock occurs when a critical software or hardware error is detected. During IO Lock all outputs are forced to their powered off state. During IO Lock the TPM is not capable of performing protective or vibration functions. IO Lock is a critical error and should be monitored by the supervisory system. If IO Lock occurs, the Toolkit service tool should be used to determine the cause of IO Lock.

The TPM performs a Power-On-Self-Test (POST) during boot time. The POST tests communication with each module and verifies correct configuration. If the POST fails the TPM with enter IO Lock.

Common causes of IO Lock:
1. A module required by the configuration is missing or faulted.
    - Slot 1 – NI9232: Required
    - Slot 2 – NI9232: Required if redundant vibration is enabled
    - Slot 3 – NI9205: Required if any of the FSOV monitors are enabled
    - Slot 4 – NI9221: Required
    - Slot 5 – NI9421: Required
    - Slot 6 – NI9485: Required
    - Slot 7 – NI9265: Required
    - Slot 8 – NI9265: Required if wideband outputs are enabled

2. The combination of the configuration parameters “Hz to RPM” and overspeed trip setpoint exceed 10 kHz measurement frequency.

   Examples:
   Overspeed Threshold = 15,000 RPM
   Hz to RPM = 0.5
   0.5 X 15,000 = 7,500 Hz
   Acceptable: 7,500 Hz < 10,000 Hz

   Overspeed Threshold = 15,000 RPM
   Hz to RPM = 0.7
   0.7 X 15,000 = 10,500 Hz
   NOT Acceptable: 10,500 Hz > 10,000 Hz

If IO Lock occurs for any other reason, please contact Woodward.

Solid - Safe Mode

Safe mode occurs when a software or hardware error is detected. In safe mode the TPM is capable of issuing a trip for a single overspeed or FSOV over/under current event. However, the TPM will only be able to issue a single trip and will not be able to be reset without a power cycle. If Safe Mode occurs, the Toolkit service tool should be used to determine the cause of Safe Mode. The most likely cause of Safe Mode is a module error. If Safe Mode occurs for any other reason, please contact Woodward.

Chapter 7
Example Hardware Configurations

Below are examples of possible configurations of the hardware for the TPM system.

Example 1:

Functionality

- Simplex Vibration with Tracking Filter
- FSOV Over/Undercurrent of 1-4 fuel valves
- Overspeed

Table 7-1. Example 1 TPM Hardware Configurations

Module	Woodward Part Number	Location
NI 9232	1751-6701	Slot 1
Blank Filler	1751-6707	Slot 2
NI 9205	1751-6702	Slot 3
NI 9221	1751-6703	Slot 4
NI 9421	1751-6706	Slot 5
NI 9485	1751-6705	Slot 6
NI 9265	1751-6704	Slot 7
Blank Filler	1751-6707	Slot 8

Example 2:

Functionality

- Redundant Vibration with Tracking Filter and Wideband
- Overspeed

Table 7-2. Example 2 TPM Hardware Configurations

Module	Woodward Part Number	Location
NI 9232	1751-6701	Slot 1
NI 9232	1751-6701	Slot 2
Blank Filler	1751-6707	Slot 3
NI 9221	1751-6703	Slot 4
NI 9421	1751-6706	Slot 5
NI 9485	1751-6705	Slot 6
NI 9265	1751-6704	Slot 7
NI 9265	1751-6704	Slot 8

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 **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

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

Product Service Options

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

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

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

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

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

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

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

Returning Equipment for Repair

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

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

- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

Contacting Woodward's Support Organization

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

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

Products Used in Electrical Power Systems

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

Products Used in Engine Systems

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

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

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

General

Your Name

Site Location

Phone Number

Fax Number

Prime Mover Information

Manufacturer

Turbine Model Number

Type of Fuel (gas, steam, etc.)

Power Output Rating

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter

Control Description or Governor Type

Serial Number

Symptoms

Description

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

Technical Specifications

Physical Characteristics

If you need to clean the controller, wipe it with a dry towel.

Screw-Terminal Wiring:	0.2 mm2 (24 AWG) to 2.1 mm2 (14 AWG) copper conductor wire with 10 mm (0.39 in.) of insulation stripped from the end
Torque for Screw Terminals:	0.5 to 0.6 N m (4.4 to 5.3 lb in.)

Power Requirements

Voltage Input Range	9 to 30 V
Maximum Power Input	25W
Maximum Power Consumption	25W

Network

Network Interface:	10/100/1,000 Ethernet
Compatibility:	IEEE 802.3
Communication Rates:	10 Mbps, 100 Mbps, 1,000 Mbps auto-negotiated
Maximum Cabling Distance:	100 m/segment

Battery

Typical battery life with power applied to power connector:	10 Years
Typical battery life in storage at 55 °C:	5.7 Years
Minimum battery life in storage at 85 °C:	5.3 Years

Safety Voltages

Connect only voltages that are within these limits.

V Terminal to C Terminal:	30 V max, Measurement Category I
Isolation Voltage, RS-485 Serial Port to Earth Ground Continuous:	60 VDC, Measurement Category I
Withstand:	1,000 Vrms, verified by a 5 s dielectric withstand test

Environment

Operating Temperature (IEC 60068-2-1, IEC 60068-2-2):	-40 to 70 °C
Storage Temperature (IEC 60068-2-1, IEC 60068-2-2):	-40 to 85 °C
Ingress Protection	IP 40
Operating Humidity (IEC 60068-2-56):	10 to 90% RH, noncondensing
Storage Humidity (IEC 60068-2-56):	5 to 95% RH, noncondensing
Maximum Altitude:	2,000 m
Pollution Degree (IEC 60664)	2 Indoor Use Only

Shock and Vibration

To meet these specifications, you must mount the chassis directly on a flat, rigid surface as described in the Mounting the Chassis Directly on a Flat Surface Using the Mounting Holes, affix ferrules to the ends of the terminal lines, and provide strain relief for all cables.

Operating Shock (IEC 60068-2-27):	30 g, 11 ms half sine 50 g, 3 ms half sine,18 shocks at 6 orientations
Operating Vibration, Random (IEC 60068-2-64):	5 g, 10 to 500 Hz
Operating vibration, sinusoidal (IEC 60068-2-6):	5 g, 10 to 500 Hz

Performance Specifications

Overspeed Maximum Input Frequency	10 kHz
Overspeed trip time:	5 ms
FSOV Monitoring Over/Under Current Trip Time:	5 ms after delay time
Vibration	
Minimum Input Frequency	15 Hz
5 Hz Bandwidth Tracking Filter Response Time:	100 +/-20 ms

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 35027.

B35027 : A

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Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.