Trusted TMR Speed Monitor

Product Overview

The Trusted® T8442 TMR Speed Monitor monitors the shaft speed and acceleration of rotating machinery. It provides machine protection for over-speed and over-acceleration shutdown functions. Typical machinery applications include steam and gas turbines driving pumps, compressors and generators. A T8442 Speed Monitor Module within a Trusted System provides the capability to perform turbine speed control independent of the machinery protection functions.

System response times are often critical for these types of application. To minimize processing delays the T8442 operates as a self-contained fault tolerant control sub-system within the Trusted System environment.

Each T8442 has three monitoring and control groups. Each group provides the Speed Monitoring and shutdown control facilities required for one rotating machine. Up to three turbine trains can be handled by a single T8442. A single rotating machine group comprises of three separate Triple Modular Redundant (TMR) speed input channels and two separate quad redundant, fault tolerant output drive structures. Turbines having more than three speed pickups can be accommodated by combining monitoring and control groups.

The speed input channels are designed to interface directly with a Trusted T8846 Speed Input Field Termination Assembly (SIFTA). A single T8846 provides signal conditioning and field cable termination facilities for the nine TMR speed input channels required for three rotating machine groups. Both active and passive speed probes can be accommodated by the T8846. Active probes can be powered from the field cable termination.

The shutdown control outputs are designed to interface directly with three Trusted T8891 Speed Output Field Termination Assemblies (SOFTA). A single T8891 contains the two quad redundant, fault tolerant, volt-free contact structures required for a single rotating machine group.

The inter-connections between the Module and the Field Termination Assemblies (FTAs) are provided by a Trusted TC-801 Cable Assembly.

Features:

- Three rotating machine groups.
- Three Triple Module Redundant (TMR) speed inputs per rotating machine group.
- Active or passive probe speed inputs.
- Two quad redundant, fault tolerant, volt-free shutdown control output structures per rotating machine group.
- 2500 V impulse withstand opto/galvanic isolation barrier.
- Galvanic isolation between field Inputs/Outputs.
- On-board Sequence of Events (SOE) reporting with 1 ms resolution.
- Hot standby module configurations using companion slot.
- Hardware Implemented Fault Tolerance (HIFT).
- Front panel status LEDs indicate module health, operating mode and rotating machine group Input/Output status. Comprehensive automatic diagnostics and self-test.
- TüV Certified IEC 61508 SIL 3.

PREFACE

DISCLAIMER

It is not intended that the information in this publication covers every possible detail about the construction, operation, or maintenance of a control system installation. You should also refer to your own local (or supplied) system safety manual, installation and operator/maintenance manuals.

REVISION AND UPDATING POLICY

This document is based on information available at the time of its publication. The document contents are subject to change from time to time. The latest versions of the manuals are available at the Rockwell Automation Literature Library under "Product Information" information "Critical Process Control & Safety Systems".

TRUSTED RELEASE

This technical manual was updated for **Trusted Release 4.0**.

LATEST PRODUCT INFORMATION

For the latest information about this product review the Product Notifications and Technical Notes issued by technical support. Product Notifications and product support are available at the Rockwell Automation Support Centre at
http://rockwellautomation.custhelp.com

At the Search Knowledgebase tab select the option "By Product" then scroll down and select the Trusted product.

Some of the Answer ID's in the Knowledge Base require a TechConnect℠ Support Contract. For more information about TechConnect Support Contract Access Level and Features, click on the following link:

https://rockwellautomation.custhelp.com/app/answers/detail/a_id/50871

This will get you to the login page where you must enter your login details.

IMPORTANT A login is required to access the link. If you do not have an account then you can create one using the "Sign Up" link at the top right of the web page.

DOCUMENTATION FEEDBACK

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete the How Are We Doing? form at http://literature.rockwellautomation.com/idc/groups/literature/documents/du/ra-du002_-en-e.pdf.

SCOPE

This manual specifies the maintenance requirements and describes the procedures to assist troubleshooting and maintenance of a Trusted system.

WHO SHOULD USE THIS MANUAL

This manual is for plant maintenance personnel who are experienced in the operation and maintenance of electronic equipment and are trained to work with safety systems.

SYMBOLS

In this manual we will use these notices to tell you about safety considerations.

	SHOCK HAZARD: Identifies an electrical shock hazard. If a warning label is fitted, it can be on or inside the equipment.
	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which can cause injury or death, property damage or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can cause injury or death.
	CAUTION: Identifies information about practices or circumstances that can cause property damage or economic loss.
	BURN HAZARD: Identifies where a surface can reach dangerous temperatures. If a warning label is fitted, it can be on or inside the equipment.
	This symbol identifies items which must be thought about and put in place when designing and assembling a Trusted controller for use in a Safety Instrumented Function (SIF). It appears extensively in the Trusted Safety Manual.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
NOTE	Provides key information about the product or service.
TIP	Tips give helpful information about using or setting up the equipment.

WARNINGS AND CAUTIONS

WARNING: EXPLOSION RISK

Do not connect or disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations or equivalent

AVERTISSEMENT - RISQUE D'EXPLOSION

Ne pas connecter ou déconnecter l'équipement alors qu'il est sous tension, sauf si l'environnement est exempt de concentrations inflammables ou équivalente

MAINTENANCE

Maintenance must be carried out only by qualified personnel. Failure to follow these instructions may result in personal injury.

CAUTION: RADIO FREQUENCY INTERFERENCE

Most electronic equipment is influenced by Radio Frequency Interference. Caution should be exercised with regard to the use of portable communications equipment around such equipment. Signs should be posted in the vicinity of the equipment cautioning against the use of portable communications equipment.

CAUTION:

The module PCBs contains static sensitive components. Static handling precautions must be observed. DO NOT touch exposed connector pins or attempt to dismantle a module.

ISSUE RECORD

Issue	Date	Comments
Draft A	Sept 04	
Draft B	Sept 04	
Draft C	Sept 04	Changes resulting from CDR#4 8442
Draft D	Jan 04	Speed probe defined
1	March 05	
2	Aug 05	Format Sect 6.5 400w Power requirement deleted Removed Sect 5.5 SmartSlot and some references to SmartSlot
3	Aug 06	FB_INT ch62 SOFTA Present Technical corrections
4	Dec 06	Weights & Dims
5	Mar 07	Corrections
6	Sep 07	Peer review
7	Nov 09	Field fault note added
8	Apr 10	Rack 7 minor change
9	Jun 16	Rebranded and reformatted with correction to Relative Humidity Range and Operating Temperature statements in the Specification Section, also any typographical errors

10	Dec 19	Updated Documentation Feedback section. Added trademarks statement. Table 5 Complex Equipment Definition updated. Front Panel image (Figure 7) updated to show new label. Rotating Machine Group Status Indicators (Figure 8) updated to show new label. In Specifications section, "Field Common Isolation" changed to "Field Common Insulation". Updated document to display Rockwell Automation publication numbers. Updated Section 6.1 Speed Input Specifications to include information about the relationship between RPM and Number of Teeth.

Table of Contents

1. Description

1.1. Product Overview

This section gives a brief overview of the input to output architecture of the T8442 Speed Monitor Module showing the methods that are employed to achieve fault tolerant operation.

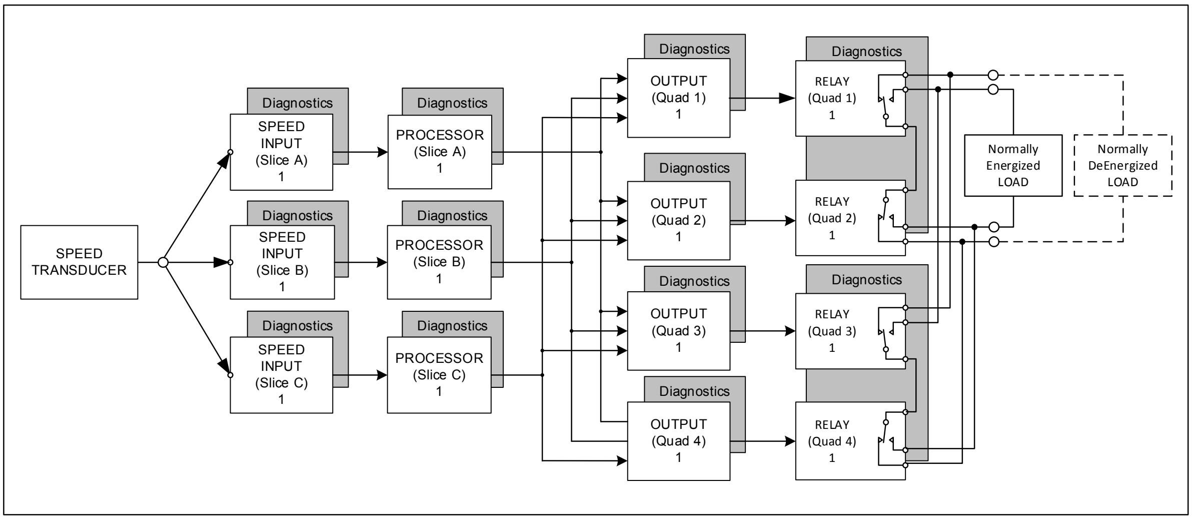

Figure 1 Module Architecture

The T8442 utilizes a hybrid redundant architecture to achieve fault tolerant speed sensing and output control. Critical circuits use either triple or quad redundancy depending on function.

Figure 1 shows the triple and quad arrangements and their associated functions with respect to the Input to Output signal path.

Each speed transducer input signal from the T8846 SIFTA feeds three identical triple redundant input circuits on the Module.

Diagnostics allow on-line injection of a self-test signal. This is used to verify the speed input circuit functionality even when the external transducer input is steady state or below the minimum detection level.

The speed signals from the input circuits are processed by the triple redundant processing elements to determine rotational speed and acceleration.

Each of the triple redundant processing elements makes an output control decision based upon a comparison of the rotational speed data received from the speed input circuits and the safe operating ceiling parameters for that channel.

The output control signal from each of the triple redundant processing elements drives into all four of the quad redundant output drive circuits.

Each of the quad redundant output drive circuits either energizes or de-energizes based upon the majority voted data received from the three processing elements. The majority voting scheme provides both fault tolerance and fault detection requiring data, which agrees to precision within specified tolerance, for at least two out of three (2oo3) processing elements.

The quad redundant relay output stage is located on the T8891 SOFTA and is arranged as a fault tolerant structure. The four force guided relay contacts are connected in a series/parallel arrangement to verify that any single failure cannot affect the desired load state. Diagnostics detect the current in each series leg of the relay structure. The force guided auxiliary contacts are monitored to confirm contact transition.

Diagnostics are used extensively to verify that covert failures are detected and result in a fail-safe reaction. For example, a fault within Speed Input Slice A, as shown in Figure 1 is localized to that input, allowing Processor Slice A and Output Quads 1 to 4 to continue operation, i.e. the input operates one out of two with diagnostics (1oo2D) whilst the remainder of the system continues to operate 2oo3.

The notation Slice A, Slice B and Slice C for individual channels in the triplicated design is used throughout this document.

The notation Quad 1, Quad 2, Quad 3 and Quad 4 for individual channels in the quad design is used throughout this document.

1.2. Speed Monitor Sub-Assembly Architecture Overview

This section shows the physical aspects of the T8442 Speed Monitor Architecture. It shows the separate sub-assemblies that make up the Speed Monitor and how they interconnect.

The block diagram of the T8442 Speed Monitor Module is given in Figure 2 and shows that the T8442 system is made up of six separate sub-assemblies:

- HIU (Host Interface Unit).
- SFTU (Speed Field Termination Unit).
- SFIU (Speed Field Interface Unit).
- FPU (Front Panel Unit).
- T8846 SIFTA (Speed Input Field Termination Assembly).
- T8891 SOFTA (Speed Output Field Termination Assembly).

The T8846 SIFTA and T8891 SOFTA are external DIN rail mounted pieces of equipment and are considered integral to the overall T8442 system.

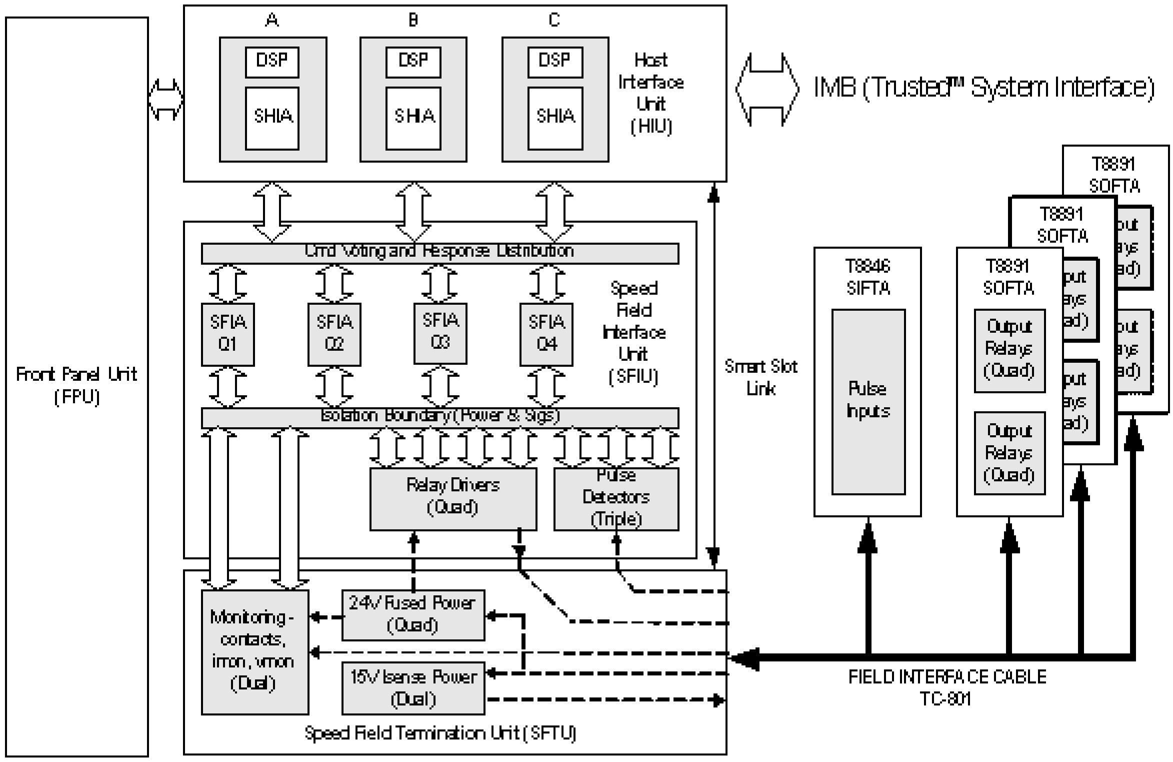

Figure 2 Functional Block Diagram

1.2.1. Host Interface Unit (HIU)

The HIU is a common hardware platform used within all Trusted series 8000 I/O Modules. It provides the fault tolerant communications, control, and processing facilities for the T8442 Module. The HIU is the point access to the Trusted Inter Module Bus (IMB). Each HIU slice is considered a Fault Containment Region (FCR) in that a fault on one slice has no effect on the operation of the other slices. All data sent to the Module from the Trusted System Processor is 2oo3 voted by each HIU slice. The HIU has housekeeping and automatic test functions. The HIU also carries out time stamping of input and output changes for Sequence of Event (SOE) recording.

The two main elements of each HIU slice are the Digital Signal Processor (DSP) and Host Interface ASIC (HIA). The DSP provides the data processing capability while the HIA provides Module specific hardware communication and voting logic between the DSP, FIU and IMB. Each HIU slice is clock asynchronous with respect to the other two slices.

The T8442 Module HIA is referred to as the SHIA (Speed Host Interface ASIC).

1.2.2. Speed Field Interface Unit (SFIU)

The Field Interface Unit (FIU) connects the HIU to the Field Termination Unit (FTU).

The T8442 Module FIU is referred to as the SFIU (Speed Field Interface Unit).

The SFIU utilizes a hybrid redundant architecture with quad-redundancy to achieve fault tolerant output control and triple-redundancy to achieve fault tolerant Speed Monitoring. The Speed Field Interface ASICs (SFIA) provide the interfaces between the HIU and the quad/triple redundant I/O circuits and dual redundant status monitoring circuits. The SFIA circuits are galvanically isolated from the relay driver and speed input detector circuits. Redundant power supplies are used.

1.2.3. Speed Field Termination Unit (SFTU)

The Field Termination Unit (FTU) connects the FIU to the field.

The T8442 Module FTU is referred to as the SFTU (Speed Field Termination Unit).

The SFTU allows speed input signals and shutdown output signals to be routed from the SFIU to the field connector. It also converts the 24 Vdc field power supply into dual redundant ±15 Vdc power for the SOFTA relay current sensors and quad 24 Vdc power for the SFIU relay drivers. It provides dual-redundant monitoring circuits for relay status, load status, 24 Vdc power status, and ±15 Vdc power status. A SmartSlot link connects the SFTU to the HIU and is used to co-ordinate Active and Standby Modules during Module replacement.

1.2.4. FPU Front Panel Unit (FPU)

The FPU is a common hardware platform used within all Trusted 8000 series I/O Modules. It provides voted Front Panel status indication and Module removal detection.

The T8442 Module LED indicators provide status information for the following:

- Slice A healthy
- Slice B healthy
- Slice C healthy
- Module Active/Standby mode
- Module Educated.
- Speed Input Status (x9)
- Over-speed Output Status (x3)
- Over-acceleration Output Status (x3)

1.2.5. T8846 Speed Input Field Termination Assembly (SIFTA)

The T8846 Speed Input Field Termination Assembly (SIFTA) is an integral part of the overall T8442 Speed Monitor System. It is DIN rail mounted, containing passive signal conditioning, power distribution and protection components.

1.2.6. T8891 Speed Output Field Termination Assembly (SOFTA)

The T8891 Speed Output Field Termination Assembly (SOFTA) is an integral part of the overall T8442 Speed Monitor System. It is DIN rail mounted, containing two fault tolerant, quad-redundant relay output channels. Three T8891 units are required for each T8442 Speed Monitor.

1.3. Speed Monitor

Figure 3 illustrates how the assemblies utilize various levels of redundancy to achieve fault tolerant Speed Monitoring and output control:

- HIU Interface (quad redundant, Q1 through Q4)
- Relay Drives (quad redundant, Q1 through Q4)
- Pulse Detectors (triple redundant, Q1 through Q3)
- Status Monitors (dual redundant, Q1 through Q2)

The four quadrants, labelled Q1 to Q4, are completely independent of each other, and behave as separate fault containment regions (FCRs).

The I/O circuits are divided into three galvanically isolated speed groups, each group containing 3 speed inputs and 2 relay outputs (over-speed and over-acceleration). The speed groups are shown in the diagram as three stacked functional blocks.

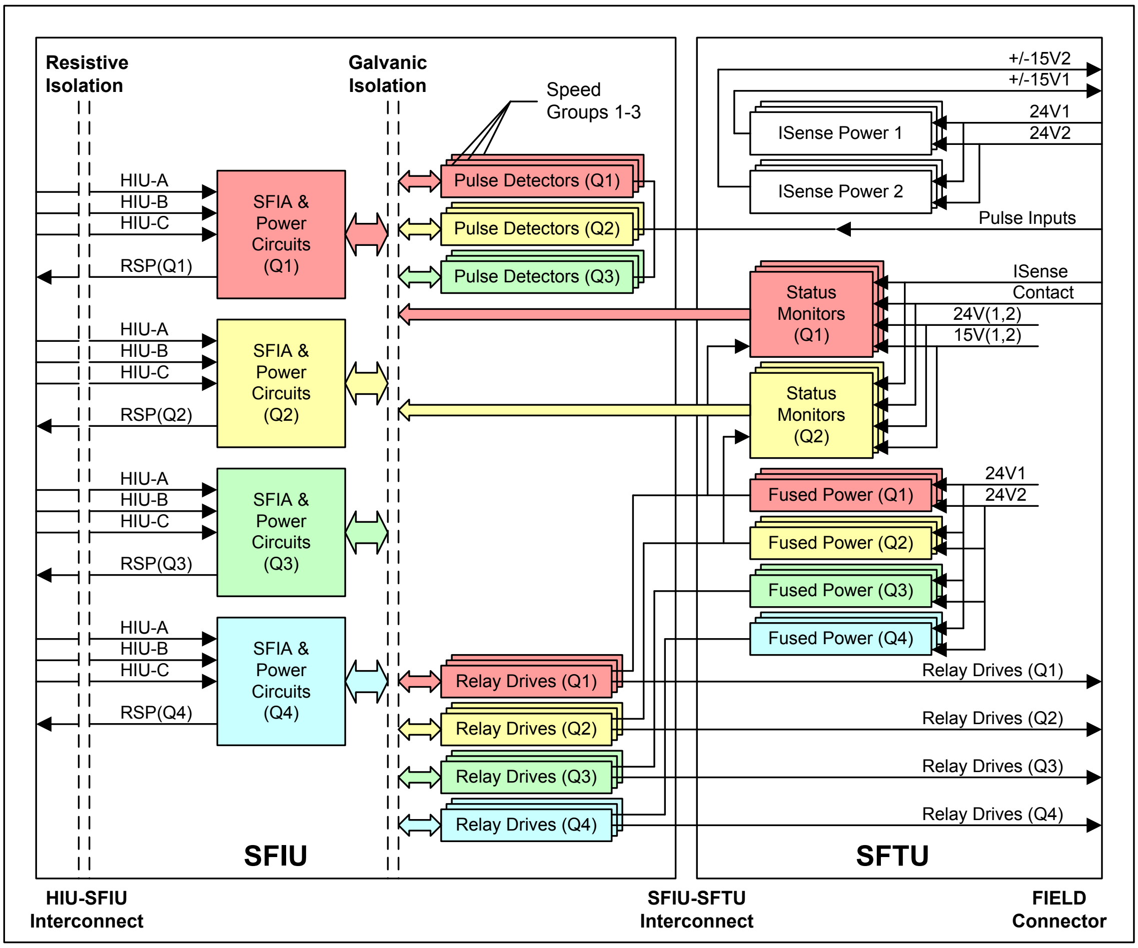

Figure 3 SFIU and SFTU Assembly Architecture

The quad redundant relay architecture provides fault tolerant control of the volt-free output and allows a single relay to be tested without disturbing the load. ISENSE and CONTACT data from the SOFTA is analyzed to determine if each relay is operable and if a load is connected (de-energize to trip only). ISENSE is an analogue signal that represents the load current in each relay leg (of the quad-voted output). CONTACT is a digital signal that pulses during a change of state of any relay within a speed group. ISENSE and CONTACT are processed via dual-redundant circuits. The relay circuits are powered via dual redundant 24 Vdc field power, and dual redundant ±15 Vdc power is provided to the current sensors on the SOFTA.

The triple redundant speed input architecture provides fault tolerant sensing of rotational speed and acceleration. These circuits receive transformer-coupled power from their associated SFIU quadrant. A test enable from the SFIA causes the speed input to enter self-test mode.

1.3.1. SFIU

The SFIU assembly contains the following circuits:

- **Resistor Isolation**
  The interface to the HIU contains resistor isolation to limit the current flow between TMR/QUAD fault containment regions during a power transition or over-voltage fault.

- **SFIA (Speed Field Interface ASIC) & Power Circuits**
  The SFIA votes and processes HIU command packets and distributes response packets to all three HIU slices. Decoded coil commands are provided to the relay drive circuits. Relay monitor data and speed input data are processed and provided to the HIU. The power circuits provide fault tolerant ORed HIU power for the SFIA and isolated power for the pulse detectors.

- **Galvanic Isolation**
  The SFIU provides a 2500 V impulse withstand galvanic isolation barrier between the SFIA and the field circuits for power and digital signals.

- **Pulse Detectors**
  The pulse detectors provide signal conditioning (amplification and threshold detection) for the speed input signals. Each pulse detector is able to replace its speed input signal with a test excitation signal when commanded by the SFIA.

- **Relay Drives**
  The relay drive circuits provide the interface between the SFIA and the 24 Vdc relay coils. Each drive circuit provides a diagnostic signal back to the SFIA, indicating the status of the relay coil.

1.3.2. SFTU

The SFTU assembly contains the following circuits.

- **ISENSE Power**
  These circuits convert the dual-redundant 24 Vdc field power into dual redundant ±15 Vdc power for the current sensors on the SOFTA.
- **Fused Power**
  These circuits provide independent wire-ORed and fused 24 Vdc power to each of the relay drive quadrants and the two relay monitor quadrants.
- **Relay Monitors**
  These circuits provide dual-redundant multiplexing and signal encoding for the ISENSE and CONTACT signals, 24 Vdc field power monitor, and ±15 Vdc ISENSE power monitor. The encoded data is provided to the SFIA.
- **Field Connector**
  The field connector provides the external interface to the SIFTA and SOFTA(s).

1.3.3. SIFTA

Each T8442 Speed Monitor Module hot swap pair requires a single T8846 SIFTA when installed in a Trusted System.

The SIFTA has nine identical speed transducer signal conditioning circuits arranged as three groups of three.

Each of the three groups is an isolated entity, with its own field power and I/O signal interfaces.

A single transducer signal on the SIFTA is taken to three monitoring circuits on the T8442. A fault causes that transducer to fail safe.

Multiple sensors must be employed for SIL 3 applications.

The input transducer fault containment region contains the SIFTA and field cable. It extends from the transducer to the Module/field cable interface.

1.3.4. SOFTA

A single SOFTA assembly provides the relay switching elements for one over-speed output and one over-acceleration output.

A T8442 Speed Monitor Module interfaces with three SOFTA assemblies.

For each output channel, an isolated Hall Effect current sensor is connected in series with each of the two parallel contact switching paths. The outputs from these sensors connect to the T8442 SFTU via the field interface cable and are used for relay contact diagnostic and fault detection purposes.

Force guided contact, safety relays are used on the assembly. The physical properties of these relays verify that welded primary contacts can be detected by monitoring the auxiliary contact status signal. This status signal is passed back to the T8442 SFTU via the field interface cable for diagnostic and fault detection purposes.

Each of the two outputs provides two connection options via separate pairs of screw terminals. The normally closed pair is for use with energize-to-trip loads. The normally open pair is for use with de-energize-to-trip loads (preferred).

Note: Only one pair of output terminals may be used from each output.

Power, relay drive, contact current sense, and contact status signals all interface directly to the T8442 via the field interface cable.

1.3.5. Common Trusted System I/O Safety Features

The following list details common safety strategies employed on Trusted series 8000 I/O Modules which apply to the T8442:

- Module faults are reported through the Module Front Panel LED indicators and via status variables in the IEC 61131 Toolset application program. There are two main types of faults: external wiring and Module/FTA faults. The Module detects wiring faults through dedicated hardware and software. Diagnostic functions are used to detect Module and FTA faults.
- The FCR interconnects are high speed busses, used to vote incoming IMB data and to distribute data from the Module slices to the IMB.
- The HIU and FIU have galvanically isolated links for data and power. Their power supplies are dual redundant.
- The DSPs on each HIU slice perform diagnostic self-test functions.
- Housekeeping functions within the HIU and FIU monitor voltages, current and temperature.
- Data input from the IMB is stored in redundant error detecting RAM on each HIU slice. Received data is majority voted by each HIU slice. All data transmissions include an acknowledgement from the receiver.
- The Module performs extensive diagnostic tests.
- The Module is reset if a fault is detected at any stage during configuration.
- Memory components are verified.
- The address and data lines connecting the DSP and SRAM are scrambled (different) between the three slices to reduce systematic failures in the RAM device affecting all three slices in the same way.
- Each slice has a 25 MHz crystal oscillator, used as a local timing source for the HIA and DSP.
- Voltage and currents local to each slice are monitored and verified to be within limits.

- A watchdog circuit supervises critical internal power supplies.
- The dual power feeds from the IMB backplane are fused and EMI filtered. Over-voltage protection is employed.
- The power feed to the FPU is arranged so that the three HIU slices are able to feed power to the display. Protection circuitry helps prevent a short circuit fault on any slice power supply or the FPU from propagating.
- IMB system clocks are distributed between even and odd numbered I/O slots along the IMB Backplane. The clock signals are logically NORed together and distributed to the local HIA and to the other HIAs.

1.3.6. Speed Monitor Module Safety Features

The T8442 system is able to provide uninterrupted functionality, Speed Monitoring and output control functions under the following circumstances:

- Complete failure of Trusted System Processors.
- Complete failure of any or all communication links between the T8442 and the Trusted System Processors.

The following safety strategies are also observed:

- T8442 operating parameters are downloaded from the Trusted System Processors on system or Module initialization (start-up).
- It is not possible to change the safety parameters for a speed input group while any input in that group is above zero speed.
- Over-speed and over-acceleration shutdown parameters are downloaded from the Trusted System Processors on Module initialization.
- It is not possible to increase the over-speed or over-acceleration thresholds beyond the safety limits passed at initialization. These parameters may be moved in a safe direction via the IEC 61131 TOOLSET.
- A Standby T8442 Module is educated with operating parameters from the Active T8442 Module prior to on-line replacement using the Trusted System Companion Slot method. The Trusted SmartSlot method of on-line replacement is not supported by this Module.
- Over-speed test mode is limited by a configurable timer.
- Every group-specific configuration parameter can be changed when the group is at zero speed.
- The safety case for the Module is maintained within the Module while the turbine is running and cannot be affected by the Trusted System Processor in any way.

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2. Installation

2.1. Module Insertion/Removal

CAUTION:

The Module contains static sensitive parts. Static handling precautions must be observed. Specifically ensure that exposed connector pins are not touched. Under no circumstances should the module housing be removed.

Before installation, visually inspect the module for damage. Ensure that the module housing appears undamaged and inspect the I/O connector at the back of the module for bent pins. If the module appears damaged or any pins are bent, do not install the module. Do not try to straighten bent pins. Return the module for replacement.

Ensure that the module is of the correct type.

Record the module type, revision and serial number of the module before installation.

To install the module:

1. Ensure that the field cable assembly is installed and correctly located.
2. Release the ejector tabs on the module using the release key. Ensure that the ejector tabs are fully open.
3. Holding the ejectors, carefully insert the module into the intended slot.
4. Push the module fully home by pressing on the top and bottom of the module fascia.
5. Close the module ejectors, ensuring that they click into their locked position.

The module should mount into the chassis with a minimum of resistance. If the module does not mount easily, do not force it. Remove the module and check it for bent or damaged pins. If the pins have not been damaged, try reinstalling the module.

2.2. External Interfaces

2.2.1. Speed Output Signals

Speed output signals are from normally energized relays with both normally open (de-energize to trip) and normally closed (energize to trip) volt-free contacts available. Hardware fault tolerance is maintained through the use of a quad relay structure with shared paths.

Each group provides an output signal for over-speed and also for over-acceleration.

2.2.2. Speed Input Signals

The speed inputs are arranged as three groups of three inputs. Each external speed sensor input on the Module is monitored by three separate Speed Monitoring circuits.

Hardware fault tolerance is provided for each sensor input on the Module.

2.2.3. Communications

The only external communication interface available to the T8442 Speed Monitor is the Trusted System IMB.

The Trusted System architecture allows many intermediate transport methodologies between the IMB on an I/O Chassis and the IMB on the Main Controller Chassis.

2.3. Field Interface Connector

The field interface on the Module is via a 96 way DIN41612 C type connector. This mates with a TC-801 cable assembly. The cable assembly must be pre-installed in a Trusted Chassis I/O slot that has been configured for use with T8442 Module.

The field connector is made up of three columns of 32 pins. The functions of these pins are detailed in Table 1, Table 2 and Table 3. Note that the table below is provided for reference only, since the T8442 Module must always be connected to a T8446 SIFTA for speed inputs, and one or more T8891 SOFTA units for outputs. Direct connection of the field interface connector to field devices is not supported.

Pin	Signal Name	Description
A1	SMART_A	SmartSlot Link A
A2	-	Not used
A3	PASSIVE_PULSE_POS_G1_3	Group 1, Channel 3, Positive Passive Speed input
A4	PASSIVE_PULSE_NEG_G1_3	Group 1, Channel 3, Negative Passive Speed input
A5	PASSIVE_PULSE_MID_G1_3	Group 1, Channel 3, Passive Speed input Bias
A6	SENSOR_G1_1	Group 1, Current Sensor Input 1
A7	SENSOR_G1_3	Group 1, Current Sensor Input 3
A8	COIL_DRIVE_G1_Q1_1	Group 1, Quad 1, Channel 1, Relay coil drive output.
A9	COIL_DRIVE_G1_Q2_1	Group 1, Quad 2, Channel 1, Relay coil drive output.
A10	COIL_DRIVE_G1_Q3_1	Group 1, Quad 3, Channel 1, Relay coil drive output.
A11	COIL_DRIVE_G1_Q4_1	Group 1, Quad 4, Channel 1, Relay coil drive output.
A12	CONTACTS_G1	Group 1, Relay contact status input.
A13	PASSIVE_PULSE_POS_G2_3	Group 2, Channel 3, Positive Passive Speed input
A14	PASSIVE_PULSE_NEG_G2_3	Group 2, Channel 3, Negative Passive Speed input

Pin	Signal Name	Description
A15	PASSIVE_PULSE_MID_G2_3	Group 2, Channel 3, Passive Speed input Bias
A16	SENSOR_G2_1	Group 2, Current Sensor Input 1
A17	SENSOR_G2_3	Group 2, Current Sensor Input 3
A18	COIL_DRIVE_G2_Q1_1	Group 2, Quad 1, Channel 1, Relay coil drive output.
A19	COIL_DRIVE_G2_Q2_1	Group 2, Quad 2, Channel 1, Relay coil drive output.
A20	COIL_DRIVE_G2_Q3_1	Group 2, Quad 3, Channel 1, Relay coil drive output.
A21	COIL_DRIVE_G2_Q4_1	Group 2, Quad 4, Channel 1, Relay coil drive output.
A22	CONTACTS_G2	Group 2, Relay contact status input.
A23	PASSIVE_PULSE_POS_G3_3	Group 3, Channel 3, Positive Passive Speed input
A24	PASSIVE_PULSE_NEG_G3_3	Group 3, Channel 3, Negative Passive Speed input
A25	PASSIVE_PULSE_MID_G3_3	Group 3, Channel 3, Passive Speed input Bias
A26	SENSOR_G3_1	Group 3, Current Sensor Input 1
A27	SENSOR_G3_3	Group 3, Current Sensor Input 3
A28	COIL_DRIVE_G3_Q1_1	Group 3, Quad 1, Channel 1, Relay coil drive output.
A29	COIL_DRIVE_G3_Q2_1	Group 3, Quad 2, Channel 1, Relay coil drive output.
A30	COIL_DRIVE_G3_Q3_1	Group 3, Quad 3, Channel 1, Relay coil drive output.
A31	COIL_DRIVE_G3_Q4_1	Group 3, Quad 4, Channel 1, Relay coil drive output.
A32	CONTACTS_G3	Group 3, Relay contact status input.

Table 1 Field Interface Connector Pin Assignment (column A)

Pin	Signal Name	Description
B1	SMART_B	SmartSlot Link B
B2	-	Not used
B3	PASSIVE_PULSE_POS_G1_2	Group 1, Channel 2, Positive Passive Speed input
B4	PASSIVE_PULSE_NEG_G1_2	Group 1, Channel 2, Negative Passive Speed input
B5	PASSIVE_PULSE_MID_G1_2	Group 1, Channel 2, Passive Speed input Bias
B6	SENSOR_G1_2	Group 1, Current Sensor Input 2
B7	SENSOR_G1_4	Group 1, Current Sensor Input 4
B8	COIL_DRIVE_G1_Q1_2	Group 1, Quad 1, Channel 2, Relay coil drive output.
B9	COIL_DRIVE_G1_Q2_2	Group 1, Quad 2, Channel 2, Relay coil drive output.
B10	COIL_DRIVE_G1_Q3_2	Group 1, Quad 3, Channel 2, Relay coil drive output.
B11	COIL_DRIVE_G1_Q4_2	Group 1, Quad 4, Channel 2, Relay coil drive output.
B12	VF_RTN_G1	Group 1, field power supply return.

Pin	Signal Name	Description
B13	PASSIVE_PULSE_POS_G2_2	Group 2, Channel 2, Positive Passive Speed input
B14	PASSIVE_PULSE_NEG_G2_2	Group 2, Channel 2, Negative Passive Speed input
B15	PASSIVE_PULSE_MID_G2_2	Group 2, Channel 2, Passive Speed input Bias
B16	SENSOR_G2_2	Group 2, Current Sensor Input 2
B17	SENSOR_G2_4	Group 2, Current Sensor Input 4
B18	COIL_DRIVE_G2_Q1_2	Group 2, Quad 1, Channel 2, Relay coil drive output.
B19	COIL_DRIVE_G2_Q2_2	Group 2, Quad 2, Channel 2, Relay coil drive output.
B20	COIL_DRIVE_G2_Q3_2	Group 2, Quad 3, Channel 2, Relay coil drive output.
B21	COIL_DRIVE_G2_Q4_2	Group 2, Quad 4, Channel 2, Relay coil drive output.
B22	VF_RTN_G2	Group 2, field power supply return.
B23	PASSIVE_PULSE_POS_G3_2	Group 3, Channel 2, Positive Passive Speed input
B24	PASSIVE_PULSE_NEG_G3_2	Group 3, Channel 2, Negative Passive Speed input
B25	PASSIVE_PULSE_MID_G3_2	Group 3, Channel 2, Passive Speed input Bias
B26	SENSOR_G3_2	Group 3, Current Sensor Input 2
B27	SENSOR_G3_4	Group 3, Current Sensor Input 4
B28	COIL_DRIVE_G3_Q1_2	Group 3, Quad 1, Channel 2, Relay coil drive output.
B29	COIL_DRIVE_G3_Q2_2	Group 3, Quad 2, Channel 2, Relay coil drive output.
B30	COIL_DRIVE_G3_Q3_2	Group 3, Quad 3, Channel 2, Relay coil drive output.
B31	COIL_DRIVE_G3_Q4_2	Group 3, Quad 4, Channel 2, Relay coil drive output.
B32	VF_RTN_G3	Group 3, field power supply return.

Table 2 Field Interface Connector Pin Assignment (Column B)

Pin	Signal Name	Description
C1	SMART_C	SmartSlot Link C
C2	-	Not used
C3	PASSIVE_PULSE_POS_G1_1	Group 1, Channel 1, Positive Passive Speed input
C4	PASSIVE_PULSE_NEG_G1_1	Group 1, Channel 1, Negative Passive Speed input
C5	PASSIVE_PULSE_MID_G1_1	Group 1, Channel 1, Passive Speed input Bias
C6	VFIELD_P15_G1_1	Group 1, +15V sensor power supply output 1.
C7	VFIELD_M15_G1_1	Group 1, -15V sensor power supply output 1.
C8	VFIELD_P15_G1_2	Group 1, +15V sensor power supply output 2.
C9	VFIELD_M15_G1_2	Group 1, -15V sensor power supply output 2.
C10	VF_24V_G1_1	Group 1, +24V field power supply input 1.

Pin	Signal Name	Description
C11	VF_24V_G1_2	Group 1, +24V field power supply input 2.
C12	VF_RTN_G1	Group 1, field power supply return.
C13	PASSIVE_PULSE_POS_G2_1	Group 2, Channel 1, Positive Passive Speed input
C14	PASSIVE_PULSE_NEG_G2_1	Group 2, Channel 1, Negative Passive Speed input
C15	PASSIVE_PULSE_MID_G2_1	Group 2, Channel 1, Passive Speed input Bias
C16	VFIELD_P15_G2_1	Group 2, +15V sensor power supply output 1.
C17	VFIELD_M15_G2_1	Group 2, -15V sensor power supply output 1.
C18	VFIELD_P15_G2_2	Group 2, +15V sensor power supply output 2.
C19	VFIELD_M15_G2_2	Group 2, -15V sensor power supply output 2.
C20	VF_24V_G2_1	Group 2, +24V field power supply input 1.
C21	VF_24V_G2_2	Group 2, +24V field power supply input 2.
C22	VF_RTN_G2	Group 2, field power supply return.
C23	PASSIVE_PULSE_POS_G3_1	Group 3, Channel 1, Positive Passive Speed input
C24	PASSIVE_PULSE_NEG_G3_1	Group 3, Channel 1, Negative Passive Speed input
C25	PASSIVE_PULSE_MID_G3_1	Group 3, Channel 1, Passive Speed input Bias
C26	VFIELD_P15_G3_1	Group 3, +15V sensor power supply output 1.
C27	VFIELD_M15_G3_1	Group 3, -15V sensor power supply output 1.
C28	VFIELD_P15_G3_2	Group 3, +15V sensor power supply output 2.
C29	VFIELD_M15_G3_2	Group 3, -15V sensor power supply output 2.
C30	VF_24V_G3_1	Group 3, +24V field power supply input 1.
C31	VF_24V_G3_2	Group 3, +24V field power supply input 2.
C32	VF_RTN_G3	Group 3, field power supply return.

Table 3 Field Interface Connector Pin Assignment (Column C)

2.4. Trusted Module Polarisation/Keying

All Trusted Modules have been keyed to help prevent insertion into the wrong position within a Chassis. The polarization comprises two parts; the Module, and the associated field cable.

Each Module type has been keyed during manufacture. The organization responsible for the integration of the Trusted System must key the cable by removing the keying pieces from the cable so that they correspond with the bungs fitted to the associated Module prior to fitting.

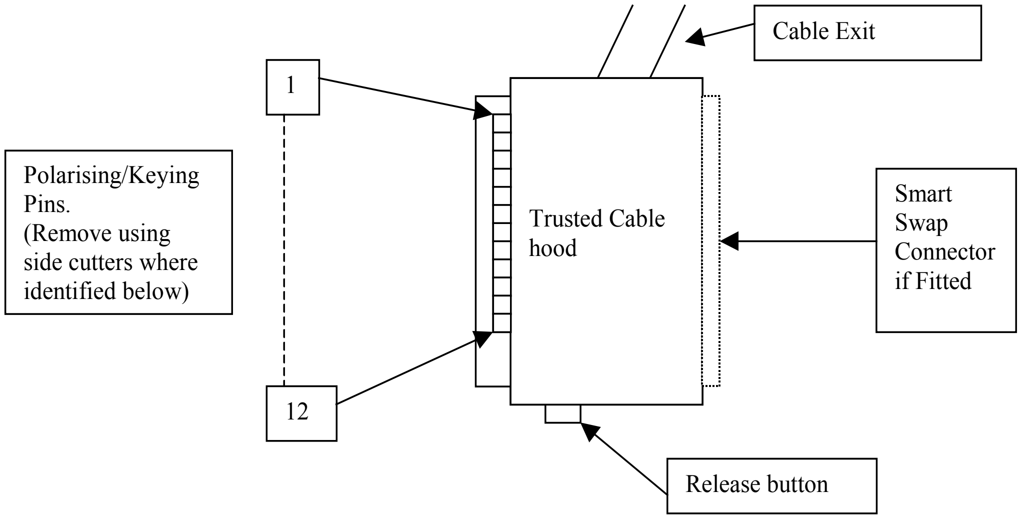

Figure 4 Module Polarisation

For Cables with Companion Slot installations both keying strips must be polarized.

For this Module (T8442) remove keying pins 1, 8 and 9.

3. Application

3.1. System Configuration

This section details Speed Monitor operating parameters that can be configured through the System Configuration tool.

Figure 5 shows the Speed Monitor configuration template in the System Configuration tool. The tool allows configuration of all user adjustable operating parameters required by the Speed Monitor. The configuration parameters become part of the resulting System.INI file which is then transferred to the Trusted TMR Processors. The configuration parameters are passed from the TMR Processors to the Speed Monitor Module during initialization.

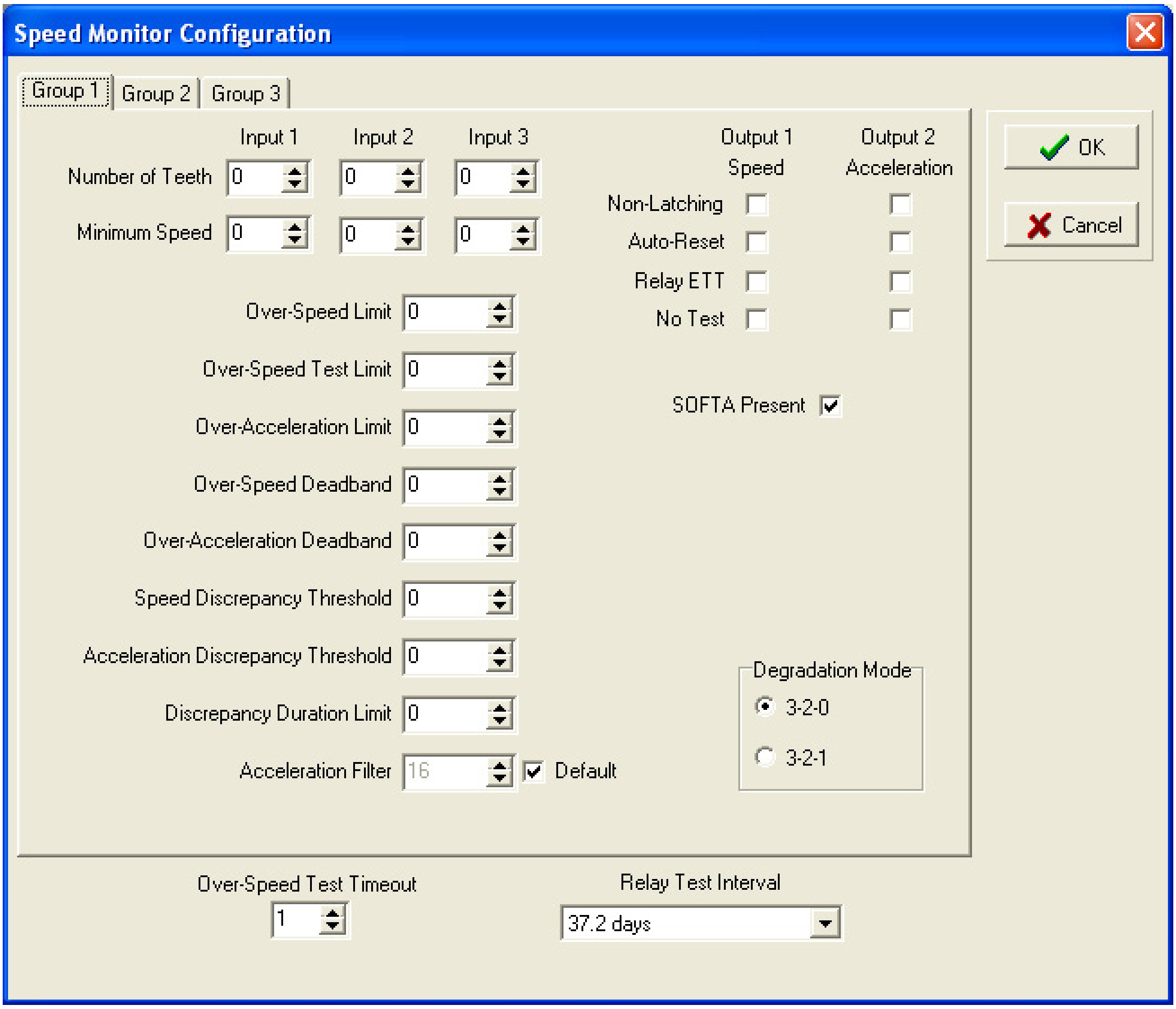

Figure 5 Group 1 Configuration Tab

3.1.1. Number of Teeth

This field can be set for each of the three input channels within a group.

The input value configures the number of teeth on the speed sensor gearwheel. It is used to scale the reported rotational speed in RPM.

The range of values that can be used for this field are 0 to 1000. The default value is zero.

If the number of teeth is set to zero, the channel will be considered disconnected and at zero speed. When the digital pulse train signal is 1/3rd Hz or less the input is considered to be at “zero speed”. Zero speed is required for all inputs in a group in order to modify certain configuration settings.

The configuration will appear in the Speed Monitor Configuration template as:

TEETH <group> <chan> <numteeth>

3.1.2. Minimum Speed

This field can be set for each of the three input channels within a group.

The input value configures the minimum speed below which channel discrepancy reporting is inhibited.

The FMIN units are RPM.

The range of values that can be used for this field are 0 to 30000. The value must be less than or equal to the Over-Speed Limit. The default value is 0, meaning the channel speed is always factored into the discrepancy reporting for the group. This configuration variable is needed for sensors, such as variable reluctance magnetic pickups that do not operate down to DC.

The configuration will appear in the Speed Monitor Configuration Speed Monitortemplate as:

FMIN <group> <chan> <rpm>

3.1.3. Over-Speed Limit

This field can be set for each input group.

The input value configures the over-speed threshold ceiling in RPM. This defines the maximum over-speed threshold level that can be set through the application interface. The over-speed output will trip when the speed is greater than, or equal to, the configured threshold.

The range of values that can be used for this field are 0 to 30000. The default value is zero.

If the limit is set to zero, the over-speed trip threshold for the group will be disabled (i.e. it will always be tripped).

The configured limit may only be increased if the group is at zero speed.

The configuration will appear in the Speed Monitor Configuration Speed Monitortemplate as:

OSL <group> <rpm>

3.1.4. Over-Speed Test Limit

This field can be set for each input group (see also Over-speed Test Timeout). The input value configures the over-speed test threshold ceiling in RPM. This defines the maximum over-speed test threshold level that can be set through the application interface.

The range of values that can be used for this field are 0 to 30000. The default value is zero.

If the limit is set to zero, the over-speed test threshold for the group will be disabled (i.e. always tripped when Over-Speed Test mode is enabled).

The configured limit may only be increased if the group is at zero speed.

The configuration will appear in the Speed Monitor Configuration Speed Monitortemplate as:

OST <group> <rpm>

3.1.5. Over-Acceleration Limit

This field can be set for each input group.

The input value configures the over-acceleration threshold ceiling in RPM/second. This defines the maximum over-acceleration threshold level that can be set through the application interface. The over-acceleration output will trip when the acceleration is greater than, or equal to, the configured threshold.

The range of values that can be used for this field are 0 to 10000. The default value is zero.

If the limit is set to zero, the over-acceleration trip threshold for the group will be disabled (i.e. always tripped).

The configured limit may only be increased if the group is at zero speed.

The configuration will appear in the Speed Monitor Configuration Speed Monitortemplate as:

OAL <group> <rpm_per_sec>

3.1.6. Over-Speed Deadband

This field can be set for each input group.

The input value configures the over-speed trip deadband (hysteresis) in RPM.

The deadband value defines the speed at which a tripped over-speed output will revert to the non-tripped condition. The over-speed output will revert to the non-tripped condition at a speed determined by (OSL - OSDB). Where OSL is the Over-speed Limit and OSDB is the Over-speed Deadband. OSDB is used in both normal and over-speed test modes.

Note: The associated over-speed output relay will not automatically return to the non-tripped state unless it is configured with the non-latching attribute. Refer to section 3.1.13.

The range of values that can be used for this field are 0 to 30000. The default value is zero.

The configured deadband value may only be decreased when the group is at zero speed.

Consider the following example:

> A channel has been configured with an over-speed trip threshold of 2000 RPM and an over-speed deadband value of 100 RPM.
>
> The channel will trip when the speed reaches or exceeds 2000 RPM and will not revert to the non-tripped state until the speed falls to 1900 RPM or less.

The configuration will appear in the Speed Monitor configuration template as:

OSDB <group> <rpm>

3.1.7. Over-Acceleration Deadband

This field can be set for each input group.

The input value configures the over-acceleration trip deadband in RPM/second.

The deadband value defines the acceleration value at which a tripped over-acceleration output will revert to the non-tripped condition. The over-acceleration output will revert to the non-tripped condition at an acceleration determined by (OAL - OADB). Where OAL is the Over-acceleration Limit and OADB is the Over-acceleration Deadband.

Note: The associated Over-acceleration output relay will not automatically return to the non-tripped state unless it is configured with non-latching attribute. Refer to section 3.1.13.

The range of values that can be used for this field are 0 to 10000. The value must be less than or equal to the Over-acceleration Limit. The default value is zero.

The configured deadband value may only be decreased when the group is at zero speed.

Consider the following example:

> A channel has been configured with an over-acceleration trip threshold of 1000 RPM/second and an Over-acceleration Deadband value of 950 RPM/second.
>
> The channel will trip when the acceleration reaches or exceeds 1000 RPM/second and will not revert to the non-tripped state until the acceleration falls to 50 RPM/second or less.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

OADB <group> <rpm>

3.1.8. Speed Discrepancy Threshold

This field can be set for each input group.

The input value configures the maximum speed discrepancy in RPM that can be tolerated between the three channels within a group.

The range of values that can be used for this field are 0 to 10000. The value must be less than or equal to the Over-speed Limit. The default value is zero. The configured value may be adjusted when the group is at zero speed.

If the speed discrepancy between channels within the same group exceeds this configured value, for a period exceeding the configured Discrepancy Duration Limit (see 3.1.10), then the discrepant channel is declared faulty.

Speed discrepancy detection is disabled for input channels operating below the configured Minimum Speed (see 3.1.2) or configured with zero teeth (see 3.1.1).

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

SPEED_D <group> = <rpm>

3.1.9. Acceleration Discrepancy Threshold

This field can be set for each input group.

The input value configures the maximum acceleration discrepancy in RPM/second that can be tolerated between the three channels within a group.

The range of values that can be used for this field are 0 to 10000. The value must be less than or equal to the Over-acceleration Limit. The default value is zero. The configured value may be adjusted when the group is at zero speed.

If the acceleration discrepancy between channels within the same group exceeds this configured value, for a period exceeding the configured Discrepancy Duration Limit (see 3.1.10), then the discrepant channel is declared faulty.

Acceleration discrepancy detection is disabled for input channels operating below the configured Minimum Speed (see 3.1.2) or configured with zero teeth (see 3.1.1).

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

ACC_D <group> = <rpm_per_second>

3.1.10. Discrepancy Duration Limit

This field can be set for each input group.

The input value configures the time limit in milliseconds, after which discrepant channels within a group are declared faulty.

The range of values that can be used for this field are 0 to 65535. The default value is zero. The configured value may be adjusted when the group is at zero speed. A value of 0 will disable both speed and acceleration discrepancy latching (i.e. discrepant channels will not be declared as faults).

The discrepancy timer automatically resets when a previously discrepant channel returns below the discrepancy threshold.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

D_DUR <group> = <milliseconds>

3.1.11. Acceleration Filter

This field can be set for each input group.

The input value configures the number of speed samples that are averaged together to produce an acceleration value. Larger values result in less acceleration noise, but greater response time.

The range of values that can be used for this field are from 0 to 40 (excluding 1 which is not accepted). The default value is 16.

A value of 0 will yield the default filter value, which is 16 samples. The boxcar averaging length is equal to num_samples-1 multiplied by the sample time. The sample time is 6 milliseconds.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

ACC_F <group> = <num_samples>

3.1.12. Acceleration Filter Default Checkbox

This checkbox can be set for each input group.

Setting this checkbox to the ticked state forces the Acceleration Filter to its default value.

3.1.13. Output Non-Latching Checkbox

This checkbox can be set for each output within a group.

Setting this checkbox to the ticked state will configure the associated output as non-latching. If the checkbox is clear the associated output will be configured as latching.

In non-latching mode an output trip condition will only persist while the speed or acceleration value for the group exceeds the configured threshold, taking into account the configured deadband.

In latching mode (default) an output trip condition will persist until the associated output is explicitly cleared through the application interface or by the auto-reset function (see

3.1.14). A latched output trip cannot be cleared through the application interface if the input trip condition still persists.

The default mode of operation is latching outputs.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

NO_LATCH <group> <chan> <0|1>

Channel 0 is for the over-speed output, and channel 1 is for the over-acceleration output within a group.

Mode 0 is latching and 1 is non-latching.

3.1.14. Output Auto-Reset Checkbox

This checkbox can be set for each output within a group.

If an output has been configured as latching (see 3.1.13), setting this checkbox to the ticked state will configure the output for automatic trip reset. For outputs that are configured as non-latching, this configuration item has no effect.

Clearing the checkbox (default) will disable the automatic reset function for that output.

In Auto-Reset mode an output trip condition for a latching output will be automatically reset when the group is at zero speed.

The default mode of operation is for automatic reset to be disabled.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

AUTO_RST <group> <chan> <0|1>

Channel 0 is for the over-speed output, and channel 1 is for the over-acceleration output within a group.

3.1.15. Relay Energize to Trip (ETT) Checkbox

This checkbox can be set for each output within a group.

This parameter only affects the load current monitoring mechanism and does not influence the output relay coil drivers, which always operate in the de-energize to trip mode.

Setting this checkbox to the ticked state will configure the associated output load current monitoring for energized to trip operation, i.e. load current is expected only when the output is tripped.

If the checkbox is cleared (default), the output load current monitoring will be configured for de-energized to trip operation, i.e. load current is not expected when the output is tripped.

The default mode of operation is for de-energized to trip outputs, and requires the load to be connected to the normally open output terminals. When energize to trip operation is selected, the load must be connected to the normally closed pair of output terminals.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

ETT <group> <chan> <0|1>

Channel 0 is for the over-speed output, and channel 1 is for the over-acceleration output within a group.

3.1.16. No Test Checkbox

This checkbox can be set for each output within a group.

Setting the checkbox to the ticked state will disable relay testing on the associated output.

If the checkbox is cleared, relay testing will be enabled on the associated output.

The default mode of operation is for relay testing to be enabled.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

NO_RLY_TST <group> <chan> <0|1>

Channel 0 is for the over-speed output, and channel 1 is for the over-acceleration output within a group.

3.1.17. SOFTA Present Checkbox

This checkbox can be set for each group.

If the checkbox is ticked, the Speed Output Field Termination Assembly (SOFTA) is considered to be in use and the front panel indicators will be enabled for normal operation.

Clearing the checkbox will disable Front Panel indicators on the associated group. In this configuration the SOFTA is considered to be unused.

The default mode of operation is for the SOFTA to be in use.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

SOFTA <group> <0|1>

A value of 1 indicates the SOFTA is in use.

3.1.18. Degradation Mode Radio Buttons

This pair of radio buttons can be set for each group.

If the 3-2-0 button is selected, the group input degradation will be configured as 3-2-0. In this mode, operation with a single sensor is not possible. The over-speed and over-acceleration outputs will both trip when only one sensor remains available to the group.

If the 3-2-1 button is selected, the group input degradation will be configured as 3-2-1. In this mode, operation with a single sensor is possible. The over-speed and over-acceleration outputs will both operate normally with only one sensor available to the group.

The default mode of operation is for 3-2-0 degradation.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

NO_DEGRD <group> <0|1>

A value of 0 indicates 3-2-0 degradation mode.

3.1.19. Over-speed Test Timeout

This field can be set globally for the Module. (see also, over-speed test limit 3.1.4)

The input value configures the maximum time period in minutes that a group can remain in over-speed test mode.

If an over-speed test is initiated and an over-speed or zero speed event fails to occur within the configured time limit, the group will be automatically removed from over-speed test mode and the normal over-speed threshold will be restored for that group.

The range of values that can be used for this field are 0 to 120.

The default timeout value is 0 minutes.

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

OST_TOUT <minutes>

3.1.20. Relay Test Selector

This selector field can be set globally for the Module.

The selection in this field configures the behavior of the automatic relay tests.

There are three behavior types:

- Automatic relay testing disabled.
- A test time interval may be selected. Relay contact transition tests are performed on each quadrant of the output structure at the interval specified. Background coil testing is enabled in this mode.

- Only relay coil testing enabled. Relay contact transition tests are not performed in this mode.

Table 4 shows each of the behaviors available for selection.

The time intervals available for selection determine the configured rate at which the output relay quadrants are automatically tested.

The default behavior is for automatic relay testing to be disabled.

Number	Relay Test
0	All automatic relay testing is disabled.
1	Relay quadrant test interval = 37.2 days Relay coil testing is enabled.
2	Relay quadrant test interval = 18.6 days Relay coil testing is enabled.
3	Relay quadrant test interval = 9.30 days Relay coil testing is enabled.
4	Relay quadrant test interval = 4.65 days Relay coil testing is enabled.
5	Relay quadrant test interval = 2.33 days Relay coil testing is enabled.
6	Relay quadrant test interval = 27.9 hrs Relay coil testing is enabled.
7	Relay quadrant test interval = 14.0 hrs Relay coil testing is enabled.
8	Relay quadrant test interval = 6.98 hrs Relay coil testing is enabled.
9	Relay quadrant test interval = 3.48 hrs Relay coil testing is enabled.
10	Relay quadrant test interval = 1.74 hrs Relay coil testing is enabled.
11	Relay quadrant test interval = 52.4 min Relay coil testing is enabled.
12	Relay quadrant test interval = 26.3 min Relay coil testing is enabled.

Number	Relay Test
13	Relay quadrant test interval = 13.1 min Relay coil testing is enabled.
14	Relay quadrant test interval = 6.54 min Relay coil testing is enabled.
15	Relay quadrant test interval = 3.27 min Relay coil testing is enabled.
16	Relay quadrant test interval = 1.64 min Relay coil testing is enabled.
17	Only relay coil testing enabled. The relay contacts will not be exercised.

Table 4 Relay Test Interval

The configuration will appear in the Speed Monitor Configuration Speed Monitor template as:

RLY_T_TIME <number>

See Table 4 for reference to <number>. The default value is 0 (disabled).

3.2. IEC 61131 Toolset Complex Equipment Definition

This section details the Speed Monitor application interface as seen through the IEC 61131 TOOLSET. Figure 6 shows a view of the I/O connection screen with one TMR Processor and one Speed Monitor installed.

As shown in the figure, the T8442 Speed Monitor I/O Complex Equipment Definition includes ten I/O boards, referenced by rack number (See Table 5):

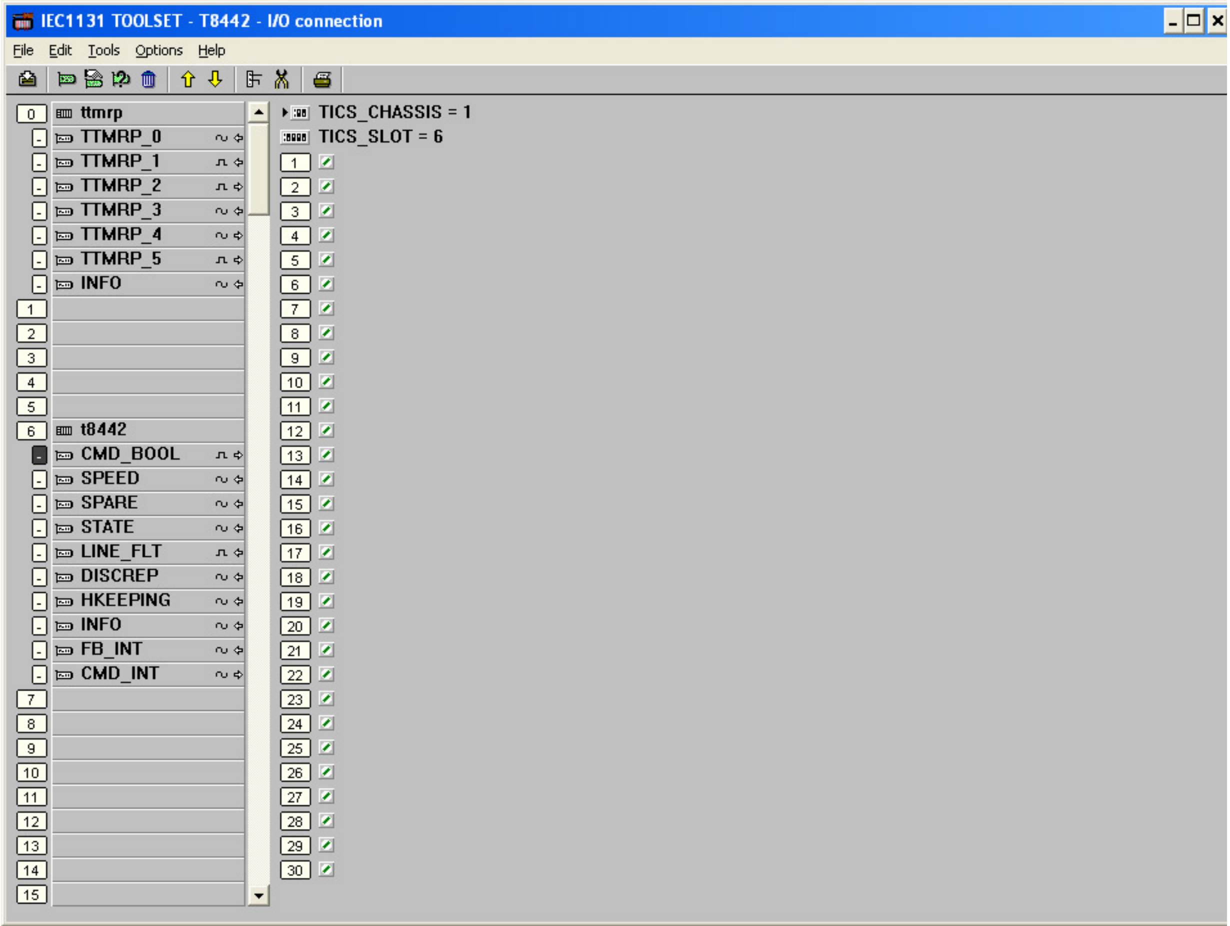

Figure 6 Complex Equipment Definition

Rack	I/O Board	Description	Data Type	Direction	No. of Channels
1	CMD_BOOL	OEM Parameters	-	-	-
		Commands	Boolean	Out	30
2	SPEED	Speed & Acceleration	Integer	In	27
3	SPARE	Spare	Integer	In	40
4	STATE	I/O Channel Status	Integer	In	24
5	LINE_FLT	Line Fault Status	Boolean	In	21
6	DISCREP	Channel Discrepancy	Integer	In	3
7	HKEEPING	Housekeeping Registers	Integer	In	63
8	INFO	I/O Module Information	Integer	In	11
9	FB_INT	Threshold feedback	Integer	In	65

Rack	I/O Board	Description	Data Type	Direction	No. of Channels
10	CMD_INT	Commands	Integer	Out	21

Table 5 Complex Equipment Definition

There are two OEM parameters included in the first rack. These OEM parameters define the primary module position by declaring the Module's chassis and slot location. There is no need to define the secondary module position within the IEC 61131 TOOLSET. Where systems may be required to start-up with a Module in the secondary position as the Active Module, e.g. the primary module is not installed when the application is started, then the secondary module's position should be declared in the Module definition dialog of the System Configuration Manager.

OEM Parameter	Description	Notes
TICS_CHASSIS	The number of the Trusted Chassis where the primary Speed Monitor is installed	The Trusted Controller Chassis is 1, and Trusted Expander Chassis are 2 to 15.
TICS_SLOT	The slot number in the Chassis where the primary Speed Monitor is installed	The I/O Module slots in the Trusted Controller chassis are numbered from 1 to 8. The I/O Module slots in the Trusted Expander Chassis are numbered from 1 to 12.

Table 6 OEM Parameters

3.2.1. Rack 1 CMD_BOOL (Command Booleans)

<table>
<tr><th>Ch.</th><th>Channel Description</th><th>Detail</th></tr>
<tr><td>1</td><td>Group 1 Over-speed command enable</td><td rowspan="6">Command Enable:
Enables the outputs to be controlled by the command channels through the application interface.
Command Enable = 1
The output will assume the state of the associated command channel (rack 1, channels 7 to 12) as set through the application interface.
An output trip condition as determined by the Speed MonitorSpeed Monitor will always prevail over output states set through the application interface.
If communications with the main processor are lost or the application is stopped, the outputs will assume the tripped state.
Command Enable = 0
The outputs will operate under normal under Speed Monitor control. Configured shutdown states are ignored.</td></tr>
<tr><td>2</td><td>Group 1 Over-acceleration command enable</td></tr>
<tr><td>3</td><td>Group 2 Over-speed command enable</td></tr>
<tr><td>4</td><td>Group 2 Over-acceleration command enable</td></tr>
<tr><td>5</td><td>Group 3 Over-speed command enable</td></tr>
<tr><td>6</td><td>Group 3 Over-acceleration command enable</td></tr>
<tr><td>7</td><td>Group 1 Over-speed command</td><td rowspan="6">Command:
The state that will be assumed by the output if the associated command enable channel is asserted.
Command = 0
If the associated command enable channel (rack 1, channels 1 to 6) is asserted the output will trip (transition to the de-energized relay state).
Command = 1
Speed Monitor operation is unaffected.
An output trip condition as determined by the Speed Monitor will always prevail over output states set through the application interface.</td></tr>
<tr><td>8</td><td>Group 1 Over-acceleration command</td></tr>
<tr><td>9</td><td>Group 2 Over-speed command</td></tr>
<tr><td>10</td><td>Group 2 Over-acceleration command</td></tr>
<tr><td>11</td><td>Group 3 Over-speed command</td></tr>
<tr><td>12</td><td>Group 3 Over-acceleration command</td></tr>
<tr><td>13</td><td>Group 1 Over-speed test enable</td><td rowspan="3">Over-speed Test Enable:
Temporarily increases the over-speed trip threshold to the over-speed test threshold.
There is a Module-wide timeout set in the system configuration which is applied to this function. (See 3.1.19)
Over-speed Test Enable = 1.
The temporary over-speed test threshold is enabled.
Over-speed Test Enable = 0.
The temporary over-speed test threshold is disabled.
The over-speed test threshold is automatically disabled by the following:
The over-speed test enable command is negated.
An over-speed trip occurs.
An over-speed test timeout for this group occurs.
All inputs for the group are at zero speed.
The over-speed test state may be read through rack 4, channels 22 to 24.</td></tr>
<tr><td>14</td><td>Group 2 Over-speed test enable</td></tr>
<tr><td>15</td><td>Group 3 Over-speed test enable</td></tr>
</table>

Ch.	Channel Description	Detail
16	Group 1 Over-speed trip reset	Trip Reset: The 0=>1 transition of this signal is used to reset latching outputs that have been tripped. Trip Reset = 1 Resets the trip state of the associated output. This has no effect if the trip condition is still in force. Trip Reset = 0 Speed Monitor operation is unaffected.
17	Group 1 Over-acceleration trip reset	
18	Group 2 Over-speed trip reset	
19	Group 2 Over-acceleration trip reset	
20	Group 3 Over-speed trip reset	
21	Group 3 Over-acceleration trip reset	
22	Group 1, Channel 1, Maximum RPM reset.	Maximum RPM Reset: Used to clear the stored maximum speed value recorded for an individual input channel. Maximum RPM Reset = 1 Clears the stored maximum speed value for the associated input channel. Maximum RPM Reset = 0 Speed Monitor operation is unaffected.
23	Group 1, Channel 2, Maximum RPM reset.	
24	Group 1, Channel 3, Maximum RPM reset.	
25	Group 2, Channel 1, Maximum RPM reset.	
26	Group 2, Channel 2, Maximum RPM reset.	
27	Group 2, Channel 3, Maximum RPM reset.	
28	Group 3, Channel 1, Maximum RPM reset.	
29	Group 3, Channel 2, Maximum RPM reset.	
30	Group 3, Channel 3, Maximum RPM reset.	

Table 7 Rack 1: CMD_BOOL

3.2.2. Rack 2 SPEED (Speed Integers)

Ch.	Channel Description	Detail
1	Group 1, Channel 1, RPM	Revolutions Per Minute: The instantaneous RPM value for each of the input channels. The values reported are scaled as 1 bit per RPM.
2	Group 1, Channel 2, RPM	
3	Group 1, Channel 3, RPM	
4	Group 2, Channel 1, RPM	
5	Group 2, Channel 2, RPM	
6	Group 2, Channel 3, RPM	
7	Group 3, Channel 1, RPM	
8	Group 3, Channel 2, RPM	
9	Group 3, Channel 3, RPM	
10	Group 1, Channel 1, Peak RPM	Maximum RPM: The maximum RPM value recorded for each input channel. The values are stored in non-volatile memory on the Speed Monitor. This verifies that the values are retained across power-cycles, Module boot-cycles and hot-swaps to partner Modules. The values reported are scaled as 1 bit per RPM.
11	Group 1, Channel 2, Peak RPM	
12	Group 1, Channel 3, Peak RPM	
13	Group 2, Channel 1, Peak RPM	
14	Group 2, Channel 2, Peak RPM	
15	Group 2, Channel 3, Peak RPM	
16	Group 3, Channel 1, Peak RPM	
17	Group 3, Channel 2, Peak RPM	
18	Group 3, Channel 3, Peak RPM	
19	Group 1, Channel 1, acceleration	Acceleration: The boxcar filtered acceleration value for each of the input channels. The values reported are scaled as 1 bit per RPM/second. The filter value is determined by the system configuration file (see 3.1.11).
20	Group 1, Channel 2, acceleration	
21	Group 1, Channel 3, acceleration	
22	Group 2, Channel 1, acceleration	
23	Group 2, Channel 2, acceleration	
24	Group 2, Channel 3, acceleration	
25	Group 3, Channel 1, acceleration	
26	Group 3, Channel 2, acceleration	
27	Group 3, Channel 3, acceleration	

Table 8 Rack 2: SPEED

3.2.3. Rack 3 SPARE (Reserved)

Not used.

3.2.4. Rack 4 STATE (State Integers)

Ch.	Channel Description	Detail
1	Group 1, Channel 1, Input State	Input State: The digital input state for each of the sensor inputs. State = 0: State invalid State = 1: DC low (gear valley) State = 2: DC high (gear tooth) State = 3: Sensor fault (channel discrepancy) State = 4: Normal operating speed range State = 5: Over-acceleration trip threshold exceeded State = 6: Over-speed trip threshold exceeded State = 7: Faulted or state unknown Note: State 1 and State 2 will only be reported when no new tooth data is received within 3 seconds. i.e. If at least one tooth is detected every three seconds then the channel will be reported as NORMAL State 4. State 3 will be reported while the input is discrepant unless the time exceeds the configured Discrepancy Duration Limit (see 3.1.10) at which point the channel will be declared as faulted and state 7 will be reported.
2	Group 1, Channel 2, Input State	
3	Group 1, Channel 3, Input State	
4	Group 2, Channel 1, Input State	
5	Group 2, Channel 2, Input State	
6	Group 2, Channel 3, Input State	
7	Group 3, Channel 1, Input State	
8	Group 3, Channel 2, Input State	
9	Group 3, Channel 3, Input State	
10	Group 1, Over-speed coil drive state	Coil Drive State: The digital output state for each of the coil drive outputs. Coil Drive State = 0: Invalid Coil Drive State = 1: No Coil Vfield Coil Drive State = 2: Coil de-energized Coil Drive State = 3: Load contacts not connected Coil Drive State = 4: Coil energized Coil Drive State = 5: Not used Coil Drive State = 6: Field Fault. Current is detected when there should be none. Coil Drive State = 7: Faulted or state unknown Note that there are 4 coils for each output channel. The reported state reflects the summary state of all the coils associated with the given channel.
11	Group 1, Over-acceleration coil drive state	
12	Group 2, Over-speed coil drive state	
13	Group 2, Over-acceleration coil drive state	
14	Group 3, Over-speed coil drive state	
15	Group 3, Over-acceleration coil drive state	
16	Group 1, Over-speed trip state	Trip State: The output trip state for each of the output channels. Trip State = 2: Channel Tripped Trip State = 4: Channel Not Tripped All other states are invalid.
17	Group 1, Over-acceleration trip state	
18	Group 2, Over-speed trip state	
19	Group 2, Over-acceleration trip state	
20	Group 3, Over-speed trip state	
21	Group 3, Over-acceleration trip state	

Ch.	Channel Description	Detail
22	Group 1, Over-speed test state	Over-speed test state: Reports if the group over-speed test is still in effect or has expired due to a timeout, trip, or reset. Test State = 0: Not in test mode Test State = 1: Test mode is active All other states are invalid.
23	Group 2, Over-speed test state	
24	Group 3, Over-speed test state	

Table 9 Rack 4: STATE

3.2.5. Rack 5 LINE_FLT (Line Fault Integers)

Ch.	Channel Description	Detail
1	Group 1, Channel 1, Input line fault	Input Line Fault: Asserted TRUE by the System Main Processor if a Speed Monitor input reports a line fault (State 3) in Rack 4, channels 1 through 9. State 3 is determined by an algorithm that monitors the input dynamically. Line Fault Input = 0: Normal Line Fault Input = 1: Line fault
2	Group 1, Channel 2, Input line fault	
3	Group 1, Channel 3, Input line fault	
4	Group 2, Channel 1, Input line fault	
5	Group 2, Channel 2, Input line fault	
6	Group 2, Channel 3, Input line fault	
7	Group 3, Channel 1, Input line fault	
8	Group 3, Channel 2, Input line fault	
9	Group 3, Channel 3, Input line fault	
10	Group 1, Over-speed coil line fault	Coil Line Fault: Asserted by the System Main Processor if a Speed Monitor coil drive output reports a fault (All states except 2 & 4) in Rack 4, channels 10 through 15. Coil line fault = 0: Normal Coil line fault = 1: Line fault
11	Group 1, Over-acceleration coil line fault	
12	Group 2, Over-speed coil line fault	
13	Group 2, Over-acceleration coil line fault	
14	Group 3, Over-speed coil line fault	
15	Group 3, Over-acceleration coil line fault	
16	Reserved	Reserved for future use.
17		
18		
19		
20		
21		

Table 10 Rack 5: LINE_FLT

3.2.6. Rack 6 DISCREP (Discrepancy Integers)

Ch.	Bit	Channel Description	Detail
1	0	Discrepancy Group 1, Channel 1, RPM	RPM Discrepancy: Flags if an RPM value discrepancy has been detected between the TMR slices for longer than the configured discrepancy duration limit Bit = 0: Normal Bit = 1: RPM value discrepancy
	1	Discrepancy Group 1, Channel 2, RPM	
	2	Discrepancy Group 1, Channel 3, RPM	
	3	Discrepancy Group 2, Channel 1, RPM	
	4	Discrepancy Group 2, Channel 2, RPM	
	5	Discrepancy Group 2, Channel 3, RPM	
	6	Discrepancy Group 3, Channel 1, RPM	
	7	Discrepancy Group 3, Channel 2, RPM	
	8	Discrepancy Group 3, Channel 3, RPM	
	9	Discrepancy Group 1 Over-speed coil drive state	Coil Drive Discrepancy: Flags if a coil drive state discrepancy has been detected between the TMR slices for longer than the configured discrepancy duration limit Bit = 0: Normal Bit = 1: Drive state discrepancy
	10	Discrepancy Group 1 Over-acceleration coil drive state	
	11	Discrepancy Group 2 Over-speed coil drive state	
	12	Discrepancy Group 2 Over-acceleration coil drive state	
	13	Discrepancy Group 3 Over-speed coil drive state	
	14	Discrepancy Group 3 Over-acceleration coil drive state	
	15	Discrepancy Group 1 Over-speed trip state	Trip Discrepancy: Flags if an output trip state discrepancy has been detected between the TMR slices for longer than the configured discrepancy duration limit Bit = 0: Normal Bit = 1: Trip state discrepancy Note: The bit packed states for trip discrepancy span channels 1 and 2 of this rack.
2	0	Discrepancy Group 1 Over-acceleration trip state	
	1	Discrepancy Group 2 Over-speed trip state	
	2	Discrepancy Group 2 Over-acceleration trip state	
	3	Discrepancy Group 3 Over-speed trip state	

Ch.	Bit	Channel Description	Detail
	4	Discrepancy Group 3 Over-acceleration trip state	
	5	Discrepancy Group 1 Over-speed test state	Over-speed Test State Discrepancy: Flags if an over-speed test state discrepancy has been detected between the TMR slices for longer than the configured discrepancy duration limit Bit = 0: Normal Bit = 1: Over-speed test state discrepancy
	6	Discrepancy Group 2 Over-speed test state	
	7	Discrepancy Group 3 Over-speed test state	
	8 - 15	Reserved for future use.	Reserved: These bits are reserved for future use. Bit = 0: Normal.
3	0 - 15	Reserved for future use.	Reserved: These bits are reserved for future use. Bit = 0: Normal.

Table 11 Rack 6: DISCREP

3.2.7. Rack 7 HKEEPING (Housekeeping Integers)

Ch.	Channel Description	Detail
1	Slice A, 24V2 Input Voltage	HIU Housekeeping: 24V1 Input Supply Voltage The 24V1 Input supply voltage to the Speed Monitor is reported as an analogue value, scaled in mV. Range: -32768 mV to 32767 mV
2	Slice B, 24V2 Input Voltage	
3	Slice C, 24V2 Input Voltage	
4	Slice A, Internal supply voltage (post regulator)	HIU Housekeeping: Internal Supply Voltage The Internal supply voltage (post regulator) is reported as an analogue value, scaled in mV. Range: -32768 mV to 32767 mV
5	Slice B, Internal supply voltage (post regulator)	
6	Slice C, Internal supply voltage (post regulator)	
7	Slice A, Internal supply current (post regulator)	HIU Housekeeping: Internal Supply Current The Internal supply current (post regulator) is reported as an analogue value, scaled in mA. Range: -32768 mV to 32767 mA
8	Slice B, Internal supply current (post regulator)	
9	Slice C, Internal supply current (post regulator)	
10	Slice A, Input voltage (post isolation)	HIU Housekeeping: Input Voltage The Input supply voltage (post isolation) is reported as an analogue value, scaled in mV. Range: -32768 mV to 32767 mV
11	Slice B, Input voltage (post isolation)	
12	Slice C, Input voltage (post isolation)	
13	Slice A, 24V1 Input Voltage	HIU Housekeeping: 24V2 Input Supply Voltage The 24V2 Input supply voltage to the Speed Monitor is reported as an analogue value, scaled in mV. Range: -32768 mV to 32767 mV
14	Slice B, 24V1 Input Voltage	
15	Slice C, 24V1 Input Voltage	

Ch.	Channel Description	Detail
16	Slice A, HIU Board Temperature (Note: Temperature, °C = input value / 256)	HIU Housekeeping: HIU Temperature The Speed Monitor HIU temperature is reported as an analogue value. To determine the temperature in °C, the analogue value must be divided by 256. Range: -32768 units to 32767 units Which corresponds to: Range: -128 °C to 128 °C
17	Slice B, HIU Board Temperature (Note: Temperature, °C = input value / 256)	
18	Slice C, HIU Board Temperature (Note: Temperature, °C = input value / 256)	
19	Slice A Front Panel Load Current	HIU Housekeeping: Front Panel Load Current The front panel load current is reported as an analogue value, scaled in mA. Range: -32768 mV to 32767 mA
20	Slice B Front Panel Load Current	
21	Slice C Front Panel Load Current	
22	Slice A, Smart-Slot link Voltage	HIU Housekeeping: Smart-Slot Link Voltage The Smart-Slot link voltage is reported as an analogue value, scaled in mV. Range: -32768 mV to 32767 mV
23	Slice B, Smart-Slot link Voltage	
24	Slice C, Smart-Slot link Voltage	
25	Slice A, Group 1, Over-speed Relay Contact Current	FIU Housekeeping: Output Relay Contact Current The output relay contact current is reported as an analogue value, scaled in mA. The reported value is the sum of the currents flowing in each shared contact path. Range: -32768 mA to 32767 mA. This value is non-linear outside of the range 0-250 mA.
26	Slice B, Group 1, Over-speed Relay Contact Current	
27	Slice C, Group 1, Over-speed Relay Contact Current	
28	Slice A, Group 1, Over-acceleration Relay Contact Current	
29	Slice B, Group 1, Over-acceleration Relay Contact Current	
30	Slice C, Group 1, Over-acceleration Relay Contact Current	
31	Slice A, Group 2, Over-speed Relay Contact Current	
32	Slice B, Group 2, Over-speed Relay Contact Current	
33	Slice C, Group 2, Over-speed Relay Contact Current	
34	Slice A, Group 2, Over-acceleration Relay Contact Current	
35	Slice B, Group 2, Over-acceleration Relay Contact Current	
36	Slice C, Group 2, Over-acceleration Relay Contact Current	
37	Slice A, Group 3, Over-speed Relay Contact Current	
38	Slice B, Group 3, Over-speed Relay Contact Current	
39	Slice C, Group 3, Over-speed Relay Contact Current	
40	Slice A, Group 3, Over-acceleration Relay Contact Current	
41	Slice B, Group 3, Over-acceleration Relay Contact Current	
42	Slice C, Group 3, Over-acceleration Relay Contact Current	

Ch.	Channel Description	Detail
43	Slice A, Group 1, 24V Field Supply 1 Voltage	FIU Housekeeping: 24V Field Supply Voltage The 24V field supply voltage is reported as an analogue value, scaled in mV. Range: 0 mV to 65535 mV
44	Slice B, Group 1, 24V Field Supply 1 Voltage	
45	Slice C, Group 1, 24V Field Supply 1 Voltage	
46	Slice A, Group 1, 24V Field Supply 2 Voltage	
47	Slice B, Group 1, 24V Field Supply 2 Voltage	
48	Slice C, Group 1, 24V Field Supply 2 Voltage	
49	Slice A, Group 2, 24V Field Supply 1 Voltage	
50	Slice B, Group 2, 24V Field Supply 1 Voltage	
51	Slice C, Group 2, 24V Field Supply 1 Voltage	
52	Slice A, Group 2, 24V Field Supply 2 Voltage	
53	Slice B, Group 2, 24V Field Supply 2 Voltage	
54	Slice C, Group 2, 24V Field Supply 2 Voltage	
55	Slice A, Group 3, 24V Field Supply 1 Voltage	
56	Slice B, Group 3, 24V Field Supply 1 Voltage	
57	Slice C, Group 3, 24V Field Supply 1 Voltage	
58	Slice A, Group 3, 24V Field Supply 2 Voltage	
59	Slice B, Group 3, 24V Field Supply 2 Voltage	
60	Slice C, Group 3, 24V Field Supply 2 Voltage	
61	Slice A, Diagnostic Error Code	Diagnostic Error Code: The most recent diagnostic error code from each slice is reported as an unsigned value. See Table 13 for T8442 Specific error codes.
62	Slice B, Diagnostic Error Code	
63	Slice C, Diagnostic Error Code	

Table 12 Rack 7: HKEEPING

3.2.8. T8442 Specific Diagnostic Error Codes

Error Code	'm'	'n'	Name	Fault Condition
0x5000			SFIU_FIA_COMM_ERR (Q1)	Communication error, SFIU FIA, Quad 1
0x5001			SFIU_FIA_COMM_ERR (Q2)	Communication error, SFIU FIA, Quad 2
0x5002			SFIU_FIA_COMM_ERR (Q3)	Communication error, SFIU FIA, Quad 3
0x5003			SFIU_FIA_COMM_ERR (Q4)	Communication error, SFIU FIA, Quad 4
0x5004			SFIU_FIA_COMM_ERR (ALL)	Communication error, SFIU FIA, All Quads
0x5005			HSIU_RAM_TEST_FAULT	Any fault in free RAM
0x5006			HSIU_RAM_PAGE_FAULT	Any fault in free RAM that is related to RAM

Error Code	'm'	'n'	Name	Fault Condition
				paging
0x5007			SFIU_ISLSEQ_FAULT	Improper progression of ISL Sequence Reg
0x5008			SFIU_DSCRP_TST_LATE	Systematic type of problem with ISL discrepancy test scheduling
0x5009			HSIU_RELAY_CMD_CHECKSUM_ER R	Relay Command Checksum error
0x5010			SFIU_ISO_POWER_FAULT (Q1)	All speed channels faulted in Q1
0x5011			SFIU_ISO_POWER_FAULT (Q2)	All speed channels faulted in Q2
0x5012			SFIU_ISO_POWER_FAULT (Q3)	All speed channels faulted in Q3
0x5013			HSIU_ACCUM_TSTAMP_DISCREP	TSTAMP(n) - TSTAMP(n-1) /= ACCUM
0x5014			SFIU_IO_TEST_REG_SLICE_DISCREP	Inter-slice discrepancy of IO_TEST register
0x5015			SFIU_IO_TEST_REG_ERR	IO_TEST register disabled with "no fault"
0x5016			SFIU_TEST_CTRL_REG_ERR	Incorrect data in test control register
0x5020		Op 0-5	SFIU_TRIP_AUTO_RESET	Auto-reset of a 1oo3 trip that persisted for too long.
0x5030		Op 0-5	SFIU_TRIP_AUTO_TRIP	2oo3 trip that coerced a 3oo3 trip to maintain congruency.
0x5040		Op 0-5	SFIU_TRIP_AUTO_RE_TRIP	Re-trip after an auto-reset to prevent a spurious drive signal.
0x51mn	Qd 0-2	Inp 0-8	SFIU_SPEED_CHAN_INDEP_FAULT	TEST_COUNT > 1 on non-tested channel
0x52mn	Qd 0-2	Inp 0-8	SFIU_SPEED_CHAN_FAULT	TEST_COUNT < 2 on tested channel
0x53mn	Qd 0-2	Inp 0-8	SFIU_SPEED_CHAN_QUAD_DISCRE P	Tooth Period discrep between quads
0x5500			VFMON_RESPONSE_ERROR	reserved fault code
0x5600			SFIU_XMON_COUNT_ERR	reserved fault code
0x5700			SFIU_IMON_AV_DC_ERR	reserved fault code
0x5800			SFIU_VMON_AV_DIFF_ERR	reserved fault code
0x605n		Op 0-5	SFIU_STUCK_ON_FAULT	Relay is commanded OFF and IMON (2 legs) > Imin
0x606n		Qd 0-3	SFIU_CMD_RESP_ERR	Static or latent PWR_ENA, TEST_ANYWAY, or TEST_ENABLE fault
0x6070			SFIU_STUCK_OFF_FAULT	reserved fault code

Error Code	'm'	'n'	Name	Fault Condition
0x6080			SFIU_STUCK_X_FAULT	reserved fault code
0x6090		Qd 0-3	SFIU_LNK_DSCRP_CMD_TST	Latent CMD_ERR_A/B/C
0x60A0		Qd 0-3	SFIU_LNK_DSCRP_CFG_TST	Latent CFG_ERR_A/B/C
0x60B0		Qd 0-3	SFIU_LNK_DSCRP_CMD_ERR	Static CMD_ERR_A/B/C
0x60C0		Qd 0-3	SFIU_LNK_DSCRP_CFG_ERR	Static CFG_ERR_A/B/C
0x60Dn		Inp 0-8	SFIU_RPM_DISCREP	Slice to Slice RPM discrepancy
0x60En		Inp 0-8	SFIU_ACCEL_DISCREP	Slice to Slice Acceleration discrepancy
0x61mn	Qd 0-3	Op 0-5	SFIU_RELAY_CONTACT_TST	Latent Relay Contact fault
0x62mn	Qd 0-1	Gp 0-2	SFIU_RELAY_CONTACT_ERR	Static Relay Contact fault (ACCUM > 0)
0x63mn	Qd 0-3	Op 0-5	SFIU_RELAY_IMON_TST	Latent Relay Current fault
0x64mn	Qd0Lg0 thruQd1Lg1	Op 0-5	SFIU_RELAY_IMON_ERR	Static Relay Current vs. Command fault
0x65mn	Qd 0-3	Op 0-5	SFIU_RELAY_DRIVE_TST	Latent relay command or DIAG fault
0x66mn	Qd 0-3	Op 0-5	SFIU_RELAY_DRIVE_ERR	Static relay command or DIAG fault
0x67mn	Qd 0-3	Op 0-5	SFIU_RELAY_CONTACT_XTALK_FAULT	Crosstalk between relay contacts, group to group
0x680n		Qd 0-3	SFIU_HKAD_ERR (PMON)	PMON threshold error
0x681n		Gp 0-2	SFIU_HKAD_ERR (24V1)	24V1 threshold error
0x682n		Gp 0-2	SFIU_HKAD_ERR (24V2)	24V2 threshold error
0x683n		Gp	SFIU_HKAD_ERR (15V1)	15V1 threshold error

Error Code	'm'	'n'	Name	Fault Condition
		0-2		
0x684n		Gp 0-2	SFIU_HKAD_ERR (15V2)	15V2 threshold error
0x69mn	Qd 0-1	Gp 0-2	SFIU_IMON_SAMPLE_ERR	IMON sample count out-of-range
0x6Amn	Qd 0-1	Gp 0-2	SFIU_VMON_SAMPLE_ERR	VMON sample count out-of-range
0x6Bmn	Qd 0-1	Gp 0-2	SFIU_CONTACT_SAMPLE_ERR	Relay Contact sample count out-of-range
0x6Cmn	Qd 0-3	Op 0-5	SFIU_RELAY_DRIVE_XTALK_FAULT	Crosstalk between relay commands, or DIAGs
0x6Cmn	4+ (Qd 0-3)	Op 0-5	SFIU_RELAY_IMON_XTALK_FAULT	Crosstalk between relay IMONs
0x6D0n		Op 0-5	SFIU_IMON_QUAD_DISCREP (LEG1)	IMON Leg1 Q1-Q2 Discrepancy
0x6D1n		Op 0-5	SFIU_IMON_QUAD_DISCREP (LEG2)	IMON Leg2 Q1-Q2 Discrepancy
0x6D3n		Op 0-5	SFIU_RLY_IMON_LEG_DISCREP	IMON Leg to Leg Imbalance
0x6E0n		Gp 0-2	SFIU_VMON_QUAD_DISCREP (24V1)	24V1 Q1-Q2 Discrepancy
0x6E1n		Gp 0-2	SFIU_VMON_QUAD_DISCREP (24V2)	24V2 Q1-Q2 Discrepancy
0x6E2n		Gp 0-2	SFIU_VMON_QUAD_DISCREP (15V1)	15V1 Q1-Q2 Discrepancy
0x6E3n		Gp 0-2	SFIU_VMON_QUAD_DISCREP (15V1)	15V2 Q1-Q2 Discrepancy
0x6F0n		Gp 0-2	SFIU_CONTACT_QUAD_DISCREP	Relay Contact Q1-Q2 Discrepancy

Table 13 Specific Diagnostic Error Codes

3.2.9. Rack 8 INFO (Information Integers)

Ch.	Bit	Description	Detail
1	-	Active Module chassis number	Active Module chassis number: This indicates the chassis location of the currently active Speed Monitor.
2	-	Active Module slot number	Active Module slot number: This indicates the slot location within the chassis of the currently active Speed Monitor. This value will dynamically change on Active/Standby Module changeover to reflect the change in Active/Standby Module location.
3	-	Active Module healthy	Active Module healthy: This indicates the health status of the active Speed Monitor. Healthy = 0: A fault has been detected Healthy = 1: Normal
4	-	Active Module state	Active module state: This indicates the current operating mode of the active Speed Monitor. State = 0: Unknown, Module not present or offline. State = 1: Configuration mode State = 2: Standby mode State = 3: Active mode State = 4: Maintain mode State = 5: Shutdown mode This would normally indicate state 3, although other states may be indicated on Module initialization and during an Active/Standby changeover. All other states are invalid.
5	-	Standby Module chassis number	Standby Module chassis number: This indicates the chassis location of the standby Speed Monitor.
6	-	Standby Module slot number	Standby Module slot number: This indicates the slot location within the chassis of the standby Speed Monitor. This value will dynamically change on Active/Standby Module changeover to reflect the change in Active/Standby Module location.
7	-	Standby Module healthy	Standby Module healthy: This indicates the health status of the standby Speed Monitor. Healthy = 0: A fault has been detected Healthy = 1: Normal
8	-	Standby Module state	Standby Module state: This indicates the current operating mode of the standby

Ch.	Bit	Description	Detail
			Speed Monitor. State = 0: Unknown, Module not present or offline. State = 1: Configuration mode State = 2: Standby mode State = 3: Active mode State = 4: Maintain mode State = 5: Shutdown mode All other states are invalid. This would normally indicate state 2, although other states may be indicated on Module initialization and during an Active/Standby changeover.
9	0	Active Module FCR A Healthy	Active Module FCR healthy: These flag the health status of each of the TMR fault containment regions (slices) on the active Speed Monitor. Healthy = 0: A slice fault has been detected Healthy = 1: Normal
	1	Active Module FCR B Healthy	
	2	Active Module FCR C Healthy	
	3	Active Module Ejectors Open	Active module ejectors open: This flags the state of the Active module ejectors. Ejectors open = 0: Both front panel ejectors are closed. Ejectors open = 1: Both front panel ejectors are open. Note: If a single ejector changes state this flag will not change. i.e. if both ejectors are closed and then one is opened the flag will still report closed.
	4	Standby Module FCR A Healthy	Standby Module FCR healthy: These flag the health status of each of the TMR fault containment regions (slices) on the standby Speed Monitor. Healthy = 0: A slice fault has been detected Healthy = 1: Normal
	5	Standby Module FCR B Healthy	
	6	Standby Module FCR C Healthy	
	7	Standby Module Ejectors Open	Standby module ejectors open: This flags the state of the standby module ejectors. Ejectors open = 0: Both front panel ejectors are closed. Ejectors open = 1: Both front panel ejectors are open. Note: If a single ejector changes state this flag will not change. i.e. if both ejectors are closed and then one is opened the flag will still report closed.
	8 - 15	Reserved	Reserved for future use. Bit = 0
10	-	Active Module is the Primary module	Active Module is the primary module: This indicates if the primary module is the current Active Module, in the chassis and slot as defined within the OEM parameters. 1 = Secondary module is not active.

Ch.	Bit	Description	Detail
			0 = Secondary module is active.
11	-	Active Module is simulated	Active Module is simulated: This flags the simulated state for the Active Module. Simulated = 0: The Active Module is not simulated Simulated = 1: The Active Module is simulated. This will only be set if the Module is not present or non-operational and the simulation enable has been set within the Module configuration in the System.INI file.

Table 14 Rack 8: Information

3.2.10. Rack 9 FB_INT (Feedback Integers)

Ch.	Bit	Channel Description	Detail
1	-	Group 1, Over-speed threshold	Over-speed threshold: This reports the over-speed threshold values in use for each input group. The threshold value is reported in RPM.
2	-	Group 2, Over-speed threshold	
3	-	Group 3, Over-speed threshold	
4	-	Group 1, Over-acceleration threshold	Over-acceleration threshold: This reports the over-acceleration threshold values in use for each input group. The threshold value is reported in RPM/second.
5	-	Group 2, Over-acceleration threshold	
6	-	Group 3, Over-acceleration threshold	
7	-	Group 1, Over-speed test threshold	Over-speed test threshold: This reports the over-speed test threshold values in use for each input group. The threshold value is reported in RPM.
8	-	Group 2, Over-speed test threshold	
9	-	Group 3, Over-speed test threshold	
10	-	Group 1, Over-speed hysteresis	Over-speed hysteresis: This reports the over-speed hysteresis values in use for each input group. The hysteresis value is reported in RPM.
11	-	Group 2, Over-speed hysteresis	
12	-	Group 3, Over-speed hysteresis	
13	-	Group 1, Channel 1, Number of Teeth	Configured number of teeth. (See 3.1.1)
14	-	Group 1, Channel 2, Number of Teeth	
15	-	Group 1, Channel 3, Number of Teeth	
16	-	Group 2, Channel 1, Number of Teeth	
17	-	Group 2, Channel 2, Number of Teeth	
18	-	Group 2, Channel 3, Number of Teeth	

Ch.	Bit	Channel Description	Detail
19	-	Group 3, Channel 1, Number of Teeth	
20	-	Group 3, Channel 2, Number of Teeth	
21	-	Group 3, Channel 3, Number of Teeth	
22	-	Group 1, Over-speed Limit	Configured over-speed limit. (See 3.1.3)
23	-	Group 2, Over-speed Limit	
24	-	Group 3, Over-speed Limit	
25	-	Group 1, Over-speed Test Limit	Configured over-speed test limit. (See 3.1.4)
26	-	Group 2, Over-speed Test Limit	
27	-	Group 3, Over-speed Test Limit	
28	-	Group 1, Over-acceleration Limit	Configured over-acceleration limit. (See 3.1.5)
29	-	Group 2, Over-acceleration Limit	
30	-	Group 3, Over-acceleration Limit	
31	-	Group 1, Over-speed Deadband	Configured over-speed deadband. See 3.1.6
32	-	Group 2, Over-speed Deadband	
33	-	Group 3, Over-speed Deadband	
34	-	Over-speed Test Timeout	Configured over-speed test timeout value. (See 3.1.19)
35	-	Relay Test Interval	Configured relay test interval. See 3.1.20
36	-	Group 1, Channel 1, Sensor Minimum Speed	Configured sensor minimum speed value. (See 3.1.2)
37	-	Group 1, Channel 2, Sensor Minimum Speed	
38	-	Group 1, Channel 3, Sensor Minimum Speed	
39	-	Group 2, Channel 1, Sensor Minimum Speed	
40	-	Group 2, Channel 2, Sensor Minimum Speed	
41	-	Group 2, Channel 3, Sensor Minimum Speed	
42	-	Group 3, Channel 1, Sensor Minimum Speed	
43	-	Group 3, Channel 2, Sensor Minimum Speed	
44	-	Group 3, Channel 3, Sensor Minimum Speed	
45	-	Group 1, Over-acceleration Deadband	Configured over-acceleration deadband value. (See 3.1.7)
46	-	Group 2, Over-acceleration Deadband	
47	-	Group 3, Over-acceleration Deadband	
48	-	Group 1 Speed Discrepancy Threshold	Configured speed discrepancy threshold.
49	-	Group 2 Speed Discrepancy Threshold	

Ch.	Bit	Channel Description	Detail
50	-	Group 3 Speed Discrepancy Threshold	(See 3.1.8)
51	-	Group 1, Acceleration Discrepancy Threshold	Configured acceleration discrepancy threshold. (See 3.1.9)
52	-	Group 2, Acceleration Discrepancy Threshold	
53	-	Group 3, Acceleration Discrepancy Threshold	
54	-	Group 1, Discrepancy Duration Limit	Configured discrepancy duration value. (See 3.1.10)
55	-	Group 2, Discrepancy Duration Limit	
56	-	Group 3, Discrepancy Duration Limit	
57	-	Group 1, Acceleration Filter	Configured acceleration filter value. (See 3.1.11)
58	-	Group 2, Acceleration Filter	
59	-	Group 3, Acceleration Filter	
60	0	Group 1, Over-speed Output Latching	Configured output latching mode. (See 3.1.13)
	1	Group 1, Over-acceleration Output Latching	
	2	Group 2, Over-speed Output Latching	
	3	Group 2, Over-acceleration Output Latching	
	4	Group 3, Over-speed Output Latching	
	5	Group 3, Over-acceleration Output Latching	
	6 -15	Reserved	Reserved for future use. Bit = 0
61	0	Group 1, Over-speed Output Auto Reset	Configured output auto reset mode. (See 3.1.14)
	1	Group 1, Over-acceleration Output Auto Reset	
	2	Group 2, Over-speed Output Auto Reset	
	3	Group 2, Over-acceleration Output Auto Reset	
	4	Group 3, Over-speed Output Auto Reset	
	5	Group 3, Over-acceleration Output Auto Reset	
	6 - 15	Reserved	Reserved for future use. Bit = 0
62	0	Group 1, SOFTA Present	Group configuration for SOFTA. (See 3.1.17)
	1	Group 2, SOFTA Present	
	2	Group 3, SOFTA Present	
	3 - 15	Reserved	Reserved for future use. Bit = 0
63	0	Group 1, Degrade_3_2_1	Configured group degradation mode. (See 3.1.18)
	1	Group 2, Degrade_3_2_1	

Ch.	Bit	Channel Description	Detail
	2	Group 3, Degrade_3_2_1	
	3 - 15	Reserved	Reserved for future use. Bit = 0
64	0	Group 1, Over-speed Relay, Energize To Trip (ETT)	Configured output load current monitoring mode. (See 3.1.15)
	1	Group 1, Over-acceleration Relay, Energize To Trip (ETT)	
	2	Group 2, Over-speed Relay, Energize To Trip (ETT)	
	3	Group 2, Over-acceleration Relay, Energize To Trip (ETT)	
	4	Group 3, Over-speed Relay, Energize To Trip (ETT)	
	5	Group 3, Over-acceleration Relay, Energize To Trip (ETT)	
	6 - 15	Reserved	Reserved for future use. Bit = 0
65	0	Group 1, Over-speed Relay, No Relay Test	Configured relay test mode. (See 3.1.16)
	1	Group 1, Over-acceleration Relay, No Relay Test	
	2	Group 2, Over-speed Relay, No Relay Test	
	3	Group 2, Over-acceleration Relay, No Relay Test	
	4	Group 2, Over-speed Relay, No Relay Test	
	5	Group 2, Over-acceleration Relay, No Relay Test	
	6 - 15	Reserved	Reserved for future use. Bit = 0

Table 15 Rack 9: FB_INT

3.2.11. Rack 10 CMD_INT (Command Integers)

Ch.	Channel Description	Detail
1	Group 1, Set over-speed threshold	Set over-speed threshold: This sets the over-speed threshold values for each input group. This value comes into force immediately. The value will be ignored if it exceeds the configured absolute over-speed threshold limit. (see 3.1.3) A setting of zero forces the Speed Monitor to use the configured over-speed threshold value. The threshold units are RPM.
2	Group 2, Set over-speed threshold	
3	Group 3, Set over-speed threshold	
4	Group 1, Set over-acceleration threshold	Set over-acceleration threshold: This sets the over-acceleration threshold values for each
5	Group 2, Set over-acceleration threshold	

Ch.	Channel Description	Detail
6	Group 3, Set over-acceleration threshold	input group. This value comes into force immediately. The value will be ignored if it exceeds the configured absolute over-acceleration threshold limit (see 3.1.5). A setting of zero forces the Speed Monitor to use the configured over-acceleration threshold value. The threshold units are RPM/second.
7	Group 1, Set over-speed test threshold	Set over-speed test threshold: This sets the over-speed test threshold values for each input group. This value comes into force immediately. The value will be ignored if it exceeds the configured absolute over-speed test threshold limit (see 3.1.4). A setting of zero forces the Speed Monitor to use the configured over-speed test threshold value. The threshold units are RPM.
8	Group 2, Set over-speed test threshold	
9	Group 3, Set over-speed test threshold	
10	Group 1, Set over-speed deadband	Set over-speed deadband: This sets the over-speed deadband for each input group. This value comes into force immediately. This value is used in both normal and overs-peed test modes The value will be ignored if it is less than the configured deadband value. A setting of zero forces the Speed Monitor to use the configured over-speed deadband value (see 3.1.6). The deadband units are RPM.
11	Group 2, Set over-speed deadband	
12	Group 3, Set over-speed deadband	
13	Group 1, Channel 1, LED override.	Input channel LED override: This value overrides the input channel LED indicator state. Override = 0: LED is controlled by Module defaults. Override = 1: LED is Off Override = 2: LED is Red Override = 3: LED is Green Override = 4: LED is Amber Override = 5: Not used (LED is Off) Override = 6: LED is Red Flashing Override = 7: LED is Green Flashing
14	Group 1, Channel 2, LED override.	
15	Group 1, Channel 3, LED override.	
16	Group 2, Channel 1, LED override.	
17	Group 2, Channel 2, LED override.	
18	Group 2, Channel 3, LED override.	
19	Group 3, Channel 1, LED override.	
20	Group 3, Channel 2, LED override.	
21	Group 3, Channel 3, LED override.	

Table 16 Rack 10: CMD_INT

4. Operation

Status LED indicators on the front of the Module provide visual feedback of the Module's operational status, field input and output status. Each LED is a tri-color indicator. During normal operation only two colors are used; red and green which may be steady or flashing.

Located at the top and bottom of each Module Front Panel is an ejector lever that is used to remove the Module from the Chassis. Limit switches detect the open/closed position of the module ejector levers. The levers are normally latched closed when the Module is firmly seated into the Controller or Expander Chassis.

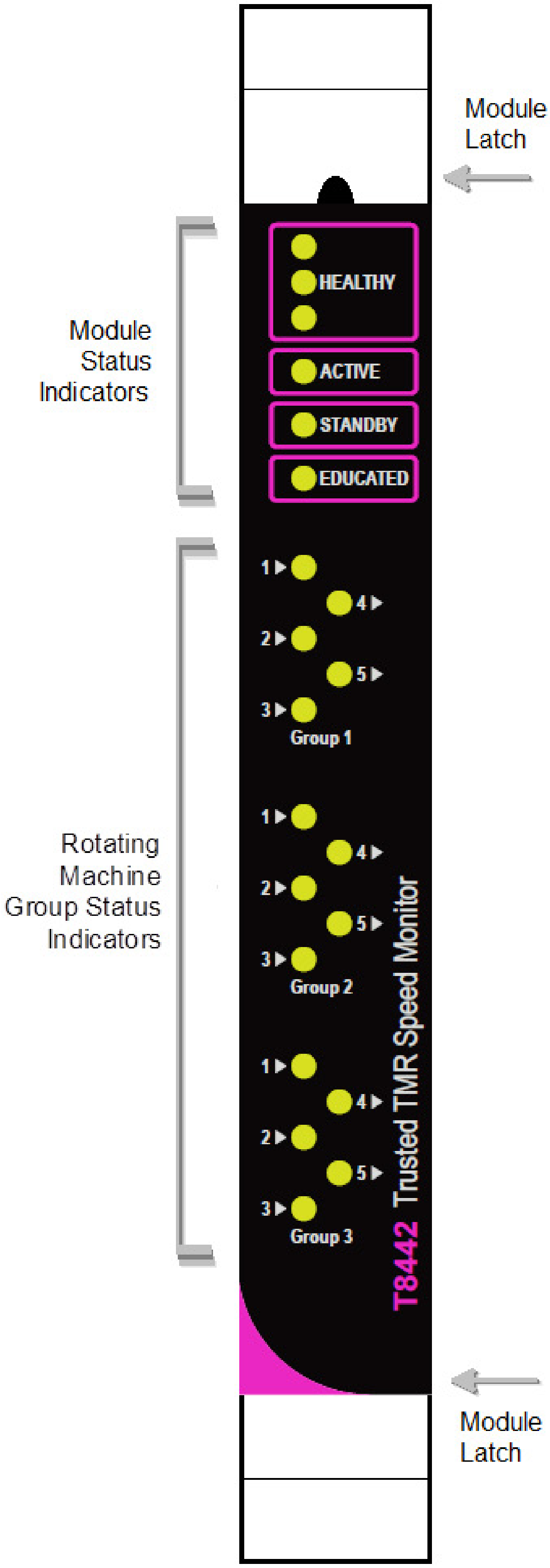

Figure 7 Module Front Panel

4.1. Module Status Indicators

There are six Module status indicators on the Module Front Panel; three Healthy, one Active, one Standby, and one Educated. The Healthy indicators are controlled directly by each Module slice. The Active, Standby, and Educated status from each of the three Module slices is 2oo3 voted by the FPU, and the indicators are set accordingly.

The Module status indicator states are described in Table 17.

Indicator	Indicator State	Description
Healthy	Off	No power applied to the Module.
	Amber	Slice is in the start-up state (momentary after installation or power-up).
	Green	Slice is healthy.
	Red – flashing	Fault present on the associated slice but the slice is still operational or one 24 V feed to the Chassis has failed.
	Red (momentary)	On installation – power applied to the associated slice.
	Red	The slice is offline. A critical fault has been detected and the slice disabled.
Active	Off	Module is not in the Active state.
	Green	Module is in the Active (or Maintain) state.
	Red – flashing	Module is in the shutdown state if the Standby LED is off.
	Red – flashing	Module is in the offline state if the Standby LED is also flashing.
Standby	Off	Module is not in the Standby state.
	Green	Module is in the Standby state.
	Red – flashing	Module is in the offline state. The Active LED will also be flashing red.

Indicator	Indicator State	Description
Educated	Off	Module is not educated.
	Green	Module is educated.
	Green – flashing	Module is recognized by the Processor but education is incomplete.
	Amber - flashing	Active/Standby changeover in progress.

Table 17 Module Status Indicators

4.2. Rotating Machine Group - Status Indicators

Front Panel status indication is provided for each rotating machine group.

Figure 8 shows the indicator arrangement for one rotating machine group.

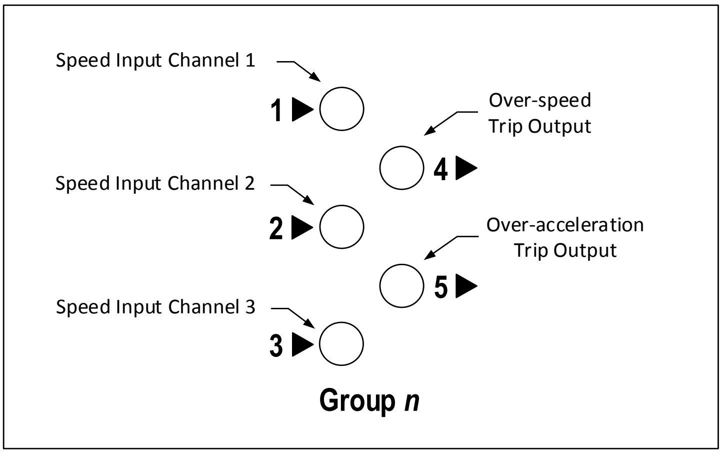

Figure 8 Rotating Machine Group Status Indicators

Speed input channels report their status as one of eight pre-defined Input states.

Table 18 shows the default relationship between the input operational state and its associated indicator state.

Input State	Description	Indicator State
0	State invalid	Off
1	DC low (gear valley)	Off
2	DC high (gear tooth)	Off
3	Sensor fault (channel discrepancy)	Green - flashing

Input State	Description	Indicator State
4	Normal operating speed range	Green
5	Over-acceleration trip threshold exceeded	Red
6	Over-speed trip threshold exceeded	Red
7	State faulted or unknown	Red - flashing

Table 18 Default Speed input Channel Status Indication

The Trip output channels also report their status as one of eight pre-defined states.

Table 19 shows the default relationship between the Trip output operational state and its associated indicator state.

Output State	Description	Indicator State
0	State invalid	Off
1	No Coil Vfield	Off
2	Coil de-energized	Off
3	Coil not connected	Green - flashing
4	Coil energized	Green
5	Not used	Red
6	Field fault	Red
7	State faulted or unknown	Red - flashing

Table 19 Default Relay Output Status Indication

Note: Although the Input and Output states are pre-defined, the System Configuration utility allows the user to individually associate Indicator states to both Input and Output states. This allows the user to create custom indication schemes for their application. This can be achieved by implementing the procedure for configuring the System.INI file detailed in Trusted Toolset Suite, publication ICSTT-RM249 (PD-T8082).

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5. Fault Finding and Maintenance

5.1. Fault Reporting

Input Module faults are reported to the user through visual indicators (LEDs) on the Front Panel of the Module. Faults are also reported via status variables which may be automatically monitored in the application programs, and external system communications interfaces. There are generally two types of faults that must be remedied by the user; external wiring and Module faults. External wiring faults require corrective action in the field to repair the fault condition. Module faults require replacement of the Input Module.

The Module monitors the speed input to determine if they are within the appropriate parameters.

5.2. Field Faults

The input circuits of the Module may be used to detect field wiring faults in addition to alarm states. To achieve this, line monitoring components must be fitted to the field device.

By comparing the input signal from the field with pre-configured alarm thresholds, the Module can automatically detect field wiring faults. When a field signal fails open or short-circuit, or to an intermediate value, the input channel status LED will flash red (default setting). The corresponding input state will be reported and the line fault status for that channel will be set to ‘1’. All other input channels will be unaffected, except in the case of common cause wiring faults in the field.

Note: A loss of a speed input is a safety critical fault. Once the field fault has been identified and corrected, the Processor RESET button must be pressed to clear the fault indication and then the input status and the input status LED will display the normal on/off status of the field device and field wiring.

5.3. Module Faults

Extensive diagnostics provide the automatic detection of Module faults. The TMR architecture of the Input Module and the diagnostics performed verify the validity of all critical circuits. Using the TMR architecture provides a fault tolerant method to withstand the first fault occurrence on the Module and continue normal input measurements without interruption in the system or process. Faults are reported to the user through the Healthy status LEDs on the Front Panel of the Module and through the INFO and HKEEPING variables. Under normal operations all three Healthy LEDs are green. When a fault occurs, one of the Healthy LEDs will flash red. It is recommended that this condition is investigated, and if the fault is within the Module, it should be replaced.

Module replacement activities depend on the type of spare module configuration chosen when the system was configured and installed. The Module may be configured with a dedicated Companion Slot for a spare replacement Module. SmartSlot operation is not available. Refer to Operator and Maintenance Manual for Module replacement procedure.

5.4. Companion Slot

For a Companion Slot configuration, two adjacent slots in a Trusted Chassis are configured for the same Input Module function. One slot is the primary slot and the other a unique secondary (or spare) slot. The two slots are joined at the rear of the Trusted Chassis with a double-wide I/O Interface Cable that connects both slots to common field wiring terminations. During normal operations, the primary slot contains the Active Module as indicated by the Active indicator on the Front Panel of the Module. The secondary slot is available for a spare Module that will normally be the Standby Module as indicated by the Standby indicator on the Front Panel of the Module.

Depending on the installation, a hot-spare Module may already be installed, or a Module blank will be installed in the Standby slot. If a hot-spare Module is already installed, transfer to the Standby Module occurs automatically if a Module fault is detected in the Active Module. If a hot-spare is not installed, the system continues operating from the Active Module until a spare Module is installed.

SmartSlot operation is not available on this Module.

5.5. Cold Start

If an I/O Module has shut down (due, for example, to two existing faults), the three Healthy LEDs will be red, the Active and Standby LEDs will be flashing red and the Educated LED will be flashing amber. The I/O functions provided by this Module will have been lost if a hot swap partner has not taken over control. The Module can only be restarted by removing it from its slot and re-inserting it.

If an I/O Module is inserted into a functional system slot which previously had no Active Module (e.g. removing and reinserting as above), then the Processor will educate the Module once it has booted. Once educated, the Educated LED will be steady green and the Active LED will be red flashing.

Input Modules will now be reading and reporting their inputs. Output Modules have not yet energized their outputs. To activate outputs and to set the Module’s Active LED and the Processor’s System Healthy LED steady green, press the Processor Reset pushbutton.

5.6. Transfer between Active and Standby Modules

The TMR Processor is responsible for managing a pair of I/O Modules through an Active/Standby changeover. The following rules apply to Active/Standby changeovers, though the TMR Processor and not the I/O Module enforces them:

- The user must define the primary, and optionally the secondary, I/O Module location for each I/O Module pair. Each primary module location must be unique and is defined as part of the complex equipment definition within the IEC 61131 TOOLSET. Secondary module locations can be unique or shared between multiple secondary modules and are defined within the Module's section within the System.INI file. The system will automatically determine the secondary module position if the primary module is installed and is operable.
- On initial start-up, if the primary module is installed, it will become the Active Module by default. If the secondary module has been defined within the System.INI file and no primary module is present, and if the secondary module location is unique, the secondary module will become the Active Module by default.
- In order for a Module to become the Active Module, the TMR Processor will verify that the Module is the correct I/O Module type and that both Module Removal levers (and hence micro switches) are closed. At this point the I/O Module is configured and eventually placed in the Active state.
- A module in the Active state should never be removed.
- When a fault occurs on the Active Module, the TMR Processor will be informed. Once it becomes aware of the fault, the TMR Processor will attempt an Active/Standby changeover.
- An Active/Standby changeover starts with the TMR Processor checking to see if a Standby I/O Module is installed. If no Standby I/O Module is available, the TMR Processor will continue to utilize the Active Module and will continue to check for an available Standby I/O Module. Once a Standby Module is found, the TMR Processor will verify that the I/O Module is of the correct type, that both Module Removal switches are closed, and that the I/O Module is a part of the correct Module pair by using the SmartSlot link. At this point, the TMR Processor will configure the Standby I/O Module with the same configuration information as the currently Active I/O Module and place the Standby I/O Module into the Standby state. The Active Module is then placed in the Maintain state (which suspends field loop testing), and any Module specific changeover data is transferred. The Educated light flashes amber before the Active/Standby changeover takes place, to indicate transfer of dynamic change over data (COD). The previous Standby Module then becomes the Active Module and the original Module becomes Standby. If the currently Active Module does not successfully complete the self-tests, the TMR Processor will revert

it to the Standby state, and the Module in the Maintain state will revert back to the Active state.

- When both Module Removal switches are opened on an Active Module, regardless of the Module fault status, the TMR Processor will treat it as a request to perform an Active/Standby changeover.

Under normal conditions, an Active/Standby changeover will only occur if the new Active Module is fault free. Under some circumstances, it is desirable to be able to force a changeover to a known faulted Module. This can be accomplished by opening the Module Removal switches on the currently Active Module and pressing the reset pushbutton on the TMR Processor. This will force the changeover to proceed even if the new Active Module is not fault free.

6. Specifications

The following tables apply to the interface signals existing between the T8442 Speed Monitor Module and the SIFTA and SOFTA. Refer to product descriptions Trusted Speed Monitor Input FTA (SIFTA), publication ICSTT-RM302 (PD-T8846) and Trusted Speed Monitor Output FTA (SOFTA), publication ICSTT-RM309 (PD-T8891) for the specifications relative to signal field connections.

6.1. Speed Input Specifications

Parameter	Min.	Typ.	Max.	Unit	Note
Speed input frequency range Active sensor			30000	Hz	
Speed input frequency range Passive sensor			30000	Hz	
Speed input duty cycle	20		80	%	Steady State
Speed input speed measurement resolution			±1	RPM	
Speed input accuracy			0.01	%	Of Full Scale or 1 RPM whichever is the greater
Speed input detection threshold dc coupled	200			mV pk-pk	Across entire frequency range

Table 20 Speed Input Specification

The following equation shows the relationship between RPM and number of teeth:

$$RPM = Frequency * \frac{60}{Number\ of\ Teeth}$$

The following graph demonstrates the acceptable range of input for the T8442 module. The outer boundary shows the maximum RPM a T8442 module can detect with a given number of teeth where the frequency is set to 30 KHz.

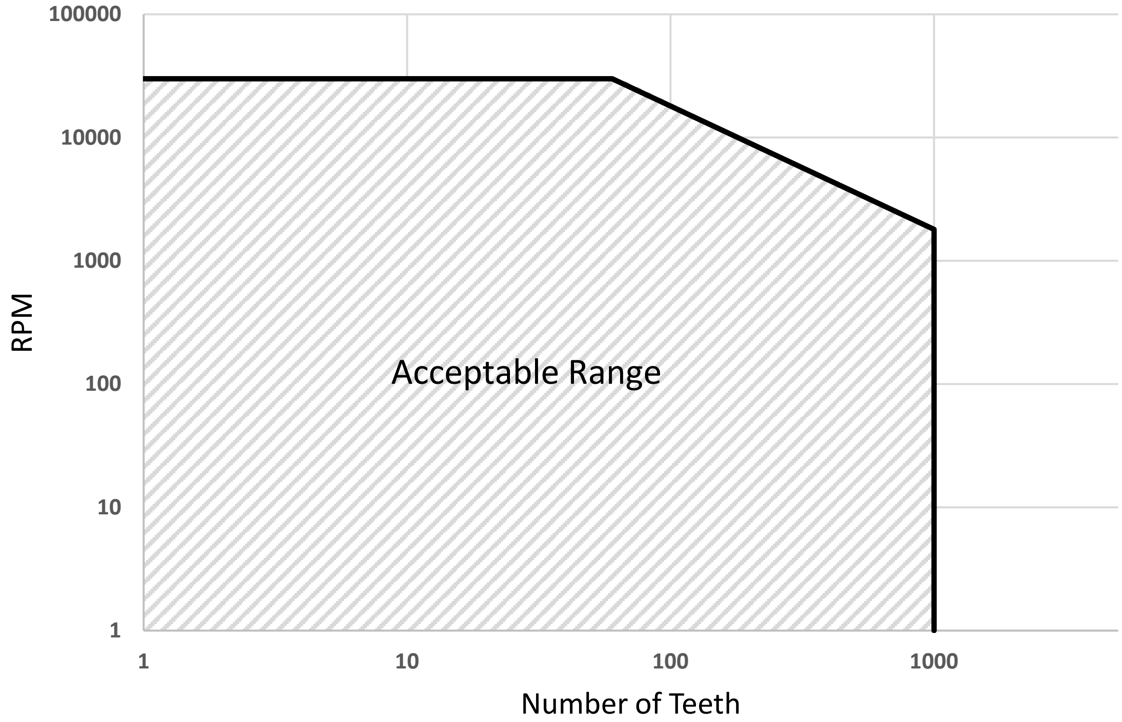

Figure 9 RPM vs Number of Teeth

6.2. Dual VField 24 V Power Supply Input Specifications

Parameter	Min	Typ.	Max	Unit	Note
Input voltage	18	24	32	Vdc	w.r.t. VField Return
Input protection					Fused with reverse polarity protection.

Table 21 Dual VField 24 V Power Supply Input Specifications

6.3. System Power Supply Input Specifications

Parameter	Min	Typ.	Max	Unit	Note
Input voltage	20	24	32	Vdc	
Power consumption		22		W	@ 24 Vdc Input voltage
Input protection					Fused with reverse polarity protection.

Table 22 System Power Supply Input Specifications

6.4. General Module Specifications

Parameter	Min	Typ.	Max	Unit	Note
Sequence of Events (SOE)					
Resolution		1		ms	
Accuracy	-0.5		0.5	ms	
Field Common Insulation					
Basic Insulation		250		Vdc/Vac_{rms}	
Maximum Impulse Withstand		2.5		kV	
Temperature					
Operating temperature	0		+60	°C	
Storage temperature	-25		+70	°C	
Temperature change			±0.5	°C/min	
Humidity					
Relative Humidity range (operating, storage and transport)	10		95	%	Non-condensing

Parameter	Min	Typ.	Max	Unit	Note
Dimensions					
Height		266 (10.5)		mm (in)	
Width		30 (1.2)		mm (in)	
Depth		303 (12)		mm (in)	
Weight		1.28 (2.8)		kg (lb)	

Table 23 General Module Specifications

Refer to product descriptions Trusted Speed Monitor Input FTA (SIFTA), publication ICSTT-RM302 (PD-T8846) and Trusted Speed Monitor Output FTA (SOFTA), publication ICSTT-RM309 (PD-T8891) for input and output requirements.

6.5. Environmental Specifications

For full environmental specifications refer to Trusted 8000 - Series B: International Safety & Environmental Approvals, publication ICSTT-TD003.