Trusted TMR 24 Vdc Zone Interface Module 40 Channel

Product Overview

The Trusted® TMR Zone Interface Module has been designed to provide a configurable interface specifically for use in Fire and Gas protection systems. The Module interfaces to up to 40 Fire and Gas field device inputs or actuators. Each of the 40 I/O Channels can be individually configured as Analogue Input, Digital Input or Digital Output to provide all of the interfaces needed to protect one or more Fire and Gas Zones. Interfacing to the field devices is through a Versatile Field Termination Assembly type 8842, which provides the field loop conditioning for each of the types of signal, and enables the connection of reset signals for latching type detectors without the need for external hardware. The Module is separated into 5 power groups each with 8 channels. Power groups can be combined together to provide a configurable number of channels for each Fire/Gas Zone. All of these functions provide data to the Trusted TMR System which acts as the logic solver. This Module is not approved for direct connection to hazardous areas and should be used in conjunction with Intrinsic Safety Barrier devices.

Triplicated diagnostic tests are performed throughout the Module, including measurements for current and voltage on each portion of voted input or output channels. Tests are also performed for stuck on and stuck off failures. All inputs are treated as analogue and are fully tested. Fault tolerance is achieved through a Triple Modular Redundant (TMR) architecture within the Module for each of the 40 channels.

Features:

- 40 Triple Modular Redundant selectable input/output points per Module.
- Inputs interface to 4-20 mA gas detectors, Fire and Heat detectors, Break Glass units etc.
- Programmable Field Device Reset signals (up to 5 individual resets).
- Two or Three Wire Field devices through 8842.
- Fuse Protection of Inputs and Outputs through 8842, external to the Module.
- High Power Digital Outputs to interface to Dampers, Extinguishant Release, Fire pumps etc.
- 5 Isolated Power Groups to allow flexible and efficient field configurations.

- Comprehensive automatic diagnostics and self-test.
- Automatic line monitoring per point to detect faults in field wiring and loads.
- 2500 V impulse withstand opto/galvanic isolation barrier.
- Automatic over-current protection (per channel), no external fuses required.
- On-board Sequence of Events (SOE) reporting with 1 ms resolution.
- Module can be hot-replaced on-line using dedicated Companion (adjacent) Slot or SmartSlot (one spare slot for many Modules) configurations.
- Front Panel output status Light Emitting Diodes (LEDs) for each channel indicate status and field wiring faults.
- Front Panel Module status LEDs indicate Module health and operational mode (Active, Standby, Educated).
- 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 please 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 help us to write better user documentation. If you discover an error, or have a suggestion on how to make this publication better, send your comment to our technical support group at http://rockwellautomation.custhelp.com

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 contain 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
7	July 05	Reformat Sect 3 Application Resistor Sect 1.5 Default Thresholds added
8	Feb 06	Format correction
9	Aug 06	Input power
10	Dec 06	Weights & Dims
11	Mar 07	Accuracy
12	Nov 07	STATE descriptions
13	Aug 08	Accuracy
14	Apr 10	Rack 7 changes
15	Jun 16	Rebranded and reformatted with correction to Relative Humidity Range and Operating Temperature statements in the Specification Section, also correcting any typographical errors. This Product Description has also been updated incorporating IEEE standards.
16	Apr 19	Updated Specifications section and main text to a more consistent format. Updated Front Panel section to updated product design. Updated content for the following sections: • 1.2 Field Interface Unit (FIU) • 1.3 Host Interface Unit (HIU) • 1.4 Front Panel Unit (FPU) • 1.7 Fault Detection and Testing • 3.4 System.INI File Configuration Updated Output Turn-on/off Delay specification. Updated document to display Rockwell Automation publication numbers. Added trademarks statement.

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Table of Contents

1. Description

The TMR Zone Interface Module is a member of the Trusted range of Input/Output (I/O) Modules. All Trusted I/O Modules share common functionality and form. At the most general level, all I/O Modules interface to the Inter-Module Bus (IMB) which provides power and allows communication with the TMR Processor. In addition, all Modules have a field interface that is used to connect to Module specific signals in the field. All Modules are Triple Modular Redundant (TMR).

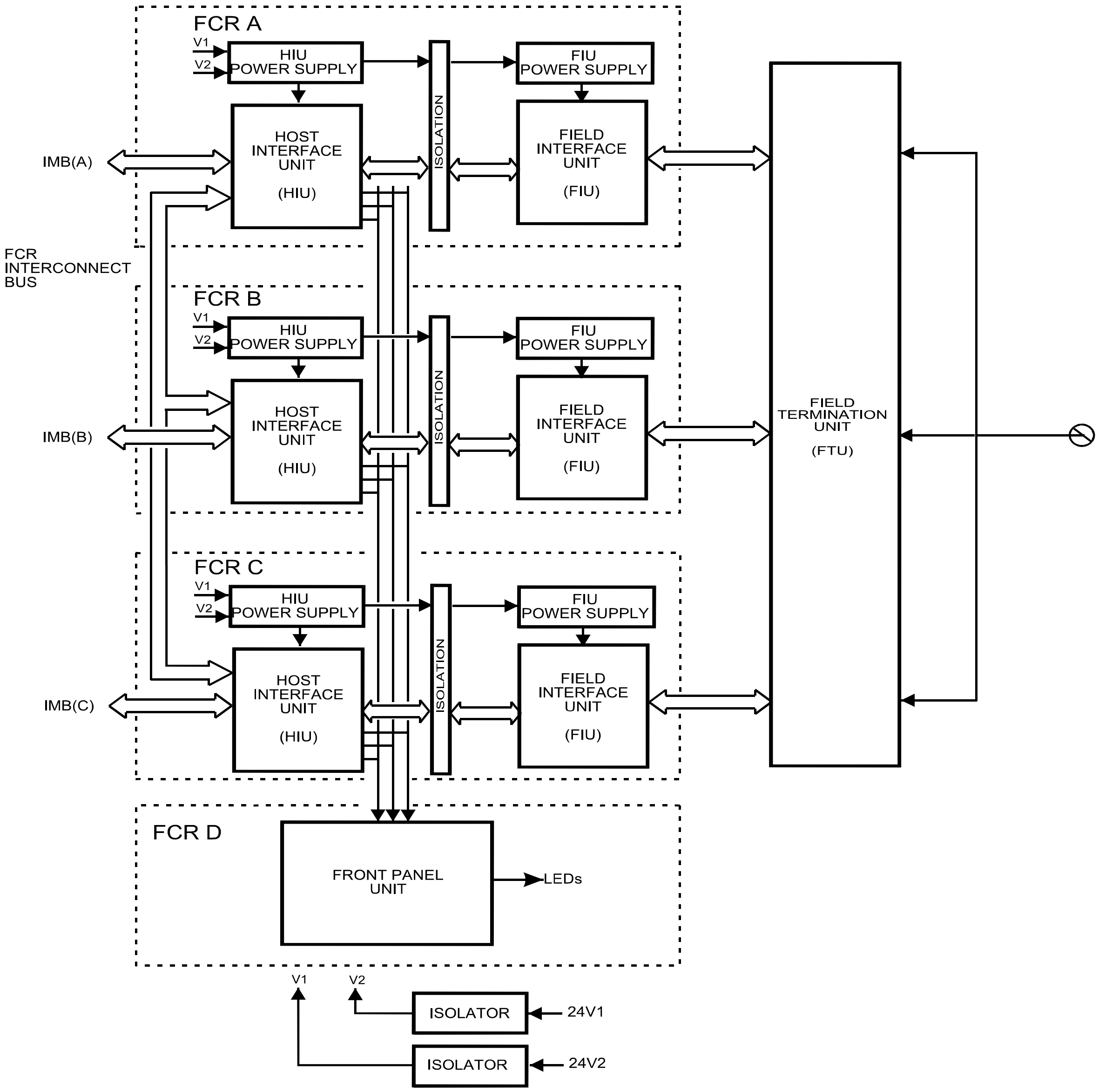

Figure 1 Module Architecture

All High Integrity I/O Modules are made up of 4 sections: Host Interface Unit (HIU), the Field Interface Unit (FIU), the Field Termination Unit (FTU), and the Front Panel Unit (or FPU).

Figure 2 shows a simplified block diagram of the Trusted Zone Interface Module.

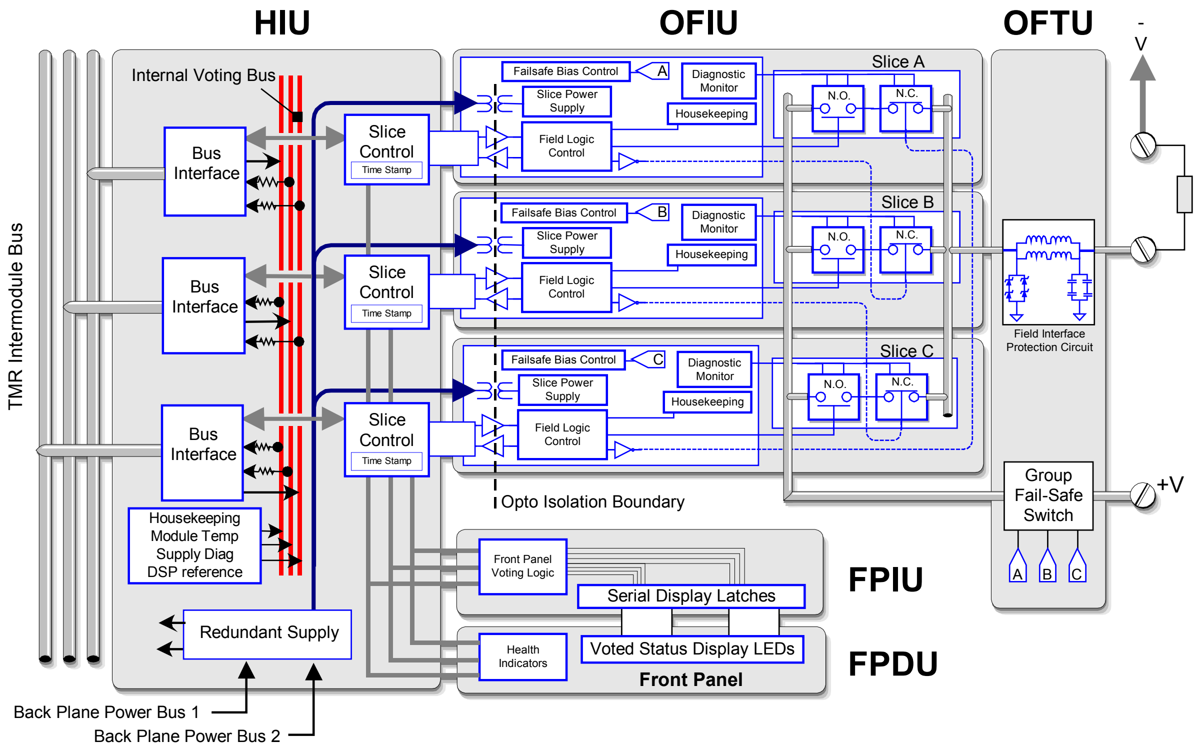

Figure 2 Function Block Diagram

1.1. Field Termination Unit (FTU)

The Field Termination Unit (FTU) is the section of the I/O Module that connects all three FIUs to a single field interface. The FTU provides the Group Fail Safe switches and passive components necessary for signal conditioning, over-voltage protection, and EMI/RFI filtering. When installed in a Trusted Controller or Expander Chassis, the FTU field connector interconnects to the Field I/O Cable Assembly attached at the rear of the Chassis.

The SmartSlot link is passed from the HIU to the field connections via the FTU. These signals go directly to the field connector and maintain isolation from the I/O signals on the FTU. The SmartSlot link is the intelligent connection between Active and Standby Modules for co-ordination during Module replacement.

1.2. Field Interface Unit (FIU)

The Field Interface Unit (FIU) is the section of the Module that contains the specific circuits necessary to interface to the particular types of field I/O signals. Each Module has three FIUs, one per slice. For the TMR Zone Interface Module, the FIU contains one stage of the output switch structure, and analogue to digital (ADC) monitoring circuits for each of the channels Two additional ADC circuits provide optional monitoring of the external field I/O supply voltage.

The FIU receives isolated power from the HIU for logic. The FIU provides additional power conditioning for the operational voltages required by the FIU circuitry. An isolated 6.25 Mbit/sec serial link connects each FIU to one of the HIU slices.

The FIU also measures a range of on-board “housekeeping” signals that assist in monitoring the performance and operating conditions of the Module. These signals include power supply voltages, current consumption, on-board reference voltages and board temperature.

1.3. Host Interface Unit (HIU)

The HIU is the point of access to the Inter-Module Bus (IMB) for the Module. It also provides power distribution and local programmable processing power. The HIU is the only section of the I/O Module to directly connect to the IMB backplane. The HIU is common to most high integrity I/O types and has type dependent and product range common functions. Each HIU contains three independent slices, commonly referred to as A, B, and C.

All interconnections between the three slices incorporate isolation to prevent any fault interaction between the slices. Each slice is considered a Fault Containment Region (FCR), as a fault on one slice has no effect on the operation of the other slices.

The HIU provides the following services common to the Modules in the family:

- High Speed Fault Tolerant Communications with the TMR Processor via the IMB interface.
- FCR Interconnect Bus between slices to vote incoming IMB data and distribute outgoing I/O Module data to the IMB.
- Galvanically isolated serial data interface to the FIU slices.
- Redundant power sharing of dual 24 Vdc Chassis supply voltage and power regulation for logic power to HIU circuitry.
- Magnetically isolated power to the FIU slices.
- Serial data interface to the FPU for Module status LEDs.
- SmartSlot link between Active and Standby Modules for co-ordination during Module replacement.
- Digital Signal Processing to perform local data reduction and self-diagnostics.
- Local memory resources for storing Module operation, configuration, and field I/O data.
- On-board housekeeping, which monitors reference voltages, current consumption and board temperature.

1.4. Front Panel Unit (FPU)

The Front Panel Unit (FPU) contains the necessary connectors, switches, logic, and LED indicators for the Front Panel. For every type of Trusted I/O Module, the FPU contains the Slice Healthy, Active/Standby, and Educated indicators (LEDs), also the Module removal switches. Additional bi-colour LEDs provide status indication for the individual I/O signals. Serial data interfaces connect the FPU to each of the HIU slices to control the LED status indicators and monitor the Module removal switches.

1.5. Input Line Monitoring Thresholds

Whether selected as a digital or an analogue input, the Module measures the voltage applied to each input and compares this with four user programmed thresholds and two fixed (minimum and maximum) thresholds. These may be used within the application to signal a field device state. Hysteresis is provided on the thresholds by upscale and downscale values, corresponding to the thresholds for increasing and decreasing values respectively. The analogue voltage reading is also provided to the application for conversion to engineering units and/or direct trip derivation.

Default threshold values used for non line monitored inputs are as follows (in raw units):

Default = -5000, -5000, 5000, 5000, 7500, 7500, 11750, 11750

1.6. Housekeeping

The Zone Interface Module automatically performs local measurements of several on-board signals that can be used for detailed troubleshooting and verification of Module operating characteristics. Measurements are made within each slice’s HIU and FIU.

1.7. Fault Detection and Testing

Extensive diagnostics provide the automatic detection of Module faults. The TMR architecture of the Output 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 output controls without interruption in the system or process. Faults are reported to the user through the Healthy status indicators on the Front Panel of the Module and through the information reported to the TMR Processor. Under normal operations all three Healthy indicators are green. When a fault occurs, one of the Healthy indicators will be flashing red. It is recommended that this condition be investigated and if the cause 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 or with a SmartSlot for a spare replacement Module.

From the IMB to the field connector, the I/O Module contains extensive fault detection and integrity testing. Most testing is performed in a non-interfering mode. Data input from the IMB is stored in redundant error-correcting RAM on each slice portion of the HIU. Received data is voted on by each slice. All data transmissions include a confirmation response from the receiver.

Periodically, the TMR Processor commands the on-board Digital Signal Processors (DSPs) to perform a Safety Layer Test (SLT). The SLT results in the DSP verifying with the TMR Processor its ability to process data with integrity. In addition, the DSP uses Cyclical Redundancy Checks (CRC) to verify the variables and configuration stored in Flash memory.

Between the HIU and FIU are a series of galvanically isolated links for data and power. The data link is synchronized and monitored for variance. Both FIU and HIU have on-board temperature sensors to characterize temperature-related problems.

The power supplies for both the HIU and FIU boards are redundant, fully instrumented and testable. Together these assemblies form a Power Integrity Sub-system.

1.8. Sequence of Events Characteristics

The Module automatically measures the field voltage and current to determine the state of each channel. An event occurs when the channel transitions from one state to another. When a channel changes state, the on-board timer value is recorded. When the TMR Processor next reads data from the Module, the channel state and real-time clock value are retrieved. The TMR Processor uses this data to log the state change into the system Sequence of Events (SOE) log.

The user may configure each channel to be included in the system SOE log. Full details of SOE are contained in Trusted Sequence of Events and Process Historian Package, publication ICSTT-RM243 (PD-T8013).

1.9. Output Switch Structure

The Zone Interface Module provides a TMR switch topology where the load is driven by a total of three fully monitored, fail safe (6 element) switch channels, one physically resident on each OFIU in the Module. Any single switch or entire slice failure is designed to leave two of the three fail safe switch channels operational to power the load.

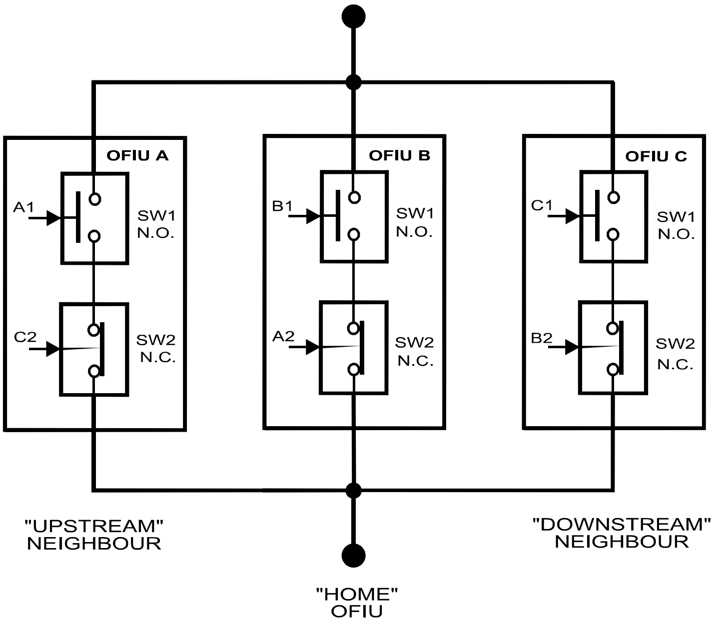

Figure 3 Output Switch Structure

The upper switches as shown in Figure 3 are denoted as N.O. (Normally Open), and are controlled by the FIU on which they are physically resident.[1] The lower switches are depicted as N.C. (Normally Closed), and are controlled by the “upstream” neighbouring FIU.[2]

Note: In this context, N.O. is defined as being in the off state in the absence of control signal power, and similarly, N.C. is the on state in the absence of control signal power. These switches are constructed from enhancement mode MOSFETs and are both guaranteed to be off in the absence of Module power to create gate voltage signals to bias them on3 (unlike electromechanical relays for example).

The reason that the lower switches are specified to be on in the absence of control signal power is to allow two channels to power the load should an entire slice fail. Even if an entire slice fails, the surviving output circuits will carry the necessary control. The structure of each FIU output is shown below:

1 Their “home” FIU.

2 The home FIU, supplies an independent control signal for the “downstream” FIU FSS.

3 For an un-faulted transistor.

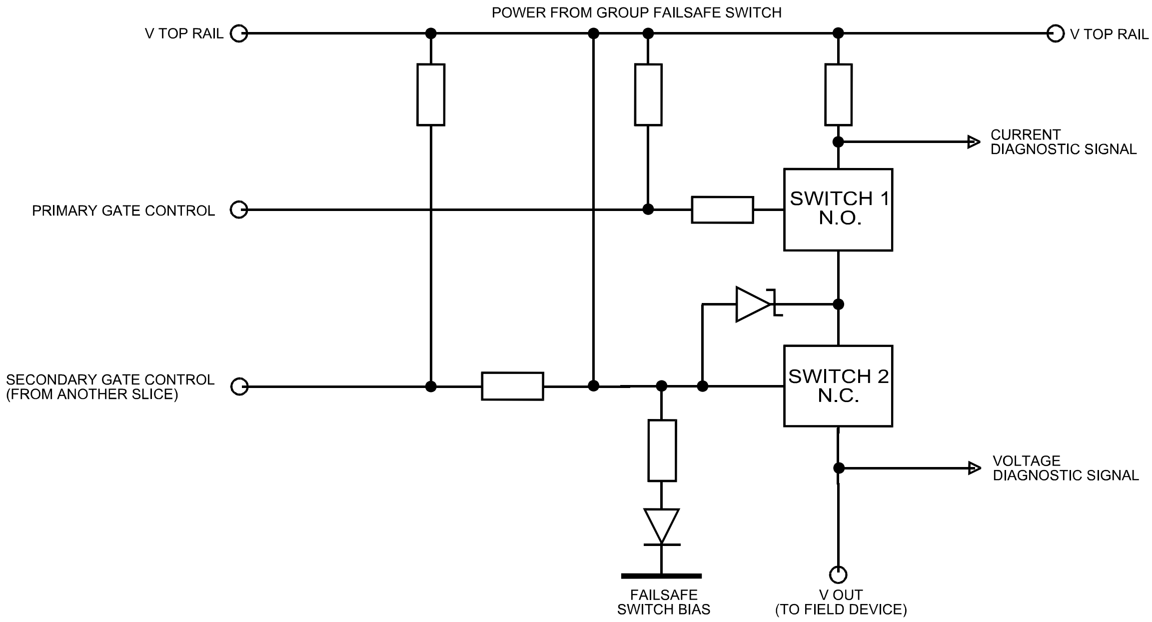

Figure 4 Simplified Switch Circuit Diagram

A resistor provides a means of continuously monitoring the switch current. A signal transistor is used to drive the gate of Switch 2. It provides Switch 2 with a negative gate voltage, to minimize it's on resistance, and serves to hold Switch 2 on in the event that the secondary gate control loses power.

The Zener diode between the gate of Switch 2 and source is only required to protect the gate from large voltage spikes on the drain that might capacitively couple through when Switch 1 and Switch 2 are in the off state.

The resistors in series with the gate of Switch 1 and the signal transistor serve to protect the drive logic in the event of a malicious switch failure. The pull-up resistors define the gate voltages in the absence of power.

1.9.1. Switch Diagnostics

During normal operation, Switch 1 and Switch 2 are maintained on. In this state, Switch 1 and Switch 2 exhibit a low resistance.

To determine the ability of the system to control the load via Switch 1 and Switch 2, their gate voltages are modulated, one at a time. As the gate voltages are modulated, the monitoring signals synchronously change in a predictable fashion. The local DSP analyses the relative amplitude and phase of these small AC signals, to determine the on resistance and threshold voltages of each switch.

The current to the load does not need to be completely interrupted in order to obtain a level of confidence in the ability of the transistors to turn off. For the TMR switch configuration in the on state, only one fail safe switch at a time needs to be modulated, while the other two bear the load current.

1.9.2. Short Circuit Protection

Output channels are classified as protected under IEC 61131-2, specifically 'Protected Outputs Requirements'.

In a fuse-free design such as in the Trusted System, the Module is required to respond rapidly in the event of an over-current or over-power situation. In fact, this protection scheme offers advantages to fuses in both automatic recovery and speed of action.

The topology of the channel provides a natural limit to the instantaneous current flow, giving the Module time to respond. Furthermore, the over-current protection circuitry is inherently self-testable, since the threshold can be set to a programmable value.

The P-channel architecture of Switch 1 and Switch 2 has an open-drain output structure. Under short-circuit conditions the maximum instantaneous current with a 24 V field voltage is naturally limited to less than 5 A per channel. This is because high output currents cause the gate-source voltages of the two transistors to be reduced, tending to turn them off.

The output current is monitored by the DSP. Sustained over current conditions cause the DSP to de-energise the associated output. Once the fault has been corrected, the latched de-energised state can be cleared by operating the system Fault Reset button or by transitioning the commanded channel state.

The output also includes a non-replaceable fusible link for absolute protection.

1.9.3. Group Fail Safe Switches

To support safe operation, the Zone Interface Module is equipped with a series of switches that provide source power to a group of 8 channels. The Module Group Fail Safe Switch (GFSS) is intended as a final control switch which can de-energise any outputs that cannot be de-energised in the normal way. For safety, the presence of two or more faults within the Module will cause the Group Fail Safe Switches to de-energise. This de-energises all of the outputs in its group.

The GFSS has three switches in parallel, each controlled by one 'slice' of the group. This means that if one slice determines from the states that an output is not de-energised when it should be, then it can command its own GFSS and those of the other slices' GFSS to de-energise. This results in two of the three elements of the GFSS structure to de-energise, leaving only one GFSS element energised. If two slices do the same thing then the last GFSS will de-energise. For example, this would occur if two or more switch elements fail in a 'stuck-on' state such that the output cannot de-energise.

The GFSS control signal is generated by a charge pump driven from the comms clock to the slice power group. If the clock fails then the GFSS bias collapses. This means that even if the ability of the slice to communicate with a power group is lost, the GFSS can still be de-energised by stopping the comms clock. If a slice fails, the watchdog on the HIU will time out and reset the slice. This will shutdown the FIU power supply and the associated GFSS control signal will also de-energise.

1.10. Output Line Monitoring States

When a channel is selected as an output, the Module automatically monitors channel current and voltage to determine the state. The numerical output state and line fault status are reported back to the application and are represented below.

Description	Numerical Output State	Line Fault Status
Field Short Circuit	5	1
Output Energised (On)	4	0
No Load, Field Open Circuit	3	1
Output De-energised (Off)	2	0
No Field Supply Voltage	1	1

Table 1 Line Monitoring Fault Status

1.11. Input Interfaces

Each channel selected as an input is provided with three ADC converters which monitor the voltage at the input connection. These are the same ADC converters which are used to determine channel state in the output configuration. Each input is a high impedance channel and measures from 0 to 30V. If current is to be measured, the input must be conditioned with an external resistor. This resistor is mounted on the T8842 Versatile Field Termination Assembly. The Module uses its TMR architecture to provide fault tolerance in the event of a hardware failure. Dynamic testing of the input path is provided to support safe operation within the TMR structure.

Note that 24 V field power is required for a Zone Interface Module even if all channels are configured as volt-free inputs. This may be connected via the plug at the Chassis end of the cable to a T8290 or T8297 Distribution Unit (for cables without power wires) or at the Versatile Field Termination Assembly (VFTA) (for integral power cables).

1.12. Field Interface Selection

For details of the recommended field interface circuit configurations, please refer to the product description for the T8842 Versatile Termination Assembly.

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2. Installation

2.1. Module Insertion and Removal

CAUTION:

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

Before installation, visually inspect the Module for damage. Verify 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.

Verify 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. Verify that the field cable assembly is installed and correctly located.
2. If I/O Module keys are used, verify that all keys are installed in the correct positions and properly seated in their slots.
3. Release the ejector tabs on the Module using the release key. Verify that the ejector tabs are fully open.
4. Holding the ejectors, carefully insert the Module into the intended slot.
5. Push the Module fully home by pressing on the top and bottom of the Module fascia.
6. 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. Field Cable Selection

I/O Cables suitable for use with the Trusted TMR Zone Interface Module are detailed in the following product descriptions:

- Trusted I/O Companion Slot Cables, publication ICSTT-RM311 (PD-TC200)
- Trusted I/O SmartSlot Slot Cables, publication ICSTT-RM313 (PD-TC500)

The Product Descriptions detailed above also detail the types of Field Termination Assembly (FTA) or Versatile Field Termination Assembly (VFTA) which may be used with each type of Module.

2.3. Termination

Unused outputs should be commanded off in the application and wired through a 4K7 0.5 W resistor to zero volts.

2.4. Module Pin-out Connections

	C	B	A
1	SmartSlot Link C	SmartSlot Link B	SmartSlot Link A
2	-	-	-
3	Chan 5 (+)	Pwr Group 1 (+)	Chan 1 (+)
4	Chan 6 (+)	Pwr Group 1 (+)	Chan 2 (+)
5	Pwr Group 1 Rtn	Pwr Group 1 (+)	Pwr Group 1 Rtn
6	Chan 7 (+)	Pwr Group 1 (+)	Chan 3 (+)
7	Chan 8 (+)	Pwr Group 1 (+)	Chan 4 (+)
8	-	-	-
9	Chan 13 (+)	Pwr Group 2 (+)	Chan 9 (+)
10	Chan 14 (+)	Pwr Group 2 (+)	Chan 10 (+)
11	Pwr Group 2 Rtn	Pwr Group 2 (+)	Pwr Group 2 Rtn

	C	B	A
12	Chan 15 (+)	Pwr group 2 (+)	Chan 11 (+)
13	Chan 16 (+)	Pwr Group 2 (+)	Chan 12 (+)
14	-	-	-
15	Chan 21 (+)	Pwr Group 3 (+)	Chan 17 (+)
16	Chan 22 (+)	Pwr Group 3 (+)	Chan 18 (+)
17	Pwr Group 3 Rtn	Pwr Group 3 (+)	Pwr Group 3 Rtn
18	Chan 23 (+)	Pwr Group 3 (+)	Chan 19 (+)
19	Chan 24 (+)	Pwr Group 3 (+)	Chan 20 (+)
20	-	-	-
21	Chan 29 (+)	Pwr Group 4 (+)	Chan 25 (+)
22	Chan 30 (+)	Pwr Group 4 (+)	Chan 26 (+)
23	Pwr Group 4 Rtn	Pwr Group 4 (+)	Pwr Group 4 Rtn
24	Chan 31 (+)	Pwr Group 4 (+)	Chan 27 (+)
25	Chan 32 (+)	Pwr Group 4 (+)	Chan 28 (+)
26	-	-	-
27	Chan 37 (+)	Pwr Group 5 (+)	Chan 33 (+)
28	Chan 38 (+)	Pwr Group 5 (+)	Chan 34 (+)
29	Pwr Group 5 Rtn	Pwr Group 5 (+)	Pwr Group 5 Rtn
30	Chan 39 (+)	Pwr Group 5 (+)	Chan 35 (+)
31	Chan 40 (+)	Pwr Group 5 (+)	Chan 36 (+)
32	-	-	-

Table 2 Field Connector Pin-out

2.5. Trusted Module Polarisation/Keying

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

Each Module type has been keyed during manufacture. The organisation 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.

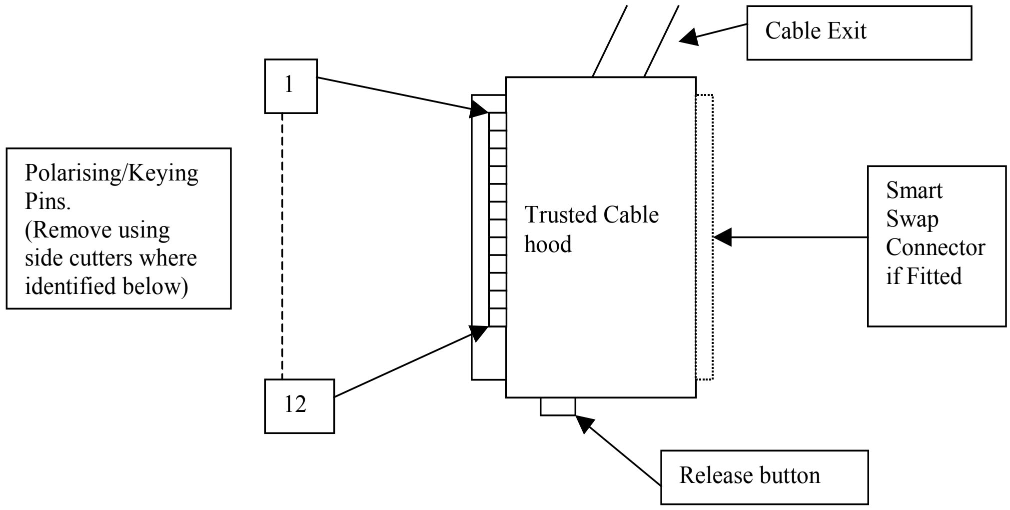

Figure 5 Module Polarisation

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

For this Module (T8448) remove keying pins 1, 7 and 9.

3. Application

The Zone Interface Module has been designed to provide a cost effective and high integrity interface with a Fire and Gas Zone. Each Zone within an application will have a unique combination of signals. In order to reduce the amount of hardware required, the Zone Interface has been made configurable using a simple software configuration package. The Zone Interface Module operates in conjunction with the Trusted Versatile Field Termination Assembly T8842.

The Termination assembly uses plug-in fuses and links to allow selection of different field loop conditioning combinations.

Under software control, the Zone Interface Module can select any channel to be input or output. When a channel is selected as output the Module provides a full TMR high integrity fault tolerant switch. In the input mode the channel becomes a voltage input analogue interface. Each field input is triplicated and the input voltage is measured using an analogue to digital converter. In the Input mode, different resistor combinations on VFTA are used to condition the field loop and provide the voltage input to the Module.

For volt-free or Zener-limited inputs, the internal input energise test will fail. To avoid fault indications due to inputs that cannot be lifted in voltage by the Module due to intrinsic shorting, a 1K 1 W resistor is required on the channel wiring between the Module and the FTA. Note that this will change the voltages seen by the Module, and will require different monitoring thresholds. This resistor may also be placed in series with the field contacts as a line monitoring component. The energise tests are required by TUV for AK6 operation to verify the input circuitry.

One Channel in each power group can be selected on the Versatile Field Termination Assembly to be a fire detector power output. The power is distributed to the 7 remaining channels of that group and is controlled by the Trusted application logic. Removing power from the field loop resets fire detecting field devices. It is usual to configure the Module as groups of 7 fire inputs. However, the linking of the VFTA can allow the Reset Group to be any combination from 1 to 39 channels, evenly or randomly distributed throughout the Module, given that the total load on the output channel does not exceed 2 A.

Gas inputs are interfaced by converting a 4-20 mA current loop into a 1-5 V signal on the VFTA, but the inputs operate across a wider range in order to allow for poor field calibration and the calibration/fault modes of field devices.

Each digital input voltage can be compared to user adjustable thresholds so as to generate up to 5 distinct states (for example open circuit loop, normal, alarm, short circuit loop). Each of these thresholds has adjustable hysteresis and can be positioned anywhere within the operating range of the input. This allows for detection of field loop faults as well as alarm states.

3.1. Module Configuration

There is no configuration required to the physical Module. All configurable characteristics of the Module are performed using tools on the Engineering Workstation (EWS) and become part of the application or System.INI file that is loaded into the TMR Processor. The TMR Processor automatically configures the Module after applications are downloaded and during Active/Standby changeover.

The IEC 61131 TOOLSET provides the main interface to configure the Zone Interface Module. Details of the configuration tools and configuration sequence are provided in Trusted Toolset Suite, publication ICSTT-RM249 (PD-T8082). There are three procedures necessary to configure the Module. These are:

1. Define the necessary I/O variables for the field data and Module status data using the Dictionary Editor of the IEC 61131 TOOLSET.
2. Create an I/O Module definition in the I/O Connection Editor for each I/O Module. The I/O Module definition defines physical information, e.g. Chassis and Slot location, and allows variables to be connected to the I/O channels of the Module.
3. Using the Trusted System Configuration Manager, define custom LED indicator modes, per-channel default or fail safe states, and other Module settings.

3.2. T8448 Complex Equipment Definition

The T8448 I/O Complex Equipment Definition includes 10 I/O boards, referenced numerically by rack number.

Rack	I/O Board	Description	Data Type	Direction	No. of Channels
1	DO	OEM Parameters	-	-	-
		Field Output Status	Boolean	Out	40
2	STATE	Field Output State	Integer	In	40
3	AI	Measured voltage	Integer	In	40
4	CI	Measured current	Integer	In	40
5	LINE_FLT	Line Fault Status	Boolean	In	40
6	DISCREP	Channel Discrepancy	Integer	In	3
7	HKEEPING	Housekeeping Registers	Integer	In	57

Rack	I/O Board	Description	Data Type	Direction	No. of Channels
8	INFO	I/O Module Information	Integer	In	11
9	THRSHIN	Threshold Setting Feedback	Integer	In	9
10	THRSHOUT	Threshold Setting Command	Integer	Out	11

Table 3 Complex Equipment Definition

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

OEM Parameter	Description	Notes
TICS_CHASSIS	The number of the Trusted Chassis where the Primary I/O Module 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 I/O Module 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 4 OEM Parameters

3.2.1. Rack 1: DO

This board provides the connection to the logical output control signal for each of the field outputs.

Channel	Description
1	Field output channel 1 logical state
2	Field output channel 2 logical state
40	Field output channel 40 logical state

Table 5 Rack 1: DO Descriptions

The user application should set the output control signal to true (logic '1') to turn ON or energise an output, and false (logic '0') to turn OFF or de-energise an output.

3.2.2. Rack 2: STATE

This board provides the majority voted numerical state. This indicates the operational status of the channel and associated field connection.

Channel	Description
1	Field channel 1 state
2	Field channel 2 state
40	Field channel 40 state

Table 6 Rack 2: STATE Descriptions

The least significant 3-bits indicate the operational state of the channel. When configured as an output, the states have the following meaning.

Value	Description
7	Channel Fault
6	Field fault (e.g. field leakage to 0 V or 24V)
5	Short Circuit in field wiring or load
4	Output energised (ON)
3	Open circuit in field wiring or load
2	Output de-energised (OFF)
1	No field supply voltage
0	Unused

Table 7 Rack 2: STATE Output bit Descriptions

When configured as an input channel, the states are allocated to voltage ranges.

The usual definition for a digital input is as follows.

Value	Description
7	Channel Fault
6	Over Range
5	Short circuit
4	Contact Closed
3	Contact Indeterminate
2	Contact Open
1	Open Circuit
0	Under Range

Table 8 Rack 2: STATE Input Bit Descriptions

Note that channels configured as inputs do not have a direct Boolean indication of the input status. The Toolset application must be programmed to recognise states 2 and 4 above as open and closed contact input respectively. All other states are treated as fault conditions; the input status determination in these states is application specific.

3.2.3. Rack 3: AI

The AI board returns the field loop voltage measured by the Module. This is used for analogue and digital inputs, and also for monitoring outputs.

Channel	Description
1	Field channel 1 voltage
2	Field channel 2 voltage
40	Field channel 40 voltage

Table 9 Rack 3: AI Bit Descriptions

The voltage is the median value taken from the triplicated Module. The voltage level is reported as an integer, with the units being $^{1}/_{500}$V. This may be used directly, scaled arithmetically or scaled using the IEC 61131 TOOLSET conversion tables.

To scale the value arithmetically simply divide the returned 'integer' by 500 to return the voltage as either a REAL or INTEGER as required.

The IEC 61131 TOOLSET conversion tables may be used to convert the value to engineering units, in this case voltage. The full scale range for this number format is decimal ±64, corresponding to physical range –32000 to +32000.

3.2.4. Rack 4: CI

The CI board returns the field loop current measured by the Module. Note that current inputs sink current into the 250 Ω resistor on the VFTA, and not into the Module.

Channel	Description
1	Field channel 1 current
2	Field channel 2 current
40	Field channel 40 current

Table 10 Rack 4: CI Bit Descriptions

The current is the sum value taken from the triplicated Module. The current level is reported as an integer, with the units being $^{1}/_{1000}$A. This may be used directly, scaled arithmetically or scaled using the IEC 61131 TOOLSET conversion tables.

To scale the value arithmetically simply divide the returned ‘integer’ by 1000 to return the current as either a REAL or INTEGER as required.

The IEC 61131 TOOLSET conversion tables may be used to convert the value to engineering units, in this case current. The full scale range for this number format is decimal ±32, corresponding to physical range –32000 to +32000.

3.2.5. Rack 5: LINE_FLT

Channel	Description
1	Field channel 1 line fault
2	Field channel 2 line fault
40	Field channel 40 line fault

Table 11 Rack 5: LINE_FLT Bit Descriptions

The line fault input state is reported as true (logic ‘1’) for a line fault condition (open circuit, short circuit, and no field supply voltage). The logic state is the majority voted value.

3.2.6. Rack 6: DISCREP

Channel	Description
1	Discrepancy status channels 1 to 16 (Channel 1 is LSB)
2	Discrepancy status channels 17 to 32 (Channel 17 is LSB)
3	Discrepancy status channels 33 to 40 (Channel 33 is LSB)

Table 12 Rack 6: DISCREP Bit Descriptions

Each of the words reports the discrepancy status of 16 channels. The corresponding bit within the word is set to '1' when a discrepancy condition is detected on that channel's state (rack 2).

3.2.7. Rack 7: HKEEPING

Channel	Description				
	FCR		Units (Full Scale Range)		
1	A	24V2 Field Voltage	-32768	32767	mV
2	B				
3	C				
4	A	Internal supply voltage (post regulator)	-32768	32767	mV
5	B				
6	C				
7	A	Internal supply current (post regulator)	-32768	32767	mA
8	B				
9	C				
10	A	Output voltage (post isolation)	-32768	32767	mV
11	B				
12	C				
13	A	24V1 Field Voltage	-32768	32767	mV
14	B				
15	C				
16	A	HIU Board Temperature (Note: Temperature, ºC = input value / 256)	-32768	32767	-
17	B				

Channel	Description				
	FCR		Units (Full Scale Range)		
18	C				
19	A	Front Panel Load Current	-32768	32767	mA
20	B				
21	C				
22	A	SmartSlot Link Voltage	-32768	32767	mV
23	B				
24	C				
25	A	FIU Power Group 1 Field Supply Voltage	-32768	32767	mV
26	B				
27	C				
28	A	FIU Board Temperature, Group 1 (Note: Temperature, ºC = input value / 256)	-32768	32767	-
29	B				
30	C				
31	A	FIU Power Group 2 Field Supply Voltage	-32768	32767	mV
32	B				
33	C				
34	A	FIU Board Temperature, Group 2 (Note: Temperature, ºC = input value / 256)	-32768	32767	-
35	B				
36	C				
37	A	FIU Power Group 3 Field Supply Voltage	-32768	32767	mV
38	B				
39	C				
40	A	FIU Board Temperature, Group 3 (Note: Temperature, ºC = input value / 256)	-32768	32767	-
41	B				
42	C				
43	A	FIU Power Group 4 Field Supply Voltage	-32768	32767	mV
44	B				
45	C				
46	A	FIU Board Temperature, Group 4 (Note: Temperature, ºC = input value / 256)	-32768	32767	-
47	B				
48	C				
49	A	FIU Power Group 5 Field Supply Voltage	-32768	32767	mV

Channel	Description				
	FCR		Units (Full Scale Range)		
50	B				
51	C				
52	A	FIU Board Temperature, Group 5 (Note: Temperature, ºC = input value / 256)	-32768	32767	-
53	B				
54	C				
55	A	Diagnostic error code			
56	B				
57	C				

Table 13 Rack 7: Housekeeping Descriptions

Each input within the housekeeping rack is reported as an integer. In general, the application engineer will not normally require these inputs. They are provided to aid fault finding and diagnosis and may be used for reporting and display purposes. If a slice is Fatal, then all reported housekeeping inputs are set to zero.

3.2.8. Rack 8: INFO

Channel	Description
1	Active Module chassis number
2	Active Module slot number
3	Active Module healthy
4	Active Module mode
5	Standby Module chassis number
6	Standby Module slot number
7	Standby Module healthy
8	Standby Module mode
9	FCR Status
10	Primary Module is active
11	Active Module is simulated

Table 14 Rack 8: INFO Descriptions

The Active Module chassis and slot numbers indicate the position of the currently Active Module. These values will change to match the primary or secondary Module position, depending on their Active status, i.e. Active/Standby changeover will “swap” the values for the Active Module chassis and slot number channels with those in the Standby Module chassis and slot number channels. The chassis and slot numbers are set to zero if the Module is not present.

The Active and Standby Module healthy channel is returned as an integer, however only the least significant bit is used. A value of 0 indicates that a fault has been detected, a non-zero value indicates that the Module is healthy.

The Active and Standby Module Mode is an integer indicating the current operating mode of the associated Module. The value indicates the current internal operating mode of the Module.

Value	Module Mode
5	Shutdown
4	Maintain
3	Active
2	Standby
1	Configuration
0	Unknown, no Module present

Table 15 Rack 8: INFO Bit Descriptions

The FCR Status channel reports the fault status of the Active and Standby Modules. The value is bit-packed as shown below, the least significant byte is used with the most significant 8-bits set to zero:

Bit							
7	6	5	4	3	2	1	0
Standby Module				Active Module			
Ejectors open	FCR C Healthy	FCR B Healthy	FCR A Healthy	Ejectors open	FCR C Healthy	FCR B Healthy	FCR A Healthy

Table 16 Rack 8: FCR Bit Descriptions

The ‘Primary Module is active’ channel is set to non-zero if the primary Module is the current Active Module, i.e. the Active Module is in the chassis and slot numbers defined within the OEM parameters.

The ‘Active Module is simulated’ channel is set to non-zero if the Active Module is being simulated, this will only be set if the Module is not present or the simulation enable has been set within the Module’s configuration in the System.INI file.

3.2.9. Rack 9: THRSHIN

This board provides the threshold feedback data.

Channel	Description
1	Module channel number
2	LOW-LOW falling Threshold
3	LOW-LOW rising Threshold
4	LOW falling Threshold
5	LOW rising Threshold
6	HIGH falling Threshold
7	HIGH rising Threshold
8	HIGH-HIGH falling Threshold
9	HIGH-HIGH rising Threshold

Table 17 Rack 9: THRSHIN Descriptions

The data is updated as a result of commands issued through rack 10. The Module channel number may be 1 to 40. The thresholds relate to the channel voltages returned in rack 3.

The signal values are as follows:

- Word 1: Channel number being read. Range 1 to 60.
- Word 2: LOW-LOW falling Threshold.
- Word 3: LOW-LOW rising Threshold.
- Word 4: LOW falling Threshold.
- Word 5: LOW rising Threshold.
- Word 6: HIGH falling Threshold.
- Word 7: HIGH rising Threshold.
- Word 8: HIGH-HIGH falling Threshold.
- Word 9: HIGH-HIGH rising Threshold.

3.2.10. Rack 10: THRSHOUT

This board provides the threshold command data.

Channel	Description
1	'Write Threshold' control register
2	'Read Threshold' control register
3	Module channel number
4	LOW-LOW falling Threshold
5	LOW-LOW rising Threshold
6	LOW falling Threshold
7	LOW rising Threshold
8	HIGH falling Threshold
9	HIGH rising Threshold
10	HIGH-HIGH falling Threshold
11	HIGH-HIGH rising Threshold

Table 18 Rack 10: THRSHOUT Descriptions

The Module channel number may be 1 to 40. The thresholds relate to the channel voltages returned in rack 3. Channel 1 is used to control writing the threshold data specified in channels 4 to 11 to the Module channel specified in channel 3. The threshold data will be echoed back in rack 9. Channel 2 is used to control reading the thresholds of the Module channel specified in channel 3. The thresholds will be reported in rack 9. The reading or writing is triggered by a 0 to 1 transition in the relevant control register.

The signal values are as follows:

- Word 1: Clock out the threshold data. To write the threshold data to the Module.

  The clock is on a rising edge. Range 0 to 1.

- Word 2: lock in the threshold data. To read the threshold data from the Module.

  The channel that is read is defined by Word 3.The clock is on a rising edge. Range 0 to 1. (New threshold will appear on RACK 1.)

- Word 3: Channel number to write/read threshold data. Range 1 to 60.

- Word 4: LOW-LOW falling Threshold.

- Word 5: LOW-LOW rising Threshold.
- Word 6: LOW falling Threshold.
- Word 7: LOW rising Threshold.
- Word 8: HIGH falling Threshold.
- Word 9: HIGH rising Threshold.
- Word 10: HIGH-HIGH falling Threshold.
- Word 11: HIGH-HIGH rising Threshold.

3.3. Sequence of Events Configuration

Each Boolean Variable can be configured for automatic Sequence of Events (SOE) logging. This applies to the Input/Output Status and Line Fault Status variables. A Boolean variable is configured for SOE during the variable definition in the Data Dictionary Editor. To select SOE, press the Extended Button in the Boolean Variable Definition Dialog Box to open the Extended Definition Dialog. Then check the box for Sequence of Events to enable the variable for automatic SOE logging.

During operation, the Module automatically reports time-stamped change of state information for the input/output data. The TMR Processor automatically logs change of state for configured SOE variables into the system SOE Log. The SOE Log can be monitored and retrieved using the SOE and Process Historian Package running on the EWS. This software package is described in Trusted Sequence of Events and Process Historian Package, publication ICSTT-RM243 (PD-T8013).

3.4. System.INI File Configuration

There are many operating characteristics of the Module that can be customised for a particular application. The System Configuration Manager is a tool that allows the user to configure the specific operating characteristics for each Module. Descriptions of the items that may be configured for the Trusted 24 Vdc Zone Interface Module 8448 are contained in Trusted Toolset Suite, publication ICSTT-RM249 (PD-T8082).

Certain characteristics apply to the entire Module and are considered Module Configurable Items. Other characteristics apply to individual input/output channels and are considered Channel Configurable Items. There are specific default settings for each of the configurable items. If the default settings are appropriate for a given application, then customization of the Module definition in the System Configuration Manager is not required.

In order for short circuit detection to function while outputs are de-energised, a short circuit detection template is required.

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4. Operation

4.1. Front Panel

Status indicators on the Front Panel of the Module provide visual indications of the Module's operational status and field status. Each indicator is a bi-colour LED. Located at the top and bottom of each Module is an ejector lever that is used to remove the Module from the Chassis. Limit switches detect the open/closed position of the ejector levers. The ejector levers are normally latched closed when the Module is firmly seated into the Controller or Expander Chassis.

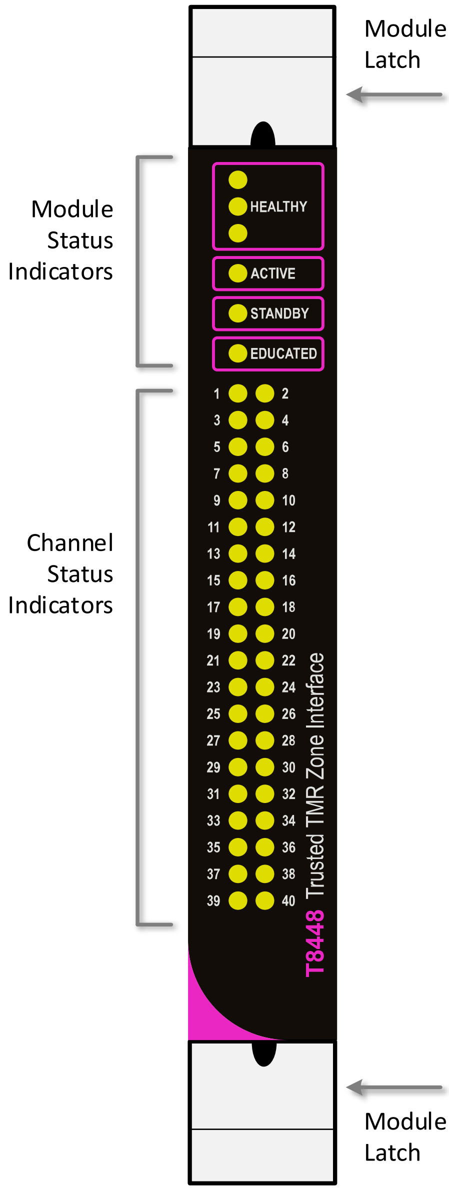

Figure 6 Module Front Panel

4.2. Module Status LEDs

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 indicators are controlled by the FPU. The FPU receives data from each of the Module slices. It performs a 2oo3 vote on each data bit from the slices and sets the indicators accordingly.

The Module status indicator modes and their meanings are described as follows:

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.
	Red (momentary)	On installation – power applied to the associated slice.
	Red	The associated slice is in the fatal state. 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 fatal 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 fatal state. The Active LED will also be flashing red.

INDICATOR	STATE	DESCRIPTION
Educated	Off	Module is not educated.
	Green	Module is educated.
	Green – flashing	Module is recognised by the Processor but education is not complete.
	Amber - Flashing	Active/Standby changeover in progress.

Table 19 Module Status LEDs

4.3. I/O Status Indicators

There are 40 channel status indicators on the Module Front Panel, one for each field input/output. These indicators are controlled by the FPU. The FPU receives data from each of the Module slices. The FPU performs a 2oo3 vote on each data bit from the slices and sets the indicators accordingly.

The input/output status indicator mode is dependent upon the numerical state of the channel. Each state can be defined to have a particular indicator mode: off, green, red, flashing green, or flashing red. Note that although it may be possible to specify yellow (green and red together) in the System Configurator, this is not recommended.

The configurable indicator modes allow users to customise the status indications to suit individual application requirements. Without customisation, the default indicator modes are as described below:

INDICATOR STATE	DESCRIPTION
Off	Output is Off or Input is Open
Green	Channel is On or Input is Closed
Green – flashing	No Output Load or Input/Output Open Circuit
Red	Output short circuit (output over current protection triggered and channel is latched off) or input short circuit
Red – flashing	Channel fault, or no field supply voltage

Table 20 I/O Status LEDs

Note: The LEDs indicating channel status may be configured to suit user requirements 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

Zone Interface Module faults are reported to the user through visual indicators on the Front Panel of the Module and through 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 Module.

5.2. Field Wiring Faults

By measuring the channel voltage and current, the Module automatically detects field wiring and load faults. When a field signal fails open circuit, short circuit or there is no field supply voltage connected, the status indicator will display the configured LED mode, the corresponding state will be reported and the line fault status for that channel will be set to '1'. All other channels will be unaffected, except in the case of common cause wiring and supply voltage faults in the field.

The field voltage and current variables can be monitored to determine the actual operating conditions of each channel. This additional information assists the user in determining the specific type of wiring fault.

Once the specific field wiring fault has been identified and corrected, the status variables and status indicator will display the normal status of the field device.

5.3. Module Faults

Extensive diagnostics provide the automatic detection of Module faults. The TMR architecture of the 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 controls without interruption in the system or process. Faults are reported to the user through the Healthy status indicators on the Front Panel of the Module and through the INFO and HKEEPING variables. Under normal operations all three Healthy Indicators are green. When a fault occurs, one of the Healthy Indicators will be flashing red. It is recommended that this condition is investigated and if the cause 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 or with a SmartSlot for a spare replacement Module.

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-width 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 when 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.

5.5. SmartSlot

For a SmartSlot configuration, the secondary slot is not unique to each primary slot. Instead, a single secondary slot is shared among many primary slots. This technique provides the highest density of Modules to be fitted in a given physical space. At the rear of the Trusted Chassis, a single-wide I/O Cable connects the secondary slot directly to the I/O Cable connected to the failed primary Module. With a spare Module installed in the SmartSlot and the SmartSlot I/O Cable connected to the failed primary Module, the SmartSlot can be used to replace the failed primary Module.

Output Module SmartSlot jumper cable TC-308-02.

SmartSlot between Chassis can be performed if the Chassis are version 2 (or higher). These have the connector fitted to enable connection of a TC-006 that verifies the 0 Volt of each Chassis is at the same potential.

5.6. 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 energised 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.

5.7. 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. If the secondary Module is installed with no primary Module present, and the secondary Module location is not unique (as in a SmartSlot configuration), then NO Module for that Module pair will become Active.
- 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 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 utilise 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

Backplane (IMB) Supply	
Voltage	20 Vdc to 32 Vdc
Power	27 W
Field Supply	
Voltage	18 Vdc to 32 Vdc
Current	2 A per channel maximum [3].
Module Location	T8100, T8300 I/O Module Slot
Isolation	
Power Group to Power Group	50 V Reinforced (continuous) [1] [Type tested at 1411 Vdc for 60 s].
Field Common	50 V Reinforced (continuous) [1] 250 V Basic (fault) [2] [Type tested at 2436 Vdc for 60 s].
Channel to Channel (within Power Group)	None
Fusing	Not user serviceable
Number of Channels	40

Output	
Output Off State Resistance	33 kΩ
Output On State resistance	1.6 Ω
Current Rating (Continuous)	2 A per channel maximum (3).
Minimum On State Load Current	50 mA
Field Voltage Range	18 Vdc to 32 Vdc
Measurement Range	0 Vdc to +32 Vdc
Maximum Withstanding	-1 to +40 Vdc
Maximum Capacitance	at least 2800 µF at 2 A
Turn-on/off Delay	5 ms
Input	
Impedance	33 kΩ
Analogue Resolution	12 Bit
Calibration Accuracy	0 V to VFIELD-4 V = 0.12 V VFIELD – 4 V to VFIELD = 0.48 V
Safety Accuracy	0.25 V
Output Short Circuit Protection	Electronic latching
Intrinsic Safety	None – External barrier required
Sequence of Events	
Event Resolution (LSB)	1 ms
Time-stamp Accuracy	±10 ms
Operating Temperature	0 °C to +60 °C (+32 °F to +140 °F)
Storage Temperature	-25 °C to +70 °C (-13 °F to +158 °F)
Relative Humidity - Operating and Storage	10 % – 95 %, non-condensing
Environmental Specifications	Refer to Document ICSTT-TD003

Dimensions	
Height	266 mm (10.5 in)
Width	31 mm (1.2 in)
Depth	303 mm (12 in)
Weight	1.3 kg (2.7 lb)

Note 1) 50 Vrms Secondary circuit derived from Mains, OVC II up to 300V.

Note 2) 250 Vrms Mains circuit, OVC II up to 300V. Exposure to voltages at these levels shall be temporally constrained consistent with the system MTTR.

Note 3) Total current per Power Group is 8A for ambient temperature T, for 0 °C < T < 50 °C, and is 6A for 0 °C < T < 60 °C.