





Trusted TMR 24 Vdc Analog Input Module 40 Channel

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Product Description Original Instructions

Product overview

The Trusted® TMR 24 Vdc Analog Input module interfaces to 40 sourcing field input devices, acting as a current sink for all these devices. Comprehensive diagnostic tests are performed on each input channel. Fault tolerance is achieved through a Triple Modular Redundant (TMR) architecture within the Module for each of the 40 input channels.

Using the built-in line-monitoring feature, the Module can detect open and shorted field cables. Line monitoring functions are independently configured for each input channel.

The Module provides onboard Sequence of Events (SOE) reporting with a resolution of 1 ms. A change of state triggers an SOE entry. States are determined by voltage thresholds that can be configured on a per channel basis. When the field voltage and field return are connected to the auxiliary input channels of the Module, thresholds can be specified as a ratio of the field supply voltage.

Features

- 40 Triple Modular Redundant (TMR) input channels per Module.
- Comprehensive, automatic diagnostics and self-test.
- Selectable line monitoring per channel to detect open circuit and short circuit field wiring faults.
- 2500V impulse withstand opto/galvanic isolation barrier.
- Onboard Sequence of Events (SOE) reporting with 1 ms resolution.
- Module can be hot-replaced online using dedicated Companion (adjacent) Slot or SmartSlot (one spare slot for many modules) configurations.
- Front panel input status Light Emitting Diodes (LEDs) for each channel indicate input 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.

Description

The Trusted® TMR 24 Vdc Analog Input 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 Trusted 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).

All High Integrity I/O Modules comprise four 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 functional block diagram of the Trusted 24 Vdc Analog Input Module.

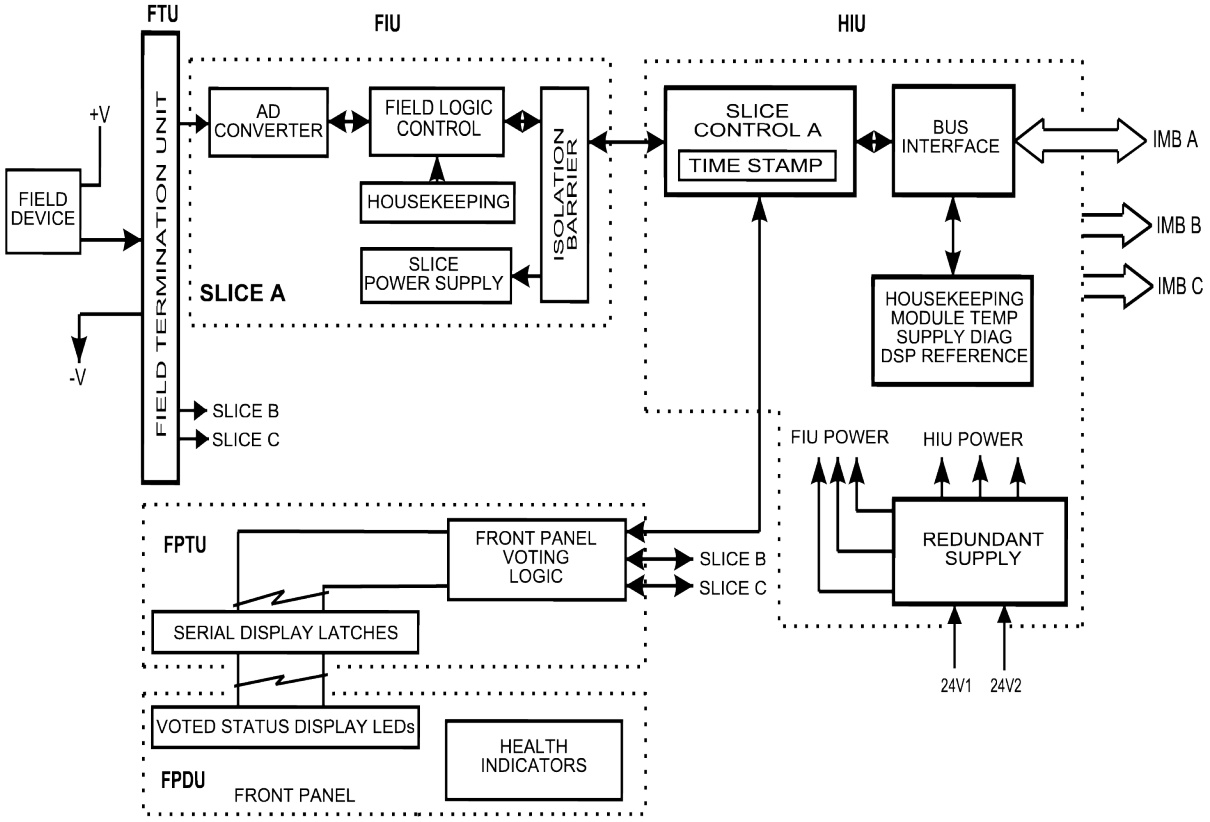


Figure 2: Functional Block Diagram

Field Termination Unit (FTU)

The Field Termination Unit (FTU) is the I/O Module assembly that connects all three FIUs to a field connector. The FTU primarily contains passive components necessary for front-end signal conditioning. When installed in a Trusted Controller or Expander Chassis, the FTU field connector mates 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 I/O cable assembly and maintain isolation from the I/O signals on the FTU. The SmartSlot link is the intelligent connection between Active and Standby Modules for coordination during Module replacement.

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 24 Vdc Analog Input Module, the FIU contains an analog to digital converter (ADC) for each of the 40 field inputs.

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 onboard "housekeeping" signals that assist in monitoring the performance and operating conditions of the Module. These signals include power supply voltages, current consumption, onboard reference voltages and board temperature.

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 Trusted I/O Module 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 coming IMB data and distribute outgoing I/O Module data to the IMB.
- Optically 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 coordination 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.
- Onboard housekeeping, which monitors reference voltages, current consumption and board temperature.

Front Panel Unit (FPU)

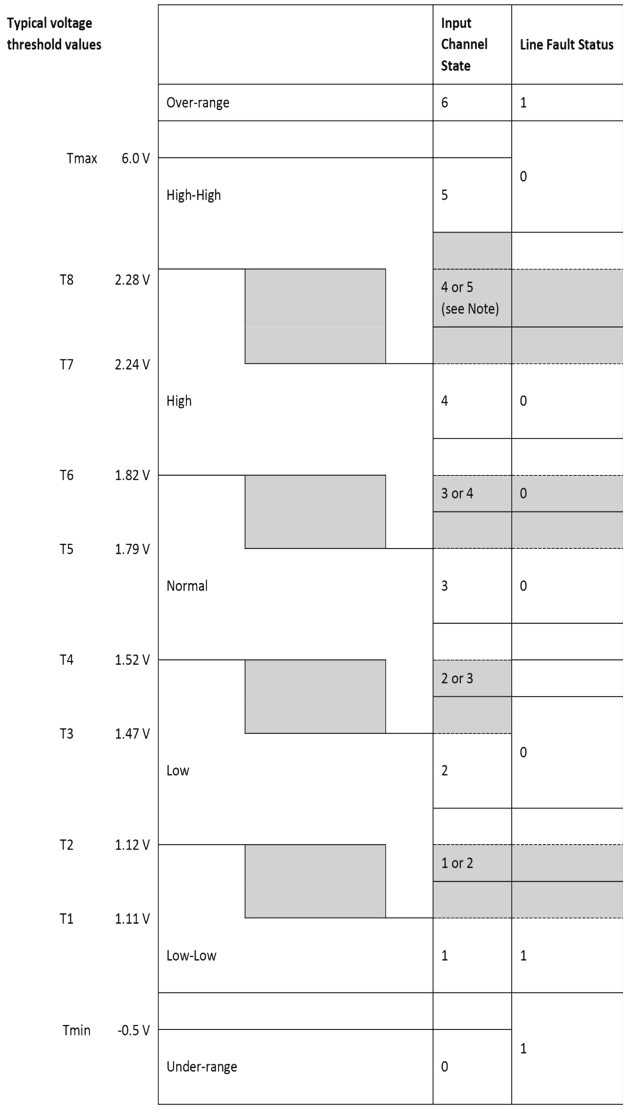
The Front Panel Unit (FPU) comprises a Front Panel Termination Unit (FPTU) and a Front Panel Display Unit (FPDU). The overall FPU contains the necessary connectors, switches, logic, and LED indicators for the Front Panel. For every type of Trusted I/O Module, the FPU contains the Slice Healthy, Active/Standby and Educated indicators (LEDs), and the module removal switches. Additional bicolor 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.

Line Monitoring Thresholds

The Module determines the contact state and line fault status by comparing the input voltage level to four user programmed thresholds and two fixed (minimum and maximum) thresholds. Hysteresis is provided on the thresholds by upscale and downscale values, corresponding to the thresholds for increasing and decreasing values respectively.

Table 1 Example Threshold Data (24 Vdc)



Note: The channel state value returned is dependent on the previous state value. If the input level is increasing, then the lower state value will be returned. If the input level is decreasing, the higher state value will be returned.

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

Default = 448, 576, 1344, 1472, 2240, 2368, 3520, 3648, 5120

Housekeeping

The Input Module automatically performs local measurements of several onboard signals that can be used for detailed troubleshooting and verification of Module operating characteristics. Measurements are made within each slice's HIU and FIU.

Fault detection and testing

From the IMB to the field connector, the Input Module contains extensive fault detection and integrity testing. As an input device, all 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.

Between the HIU and FIU, there are a series of optically isolated links for data and power. The data link is synchronized and monitored for variance. Both the FIU and HIU have onboard 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 Subsystem.

The module field input is connected to a single bit ADC known as the ΣΔ input circuit. These circuits, one per channel on each slice, produce a digital output that naturally transitions between on and off. Any failure in the circuit causes the output to saturate to stuck-on or stuck-off, which is automatically detected. As the conversion process is dynamic and not gated like traditional ADCs, failures are rapidly diagnosed and located.

By using the ΣΔ circuit, the analog path in the Module is short and does not involve many components. This results in analog failures being contained to a single channel on a single slice instead of causing a group of eight or more inputs to fail.

Sequence of Events characteristics

The Input Module automatically measures the field input voltage, compares the value to the configurable thresholds, and determines the state of the field input. An event occurs when the input transitions from one state to another. When an input changes state, the onboard real-time clock value is recorded. When the TMR Processor next reads data from the Input Module, the input state and real-time clock values are retrieved. The TMR Processor uses this data to log the input state change into the system Sequence of Events (SOE) log. The user may configure each input to be included in the system SOE log. Full details of SOE are contained in Trusted Sequence of Events and Process Historian Package Product Description, publication ICSTT-RM243 (PD-T8013).

Specifications

This table lists the module specifications:

Item	Description
Backplane (IMB) Supply	
Voltage	20 Vdc to 32 Vdc
Power	20 W
Field Supply	N/A
Maximum Power Dissipation	20 W
Module Location	T8100, T8300 I/O Module Slot
Isolation	
Field Common	50 V Reinforced (continuous)[1] 250 V Basic (fault)[2] [Type tested at 2436 Vdc for 60 s].
Channel to Channel	None
Fusing	None
Number of Inputs	40
Input	
Impedance (FTA)	250 Ohm
Impedance (module)[3]	16.967 K Ohm
Current	0 mA – 22 mA
Voltage	0 Vdc – 5.5 Vdc
Thresholds	Configurable
Resolution (LSB)	3.906 µA
Safety Accuracy	±200 µA
Calibration Accuracy[4]	±0.15 %
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%, noncondensing
Environmental Specifications	Refer to Trusted 8000 Series International Safety and Environmental Approvals, publication ICSTT-TD003
Dimensions	
Height	266 mm (10.5 in)

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

[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.

[3] In the case where partner modules are fitted then the effective Module input impedance is halved.

[4] Refer to T8094 Trusted Safety Manual for guidance on calibration maintenance.

Item	Description
Width	31 mm (1.2 in)
Depth	303 mm (12.0 in)
Weight	1.149 kg (2.5 lb)