Operation

Front panel

Status LEDs on the front of the Module provide visual indications of the module's operational status and field input status. Each LED is a tri-color LED of which for normal operation, only two colors are used; red and green. 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.

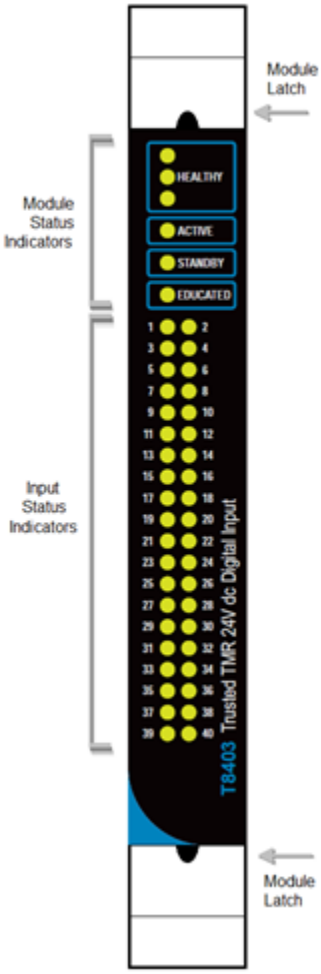

Figure 4: Module Front Panel

Module status LEDs

There are six module status LEDs 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. The FPU performs a 2003 vote on each data bit from the slices and sets the indicators accordingly.

The module status LED states and their meanings are described as follows:

Table 16 Module Status LEDs

LED	State	Description
Healthy	Off	No power applied to the module.
	Amber	Slice is in the startup 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 24V feed to the chassis has failed.
	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.
Educated	Off	Module is not educated.
	Green	Module is educated.
	Green - flashing	Module is recognized by the Processor but education is not complete.
	Amber - flashing	Active/standby changeover in progress.

I/O status LEDs

There are 40 input channel status LEDs on the Module Front Panel, one for each field input. These indicators are controlled by the FPU. The FPU receives data from each of the module slices. The FPU performs a 2003 vote on each data bit from the slices and sets the indicators accordingly.

The input status LED mode is dependent upon the voltage level of the field I/O signal. Each field input voltage is measured and compared to six threshold levels (four configurable and two fixed) which produce seven threshold bands. Each threshold band can be defined to have a particular indicator mode: off, green, red, flashing green, or flashing red.

The configurable voltage thresholds and LED modes allow users to customize the input measurement and status indications to suit individual application requirements. Without customization, the default indicator modes are suitable for digital inputs without line monitoring as described below:

Table 17 Default I/O status Indicators

Channel	Description
Off	Open field switch (contact) or open circuit or indeterminate between open and closed (states 1, 2, and 3).
Green	Closed field contact (contact) or short circuit (states 4 and 5).
Red-flashing	Channel Fault (state 7).

Tip: 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 Product Description, publication ICSTT-RM249 (PD-T8082).

Fault finding and maintenance

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 that 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.

Field wiring 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.

Once the field wiring fault has been identified and corrected, the input status and the input status LED will display the normal on/off status of the field device and field wiring.

Module faults

Extensive diagnostics provide the automatic detection of module faults. The TMR architecture of the Input Module and the diagnostics performed ensure 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 or with a SmartSlot for a spare replacement Module.

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 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.

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 input jumper 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.

Input Module Smart Slot jumper cable TC-306-02

Smart Slot 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 ensures the 0 Volt of each Chassis is at the same potential.

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 reinserting it.

If an I/O Module is inserted into a functional system slot that 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 push button.

Proof of testing

It is recommended that proof testing is carried out at two yearly intervals. Refer to Appendix F of Trusted TMR Safety Manual T8094, publication ICSTT-RM459.

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 startup, 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 use 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 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 push button on the TMR Processor. This will force the changeover to proceed even if the new Active Module is not fault free.

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	29 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	5 kΩ
Measurement Range	-6 to +36 Vdc
Thresholds	Configurable
Maximum Withstanding	±50 Vdc
Safety Accuracy	0.5 Vdc
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)
Width	31 mm (1.2 in)
Depth	303 mm (12.0 in)
Weight	1.18 kg (2.6 lb)

[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.