

## 4. Operation

### 4.1. 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-colour LED of which for normal operation, only two colours are used; red and green. 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.

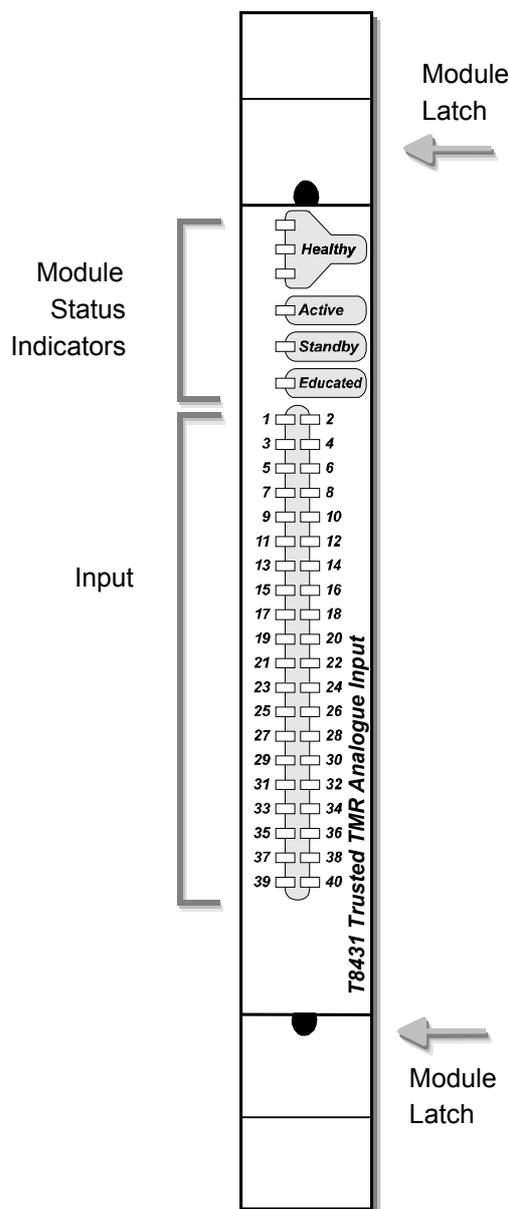


Figure 4 Module Front Panel

## 4.2. 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 2-oo-3 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:

LED	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 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 recognised by the Processor but education is not complete.
	Amber - Flashing	Active/standby changeover in progress

**Table 17 Module Status Indicators**

### 4.3. 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 2-oo-3 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 customise the input measurement and status indications to suit individual application requirements. Without customisation, the default indicator modes are suitable for analogue inputs as described below:

INDICATOR STATE	DESCRIPTION
Off	'Normal' (states 1,2,3)
Green - steady	'High alarm' (states 4,5)
Green – flashing	Ovrange (state 6)
Red – flashing	Underrange (state 0) or Channel Fault (8 to 15)

**Table 18 Default I/O Status Indicators**

**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 PD-8082B.

## 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.

### 5.2. 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 loop develops a line fault, the input channel status LED will adopt the steady red state (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 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 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 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-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.

## 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.

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.

## 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. Input Channel Calibration Check

It is recommended that you carry out a check at 2 yearly intervals on the input channel calibration. This check will detect long term drift and any inaccuracy as a result. It requires a three point check as follows:

Inject a signal to each input channel in turn using the following values and check through the workbench that the reading is as shown below:

- 4 mA signal should give a 0% of full scale reading
- 12 mA signal should give a 50% of full scale reading
- 20 mA signal should give a 100% of full scale reading

## 5.8. 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 enforce 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 **IEC1131 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.

## Trusted™ Module T8431

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 push-button reset on the TMR Processor. This will force the changeover to proceed even if the new active module is not fault free.