Fire Detector Input Modules

(T3419)

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Fire detector input modules provide interfaces for 16 fire detector inputs such as smoke detectors, flame detectors, temperature detectors, and manual alarm call points. Each module performs line monitoring on the field wiring connections and automatic testing of the module's input electronics. Input and line status are reported back to the controller for use in application program logic.

Features

- Sixteen input points.

- Individual channel Reset control output to reset latched fire detectors.

- Fault tolerant operation when redundant modules and sensors are configured.

- Hot-replaceable.

- Complete, automatic testing of all input circuits.

- Automatic line monitoring detects open and short field wiring faults.

- Individual front panel indicators on each module show the module's fault/active and power status, as well as input status indicators for each point.

- 2500 volt minimum electrical isolation between field and logic circuits.

- TÜV certified, Risk Class 5.

The input module circuits are thoroughly tested, providing a fail-safe interface for safety critical inputs. For fault tolerant configurations, two fire detector input modules are used to

connect to redundant field sensors. In this dual module configuration, a failed module can be removed and replaced without affecting system operation.

The module requires connection to a field power supply voltage, ranging from 15 to 40 VDC. This supply voltage is internally regulated to power the fire detector field input circuits.

Module Operation

A block diagram of a typical fire detector input module is shown in Figure 1.
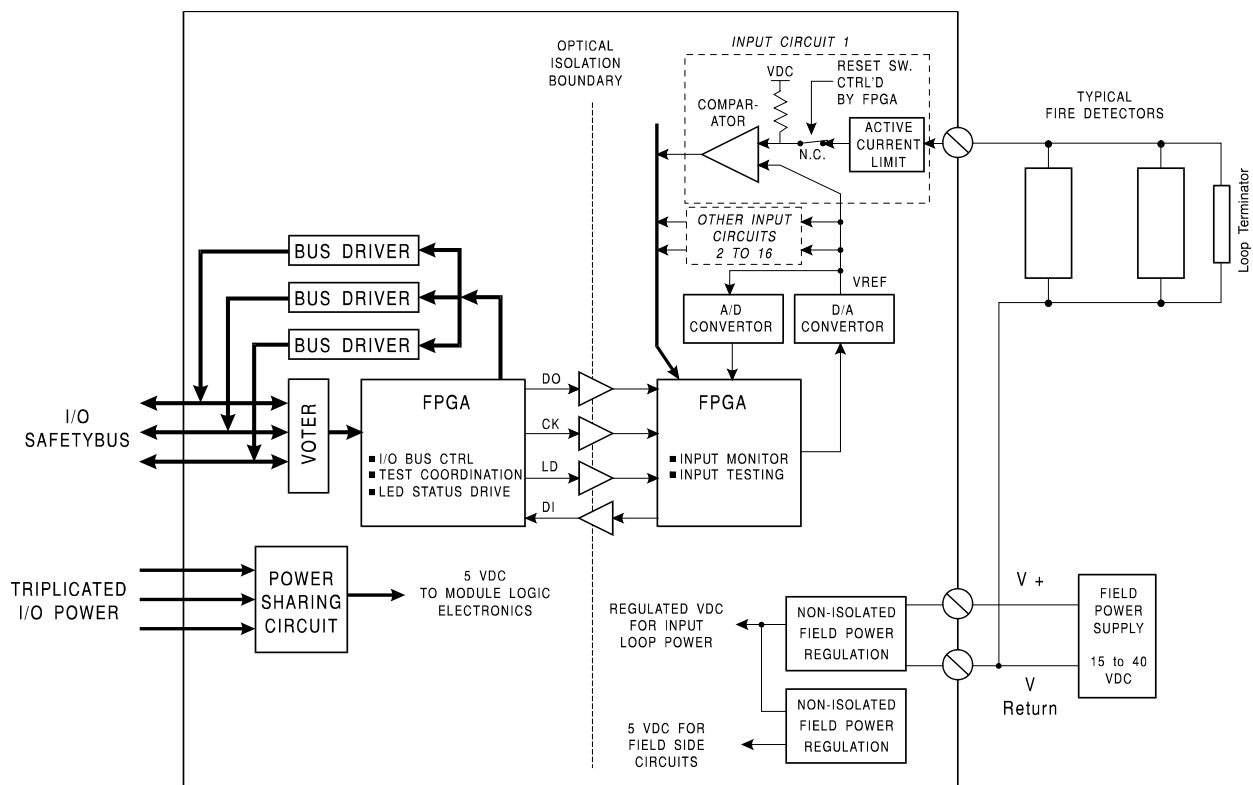

Figure 1. Block Diagram of Fire Detector Input Module.

A field power supply is connected to the fire detector input module. The field power is internally regulated to 23.5 Vdc to power the fire detector field inputs. Each input is biased to

this regulated voltage with an internal resistor. Externally each input connects to an associated field sensor and a line terminator. The module monitors the input voltage to detect a variety of input states. The module can discriminate and report sensor tripped, sensor healthy, line open and line shorted conditions. Additional circuits allow the module to reset a latched fire detector by removing power from the associated input circuit.

Internally the module generates a reference voltage that is compared to the field inputs. The comparator generates an on or off state depending on which voltage is greater. The field-side FPGA controls and monitors the reference voltage signal and reads the status of all 16 input comparators. This information is stored and sent through optical isolation to the logic-side FPGA. This FPGA interfaces the input date to the I/O safetybus and drives the module's front panel indicators.

Testing and Diagnostics

Standard I/O Module Testing

The processor modules send triplicated read data requests to the input module over the I/O Safetybus. The processors' addressing data and data read requests are voted by the module (preventing I/O Safetybus failures upstream from the module from affecting its ability to be read). The voted result is then passed to the I/O bus interface logic.

After receiving the voted data read request, the I/O bus interface logic sends its input data to the module's three bus drivers. Each of the three bus drivers is independently controlled — preventing failures in a single driver from being propagated into the rest of the system.

The bus drivers then move the data onto the I/O Safetybus which, in turn, passes it to the processors.

Each module's voter circuits are periodically tested by the processor modules. Discrepant data are sent through one of three legs of the I/O Safetybus to determine whether the module's voter is able to outvote the incorrect data. A failure to return the correct majority-voted result to the processors produces an I/O module error indication at the processor modules and a module fault indication at the I/O module.

Each type of module has a unique identification code that is read by the controller. This code lets the controller know which type of module is installed in each I/O chassis slot and address that module and its points specifically. The processor modules periodically check each module's identification code to determine whether the type of module installed matches type of module indicated in the I/O configuration that was loaded when the system was started. If a module is removed, or is replaced with a module of a different type, the processor modules will indicate I/O module errors.

Loopback logic tests periodically write data to the module and then read it back to determine whether the module's I/O bus interface logic is functioning correctly.

Input Circuit Testing

The field interface circuits of the fire detector input module are completely tested to detect stuck-on or stuck-off input circuit faults and identify input wiring open and short circuits. The automatic execution and evaluation of the input testing is controlled by the triplicated Regent processor modules.

During normal operations, the internal reference voltage is set to three levels and the comparator output is read. These three reference voltage levels represent thresholds that determine whether the input signal is in alarm or healthy and if the field wiring is open circuit or short circuit. The logic-side FPGA determines input status and line fault status based on the comparator data for the three voltage levels. The FPGA data is provided to the I/O processors for application processing.

On a background basis, the I/O processors test the input circuit comparators and logic circuits for stuck-on and stuck-off failure modes. During testing the D/A converter generates two reference voltages outside the normal operating range of the field input voltages to test that the comparator output can turn-off and turn-on. The I/O processors read the resulting input status, line fault status, and reference voltage readings for the test cycle to determine if there are faults in the input circuits or the common data paths.

If the I/O processors detect a faulted input circuit, an I/O module fault is indicated at the processor modules and the Fault LED on the face of the input module is turned on.

Input Circuit Test Interval

The Regent processor modules schedule testing of the input circuits on a background basis. The test interval for these circuits may range from a few seconds to several minutes, depending on the application program scan time and the size of the I/O configuration. The equation below can be used to estimate the test interval for monitored digital inputs.

$TI = 172 * IOU_{QTY} * TSCAN + 2$

where:

TI = Test interval, seconds

IOU_{QTY} = Quantity of I/O Units in the system (1 to 16)

$TSCAN$ = The application program scan time, seconds

For example, for a system with 8 I/O units and an application scan time of 60 milliseconds, the test interval would be:

$TI = 172 * IOU_{QTY} * TSCAN + 2$ = $172 * 8 * 0.060 + 2$

$TI = 84.6$ seconds

In this system, all of the fire detector input modules would be tested for stuck-on and stuck-off faults approximately every 85 seconds. This test interval can be used in reliability and availability calculations to select the fault tolerant input configuration that meet the application's safety requirements.

Note: Due to I/O processor fault filtering algorithms, it may take up to four test intervals to report a failed input module as a permanent fault

Front Panel Indicators

Figure 2 shows the physical features of the fire detector input modules. The front panel of each module contains fault/active and power indicators for the module as well as input status indicators for each channel.
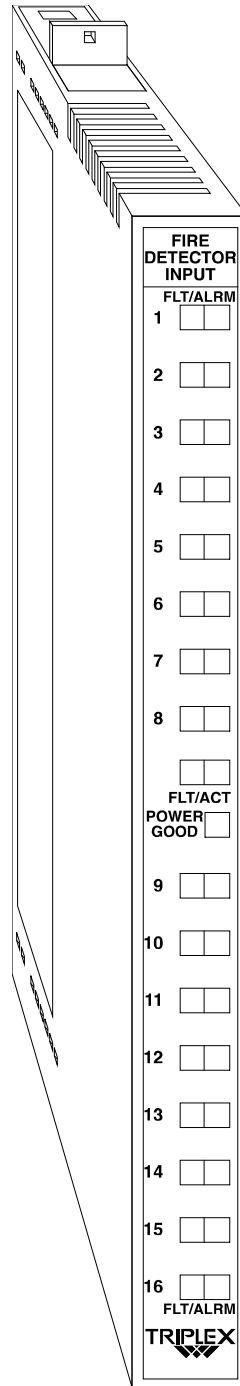
Figure 2. Fire Detector Input Module.

Active/Fault Status Indicator

This green and red LED pair indicates the overall health of the module and its field circuits. During normal operation the green ACTIVE indicator flashes at the controller's scan rate. If a module fault occurs the red FAULT indicator switches on and the green indicator switches off.

Power Status Indicator

The POWER GOOD LED indicates the presence of field voltage at the module's field power input terminals and the overall health of the module's field power regulator circuits.

Input Status Indicators

Input status indicators show Fault and Alarm status for each point.

A red ALARM status indicator turns on when the fire detector input is in the tripped alarm state. The indicator is also on if the input signal is shorted.

A yellow FAULT indicator turns on when the input circuit is open or short circuit.

Application

Simplex Configuration

Fire detector input modules provide a suitable interface to safety-critical input signals.

Fire detector input modules provide a suitable interface to safety-critical input signals. The circuits in the input modules are automatically tested and annunciated, providing a fail-safe interface to digital inputs.

Fault Tolerant Connection

For critical inputs, redundant input modules are used with redundant input sensors in a fault tolerant configuration. In this configuration each input module is connected to one of two redundant sensors in the field. With this configuration, if a fault occurs on one module or sensor, it can be removed and

replaced while the system continues to sense the inputs from the remaining module.

Note: In certain applications it may be possible to connect single fire detectors to redundant input modules. For consideration of this option, consult the factory for details.

Field Wiring

Field wiring terminal blocks on the I/O chassis are used to connect the field power supply and field input wiring to the module. The terminal blocks are located directly above and below the slot where the module is installed. Each terminal block consists of ten #6 wire clamp screw terminals capable of holding two 12 AWG wires.

The field power supply voltage is internally regulated inside the module. This power is used to source the power to the fire detector inputs. The return side of the inputs are wired back to the field power supply returns.

Figure 3 shows the proper connection of input signals to the input wiring terminals.

MODULE CIRCUITRY   FIELD WIRING

Line Terminators
Fire Detectors

CH 1
CH 2
CH 3
CH 4
CH 5
CH 6
CH 7
CH 8

Vref generated
by input module

FIELD
POWER
REG.

Vdc for
I/O Circuits

POWER
SOURCE

Do not connect
field signals to
terminals C or D.

CH 9
CH 10
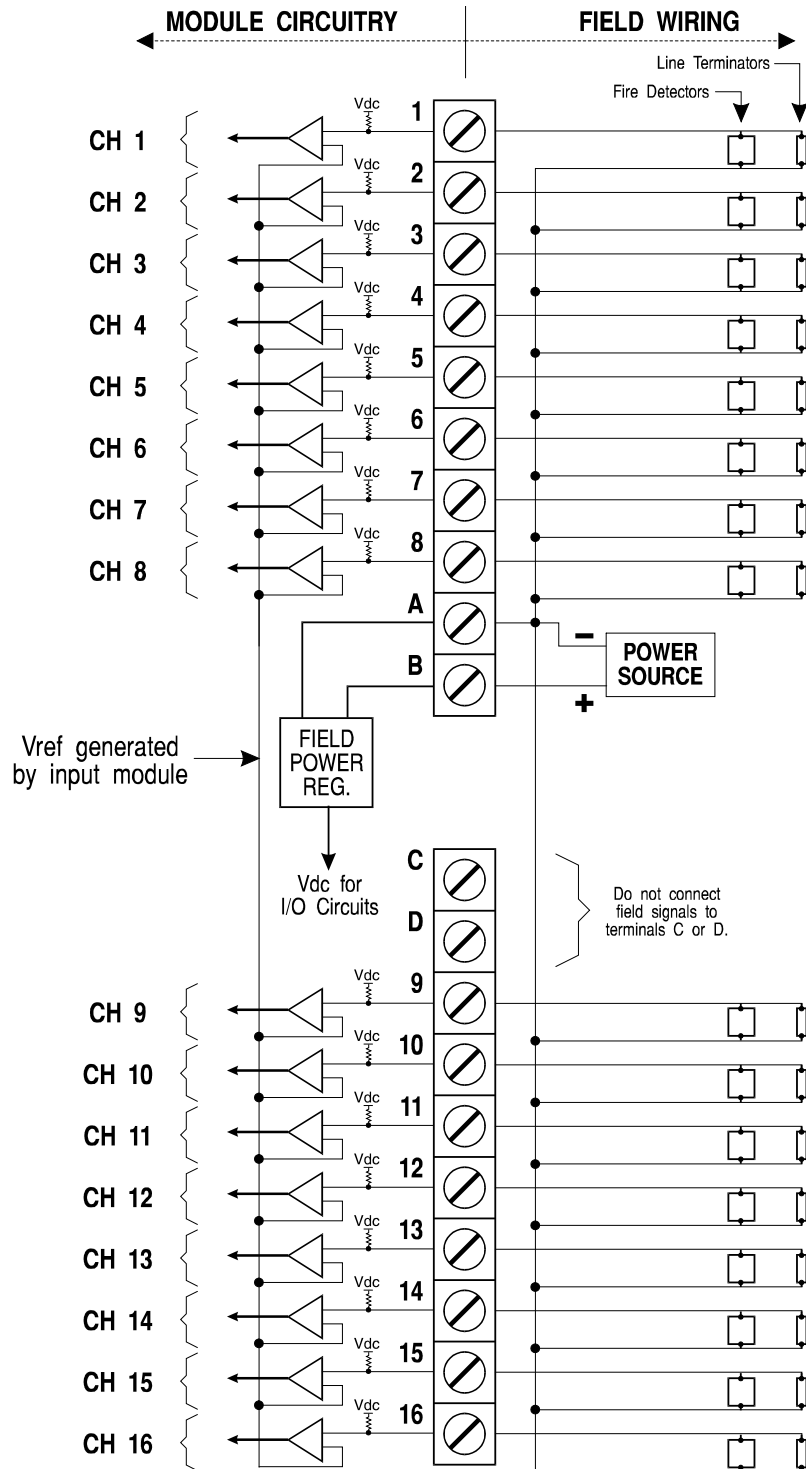CH 11
CH 12
CH 13
CH 14
CH 15
CH 16

Figure 3. Module Wiring, Single Sensors to a Fire Detector Input Module.

Matching the Input Thresholds to Specific Field Devices

The Fire Detector input module has a input characteristic load-line that is illustrated in Figure 4.
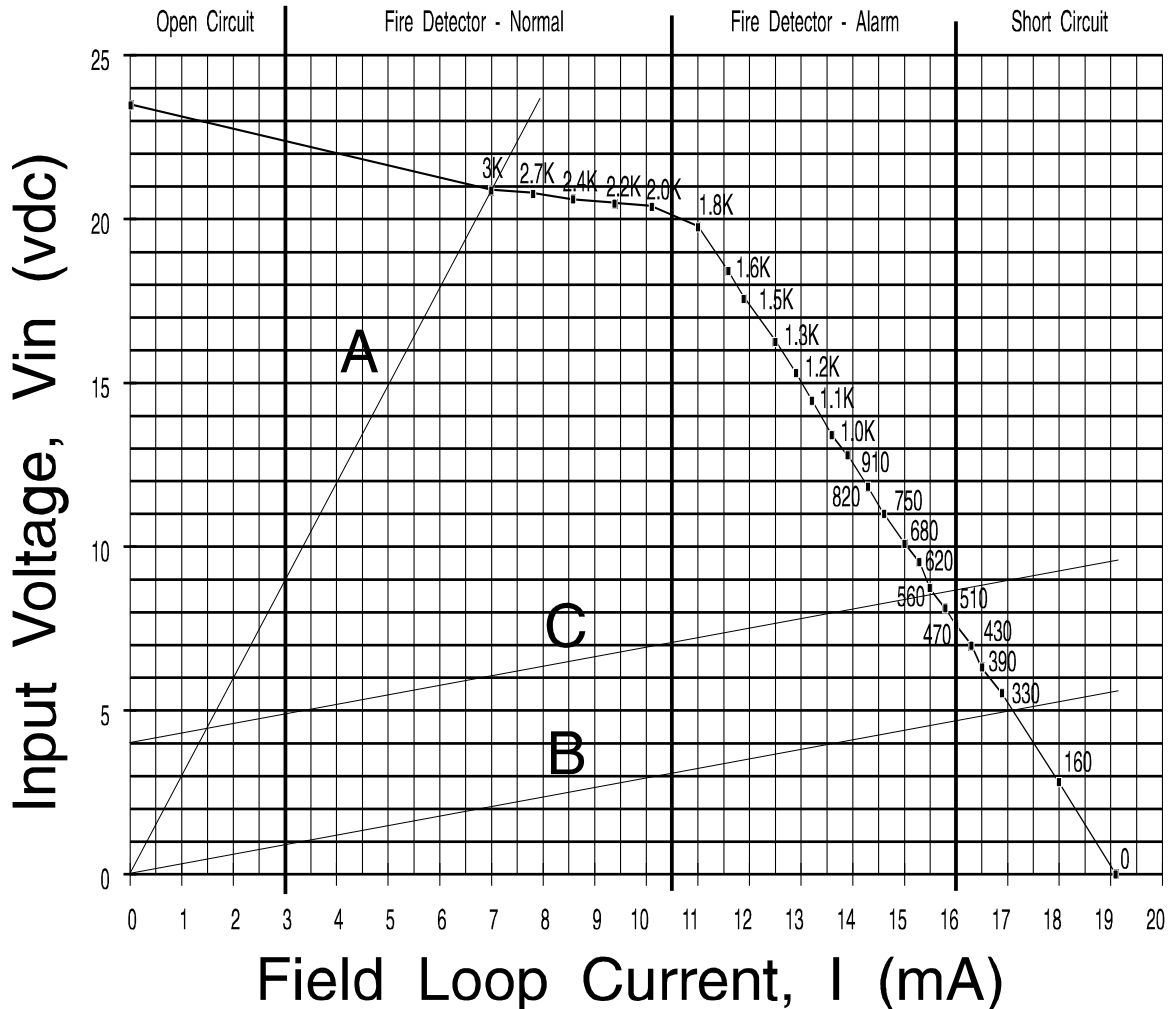

Figure 4. Input Characteristics of the Fire Detector Input

This figure plots the input voltage versus loop current. Along the curve, several points are plotted which indicate the loop resistance that produces the load-line characteristics. When applying the module to specific fire detectors, the operating points for Fire Detector -Normal, Fire Detector - Alarm, Open

Circuit and Short Circuit should be examined. Each of these points should fall within the boundaries determined by the input module thresholds. If necessary the thresholds can be adjusted during configuration of the module using WINTERPRET.

For example, consider a fire detector that has an alarm characteristic of 300Ohm with a 4Vdc Zener and a line termination resistor of 3K Ohms. When the fire detector is in the normal state (not tripped) the input load is only the 3K Ohm termination resistor. This is illustrated in Figure 4 as line A. The point at which this line intersects the load-line represents the input voltage and loop current when the fire detector is in the normal state. This point is located well between the default Open Circuit current threshold (3 mA) and the default On/Off Alarm threshold (10.5 mA).

Next, the fire detector alarm state should be examined. The alarm resistance of the fire detector is 300 Ohms and this is illustrated as Line B in the figure. However, the 4 Volt Zener of the fire detector offsets the operating point by 4 Volts as shown by Line C. The point at which Line C intersects the load-line represents the input voltage and load current when the fire detector is in the alarm state. This point should be between the On/Off threshold and the Short Circuit threshold. In this case the alarm point is rather close to the Short Circuit threshold so it may be necessary to modify the Short Circuit threshold to a slightly higher value, like 17 mA.

Finally, the Open Circuit and Short Circuit conditions must be examined. In this example, the Short Circuit condition is 0 Ohms (or a small amount of resistance representing the field wire resistance to the point at which the short occurs). This would place the Open Circuit point near to the point where the load line intersects the x-axis in the Figure. Similarly, the Open Circuit is infinite Ohms which would place the operating point where the load-line intersects the y-axis.

Note: In many applications you may also connect and intrinsic safety barrier in the field loop. In these applications the resistance and voltage drops of the barrier must also be included in determining the operating points of the input circuit under all four operating conditions. If necessary,
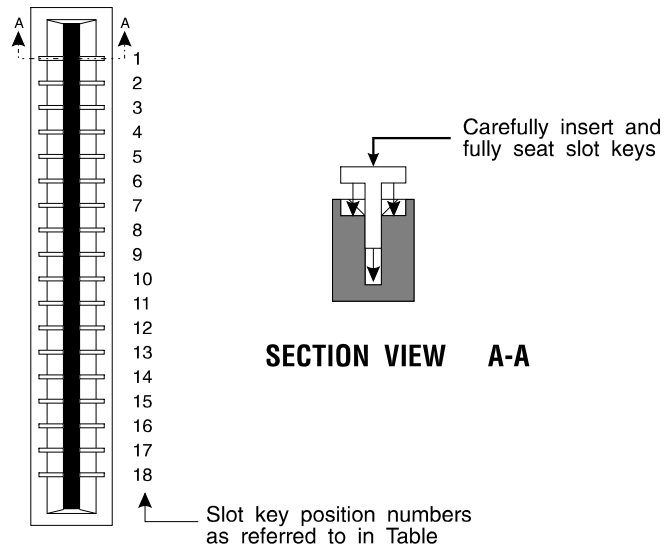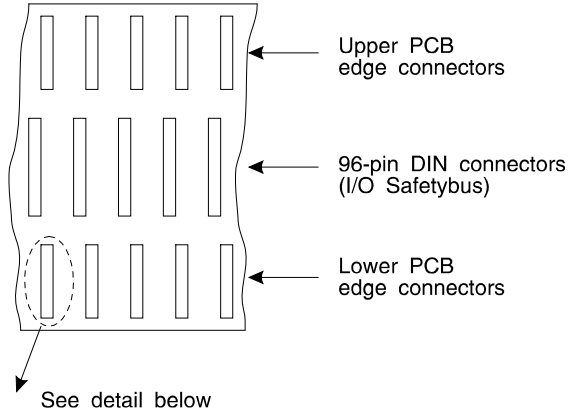
contact the factory for assistance in applying your specific field inputs and barriers to the fire detector input module.

Keying

The I/O chassis can be physically keyed to prevent accidental damage caused by inserting a module into a slot wired for a different module type. Figure 5 illustrates how the slot keys are installed on the I/O chassis slot field wiring connectors. The slot key positions for the monitored digital input module are listed in Table 1.

PARTIAL VIEW:
I/O Module Slots
in I/O Chassis

Upper PCB
edge connectors

96-pin DIN connectors
(I/O Safetybus)

Lower PCB
edge connectors

See detail below

A   A
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Carefully insert and
fully seat slot keys

SECTION VIEW   A-A

Slot key position numbers
as referred to in Table

DETAIL - EDGE CONNECTOR

Figure 5. Installing Slot Keys.

Table 1. Slot Key Positions.

Module	Upper Connector	Lower Connector
T3419	11	7

Configuration

Each fire detector input module is configured using the
WINTERPRET I/O Configuration Editor. In the editor, you will
perform the steps described below to configure the input
module.

1) Set the Module Type:

   Position the cursor on the module slot you wish to define.
   Choose Set Module Type from the Edit Menu and select
   the T3419, Fire Detector Input Module from the list.

2) Edit the Module Definition:

   Choose Edit Module Definition from the Edit Menu. A
   dialog box will open where you can define the input module
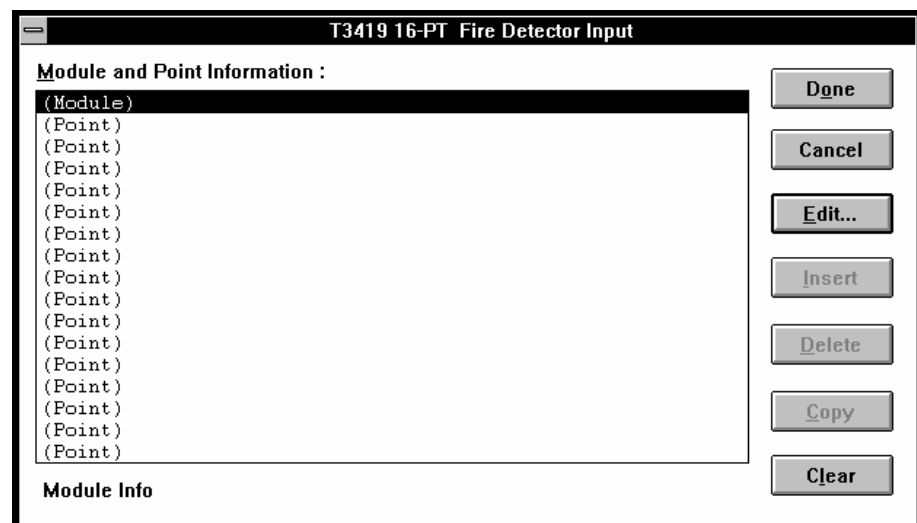   and point definitions.

Figure 6. Fire Detector Input Module Definition.

3) Define the Input Module Fields and Thresholds:

   With the cursor at the top of the list in the Module
   Definition dialog shown in Figure 6, open the Fire Detector
   Input Module dialog by pressing Enter or double clicking
   on the "(Module)" selection. The dialog box shown in
   Figure 7 will open.

Figure 7. Defining the Input Module Fields and Thresholds.

In the module definition dialog you can define a tag names representing all sixteen input points as a 16-bit word. For example, the Name field represents the On/Off status of all sixteen inputs

The module tag names represents the 16 inputs as a signed, 16-bit integer. In this format, input point one is the least significant bit (LSB) and input point 16 is the most significant bit (MSB). Enter tag names up to 12 characters long and descriptions up to 40 characters long.

In the module definition dialog you can also set the threshold currents used to determine the Open Circuit, On/Off, and Short Circuit input status. These values may need to be changed to suit the characteristics of the fire detector inputs that you are using. Refer to page 10 for discussion on Matching Input Thresholds to Specific Fire Detectors.

3) Edit each point:

Choose Edit from the Module Definition dialog box to define a name and description for each input point. In the Fire Detector Input Point dialog, enter names and values for the configuration fields as described below.

Figure 8. Defining a Fire Detector Input Point.

Name

Also called the tag name, this is the name used in the application program to reference the fire detector input's Tripped/Healthy state. The name can be up to 12 characters long.

Description

This 40-character field provides a place to describe the input point definition. The description is used to help document your system (it does not affect application program operation).

Fault Name

This is the name used in the application program to reference the input point line fault status. The name can be up to 12 characters long.

During operations the input circuit is monitored for open circuit and short circuit wiring faults. This bit is normally on and turns off if either an open circuit or short circuit is detected.

Note: Line fault status is only reported through the Fault Name variables. Line faults are not reported as a permanent I/O module fault and do not turn on the associated system control relay fault bit for the module. Line faults are not latched. If a line fault condition returns to normal, the Fault Name variable status also returns to normal.

Fault Name Description

This 40-character field provides a place to describe the input point fault name definition. The description is used to help document your system (it does not affect application program operation).

Disable Fault LED

Marking the Disable Fault LED check box disables the fault LED for this input point on the face of the input module. Marking this box does not stop the module from line monitoring the input circuit and updating the state of the Fault Name variable, it only stops the module from displaying line faults on the face of the input module. Line faults are still reported to the Regent and are available to the application program through the fault name variable.

This box can be checked for those input points are spare and have no field switches connected. In this configuration the line fault LED will always be off. If you do not check this box for unconnected spare input points, the line fault LED will always be on.

Reset Name

This is the name used in the application program to control the Reset operation for a latched fire detector input. The name can be up to 12 characters long.

Reset Description

This 40-character field provides a place to describe the Reset point definition. The description is used to help document your system (it does not affect application program operation).

LED Force

This is the name used in the application program to control the ALARM indicator for the input on the face of the input module. In some applications it is desirable to latch the alarm indication for the input after a fire detector has alarmed and then reset the indication after a fire detector reset has occurred. By naming the LED Force bit, you can control the ALARM indicator through application programming. If desired, name the LED Force bit, using up to 12-characters.

Programming

Inputs are referenced in the application program through the tag names defined in the I/O Configuration Editor. When the fire detector is in the alarm state the input is said to be on, or have a value of one. In ladder logic, the on state would produce power flow in a normally open (N.O.) contact.

Field wiring open circuit or short circuit conditions are referenced in the application program using the Fault Name tag names defined in the I/O configuration Editor. If there is a short or open circuit the Fault Name status is off.

Resetting a Latched Fire Detector

Most typical fire detector input sensors latch when tripped and need to be reset. A sensor reset occurs when the supply voltage to the detector is removed. The fire detector input module provides individual channel reset capability designed for this purpose. Through application programming, a Reset bit for each input can be turned on to reset the desired input channel. When the module receives an input reset signal, the power to the input circuit is turned off. The front panel alarm LED will go off and the inputs state reported to the processors shall remain unchanged. The module will indicate a line fault for the input (since the loop current is zero with the power removed).

When the reset signal is turned off, power is applied to the input and the status LED will report the field input state. However, the input state reported to the processors will remain in its last state for an additional period (typically 5 seconds) to all the fire detector to settle. After this delay the actual field signal shall be reported back to the processors.

To program the reset function for a fire detector, you should program the reset bit to turn on when initiated and remain on for the time required by the fire detector to reset. Consult the specifications on your sensors for the required reset time.

Maintenance

No periodic maintenance or calibration is required for the digital input modules. There are no user replaceable parts inside these modules.

Safety Considerations

TÜV   The fire detector input modules are TÜV certified for Risk Class 5 safety critical inputs. Safety critical configurations include dual and triple redundant input modules (and sensors if required) and associated application voting methods.

In safety critical input applications using a single sensor, it is important that the sensor failure modes be predictable and well understood, so there is little probability of a failed sensor not responding to a critical process condition. In such a configuration, it is important that the sensor be tested regularly, either by dynamic process conditions that are verified in the Regent, or by manual intervention testing.

Redundant sensors can be used with redundant input modules to eliminate any single points of failure and extend fault tolerance to include the sensors.

For additional safety considerations, please refer to the Safety Considerations section of the Regent User's Guide.

Specifications

Safetybus Power	0.85 load units
Number of Inputs	16
Field Circuit Type	Standard 20 volt detector loop, line monitored and tested
Field Power	
Voltage:	15 to 40 VDC
Current:	1.2 amps, maximum
Nominal Operating Voltage	Module provides regulated 23.5 Vdc for input loop
End of Line Terminator	3.0 Kohm resistor, typical
Quiescent Current, Maximum	3 to 10 mA, typical when detector in normal state
Detector Alarm	See Load-line characteristics, page 10.
Reset	
Voltage:	<1 volt
Current:	<20 μA
Time**:**	Programmable
Test Interval	15 seconds (typical)
Intrinsic Safety	External barrier
Over voltage Protection	27 volts continuous, 500 volts surge transient
Fusing	None (internal current limit 20 mA — no damage with continual short circuit or open input)
Isolation	2500 volts minimum (field wiring to control logic)
Operating Temperature	0° to 60° C (32° to 140° F)

Storage Temperature	-40° to 85° C (-40° to 185° F)
Operating Humidity	0 to 95% relative humidity, non-condensing
Vibration 10 to 55 Hz:	0.15", double amplitude
Shock Operating:	15 g ½ sine wave, 11 msec

Electromagnetic Interference

- IEC 801 Part 2 - Electrostatic Discharges
- IEC 801 Part 3 - Radiated Electromagnetic Fields
- IEC 801 Part 4 - Transients and Bursts
- ANSI/IEEE C37.90 - Surge Withstand Capability

Level 3: Contact discharge of 6 kV

Level 3: 10 V/M, 27 MHz - 500 MHz

Level 4: 2 kV, 2.5 kHz for t = 60 seconds

2.5 kV damped 1 MHz sine wave

4 kV bi-directional impulse, 10 nsec rise time, fast transient

Safety	Certified to DIN V VDE 0801 for Risk Class 5. Also designed to meet UL 508 and CSA 22.2, No. 142-M1981
Heat Dissipation	20 Watts, 70 BTUs/hour
Dimensions Height: Width: Depth:	12.6" (320 mm) 1.27" (32 mm) 10.125" (257 mm)
Weight	3.3 lbs (1.5 kg)