

TRICONEX

Tricon Version 9-10 Systems

Planning and Installation Guide for Tricon v9-v10 Systems

Assembly No. 9700077-012

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This guide includes information on planning and installing Tricon version 9 systems and Tricon version 10 systems.

Summary of Sections

- [Chapter 1, Introduction](#) – Describes the theory of operation, system configuration, and international approvals for the Tricon controller.
- [Chapter 2, System Components](#) – Describes the required and optional components that are available with Tricon systems.
- [Chapter 3, Installation and Maintenance](#) – Provides installation procedures and grounding information.
- [Chapter 4, Fault and Alarm Indicators](#) – Provides information on responding to alarm conditions.
- [Appendix A, Replacing Firmware EPROMs](#) – Provides instructions on replacing EPROMs, which allows firmware updates.
- [Appendix B, Pin-Outs for Cables and Connectors](#) – Provides pin-out information on communication cables.
- [Appendix C, Warning Labels](#) – Describes General Hazard, Hazardous Voltage, and Hot Surface warning labels.
- [Appendix D, Nonincendive Circuit Parameters](#) – Describes parameters to use for nonincendive communication circuits.
- [Appendix E, Recommended Replacement Parts](#) – Provides a list of replacement parts.
- [Appendix F, Minimum Bend Radiuses of Cables](#) – Provides a list of Triconex cable minimum bend radiuses.
- [Glossary](#) – Provides information for terms and topics used throughout the guide.

Related Documents

- *Communication Guide for Tricon v9-v10 Systems*
- *Field Terminations Guide for Tricon v9-v10 Systems*
- *Safety Considerations Guide for Tricon v9-v10 Systems*
- *TriStation 1131 Developer's Guide, v4.5*
- *TriStation 1131 Libraries Reference*

Product and Training Information

To obtain information about Triconex products and in-house and on-site training, see the Triconex Web site or contact the regional customer center.

Web Site

<http://www.ips.invensys.com/en/triconex>

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1

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Controller Features

The Tricon controller is a state-of-the-art programmable logic and process controller that provides a high level of system fault tolerance. To ensure the highest possible system integrity at all times, the Tricon controller includes these features:

- Provides Triple Modular Redundant (TMR) architecture whereby each of three identical system channels independently executes the control program, and specialized hardware/software mechanisms “vote” all inputs and outputs.
- Withstands harsh industrial environments.
- Enables field installation and repair to be done at the module level while the controller remains online. Replacing an I/O module does not disturb field wiring.
- Supports up to 118 I/O modules (analog and digital) and optional communication modules that interface with Modbus masters and slaves, Foxboro and Honeywell Distributed Control Systems (DCS), other Triconex controllers in Peer-to-Peer networks, and external host applications on Ethernet networks.
- Provides integral support for remote I/O modules located as far away as 7.5 miles (12 kilometers) from the Main Chassis, using SRXM modules.
- Executes control programs developed and debugged with TriStation 1131 or TriStation MSW software.
- Provides intelligence in the input and output modules to reduce the workload of the Main Processors. Each I/O module has three microprocessors. Input module microprocessors filter and debounce the inputs and diagnose hardware faults on the module. Output module microprocessors supply information for the voting of output data, check loopback data from the output terminal for final validation of the output state, and diagnose field-wiring problems.
- Provides integral online diagnostics with adaptive-repair capabilities.
- Allows normal maintenance while the Tricon controller is operating, without disturbing the controlled process.
- Supports transition to a hot-spare I/O module for critical applications where prompt service may not be possible.

Fault Tolerance

Fault tolerance, the most important capability of the Tricon controller, is the ability to detect transient and steady-state error conditions and to take appropriate corrective action online. With fault tolerance, there is an increase in safety and an increase in the availability of the controller and the process being controlled.

The Tricon controller provides fault tolerance through Triple Modular Redundant (TMR) architecture. The controller consists of three identical system channels, except for the Power Modules which are dual-redundant. Each channel independently executes the control program (also referred to as the TriStation application) in parallel with the other two channels. Hardware voting mechanisms qualify and verify all digital inputs and outputs from the field; analog inputs are subject to a mid-value selection process.

Because each channel is isolated from the others, no single-point failure in any channel can pass to another. If a hardware failure occurs in one channel, the faulty channel is overridden by the other channels. Repairs consist of removing and replacing the failed module in the faulty channel while the Tricon controller is online and without process interruption. The controller then reconfigures itself to full TMR operation.

Extensive diagnostics on each channel, module and functional circuit immediately detect and report operational faults by means of indicators or alarms. The diagnostics also store information about faults in system variables. If faults are detected, the operator can use the diagnostic information to modify control actions or direct maintenance procedures.

Because the triplicated system operates as one control system, the Tricon controller can be programmed with one control program that terminates sensors and actuators at a single wiring terminal.

System Configuration

Physically, a basic Tricon controller consists of Main Processors and I/O modules, communication modules, the chassis enclosing the modules, field wiring connections, and a TriStation PC. This section briefly describes these components and provides general specifications.

Tricon modules are field-replaceable units consisting of an electronic assembly housed in a metal spine. Each module has a protective cover that ensures no components or circuits are exposed even when a module is removed from the chassis. Offset backplane connectors make it impossible to plug a module in upside down, and *keys* on each module prevent the insertion of modules into incorrect slots. The Tricon controller supports digital and analog input and output points, as well as pulse and thermocouple inputs and multiple communication protocols.

Tricon Controller Chassis

A Tricon controller can include a maximum of 15 chassis, housing any appropriate combination of input, output, communication, interface, and hot-spare modules. There are 3 types of chassis: Main, Expansion, and RXM.

- The Main Chassis of the Tricon controller houses the Main Processor modules and up to 6 slot sets of I/O modules. The I/O modules in a chassis are connected via I/O expansion bus ports that are triplicated RS-485 bi-directional communication ports.
- An Expansion Chassis (chassis 2 to 15) houses up to 8 slot sets of I/O modules, and HART Interface Modules. The Expansion Chassis connects to the Main Chassis by means of a triplicated RS-485 bi-directional communication port. Generally, an Expansion Chassis must be located no more than 100 feet (30 meters) from the Main Chassis or an RXM Chassis.
- An RXM Chassis houses a Primary or Remote RXM Module set and 6 slot sets of I/O modules. An RXM Chassis enables a system to extend to remote locations up to 7.5 miles (12 kilometers) from the Main Chassis, using SRXM modules.

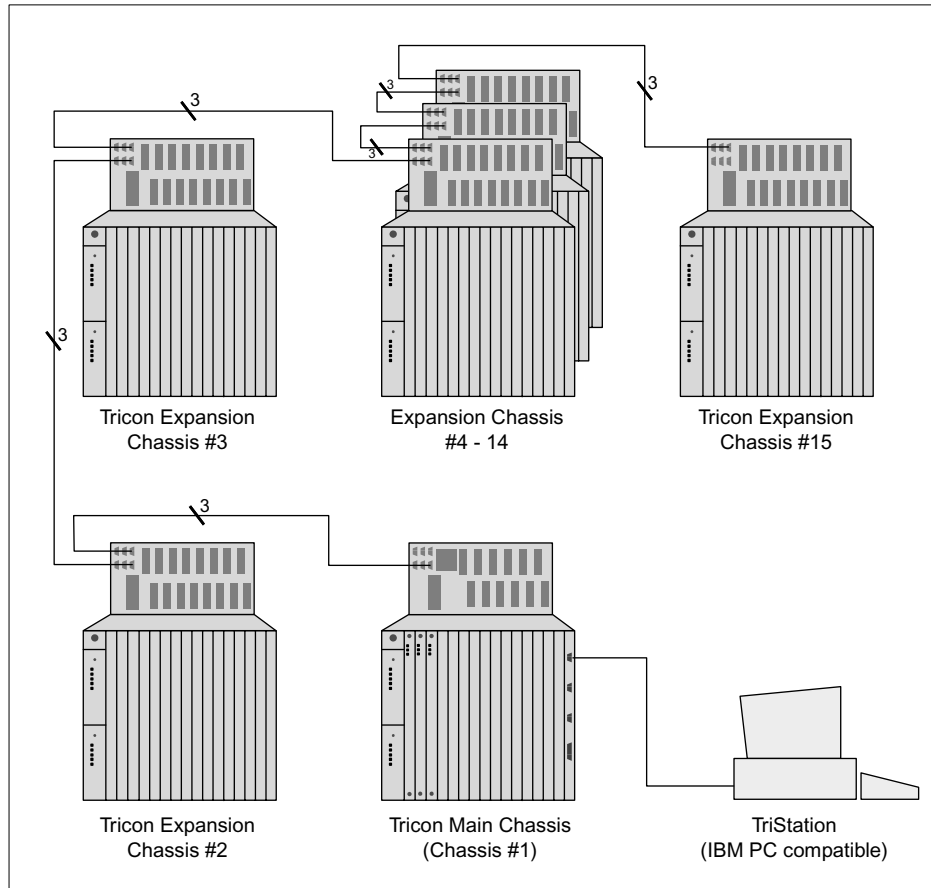


Figure 1 Tricon Sample Configuration

Tricon Controller Field Wiring

External termination assemblies are available for connection to field devices. For additional information on termination products, see the *Field Terminations Guide for Tricon v9-v10 Systems*.

TriStation Software

TriStation 1131 or TriStation MSW software is required to develop and download the control program that runs on the Tricon controller. TriStation MSW includes Relay Ladder Logic for program development. TriStation 1131 provides three programming languages which comply with the IEC 61131-3 standard: Function Block Diagram, Ladder Diagram, and Structured Text. An optional language, CEMPLE (Cause and Effect Matrix), can be purchased separately.

For more information, see the TriStation guide for the version being used.

Theory of Operation

Triple Modular Redundant (TMR) architecture ensures fault tolerance and provides error-free, uninterrupted control in the presence of either hard failures of components or transient faults from internal or external sources.

Every I/O module houses the circuitry for three independent channels. Each channel on the input modules reads the process data and passes that information to its respective Main Processor. The three Main Processors communicate with each other using a proprietary high-speed bus system called the TriBus.

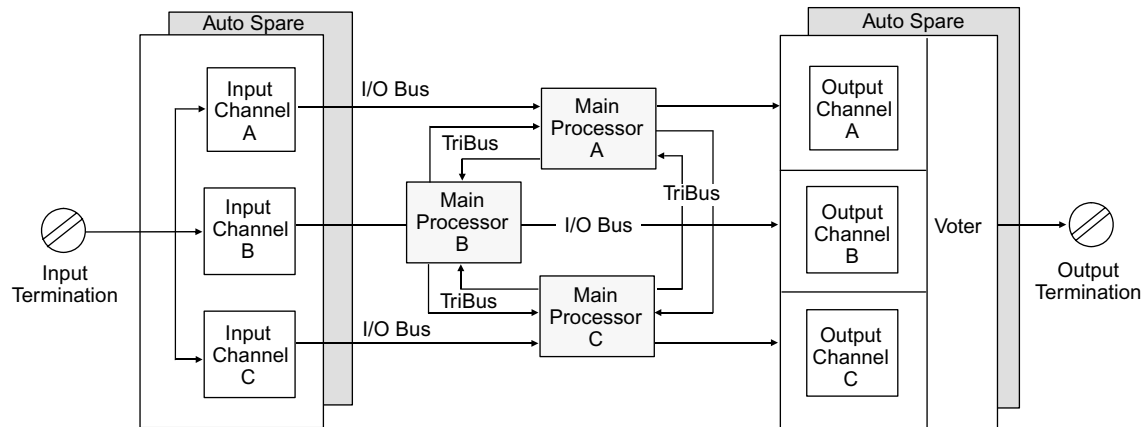


Figure 2 Triplicated Architecture of the Tricon Controller

Once per scan, the Main Processors synchronize and communicate with their neighbors over the TriBus. The TriBus votes digital input data, compares output data, and sends copies of analog input data to each Main Processor. The Main Processors execute the control program and send outputs generated by the control program to the output modules. The Tricon controller votes the output data on the output modules as close to the field as possible to detect and compensate for errors that occur between the Main Processor and the final output driven to the field.

Each I/O slot can contain two identical I/O modules which means if a fault is detected on one module, control is automatically switched to the healthy module. A faulty module can also be replaced online when only one module is installed in the slot. In this case, a healthy module is inserted in the spare slot and the control is switched to this module, which allows the faulty module to be pulled and sent for repair.

Main Processor Modules

A Tricon controller contains three Main Processor modules. Each Main Processor controls a separate channel of the system and operates in parallel with the other Main Processors. A dedicated I/O Processor on each Main Processor manages the data exchanged between the Main Processor and the I/O modules. A triplicated I/O bus, located on the chassis backplane, extends from chassis to chassis by means of I/O bus cables.

As each input module is polled, the appropriate channel of the I/O bus transmits new input data to the Main Processor. The input data is assembled into a table in the Main Processor and is stored in memory for use in the hardware voting process.

The individual input table in each Main Processor is transferred to its neighboring Main Processors over the TriBus. During this transfer, hardware voting takes place. The TriBus uses a direct memory access programmable device to synchronize, transmit, vote and compare data among the three Main Processors.

If a disagreement occurs, the signal value found in two out of three tables prevails, and the third table is corrected accordingly. One-time differences which result from sample timing variations are distinguished from a pattern of differing data. Each Main Processor maintains data about necessary corrections in local memory. Any disparity is flagged and used at the end of the scan by the Tricon controller built-in fault analyzer routines to determine whether a fault exists on a particular module.

The Main Processors put corrected data into the control program. The 32-bit main microprocessor executes the control program in parallel with the neighboring Main Processor modules.

The control program generates a table of output values which are based on the table of input values according to customer-defined rules built into the control program. The I/O Processor on each Main Processor manages the transmission of output data to the output modules by means of the I/O bus.

Using the table of output values, the I/O Processor generates smaller tables, each corresponding to an individual output module in the system. Each small table is transmitted to the appropriate channel of the corresponding output module over the I/O bus. For example, Main Processor A transmits the appropriate table to Channel A of each output module over I/O Bus A. The transmittal of output data has priority over the routine scanning of all I/O modules. The I/O Processor manages the data exchanged between the Main Processors and the communication modules using the communication bus which supports a broadcast mechanism.

Main Processors receive power from dual Power Modules and power rails in the Main Chassis. A failure on one Power Module or power rail does not affect system performance.

Model 3008 Main Processors

Model 3008 has 16 megabytes DRAM (without battery back-up) and 32 kilobytes SRAM (with battery back-up).

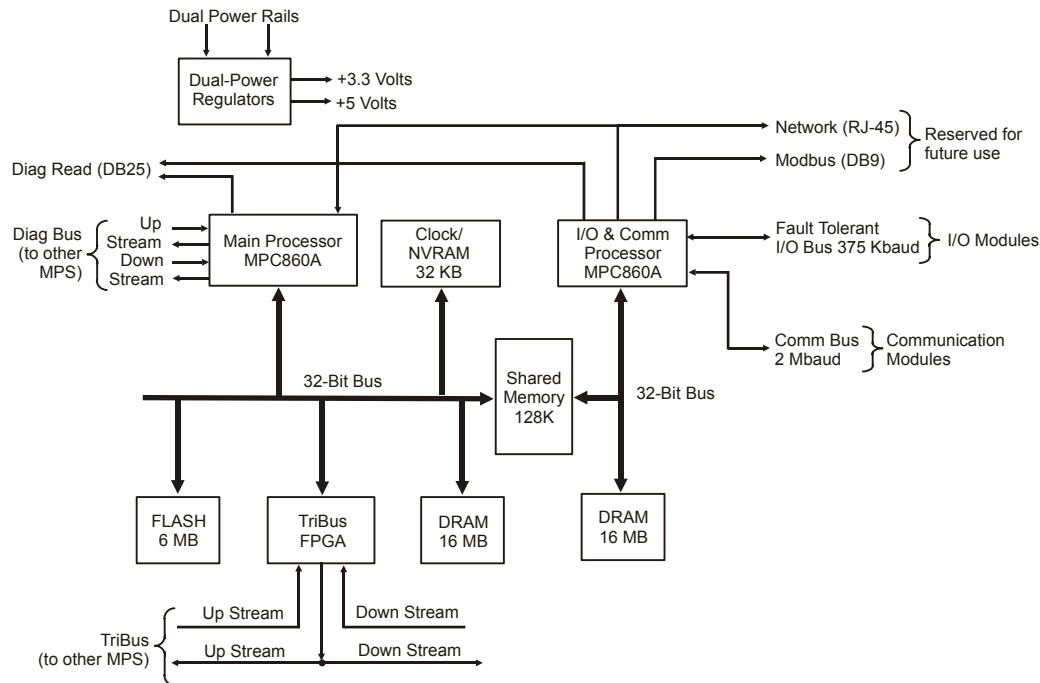


Figure 3 Architecture of a Model 3008 Main Processor

Model 3006 and 3007 Main Processors

Models 3006 and 3007 can be used with Tricon v9.0 to v9.5.x systems. They have the same architecture and specifications, except for SRAM, which is 2 megabytes for the 3006 and 1 megabyte for the 3007.

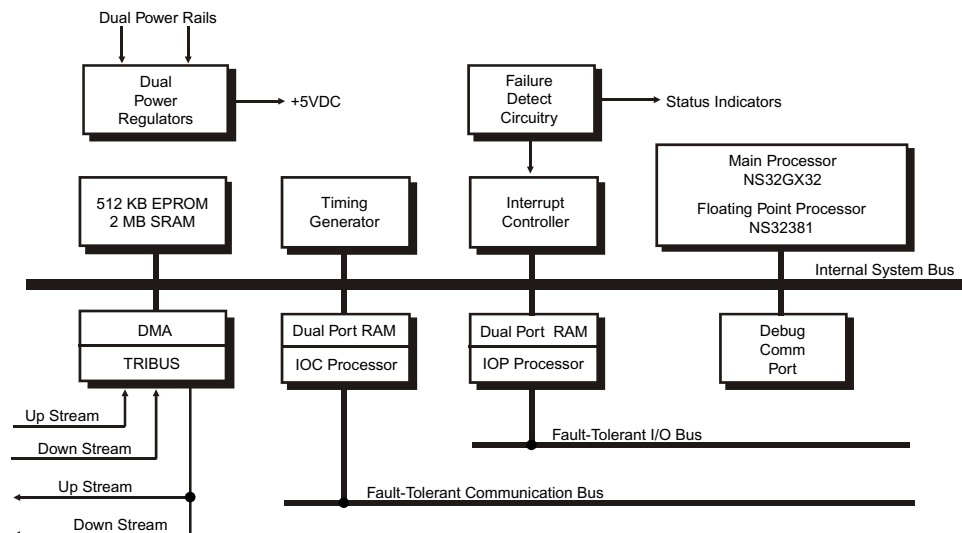


Figure 4 Architecture of a Model 3006 or 3007 Main Processor

Bus Systems and Power Distribution

This figure depicts the three triplicated bus systems which are etched on the chassis backplane: the TriBus, the I/O bus, and the communication bus.

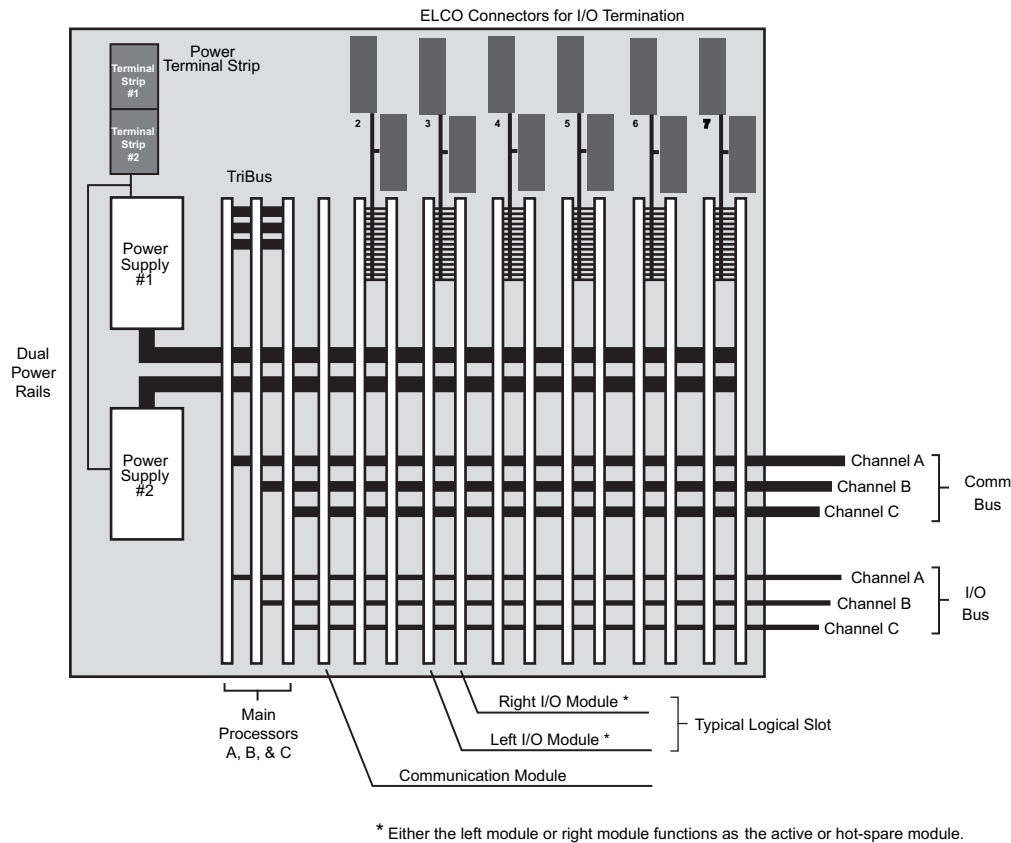


Figure 5 Tricon Bus Systems and Power Distribution

TriBus Operation

The TriBus consists of three independent serial links which synchronizes the Main Processors at the beginning of a scan, and performs either of these functions:

- Transfers I/O, diagnostic, and communication data.
- Compares data and flags disagreements of output or memory data from the previous scan.

An important feature of Tricon controller architecture is the use of a single transmitter to send data to both the upstream and downstream Main Processors which ensures the same data is received by the upstream processor and downstream processor.

I/O Bus Operation

Each I/O module transfers signals to or from the field through its associated field termination assembly. Two positions in the chassis tie together as one logical slot. Termination cables are tied to panel connectors at the top of the backplane. Each connection extends from the termination module to both active and hot-spare I/O modules, which means both the active module and the hot-spare module receive the same information from the field termination wiring.

The triplicated I/O bus transfers data between the I/O modules and the Main Processors at 375 kilobits per second. The I/O bus is carried along the bottom of the backplane. Each channel of the I/O bus runs between one Main Processor and the corresponding channels on the I/O module. The I/O bus extends between chassis using a set of three I/O bus cables.

Communication Bus Operation

The communication bus runs between the Main Processors and the communication modules at 2 megabits per second.

Power Distribution

Power for the chassis is distributed across two independent power rails and down the center of the backplane. Each module in the chassis draws power from both power rails through dual power regulators. There are four sets of power regulators on each input and output board: one set for each channel (A, B, and C) and one set for the status indicators.

Power Modules

Each Tricon controller chassis houses two Power Modules arranged in a dual-redundant configuration. Each module derives power from the backplane and has independent power regulators for each channel. Each can support the power requirements for all the modules in the chassis in which it resides, and each feeds a separate power rail on the chassis backplane. The Power Modules have built-in diagnostic circuitry which checks for out-of-range voltages and over-temperature conditions. A short on a channel disables the power regulator rather than affecting the power bus.

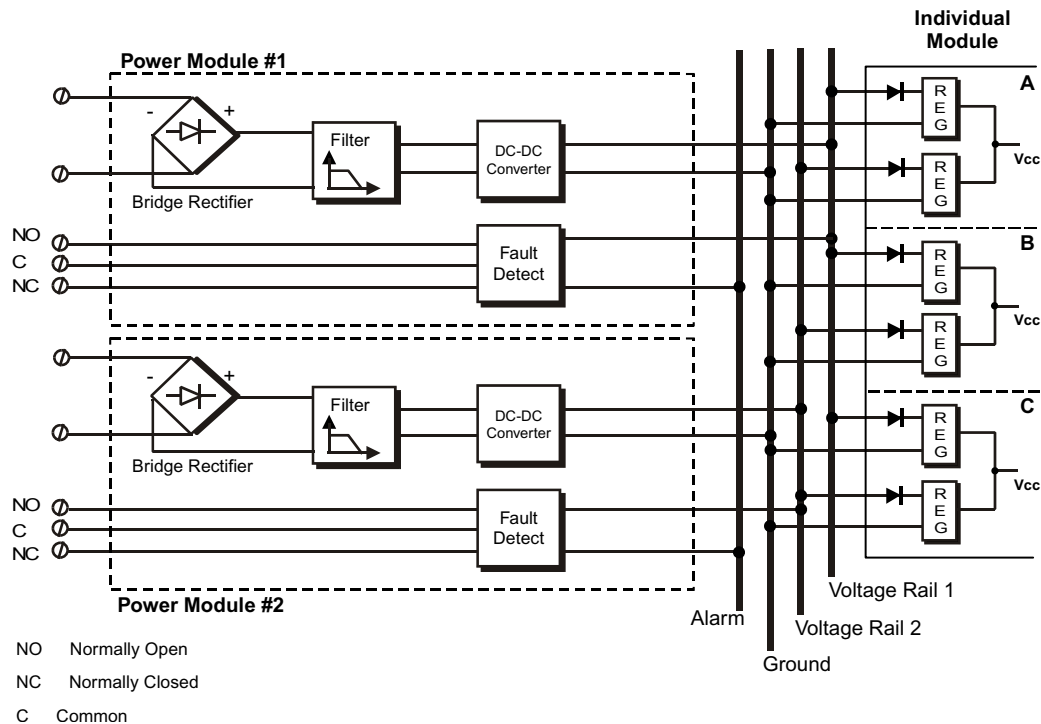


Figure 6 Architecture of Power Module Subsystem

System Diagnostics and Status Indicators

The Tricon controller incorporates integral online diagnostics. Probable failure modes are anticipated and made detectable by specialized circuitry. Fault-monitoring circuitry in each module helps fulfill this requirement. The circuitry includes but is not limited to I/O loopback, deadman timers, loss-of-power sensors, and so on. This aspect of the system design enables the Tricon controller to reconfigure itself and perform limited self-repair according to the health of each module and channel.

Each Tricon controller module can activate the system integrity alarm. The alarm consists of a normally closed or normally opened (NC or NO) relay contact on each Power Module. Any failure condition, including loss or brownout of system power, activates the alarm to summon plant maintenance personnel.

The front panel of each module provides LED (light-emitting-diode) indicators that show the status of the module or the external systems to which it is connected. Pass, Fault, and Active are common indicators. Other indicators are specific to each module.

Maintenance consists of replacing plug-in modules. A lighted Fault indicator shows that the module has detected a fault and must be replaced. The control circuitry for the indicators is isolated from each of the three channels and is redundant.

All internal diagnostic and alarm status data is available for remote logging and report generation. This reporting is done through a local or remote TriStation, or through a host computer. For more information, see the Developer's Guide for the version of TriStation being used.

Analog Input Modules

For Analog Input Modules, each of the three channels asynchronously measures the input signals and places the results into a table of values. Each of the three input tables is passed to its associated Main Processor using the I/O bus. The input table in each Main Processor is transferred to its neighbors across the TriBus. The middle value is selected by each Main Processor and the input table in each Main Processor is corrected accordingly. In TMR mode, the mid-value data is used by the control program; in duplex mode, the average is used.

Each Analog Input Module is automatically calibrated using multiple reference voltages read through the multiplexer. These voltages determine the gain and bias required to adjust readings of the analog-to-digital converter.

Analog Input Modules and termination panels are available to support a wide variety of analog inputs, in both isolated and non-isolated versions: 0 to 5 VDC, 0 to 10 VDC, 4 to 20 mA, thermocouples (types K, J, T and E), and resistive thermal devices (RTD).

For specifications, see [Analog Input Modules on page 46](#).

Analog Output Modules

An Analog Output Module receives three tables of output values, one for each channel from the corresponding Main Processor. Each channel has its own digital-to-analog converter (DAC). One of the three channels is selected to drive the analog outputs. The output is continuously checked for correctness by loop-back inputs on each point which are read by all three microprocessors. If a fault occurs in the driving channel, that channel is declared faulty, and a new channel is selected to drive the field device. The designation of driving channel is rotated among the channels so that all three channels are periodically tested.

Each AO Module is guaranteed to remain in calibration for the life of the controller; periodic manual calibration is not required.

For specifications, see [Analog Output Modules on page 61](#).

Digital Input Modules

Every Digital Input Module houses the circuitry for three identical channels (A, B and C). Although the channels reside on the same module, they are completely isolated from each other and operate independently, which means a fault on one channel cannot pass to another. In addition, each channel contains an 8-bit microprocessor called the I/O communication processor which handles communication with its corresponding Main Processor.

Each of the three input channels asynchronously measures the input signals from each point on the input termination module, determines the respective states of the input signals, and places the values into input tables A, B and C respectively. Each input table is regularly interrogated over the I/O bus by the I/O communication processor located on the corresponding Main Processor. For example, Main Processor A interrogates Input Table A over I/O Bus A.

There are two basic types of Digital Input Modules: TMR and Single. For TMR modules, all critical signal paths are 100 percent triplicated for guaranteed safety and maximum availability. On Single modules, only those portions of the signal path which are required to ensure safe operation are triplicated. Single modules are optimized for those safety-critical applications where low cost is more important than maximum availability.

For specifications, see [Digital Input Modules on page 71](#).

TMR Digital Input Modules

On TMR Digital Input Modules, all critical signal paths are 100 percent triplicated to guarantee safety and maximum availability. Each channel conditions signals independently and provides isolation between the field and the Tricon controller. The model 3504E high-density module is an exception – it has no channel-to-channel isolation.

Models 3502E, 3503E, and 3505E include a self-test feature which verifies the ability of the Tricon controller to detect transitions from a normally energized circuit to the Off state. Because most safety systems use a de-energize-to-trip setting, the ability to detect the Off state is an important feature. To test for stuck-On inputs, a switch within the input circuitry is closed to allow a zero input (Off) to be read by the optical isolation circuitry. The last data reading is frozen in the I/O Processor while the test is running.

Single Digital Input Modules

On Single Digital Input Modules, only those portions of the signal path which are required to ensure safe operation are triplicated. Single modules are optimized for those safety-critical applications where low cost is more important than maximum availability. Special self-test circuitry detects all stuck-On and stuck-Off fault conditions within the non-triplicated signal conditioners in less than half a second. This is a mandatory feature of a fail-safe system, which must detect all faults in a timely manner and upon detection of an input fault, force the measured input value to the safe state. Because the Tricon is optimized for de-energize-to-trip applications, detection of a fault in the input circuitry forces to Off (the de-energized state) the value reported to the Main Processors by each channel.

Digital Output Modules

Every Digital Output Module houses the circuitry for three identical, isolated channels. Each channel includes an I/O microprocessor which receives its output table from the I/O Processor on its corresponding Main Processor. All of the Digital Output Modules, except the dual DC modules, use a patented quadruplicated output circuitry, referred to as *Quad Voter*, which votes on the individual output signals just before they are applied to the load. This voter circuitry is based on parallel-series paths which pass power if the drivers for Channels A and B, or Channels B and C, or Channels A and C command them to close – in other words, 2-out-of-3 drivers voted On. Dual Digital Output Modules provide a single series path, with the 2-out-of-

3 voting process applied individually to each switch. The quadruplicated output circuitry provides multiple redundancy for all critical signal paths, guaranteeing safety and maximum availability.

For specifications, see [Digital Output Modules on page 87](#).

OVD (Output Voter Diagnostics)

Every Digital Output Module executes a specific type of Output Voter Diagnostics (OVD) for every point. This safety feature allows unrestricted operation under a variety of multiple-fault scenarios. In general, during OVD execution the commanded state of each point is momentarily reversed on one of the output drivers, one after another. Loop-back on the module allows each microprocessor to read the output value for the point to determine whether a latent fault exists within the output circuit. (For devices that cannot tolerate a signal transition of any length, OVD on both AC and DC voltage Digital Output Modules can be disabled.)

AC Digital Output Modules

On AC voltage Digital Output Modules, a fault switch identified by the OVD process causes the output signal to transition to the opposite state for a maximum of half an AC cycle. This transition may not be transparent to all field devices. After a fault is detected, the module discontinues further iterations of OVD. Each point on an AC voltage Digital Output Module requires periodic cycling to both the On and Off states to ensure 100 percent fault coverage.

DC Digital Output Modules

DC voltage Digital Output Modules are specifically designed to control devices which hold points in one state for long periods of time. The OVD strategy for a DC voltage Digital Output Module ensures full fault coverage even if the commanded state of the points never changes. On this type of module, the output signal transition normally occurs during OVD execution, but is guaranteed to be less than 2.0 milliseconds (500 microseconds is typical) and is transparent to most field devices.

Dual DC Digital Output Modules

Dual Digital Output (DDO) Modules provides just enough redundancy to ensure safe operation. Dual modules are optimized for those safety-critical applications where low cost is more important than maximum availability.

Supervised Digital Output Modules

Supervised Digital Output Modules provide both voltage and current loopback, allowing complete fault coverage for both energized-to-trip and de-energized-to-trip conditions. In addition, a Supervised Digital Output Module verifies the presence of the field load by doing continuous circuit-continuity checks. Any loss of field load is annunciated by the module.

Pulse Input Modules

Each Pulse Input Module includes three channels which measure the input frequency independently. Special algorithms, optimized for accurately measuring the speed of rotating machinery, are used to compensate for irregularly spaced teeth on timing gear or for periodic acceleration/de-acceleration. The results are placed into a table of values. Each input table is passed to its associated MP using the corresponding I/O bus. The input table in each MP is transferred to its neighbors across the TriBus. The middle value is selected by each MP and the input table in each MP is corrected accordingly. In TMR mode, the mid-value is used by the application; in duplex mode, the average is used. Special self-test circuitry is provided to diagnose the health state of all input points, even when an active signal is not present. Each Pulse Input Module is guaranteed to remain in calibration for the life of the controller; periodic manual calibration is not required.

For specifications, see [Pulse Input Modules on page 124](#) and [Pulse Totalizer Input Module on page 129](#).

Thermocouple Input Modules

Each Thermocouple Input Module has three independent input channels. Each input channel receives variable voltage signals from each point, performs thermocouple linearization and cold-junction compensation, and converts the result to degrees Celsius or Fahrenheit. Each channel then transmits 16-bit signed integers representing 0.125 degrees per count to the three Main Processors on demand. To ensure correct data for every scan, a value is selected using a mid-value selection algorithm.

Tripllicated temperature transducers residing on the field termination module support cold-junction compensation. Each channel of a thermocouple module performs auto-calibration and reference-junction compensation every five seconds using internal-precision voltage references. On the Isolated Thermocouple Module, a cold-junction indicator announces the failure of a cold-junction transducer. On the Non-Isolated Thermocouple Module, a Fault indicator announces a transducer fault.

Sensing of each thermocouple input is performed in a manner which prevents a single failure on one channel from affecting another channel. Each module performs complete ongoing diagnostics on each channel.

For specifications, see [Thermocouple Input Modules on page 133](#).

Field Terminations

Various termination options are available for field wiring of the Tricon chassis, including external termination panels (ETPs) and fanned-out cables.

An ETP is an electrically-passive printed circuit board to which field wiring is easily attached. An ETP passes input signals from the field to an input module or passes signals generated by an output module directly to field wiring, thereby permitting removal or replacement of the input or output module without disturbing field wiring.

A fanned-out cable is a lower-cost alternative to an ETP when using digital input or digital output modules. One end of a fanned-out cable connects to the Tricon backplane and the other

end provides 50 fanned-out leads, each individually labeled with a pin number that matches the connector signals. For more information, see the *Field Terminations Guide for Tricon v9-v10 Systems*.

Communication Modules

A Tricon controller can communicate with other Triconex controllers and external devices. Communication modules enable serial and network communication and a variety of communication protocols. The Main Processors broadcast data to the communication modules across the communication bus. Data is typically refreshed every scan; it is never more than two scan-times old.

For more information about communication setup and protocols, see the *Communication Guide for Tricon v9-v10 Systems*.

Advanced Communication Module (ACM)

The ACM (Advanced Communication Module) acts as an interface between a Tricon controller and a Foxboro Intelligent Automation (I/A) Series DCS, appearing to the Foxboro system as a safety node on the I/A Series Nodebus. The ACM communicates process information at full network data rates for use anywhere on the I/A Series DCS, transmitting all Tricon controller aliased data (including system variables and system aliases) and diagnostic information to operator workstations in display formats that are familiar to Foxboro operators.

For specifications, see [Advanced Communication Module \(ACM\) on page 148](#).

Enhanced Intelligent Communication Module (EICM)

The Enhanced Intelligent Communication Module (EICM) enables a Tricon controller to communicate with Modbus devices (masters or slaves), with a TriStation PC, and with a printer. The four serial ports are uniquely addressed and can be used for Modbus or TriStation communication at speeds up to 19.2 kilobits per second. A single Tricon High-Density controller supports up to two EICM modules which reside in one logical slot. This arrangement provides a total of six Modbus ports, two TriStation ports, and two printer ports.

For specifications, see [Enhanced Intelligent Communication Module \(EICM\) on page 151](#).

Hiway Interface Module (HIM)

The Hiway Interface Module (HIM) acts as an interface between a Tricon controller and a Honeywell TDC-3000 control system via the Hiway Gateway and Local Control Network (LCN). The HIM can also interface with a Honeywell TDC-2000 control system via the Data Hiway. The HIM enables higher-order devices on the LCN or Data Hiway, such as computers and operator workstations, to communicate with the Tricon controller. The HIM allows redundant BNC connections directly to the Data Hiway and has the same functional capacity as up to four extended Data Hiway Port (DHP) addresses.

For specifications, see [Hiway Interface Module \(HIM\) on page 153](#).

Network Communication Module (NCM)

The Network Communication Module (NCM) enables the Tricon controller to communicate with other Triconex controllers and with external devices on Ethernet networks using a high-speed 10 megabits per second data link. The NCMG allows the Tricon controller to synchronize controller time based on GPS information.

For specifications, see [Network Communication Module \(NCM\) on page 155](#).

Safety Manager Module (SMM)

The Safety Manager Module (SMM) acts as an interface between a Tricon controller and a Honeywell Universal Control Network (UCN), which is one of three principal networks of the TDC-3000 Distributed Control System. Appearing to the Honeywell system as a safety node on the UCN, the SMM communicates process information at full network data rates for use anywhere on the TDC-3000. The SMM transmits all Tricon controller aliased data (including system variables and system aliases) and diagnostic information to operator workstations in display formats that are familiar to Honeywell operators.

For specifications, see [Safety Manager Module \(SMM\) on page 157](#).

Tricon Communication Module (TCM)

The Tricon Communication Module (TCM) enables a Tricon controller to communicate with Modbus devices (masters or slaves), a TriStation PC, a network printer, other Triconex controllers, and other external devices on Ethernet networks.

Each TCM has four serial ports, two Ethernet network ports, and one debug port (for Triconex use). TCM models 4353 and 4354 have an embedded OPC server, which allows up to ten OPC clients to subscribe to data collected by the OPC server. The embedded OPC server supports the Data Access standard and the Alarms and Events standard.

A single Tricon controller supports up to four TCMs, which reside in two logical slots. This arrangement provides a total of sixteen serial ports and eight Ethernet network ports.

TCMs are compatible with only Tricon v10.0 systems and later. TCM models 4351B, 4352B, 4353, and 4354 are compatible with only Tricon v10.3 systems and later. For complete compatibility information, see the Tricon Product Release Notices available on the IPS Global Client Support Web Site.

For specifications, see [Tricon Communication Module \(TCM\) on page 159](#).

International Approvals

The Tricon controller has been certified as complying with multiple internationally recognized standards by the following internationally recognized certification agencies, these certifications have qualified the Tricon for use around the world in safety critical applications. Test reports from the various certification agencies are available upon request.

Topics include:

- Canadian Standards Association (CSA) on page 17
- Factory Mutual on page 17
- TÜV Rheinland/Berlin-Brandenburg on page 18
- U.S. Nuclear Regulatory Commission (NRC) on page 19
- European Union CE Mark on page 20

Canadian Standards Association (CSA)

CSA has certified that the Tricon controller is in full compliance with the following internationally recognized electrical safety standards and is qualified for general use in North American and other jurisdictions requiring compliance with these standards.

Standard Number	Title
CAN/CSA-C22.2 No.0-M91	General Requirements-Canadian Electrical Code, Part II
CSA Std C22.2 No.0.4-M1982	Bonding and Grounding of Electrical Equipment (Protective Grounding)
CSA Std C22.2 No. 142-M1987	Process Control Equipment
UL Std No. 508	Industrial Control Equipment

Factory Mutual

FM has certified the Tricon controller is in full compliance with the following international recognized standards and is qualified for use in Class I, Division 2 Temperature T4, Groups A, B, C, and D hazardous indoor (or outdoor in a NEMA 4 cabinet) locations. For hazardous location applications, refer to [Chapter 3, Installation and Maintenance](#) for application-specific installation instructions.

Standard Number	Title
3611	Electrical Equipment for use in Class I-Division 2; Class II-Division 2; and Class III-Divisions 1 and 2, Hazardous Locations
3810	Electrical and Electronic Test, Measuring and Process Control Equipment
3600	3600 Electrical Equipment for Use in Hazardous (Classified) Locations-General Requirements

TÜV Rheinland/Berlin-Brandenburg

TÜV has certified that the Tricon controller is in full compliance with the internationally recognized standards listed below, and thus is qualified for use in the following applications and jurisdictions.

- Emergency safety shutdown or other critical control applications requiring SIL 1-3 certification per the functional safety requirements of IEC 61508 (only Tricon v9.6 or later)
- Emergency safety shutdown or other critical control applications requiring AK 1-AK6 certification per the functional safety requirements of DIN V 19250 and DIN V VDE 0801 (only Tricon v9.x)
- Fire and gas detection applications requiring certification per the requirements of EN 54
- Fire and gas detection applications requiring certification per the requirements of NFPA 72 (only Tricon v9.6 or later)
- Burner management applications requiring certification per the requirements of DIN VDE 0116
- Burner management applications requiring certification per the requirements of NFPA 8501 or NFPA 8502 (only Tricon v9.6 or later)
- All applications for use in European Union or other jurisdictions requiring compliance with the EMC Directive No. 89/336/EEC and Low Voltage Equipment Directive No. 72/23/EEC
- All applications for use in the European Union or other jurisdictions requiring compliance with the ATEX Directive No. 94/9/EC for Zone 2, Group IIB hazardous locations
- Environmental, health, and safety applications in semiconductor manufacturing facilities per the requirements of SEMI S2 (only Tricon v9.4)

Standard Number	Title
IEC 61508, Parts 1-7, 2000 (only Tricon v9.6 or later)	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems
DIN V 19250/05:94 (only Tricon v9.x)	Fundamental Safety Aspects to Be Considered for Measurement and Control Protective Equipment
DIN V VDE 0801/01.90+A1 10/94 (only Tricon v9.x)	Principles for Computers in Safety-Related Systems, Amendment A1
DIN VDE 0116/10.89	Electrical Equipment of Furnaces
IEC 61131, Part 2/1998, EN 61131, Part2/0595 (only Tricon v9.x)	Programmable Controllers Part 2: Equipment Requirements and Test. Overvoltage Category II and Zone B (EMC Immunity) are assumed.
IEC 61131, Part 2/2003 (only Tricon v10.x)	Programmable Controllers Part 2: Equipment Requirements and Test. Overvoltage Category II and Zone B (EMC Immunity) are assumed

Standard Number	Title
DIN EN 50178/04-1998	Electrical equipment for use in power installations
IEC 68, IEC 600068	Basic environmental testing procedures
EN 50081-2:1993 (only Tricon v9.x)	EMC Requirements, Generic emission standard, industrial environment
EN 60079-15:2003	Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection “n”
EN 61000-6-2:1999	EMC requirements, Generic immunity standard, industrial environments
EN 54, Part 1/Oct 1996 and EN 54, Part 2/Dec 1997	Components of Automatic Fire Detection Systems; Introduction and Control and Indicating Equipment.
NFPA 72/96 (only Tricon v9.6 or later)	National fire alarm code
NFPA 8501/97 (only Tricon v9.6 or later)	Standard for Single Burner Boiler Operation, 1997 Edition
NFPA 8502/99 (only Tricon v9.6 or later)	Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers, 1999 Edition
SEMI S2-93A	Safety guidelines for semiconductor manufacturing equipment

Refer to [Chapter 3, Installation and Maintenance](#) for application-specific installation instructions.

U.S. Nuclear Regulatory Commission (NRC)

The NRC has certified that the Tricon controller is suitable for use in nuclear 1E applications within the limitations and guidelines referenced in the NRC Safety Evaluation Report (SER) ML013470433, *Review of Triconex Corporation Topical Reports 7286-545, “Qualification Summary Report” and 7286-546, “Amendment 1 To Qualification Summary Report,” Revision 1*. This report is available from the NRC via the Agency Document Access and Management System (ADAMS) Web site. This qualification was based upon EPRI TR-107330, *Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants*.

For details on models and revisions qualified for 1E applications, please contact Invensys Nuclear.

Telephone

Toll-free number 866-703-6300, or
Toll number 949-885-0885

Web Site

www.invensysnuclear.com

European Union CE Mark

Based upon the independent TÜV evaluation and test results, Triconex has certified that the Tricon controller is suitable to use in the European Union and all other jurisdictions requiring compliance with the European Union EMC Directive No. 89/336/EEC and Low Voltage Equipment Directive No. 72/23/EEC, see Certificate of Compliance for details. Refer to [Chapter 3, Installation and Maintenance](#) for application-specific installation instructions.

Declaration of Conformity

The following declarations of conformity with the European Union directives for electromagnetic compatibility and low-voltage equipment are provided as a convenience. These declarations are the latest available at publication time and may have been superseded. For updates, contact the IPS Global Client Support (GCS) center.

Triconex Business Unit of Invensys Systems, Inc.
15345 Barranca Parkway
Irvine, CA 92618 USA

EU-Declaration of Conformity

The EU Directives covered by this Declaration

- 89/336/EEC Electromagnetic Compatibility Directive, amended by 92/31/EEC & 93/68/EEC
- 72/23/EEC Low Voltage Equipment Directive, amended by 93/68/EEC

The Products Covered by this Declaration

Tricon (Triple Modular Redundant Controller) Version 10.x – 2770H, 2870H, 3008, 3501T, 3502E, 3503E, 3504E, 3505E, 3510, 3511, 3515, 3564, 3601T, 3603T, 3604E, 3607E, 3614E, 3615E, 3617E, 3623T, 3624, 3625, 3636T, 3664, 3674, 3700, 3700A, 3701, 3703E, 3704E, 3706A, 3708E, 3720, 3721, 3805E, 3805H, 3806E, 3807, 4119, 4119A, 4200, 4201, 4210, 4211, 4329, 4351, 4351A, 4351B, 4352, 4352A, 4352B, 4353, 4354, 4409, 4609, 8310, 8311, 8312, chassis, termination products

The Basis on which Conformity is being Declared

The product identified above complies with the requirements of the above EU Directives by meeting these standards.

1.	EN 61131, Part 2:2003 CISPR 11:1999 CISPR 16:1999	EMC - Emissions Conducted and radiated, Class A
2.	EN 61131-2:2003 EN 61000-4-2:1995/ A1:1998 EN 61000-4-3:2002 EN 61000-4-4:1995 EN 61000-4-5:1995 PrEN 61000-4-12:1995	EMC - Immunity ESD Radiated HF fields Burst Surge Ringwave
3.	EN 61131-2:2003 EN 61010-1:2001	Product Safety Overvoltage Category II

Note: Not all listed products have been tested against the latest version or all of the standards listed. In all cases, the listed products have been tested against the standards in force at the date of the product introduction.

The technical documentation required to demonstrate that the product meets the requirements of the above directives has been compiled by the signatory below and is available for inspection by the relevant enforcement authorities. The CE mark was first applied in: 1996.

Special Measures and Limitations which must be Observed

The product must be installed and operated as described in the Planning and Installation Guide for Tricon v9-v10 Systems.

Signed:



Paul Mesmer, Director, Quality Assurance
Triconex Invensys
16 October 2008

Triconex Business Unit of Invensys Systems, Inc.
15345 Barranca Parkway
Irvine, CA 92618 USA

EU-Declaration of Conformity

The EU Directives covered by this Declaration

- 89/336/EEC Electromagnetic Compatibility Directive, amended by 92/31/EEC & 93/68/EEC
- 72/23/EEC Low Voltage Equipment Directive, amended by 93/68/EEC

The Products Covered by this Declaration

Tricon (Triple Modular Redundant Controller) Version 9.x – 3006, 3008, 3501T, 3502E, 3503E, 3504E, 3505E, 3510, 3511, 3515, 3564, 3601T, 3603T, 3604E, 3607E, 3614E, 3615E, 3617E, 3623T, 3624, 3636T, 3664, 3674, 3700, 3700A, 3701, 3703E, 3704E, 3706A, 3708E, 3805E, 3806E, 4119, 4119A, 4200, 4201, 4210, 4211, 4329, 4409, 4609, 8310, 8311, 8312, chassis, termination products

The Basis on which Conformity is being Declared

The product identified above complies with the requirements of the above EU Directives by meeting these standards.

- | | | |
|----|--|--|
| 1. | EN 50081-2:1993
EN 55011:1998 Gr. 1 Kl. A | EMC - Emissions
Conducted and radiated |
| 2. | EN 61131-2:1994/A11:1996
EN 61000-4-2:1995/A1:1998
EN 61000-4-3:1996
EN 61000-4-4:1995
EN 61000-4-5:1995
PrEN 61000-4-12:1994 | EMC - Immunity
ESD
Radiated HF fields
Burst
Surge
Ringwave |
| 3. | EN 61131-2:1994/A11:1996
EN 61010-1:1993 | Product Safety
Overvoltage Category II |

Note: Not all listed products have been tested against the latest version or all of the standards listed. In all cases, the listed products have been tested against the standards in force at the date of the product introduction.

The technical documentation required to demonstrate that the product meets the requirements of the above directives has been compiled by the signatory below and is available for inspection by the relevant enforcement authorities. The CE mark was first applied in: 1996.

Special Measures and Limitations which must be Observed

The product must be installed and operated as described in the Planning and Installation Guide for Tricon v9 Systems.

Signed:



Paul Mesmer, Director, Quality Assurance
Invensys Triconex
16 October 2008

2

System Components

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Overview

This chapter describes the hardware components available for Tricon systems. A Tricon system consists of a Main Chassis and as many as 14 Expansion or RXM (remote) Chassis, with a total of 118 I/O Modules. Numerous communication modules are available to interface with OPC clients, Modbus devices, Internet devices, Foxboro and Honeywell DCS, and other Tricon and Trident controllers.

Topics include:

- [General Environmental and EMC Specifications on page 24](#)
- [Typical Weight of Components on page 25](#)
- [Ground Systems on page 25](#)

General Environmental and EMC Specifications

The Tricon fully meets the requirements of IEC 61131, Part2: Programmable Controllers, Equipment requirements and tests, for environmental withstand and immunity, and electromagnetic compatibility. This table outlines the general environmental and EMC specifications for the Tricon controller. For details, refer to IEC 61131.

Table 1 General Environmental and EMC Specifications for the Tricon

Feature	Specification
Operating Temperature	32° to 140° F (0° to 60° C), ambient, as measured at the bottom of the chassis, per IEC 60080-2-1 Test Nb
Storage Temperature	-40° to 167° F (-40° to 75° C), per IEC 60068-2-14, Test Na
Relative Humidity	5% to 95%, non-condensing, per IEC 60068-2-2, Test Bb, and IEC 60068-2-3 test Db
Sinusoidal Vibrations per Axis	2 G @ 10 to 150 Hz, per IEC 60068-2-6, Test Fc
Shock	15 G for 6-11 ms in each axis, per IEC 60068-2-27
Electrostatic Discharge	IEC 61000-4-2, 4 kV air, 8kV contact
Conducted Susceptibility	IEC 61000-4-4, Fast Transient/Burst, 2 kV power, 1kV signal lines and IEC 61000-4-5, Surge Withstand, 2 kV CM AC power lines, etc. IEC 61000-4-6, RFI, 0.15-80 MHz, 10V
Radiated Susceptibility	IEC 61000-4-3, 26-1000 MHz, 10V/m and IEC 61000-4-8, 50-60 Hz, 30A/m
Conducted Emissions	CISPR 16, Class A, 0.15-30MHz, 73-79db when installed according to the guidelines in this manual.
Radiated Emissions	CISPR 11, Class A, 30-1000 MHz @ 10m, 4-47 db when installed according to the guidelines in this manual.

The NRC has certified that the Tricon controller is suitable for use in Nuclear 1E applications per the requirements of EPRI TR - 102323, *Guidelines for Electromagnetic Interference Testing In*

Power Plants, and IEEE 344, Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

For details on models and revisions qualified for 1E applications, please contact Invensys Nuclear.

Telephone

Toll-free number 866-703-6300, or
Toll number 949-885-0885

Web Site

www.invensysnuclear.com

Typical Weight of Components

This table identifies the typical weight of components.

Table 2 Weight of Tricon Components

Component	Approximate Weight
Main or Expansion Chassis (with no modules installed)	54.0 lbs. (24.5 kg.)
Main Processor	4.7 lbs. (2.1 kg.)
Power Module	7.2 lbs. (3.3 kg.)
I/O Module	4.75 lbs. (2.1 kg. to 2.7 kg.)
Communication Module	5.0 lbs. (2.3 kg.)
16-point Termination Panel	.09 lbs. (.04 kg.)
32-point Termination Panel	2.1 lbs. (.95 kg.)
Typical Loaded Chassis	160 lbs. (72.6 kg.) – average

Ground Systems

The Tricon controller includes three separate ground systems:

- Protective earth \oplus – an AC safety or chassis ground
- Signal or instrument ground \oplus – a functional earth
- Shield ground \oplus – a functional earth

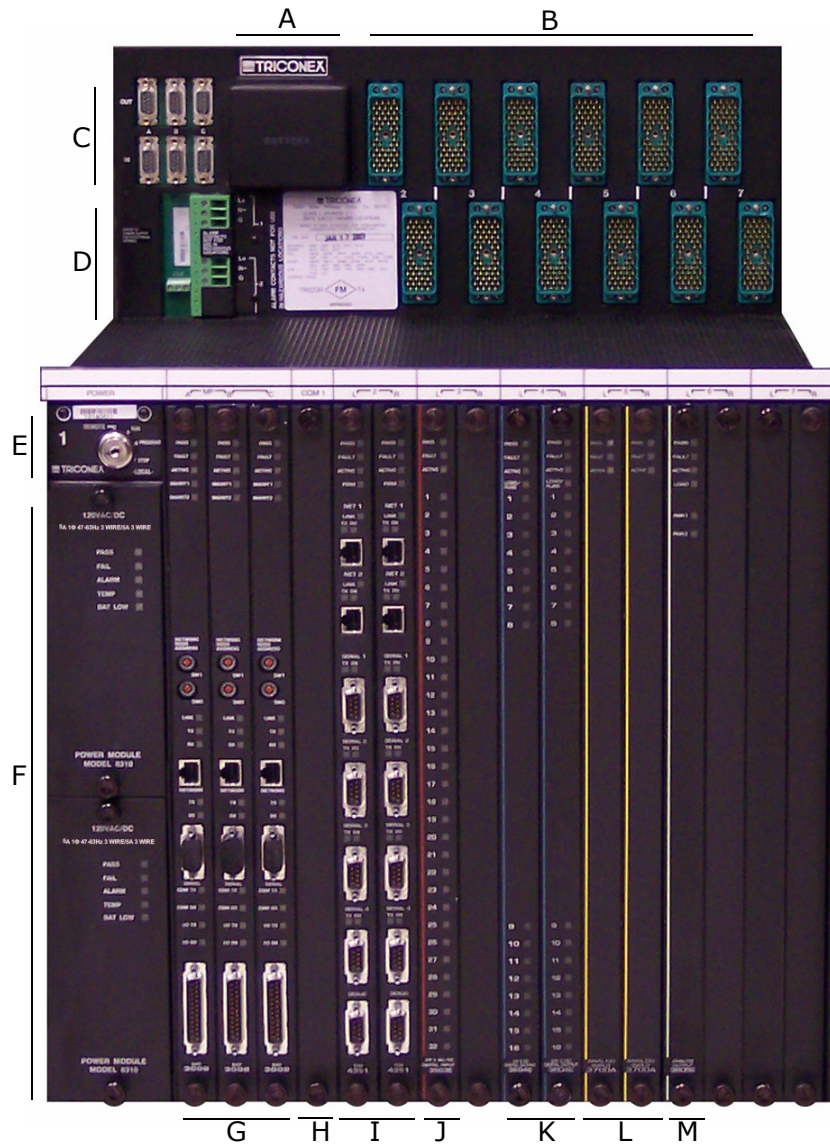
The digital and analog portions of each module use separate and isolated signal return paths which are connected together to form the Tricon controller signal ground. The chassis ground (sheet metal) of the Tricon controller acts as an electrostatic shield for the digital and analog circuitry. (All communication cable shields are terminated to the chassis ground.)

For installation procedures, see [Controller Grounding on page 208](#).

Main Chassis

A Tricon Main Chassis (model 8110) includes two Power Modules, three Main Processors, a battery, one communication (COM) slot with no hot-spare slot, and six logical slots for I/O and communication modules. Each logical slot provides two physical spaces for modules.

For installation information, see [Chassis and Module Installation](#) on page 178.



- | | | |
|--------------------------------|----------------------------|-----------------------------|
| A. Memory backup battery | F. Redundant power modules | K. DO module with hot-spare |
| B. Connectors for terminations | G. Three main processors | L. AI module with hot-spare |
| C. I/O expansion ports | H. COM slot (empty) | M. AO module without spare |
| D. Power terminals | I. Two TCMs | |
| E. Keyswitch | J. DI module without spare | |

Figure 7 Typical Tricon v10.x Main Chassis

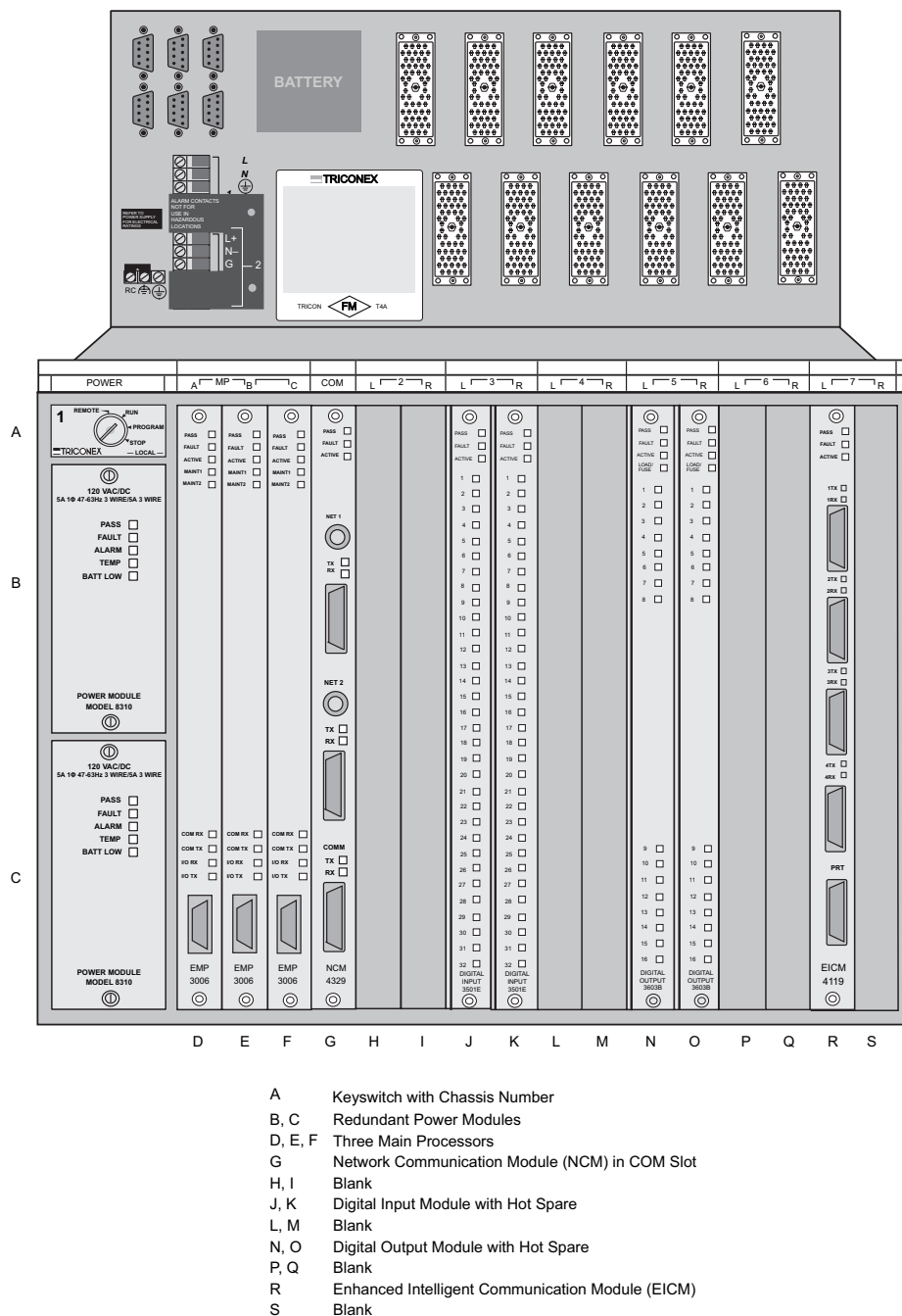


Figure 8 Typical Tricon v9 Main Chassis

Main Chassis Batteries

The Tricon controller dual-redundant batteries provide memory backup in case of a complete power failure of the controller. (The backplanes of Expansion and RXM Chassis do not include batteries.) In the absence of field power, a sole battery can sustain the control program in the Main Processor RAM.

If a total power failure occurs, these lithium batteries can maintain data and programs for a cumulative time period of six months. Each battery has a shelf-life of 8-10 years. Triconex recommends that the batteries be replaced either every 8-10 years or after they accumulate 6 months of use, whichever comes first.



There is a danger of explosion if a battery is replaced incorrectly. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

If the BAT LOW (battery low) indicator on the Power Modules is on, it indicates the battery should be replaced. For instructions, see [Replacing the Main Chassis Batteries on page 217](#).

Tricon Controller Keyswitch

The keyswitch is a four-position switch located above the Power Modules that determines the type of operations that can be taken on the Tricon controller. The position of the keyswitch is readable by the Tricon controller, Modbus masters, external devices, and the control program by using the TR_SCAN_STATUS function block. The position of the keyswitch enables or disables functions for the entire Tricon system, including Expansion and RXM Chassis.

This table describes the meaning of the keyswitch positions.

Keyswitch Position	Function
RUN	<p>Normal operation with read-only capability. The Main Processors execute the previously-loaded control program – attempts to modify program variables by TriStation, Modbus masters or external hosts are rejected. However, a control program may call gated access functions to enable external host writes during a designated window of time.</p> <p>For more information, see the GATDIS and GATENB function blocks in the Library Reference for the version of TriStation being used.</p>
PROGRAM	<p>For control program loading and verification. Allows control of the Tricon controller from the TriStation software, including Download All and Download Change. Also allows writes to program variables by Modbus masters and external hosts.</p>
STOP	<p>Stops reading inputs, forces non-retentive digital and analog outputs to 0, and halts the control program. (Retentive outputs return to the value they had before the keyswitch was turned to Stop.) The Stop setting is recommended for installation and service of process-related equipment, <i>but is not required for service of the Tricon controller</i>.</p> <p>You can use TriStation to prevent the application from halting when the keyswitch is turned to Stop. Note that this is the only position that can be overridden by TriStation. For more information, see “Restricting Access to a Tricon Controller” in the TriStation Developer’s Guide.</p>
REMOTE	<p>Allows writes to control program variables by TriStation, Modbus masters and external devices. (Download All and Download Change by TriStation are not allowed.)</p>

Expansion Chassis

This section contains information about the Model 8111 Expansion Chassis and the Model 8121 Low Density Expansion Chassis.

Model 8111 Expansion Chassis

The Model 8111 Tricon Expansion Chassis allows additional I/O and communication modules to be included in a system. The Model 8111 Expansion Chassis includes two Power Modules and eight logical slots for I/O and communication modules. (Communication modules can only be included in Expansion Chassis 2.) Expansion Chassis can be used when the total I/O Bus cable length for the system from the Main Chassis to the Expansion Chassis is not greater than 100 feet (30 meters).

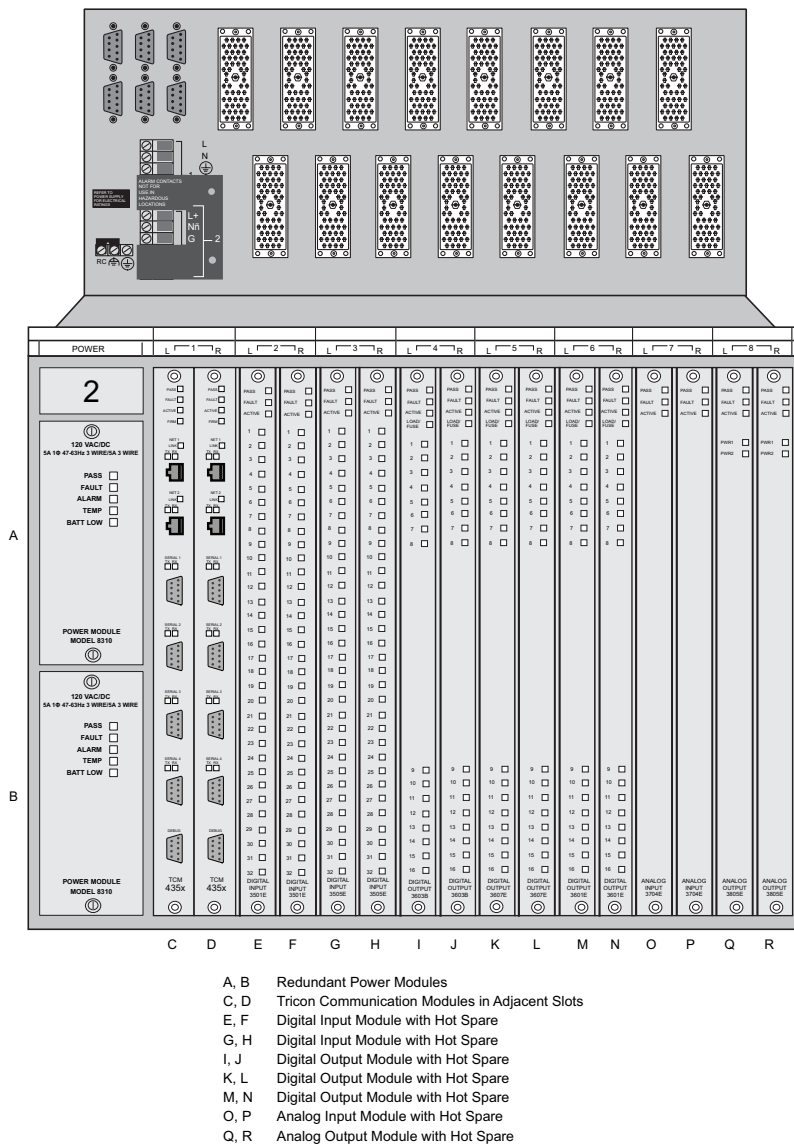


Figure 9 Typical Model 8111 Expansion Chassis

Model 8121 Enhanced Low Density Expansion Chassis

The Model 8121 Enhanced Low Density Expansion Chassis allows additional I/O modules to be included in a system and allows the use of HART communication through HART Interface Modules (2770H and 2870H). The Enhanced Low Density Expansion Chassis includes two Power Modules and five logical slots for I/O modules. Expansion Chassis can be used when the total I/O Bus cable length for the system from the Main Chassis to the Expansion Chassis is not greater than 100 feet (30 meters).

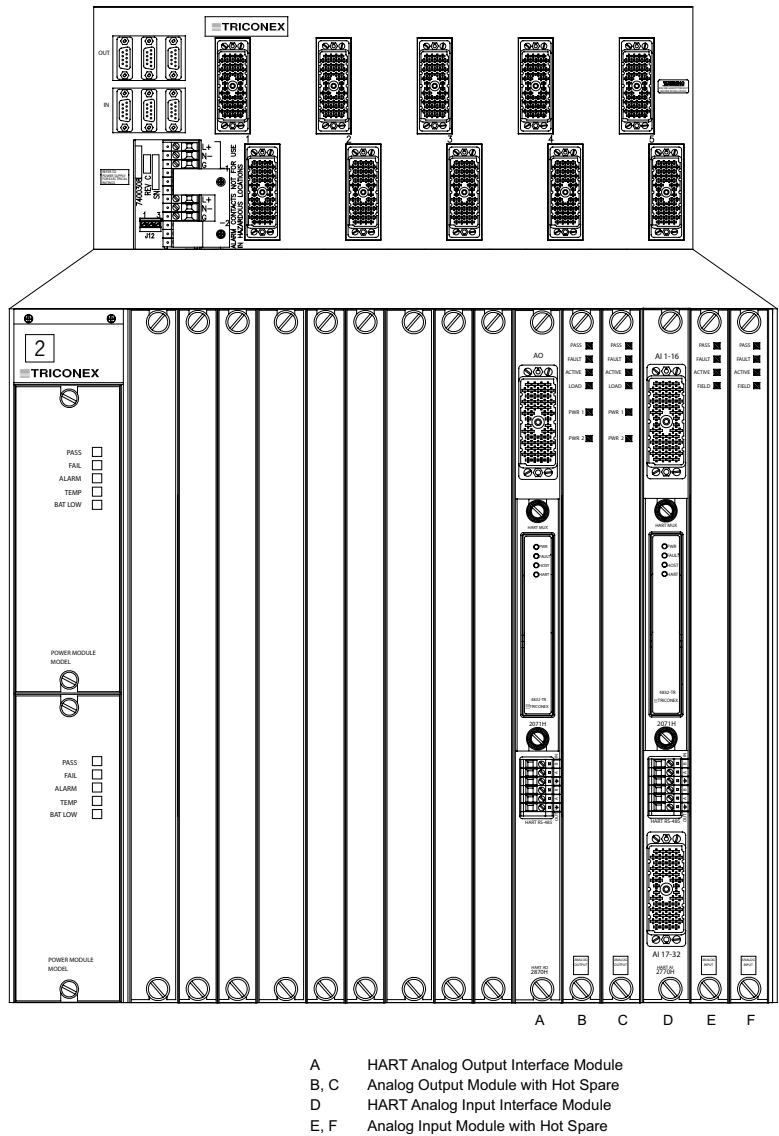


Figure 10 Typical Model 8121 Enhanced Low Density Expansion Chassis

RXM Chassis

A Tricon RXM Chassis (model 8112) enables additional I/O modules to be included in a system at a distance that exceeds 100 feet (30 meters) from the Main Chassis. RXM Chassis include two Power Modules, one Primary or Remote RXM Set, and six logical slots for I/O modules. A maximum of 3 primary RXM Chassis can be connected to the Main Chassis. Each primary RXM Chassis can support a maximum of 3 remote or Expansion Chassis, for a total of 9 remote RXM or Expansion Chassis in the system.

For installation information, see [Installing an RXM Chassis on page 206](#).

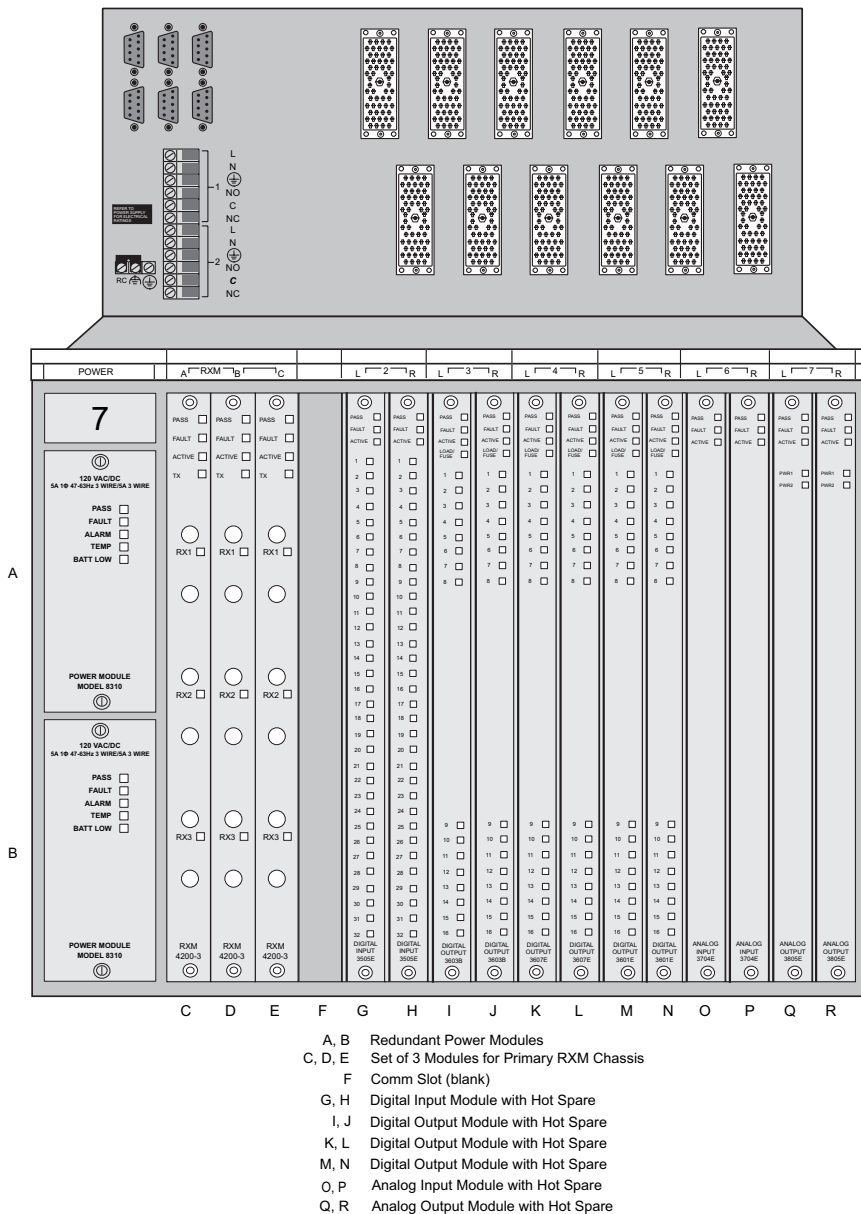


Figure 11 Typical RXM Chassis

I/O Bus Ports and Connections

Each Tricon chassis includes two sets of triplicated RS-485 I/O bus ports which enable the I/O bus to be expanded from the Main Chassis to other Tricon chassis in the system. The I/O ports are grouped as three pairs forming a triplicated extension of the Tricon controller I/O bus. The communication speed is 375 kilobits per second, which is the same rate as for the internal Tricon controller I/O bus. This means the three control channels are physically and logically extended to the Expansion Chassis without sacrificing performance.

This figure shows the location of the I/O Bus Ports, which includes a port for each input and output channel.

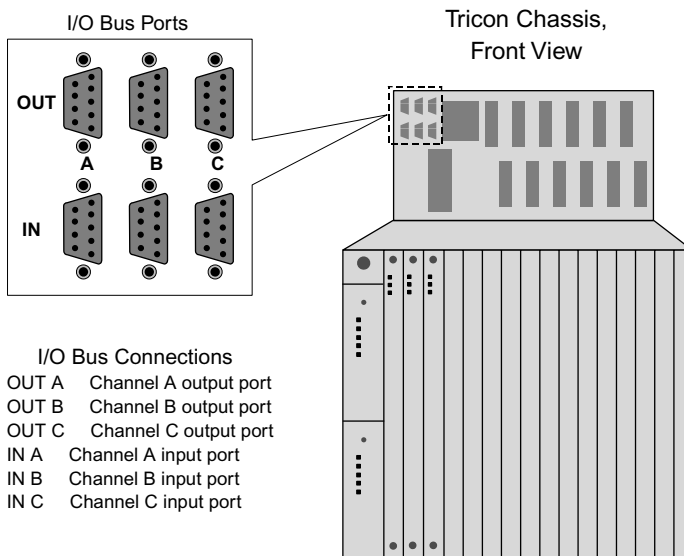


Figure 12 I/O Expansion Bus Ports

Power Modules

Each Tricon Chassis is equipped with two Power Modules — either one is fully capable of running the controller at full load and rated temperature. Power Modules convert line power to DC power appropriate for all Tricon modules. Any combination of Power Module models can be used in Tricon systems.

For more information, see [Planning Power for a Tricon System on page 166](#)

Model	Power Module
8310	120 VAC/DC Power Module
8311	24 VDC Power Module
8312	230 VAC Power Module

The Power Modules, located on the lower left side of the chassis, convert line power to DC power appropriate for all Tricon controller modules. Two terminal strips on the backplane are used to select controller grounding options, and for incoming power and alarm connections.

Each Power Module provides an in-line, slow-blow fuse for each external power source, mounted inside the module. The module can be replaced without disconnecting any wiring by removing the module from the chassis. The fuse on the Model 8311 24 VDC Power Module is not removable. If this fuse fails, you must return the module to Triconex for fuse replacement.

Each Tricon controller Power Module is a field-replaceable unit that uses high-efficiency DC-DC converters. All models of Power Modules are protected against reverse connection of the DC inputs.

[Figure 13](#) shows the terminal strip and front panel for the Power Modules. The figure does not show the covers on the terminals for alarm applications, which are required for hazardous locations.

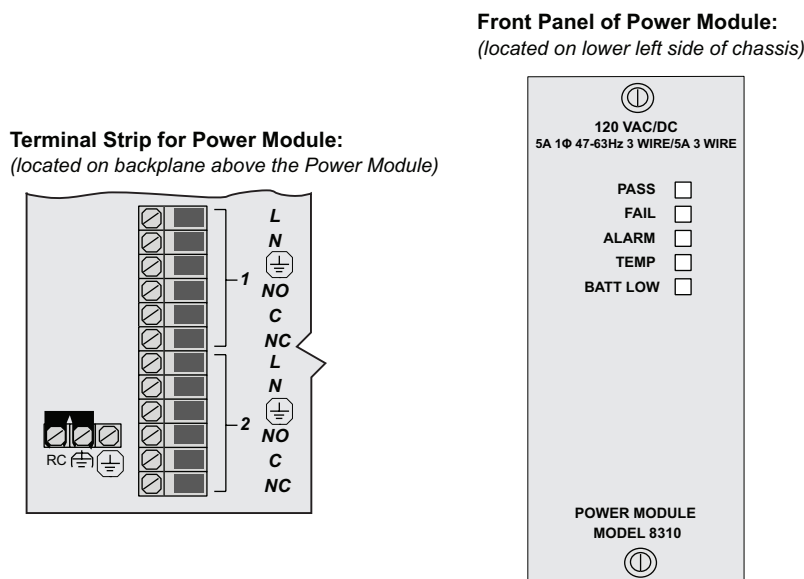




Figure 13 Power Module Terminals and Front Panel


Ground Terminals on Power Modules

This table describes the ground terminals included with the Power Module. Typically, the Tricon controller is delivered with a jumper installed between RC and signal ground. You can remove the jumper to use either a direct connection to signal ground or to chassis ground. For more information, see [Controller Grounding on page 208](#).

- RC – RC network connected to chassis ground.
-  – Direct connection to Tricon controller internal signal ground (functional earth).
-  – Direct connection to chassis ground (protective earth).

Alarm and Power Terminals on Power Modules

This table describes the alarm and power terminals included with the Power Modules, which includes 2 sets of 6 terminals for each Power Module.

Terminals 1 and 2	Description
L	Line (hot) or DC+
N	Neutral or DC-
	Chassis ground, protective earth
NO	NO (normally open) chassis alarm contact – opens when an alarm condition occurs
C	Common alarm contact
NC	NC (normally closed) chassis alarm contact – closes when an alarm condition occurs

Main Chassis Alarm Behavior

The alarm contacts on Main Chassis Power Modules are asserted when any of these situations occurs:

- The controller configuration does not match the control program configuration
- A Digital Output (DO) Module experiences a Status/Status error.
- A module is missing somewhere in the controller. (No status indicators warn you of this problem)
- A Main Processor or I/O module in the Main Chassis fails.
- An I/O module in an Expansion Chassis fails.
- A Main Processor detects a system fault. In this case, both alarm contacts may be asserted without a corresponding module failure.
- The inter-chassis I/O bus cables are incorrectly installed – for example, the cable for Channel A is accidentally connected to Channel B.

An alarm contact on at least one of the Main Chassis Power Modules is asserted when any of these situations occurs:

- A Power Module fails.
- Primary power to a Power Module is lost.
- A Power Module has a Low Battery or Over Temperature warning.

Expansion Chassis Alarm Behavior

The alarm contacts on both Power Modules of an Expansion Chassis are asserted when an I/O module fails. An alarm contact on at least one of the Power Modules of an Expansion Chassis is asserted when any of these situations occurs:

- A Power Module fails.
- Primary power to a Power Module is lost.
- A Power Module has an Over Temperature warning.

Alarm Contacts Specifications

This table lists the alarm contacts specifications for all models of Power Modules.



Do not use alarm contacts in hazardous locations.

Table 3 Alarm Contacts for Power Modules

Feature	Specification
Isolation	1000 VAC or 1500 VDC, Input to Output
Voltage range	140 VAC/VDC maximum
Switching power, resistive ¹	125 VAC, 60 W maximum
Current load	2 amp maximum
Maximum cycle rate of contacts	< 20 cycles per minute
Expected life at maximum rated load	> 10,000 cycles

1. When switching reactive loads, de-rate the switching power of the contacts to 25% of maximum – that is, 31.25 volts for AC applications, 15 watts for DC. When switching incandescent lamps, the inrush current can be 10-15 times the rated nominal load current of the lamp. Contact the lamp manufacturer for detailed specifications regarding inrush amplitude and duration. The inrush current must be used when calculating the required contact switching power.

120 Volt Power Module Specifications

This table lists the specifications for model 8310, which is a 120 VAC/VDC Power Module.

Table 4 8310 Power Module Specifications

Feature	Description
Isolation	1000 VAC or 1500 VDC, Input to Output
Recommended input voltage range	120 VAC/VDC (-15% to +10%)
Extended input voltage range	85–140 VAC, 95–180 VDC
Low line on/off hysteresis	15 VAC/VDC
Input power required	240 W (2.75 amps) minimum per power source
Input frequency	47–63 Hz
Power factor	0.70 typical
Crest factor	2.5 typical
Input current	
Steady-state	0.75 amps, typical; 2.75 amps, maximum
In-rush (1/2 AC cycle)	18 amps maximum @ 120 VAC/DC
Input fuse rating and type	5 amps, time-delay
Output voltage	6.5 VDC, $\pm 1\%$
Output current	27 amps minimum at 140° F (60° C) ambient, which is the air temperature measured at the bottom of the chassis
Output power	175 watts at 140° F (60° C) ambient
Output hold time @ 0 volts input	20 ms minimum 80 ms typical
Output over-voltage protection	115% typical, recycle power to restart
Output over-current limit	135%, typical, auto restart
Over-temperature warning sensor	Temperature monitor trips when the internal power module temperature is greater than 181° F (83° C). Typically, this occurs at an ambient temperature of 140° F (60° C) or higher.

24 Volt Power Module Specifications

This table lists the specifications for model 8311, which is a 24 VDC Power Module.

Table 5 8311 Power Module Specifications

Feature	Description
Isolation	1000 VAC or 1500 VDC, Input to Output
Recommended input voltage range	24 VDC, -15% to +20% (protected against reverse connection)
Extended input voltage range ¹	19.2 to 36 VDC
Low line on/off hysteresis	1.5 VDC minimum
Input power required	240 W minimum per power source
Input over-voltage clamp	40 VDC
Input current	
Steady-state	5 amps typical, 10 amps maximum
In-rush	23 amps maximum @ 24 VDC (10 ms)
Input fuse rating and type	15 amps, time-delay
Output voltage	6.5 VDC, $\pm 1\%$
Output current	27 amps maximum at 140° F (60° C) ambient, which is the air temperature measured at the bottom of the chassis
Output power	175 watts at 140° F (60° C) ambient
Output over-voltage protection	115%, typical, recycle power to restart
Output over-current limit	110%, typical, auto restart
Output hold time @ 0 volts input	2.0 milliseconds minimum; 5.6 milliseconds typical
Over-temperature warning sensor	Temperature monitor trips when the internal power module temperature is greater than 181° F (83° C). Typically, this occurs at an ambient temperature of 140° F (60° C) or higher.

- During normal operation, you should keep the input power within the recommended input voltage range. Operation in the extended voltage range is advisable only for short periods of time. Be careful to minimize input transients which are caused by the off/on switching of the redundant power source. Do not allow the power source to drop below the minimum input voltage (19.2 VDC) when its load increases to 100% of the Tricon controller power module requirements, or rise above the maximum voltage (36 VDC) when the load decreases to 40 to 60% of the Tricon controller power module requirements.
For example, assuming minimal voltage losses to the input wiring and a power source of 24V $\pm 5\%$, the transient response to the power source should not exceed these limits.

Typical Input Current Change	Maximum Input Voltage Deviation
+6A/ms	-3.6 volts
-6A/ms	10.8 volts

230 Volt Power Module Specifications

This table lists the specifications for model 8312, which is a 230 VAC Power Module.

Table 6 8312 Power Module Specifications

Feature	Description
Isolation	1000 VAC or 1500 VDC, Input to Output
Nominal input voltage	230 VAC (-15% to +10%)
Extended input voltage range	185 to 285 VAC
Low line on/off hysteresis	15 VAC
Input power required	240 W minimum per power source
Input frequency	47 to 63 Hz
Power factor	0.70 typical
Crest factor	2.5 typical
Input current	
Steady-state	0.4 amps, typical; 1.2 amps, maximum
In-rush (1/2 AC cycle)	18 amps maximum @ 230 VAC
Input fuse rating and type	2.5 amps, time-delay
Output voltage	6.5 VDC, $\pm 1\%$ under all operating conditions
Output current	27 amps minimum at 140° F (60° C) ambient, which refers to the air temperature measured at the bottom of the chassis.
Output power	175 watts at 140° F (60° C) ambient
Output hold time @ 0 volts input	20 ms minimum; 80 ms typical
Output over-voltage protection	125%, typical, recycle power to restart
Output over-current limit	140%, typical, auto restart
Over-temperature warning sensor	Temperature monitor trips when the internal power module temperature is greater than 181° F (83° C). Typically occurs at an ambient temperature of 140° F (60° C) or higher.



WARNING

Do not use the model 8312 Power Module in Tricon systems that are located in hazardous locations and must meet ATEX requirements. If you have 230 V line voltage and your system must meet ATEX requirements, use the model 8311 24 VDC Power Module along with the ATEX-certified 24 VDC power supply from Phoenix Contact – part number QUINT-PS-100-240AC/24DC/10/EX.

Main Processor Modules

A Tricon chassis houses three Main Processor Modules, each serving one channel (also referred to as a *leg*) of the controller. Each processor independently communicates with its I/O subsystem and executes the control program. The three MP Modules compare data and the control program at regular intervals. Each Main Processor operates autonomously with no shared clocks, power regulators, or circuitry. Processor specifications are listed in the specifications table for each MP.

A high-speed proprietary bus system called TriBus provides these functions: interprocessor communications, hardware majority voting of all digital input data, and comparison of control program variables. TriBus uses a fully isolated, serial communication channel operating at 4 megabits per second. A direct memory access controller manages the synchronization, transfer, voting and data correction independent of the control program or executive software.

DRAM (dynamic random-access memory) is used for control program, sequence-of-events data, I/O data, diagnostics, and communication buffers. SRAM (static random-access memory) is used for the defined program retentives and configuration of disabled points. Memory is regularly validated by the TriBus hardware-voting circuitry.

Sequence of Events Capability

Main Processors work with the communication modules to provide the Tricon controller with sequence-of-events (SOE) capability. During each scan, the Main Processors inspect designated discrete (Boolean) variables for changes of state known as events. When an event occurs, the Main Processors save the current state of the variable and includes a time stamp in an area of memory called a buffer which is a part of an SOE block. You can configure the SOE blocks using TriStation and retrieve the event data with software such as the Triconex SOE Recorder.

Compatible Modules

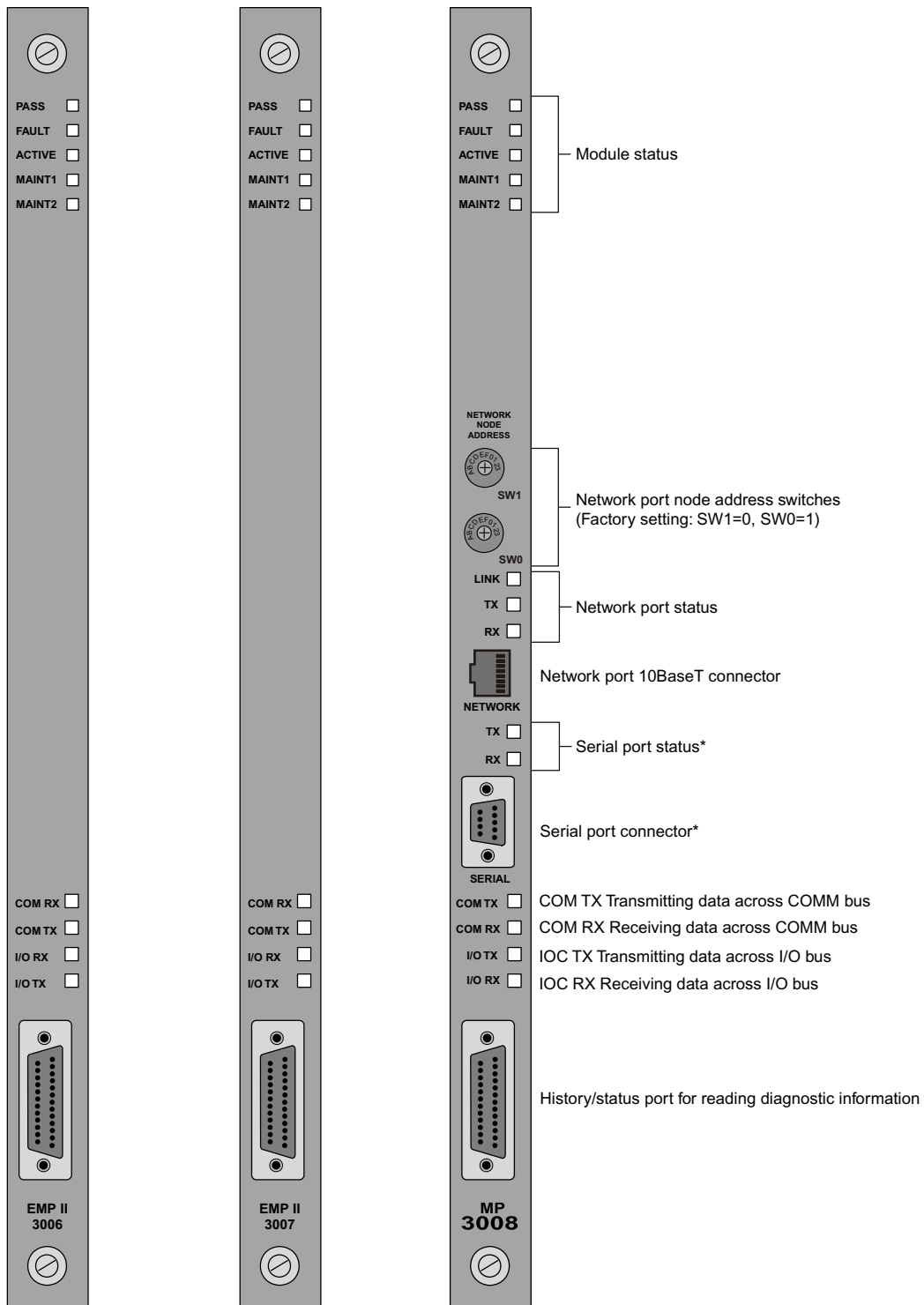
This table identifies the compatibility of Main Processor modules with Tricon versions. All the communication and I/O modules are compatible with v9–v10.x MPs.

Table 7 **Compatibility of Main Processor Modules**

Main Processor Model	Compatible Tricon Versions
3006 and 3007	v9.0–v9.5.x, and v9.51.x
3008	v9.6–v10.x

Main Processor Front Panel

This figure depicts the Main Processor front panels for models 3006, 3007, and 3008.



* Reserved for future use

Figure 14 3006, 3007, and 3008 Main Processor Front Panels

3008 Main Processor Architecture

This figure depicts the model 3008 Main Processor architecture, which can be used with Tricon v9.6 and later systems.

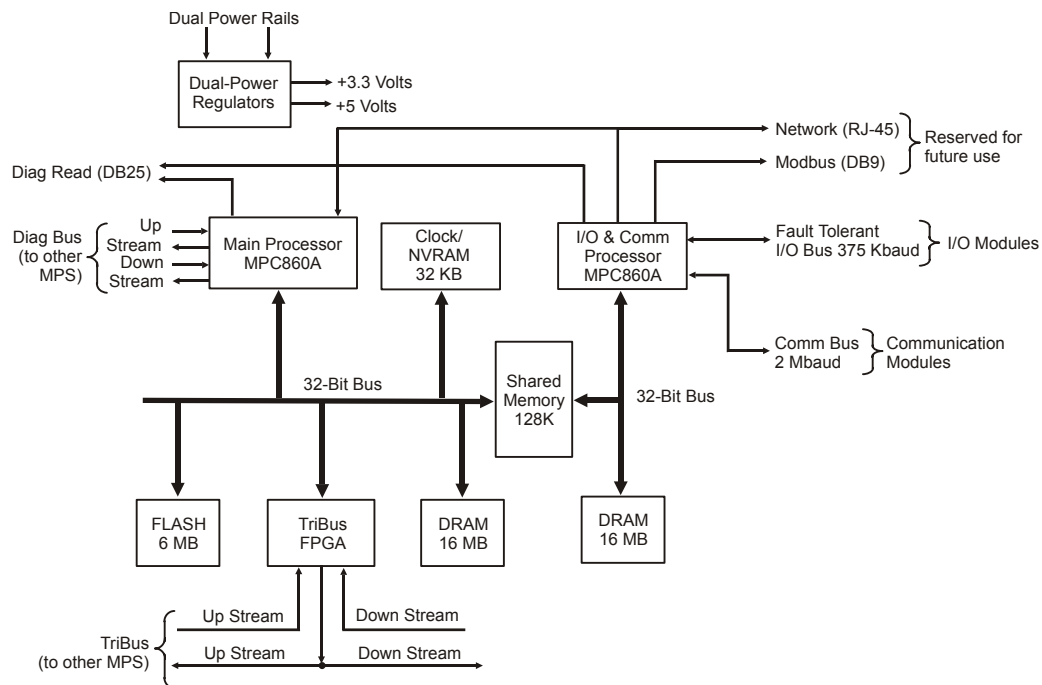


Figure 15 3008 Architecture

3008 Specifications

This table lists the specifications for the model 3008 Main Processor Module, which is available with Tricon v9.6 and later systems.

Table 8 3008 Main Processor Specifications

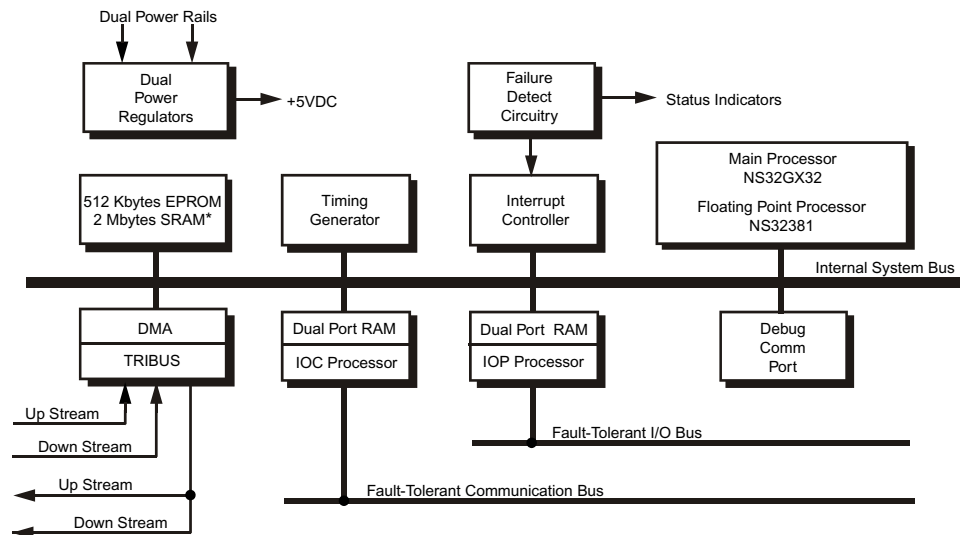
Feature	Description
Main processor	Motorola MPC860, 32-bit, 50 MHz
Memory	16 MB DRAM (without battery back-up) 32 KB SRAM (with battery back-up) 6 MB Flash PROM
TriClock	Time and date Battery back-up Typical drift: ± 2 seconds/day Maximum drift: ± 2.16 seconds/day
TriBus	25 megabits/second 32-bit CRC-protected 32-bit DMA, fully isolated

Table 8 3008 Main Processor Specifications

Feature	Description
Serial port	For diagread diagnostic analysis Optically isolated RS-232 interface on one 25-pin connector 500 VDC isolation
Communication processor	Motorola MPC860, 50 MHz, 32-bit
Communication interface	
Protocol	RS-485
Baud rate	2 megabits per second
I/O interface	
Protocol	RS-485
Baud Rate	375 kilobits per second
Logic power	10 W

3006 and 3007 Main Processor Architecture

This figure depicts the model 3006 and 3007 Main Processor architecture, which can be used with Tricon v9.0 – v9.5 systems. They have the same architecture and specifications, except for SRAM, which is 2 megabytes for the 3006 and 1 megabyte for the 3007.

**Figure 16 3006 and 3007 Main Processor Architecture**

3006 and 3007 Specifications

This table lists the specifications for the 3006 and 3007 Main Processors, which can be used with Tricon v9.0 – v9.5 systems.

Table 9 3006 and 3007 Main Processor Specifications

Feature	Specification
Central processor	National NS32GX32, 32 bits, 25 MHz
Math co-processor	National NS32381, 32 bits, 25 MHz
EPROM memory	512KB
SRAM	Model 3006: 2 MB Model 3007: 1 MB
Clock calendar	Time and date Battery backup Typical drift: ± 2 seconds per day Maximum drift: ± 8.6 seconds per day
TriBus	4 megabits per second, 16-bit DMA
Serial port	For Diagread diagnostic analysis Optically isolated RS-232 interface on one 25-pin connector 500 VDC isolation
Communication processor	Intel 80C152 32 KB EPROM, 64K shared memory interface 16 MHz
Communication Interface	
Protocol	RS-485
Baud rate	2 megabits per second
I/O processor	Intel 80C31 12 MHz 32 KB EPROM 64K Shared Memory Interface
I/O interface	
Protocol	RS-485
Baud Rate	375 kilobits per second
Logic power	15 W

Diagnostics for Main Processors

Extensive diagnostics validate the health of each Main Processor as well as each I/O module and communication channel. Transient faults are recorded and masked by the hardware majority-voting circuit. Persistent faults are diagnosed, and the errant module is hot-replaced or operated in a fault-tolerant manner until hot replacement is completed.

Main Processor diagnostics include these features:

- Verify fixed-program memory
- Verify the static portion of RAM
- Test all basic processor instructions and operating modes
- Test all basic floating-point processor instructions
- Verify the shared memory interface with I/O processors
- Verify each I/O processor, communication processor, local memory, shared memory access, and loopback of RS-485 transceivers
- Verify the TriClock interface
- Verify the Tribus interface

A standard, 25-pin, male D-connector (RS-232) at the bottom of each MP operates at 9600 bits per second and can be used by Triconex representatives for diagnostic analysis. The RS-232 port is fully isolated (500 VDC, maximum) to provide protection against ground faults.

RXM and SRXM Modules

This section describes RXM and SRXM Modules, which are used in RXM Chassis to extend the I/O communication from the Main Chassis. Multi-mode cable is used for locations as far as 1.2 miles (2 kilometers) from the Main Chassis; single-mode cable is used for locations as far as 7.5 miles (12 kilometers). RXM and SRXM Modules communicate at 375 kilobits per second. The modules provide exceptional immunity against electro-static and electro-magnetic interference and use optical modems and fiber-optic point-to-point cabling.

For installation information, see [RXM Chassis Installation on page 203](#).

Table 10 RXM and SRXM Module Sets

Model	Description
4200-3	Primary RXM Module Set uses multi-mode fiber optic cable. Supports 3 remote RXM Chassis or Expansion Chassis.
4201-3	Remote RXM Module Set uses multi-mode fiber optic cable.
4210-3	Primary SRXM Module Set uses single-mode fiber optic cable. Supports 3 remote RXM Chassis or Expansion Chassis.
4211-3	Remote SRXM Module Set uses single-mode fiber optic cable.

RXM Modules

RXM Modules (model 4200-3 and 4201-3) are optimized for use with 62.5/125 micrometer multi-mode fiber. The cable should be specified for operation at a wave length of 850 nanometers (nm), with a worst-case optical attenuation of 4 decibels per kilometer. The RXM optical transmitter/receiver pair has a total optical power budget of 15 decibels, typical (8 decibels, worst case), which allows a maximum cable length of 1.2 miles (2 kilometers).

RXM Modules are compatible with industry-standard ST fiber-optic connectors. The specified worst-case optical power budget of 8 decibels includes losses due to the fiber-optic connectors at the RXM transmitter and receiver. Additional losses incurred by fiber-optic cable splices or junction-box couplings should be considered when calculating the maximum installed cable length.

SRXM Modules

SRXM Modules (model 4210-3 and 4211-3) are optimized for use with 9/125 mm single-mode fiber. The cable should be specified for operation at a wave length of 1300 nanometers (nm), with a worst-case optical attenuation of 0.5 decibels per kilometer. The RXM optical transmitter/receiver pair has a total optical power budget of 10.0 decibels, typical (7.0 decibels, worst case), which allows a maximum cable length of 7.5 miles (12 kilometers).

SRXM Modules are compatible with industry-standard ST fiber-optic connectors. The specified worst case optical power budget of decibels includes losses due to the fiber-optic connectors at the SRXM transmitter and receiver and 2 decibels margin/aging loss. Additional losses incurred by fiber-optic-cable splices or junction-box couplings should be considered when calculating the maximum installed cable length.

Analog Input Modules

This section describes the Analog Input Modules available with Tricon v9–v10 systems. For installation information, see [Replacing I/O Modules on page 223](#).

Table 11 Analog Input Modules

Model	Voltage Range	Type	Module Description
3700 3700A	0–5 VDC	TMR	Analog Input
3701	0–10 VDC	TMR	Analog Input
3703E	0–5 or 0–10 VDC	TMR	Isolated Analog Input
3704E	0–5 or 0–10 VDC	TMR	High-Density
3720 ¹	0–5 VDC	TMR	High-Density Single-Ended
3721 ¹	0 to 5 or –5 to +5 VDC	TMR	Differential

1. The 3720 and 3721 modules can be installed only in Tricon v10.2 and later systems.

All Analog Input Modules have three independent input channels. Each input channel receives variable voltage signals from each point, converts them to digital values, and transmits the values to the three Main Processors on demand. To ensure correct data for every scan, one value is selected using a mid-value selection algorithm. Sensing of each input point is performed in a manner that prevents a single failure on one channel from affecting another channel.

The 3700A, 3703E, and 3704E, 3720, and 3721 Analog Input Modules provide a six percent over-range measurement capability. The 3703E provides open-input detection, which can be configured as upscale or downscale in TriStation 1131. If an open input (< 0 VDC) goes out of range downscale, the Main Processors receive the integer value –32,767. If an open input (> 5 VDC or 10 VDC) goes out of range upscale, the Main Processors receive the integer value +32,767.

The 3720 and 3721 can be configured in TriStation 1131 for either Standard (12 bit) resolution or High (14 bit) resolution. In High resolution, the 3721 can be configured in TriStation 1131 for Unipolar (0 to 5 VDC) or Bipolar (–5 to +5 VDC) inputs.

Each Analog Input Module sustains complete, ongoing diagnostics for each channel. Failure of any diagnostic on any channel activates the Fault indicator for the module, which in turn activates the chassis alarm signal. The Fault indicator points to a channel fault, *not* a module failure. The module is guaranteed to operate properly in the presence of a single fault and may continue to operate properly with some multiple faults.

Analog Input Modules include the hot-spare feature which allows online replacement of a faulty module. Like all I/O modules, Analog Input Modules require a separate field termination assembly with a cable interface to the Tricon controller backplane. Each module is mechanically keyed to prevent improper installation in a configured chassis.

Mis-Compare Readings

All Analog Input Modules are susceptible to mis-compare readings which can increase the probability of a fault. Generally, the greater the difference between readings and the longer the period of mis-compare, the more probable that a fault will be declared. The amount of difference and period varies among Analog Input Modules.

- For models 3700, 3700A and 3701, if the readings differ by a minimum of 2% of full scale and continue for a minimum period of 40 input samples, the probability of a fault increases.
- For models 3703E and 3704E, if the readings differ by a minimum of 0.5% of full scale and continue for a minimum period of 256 input samples, the probability of a fault increases.
- For models 3720 and 3721, if the readings differ by a minimum of 0.5% of full scale and continue for a minimum period of 25 input samples, the probability of a fault increases.

32-Point Differential Analog Input Modules

This figure is a simplified schematic for models 3700, 3700A, and 3701, which are 32-point TMR Analog Input Modules.

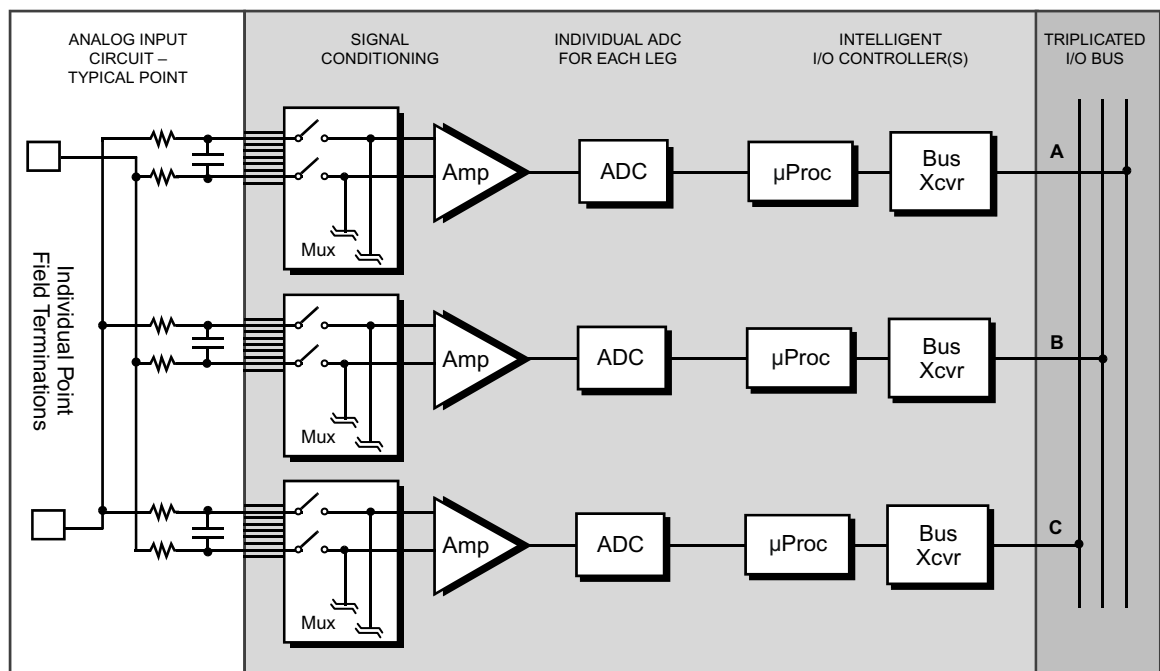


Figure 17 3700, 3700A, and 3701 Simplified Schematic

This figure is a simplified schematic for model 3721, which is a 32-point TMR Analog Input Module with field-to-system isolation.

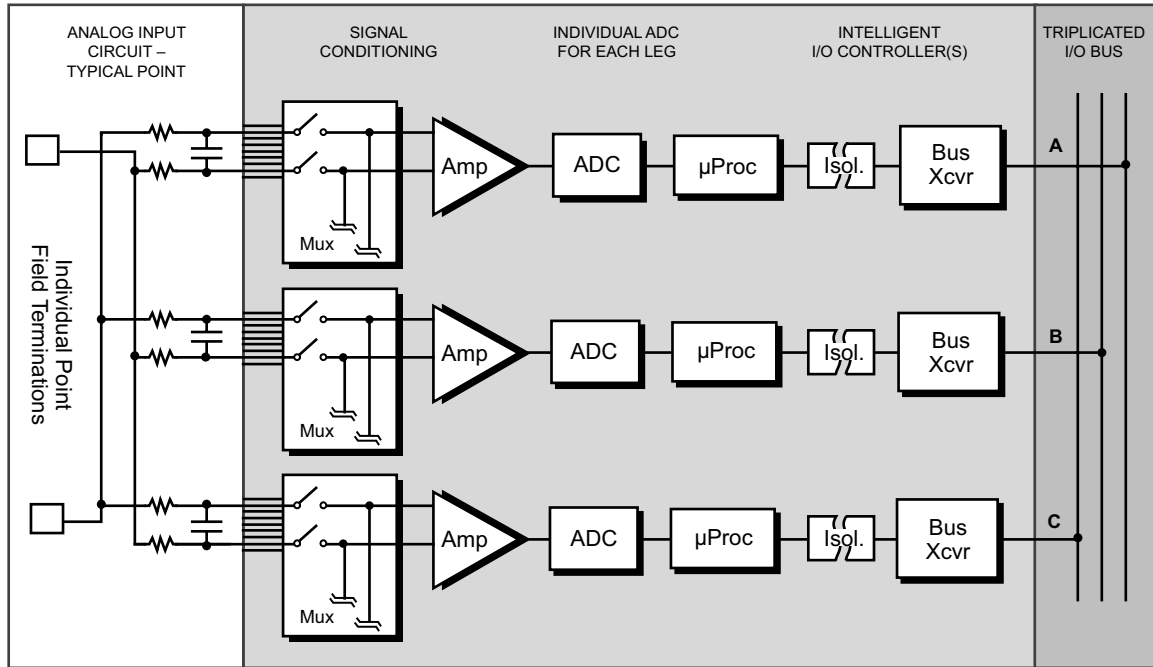


Figure 18 3721 Simplified Schematic

This figure shows the front panels of models 3700, 3700A, 3701, and 3721.

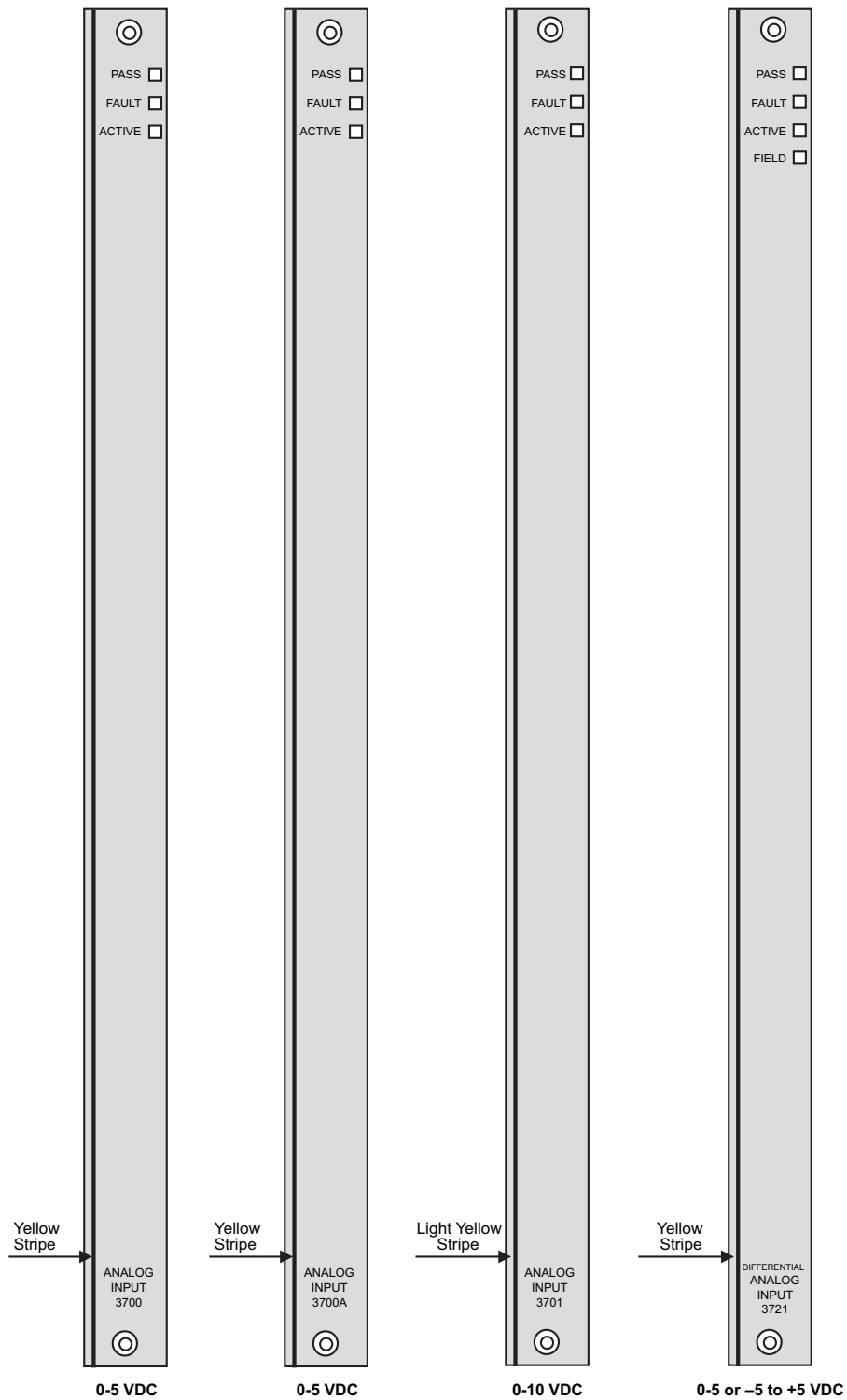


Figure 19 3700, 3700A, 3701, and 3721 Front Panels

3700A Specifications

This section includes specifications for model 3700A, which is a TMR Analog Input Module with a voltage range of 0 to 5 VDC.



If the common-mode voltage range of a channel is exceeded, Triconex does not guarantee proper operation of the module and accuracy of other channels.

Table 12 3700/3700A Analog Input Specifications

Feature	Specification
Color code	Yellow
Number of input signals	32 differential, DC-coupled
Input update rate	55 ms
Resolution	12 bits
Accuracy	< 0.15% of FSR, from 0° to 60° C
Input resistance (load)	30 M Ω (DC), minimum
Input resistance @ power off	30 k Ω (DC), typical
Common mode rejection (typical)	-80 dB (DC - 100 Hz)
Common mode range (See Warning)	-12V to +12V peak
Channel-to-channel isolation	200 k Ω , typical
Normal mode rejection	-3 dB @ 8 Hz -17 dB @ 60 Hz -23 dB @ 120 Hz
Input voltage range	0 to 5V
Input over-range measurement (only for 3700A)	+6%, 0 to 5.3 VDC
Logic power	< 10 watts
Input over-range protection	150 VDC continuous, 115 VAC continuous
Input current range	0 to 20 mA with 250 Ω shunt resistor
Module status indicators	Pass, Fault, Active
Input diagnostic fault coverage ¹	
Minimum input change	2% of full scale
Input change sample period	1 scan or 200 ms, whichever is greater
Minimum period of mis-compares	40 samples

1. Rapidly or continuously changing inputs may cause mis-compare readings because the measured values of the three channels may differ by more than 0.5 percent of full scale, which can cause a fault to be declared in error. If the input readings differ by a minimum of 2 percent of full scale and continue for a minimum period of 40 input samples, the probability of a fault increases.

3701 Specifications

This section includes specifications for model 3701, which is a TMR Analog Input Module with a voltage range of 0 to 10 VDC.



If the common-mode voltage range of a channel is exceeded, Triconex does not guarantee proper operation of the module and accuracy of other channels.

Table 13 3701 Analog Input Specifications

Feature	Specification
Color code	Light yellow
Number of input signals	32 differential, DC-coupled
Input update rate	55 ms
Resolution	12 bits
Accuracy	< 0.15% of FSR from 0° - 60° C
Input resistance (load)	30 M Ω (DC), minimum
Input resistance @ power off	30 k Ω (DC), typical
Common mode rejection (typical)	-80 dB (DC - 100 Hz)
Common mode voltage range (See Warning)	-12V to +12V peak
Channel-to-channel isolation	200 k Ω , typical
Normal mode rejection	-3 dB @ 8 Hz -17 dB @ 60 Hz -23 dB @ 120 Hz
Input voltage range	0 to 10 V
Logic power	< 10 watts
Input over-range protection	150 VDC continuous, 115 VA continuous
Input current range	0 to 20 mA with 500 Ω shunt resistor
Module status indicators	Pass, Fault, Active
Input diagnostic fault coverage ¹	
Minimum input change	2% of full scale
Input change sample period	1 scan or 200 ms, whichever is greater
Minimum period of mis-compares	40 samples

1. Rapidly or continuously changing inputs may cause mis-compare readings because the measured values of the three channels may differ by more than 0.5 percent of full scale, which can cause a fault to be declared in error. If the input readings differ by a minimum of 2 percent of full scale and continue for a minimum period of 40 input samples, the probability of a fault increases.

3721 Specifications

This section includes specifications for model 3721, which is a TMR Analog Input Module with a voltage range of 0 to 5 VDC or -5 to +5 VDC. The 3721 module can be installed only in Tricon v10.2 and later systems.

Table 14 3721 Analog Input Specifications

Feature	Specification
Color code	Yellow
Number of input signals	32 differential, DC-coupled
Input update rate	10 ms
Resolution	12 bits or 14 bits programmable
Accuracy	< 0.15% of FSR from 0° to 60° C
Input resistance (load)	10 M Ω (DC), minimum
Input resistance at power off	140 k Ω (DC), typical
Common mode rejection (typical)	-85 dB (DC - 100 Hz)
Common mode voltage range	-12V to +12V peak
Channel-to-channel isolation	420 k Ω , typical
Normal mode rejection	-3 dB @ 23 Hz -8 dB @ 60 Hz -14 dB @ 120 Hz
Input voltage range	0 to 5 or -5 to 5 VDC
Input over-range measurement	+6%, -5.3 to +5.3 VDC
Logic power	< 15 watts
Input over-range protection	150 VDC continuous, 115 VAC continuous
Input current range	0 to 20 mA with 250 Ω shunt resistor
Field to system isolation	800 VDC minimum
Module status indicators	Pass, Fault, Active, Field
Input diagnostic fault coverage ¹	
Minimum input change	2% of full scale
Input change sample period	20 ms
Minimum period of mis-compares	25 samples

1. Rapidly or continuously changing inputs may cause the time to detect a fault to increase. If an input sample changes by more than 0.25% from the previous sample the readings will not be compared.

Note The 3721 can be installed in low-density systems that have been upgraded to v10.2.x or later. For more information, see Appendix I, Low-Density Chassis I/O Module Compatibility in the *Field Terminations Guide for Tricon v9-v10 Systems*.

16-Point Isolated Analog Input Modules

This figure is a simplified schematic for model 3703E, which is a 16-point TMR Analog Input Module that can be configured as 0 to 5 VDC or 0 to 10 VDC.

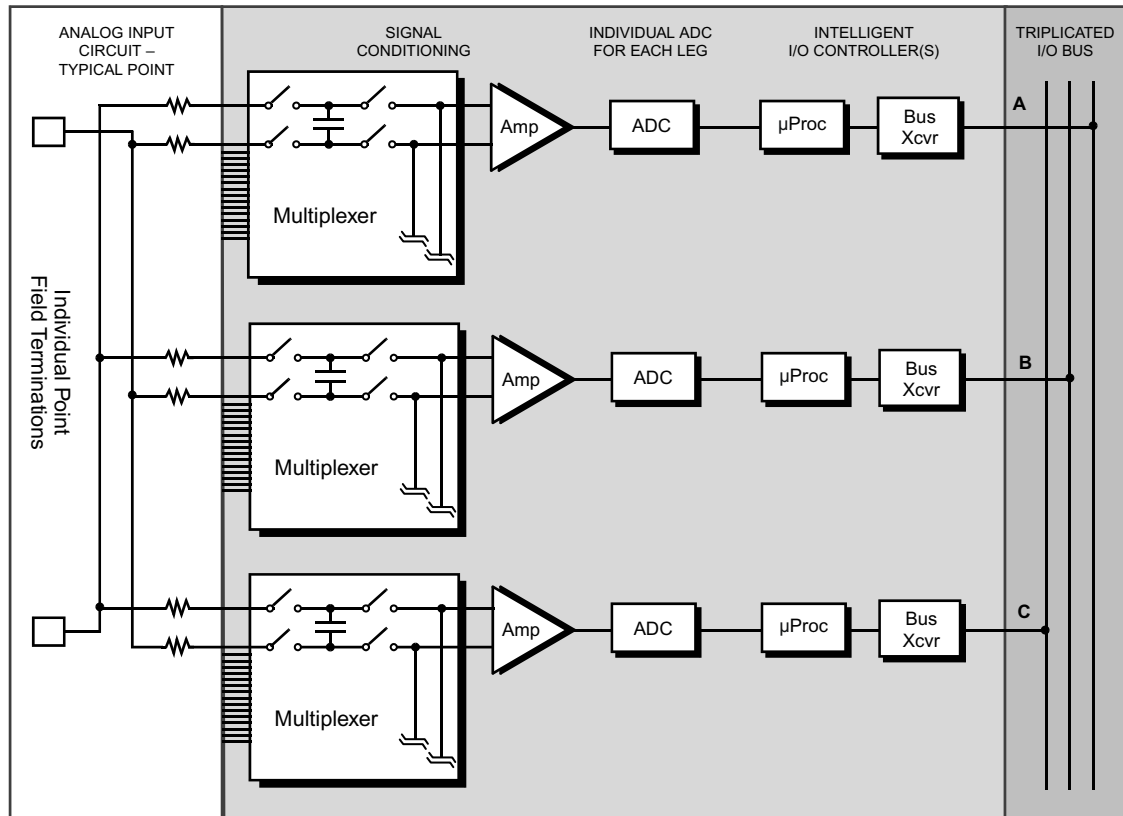


Figure 20 3703E Simplified Schematic

This figure shows the front panel of model 3703E.

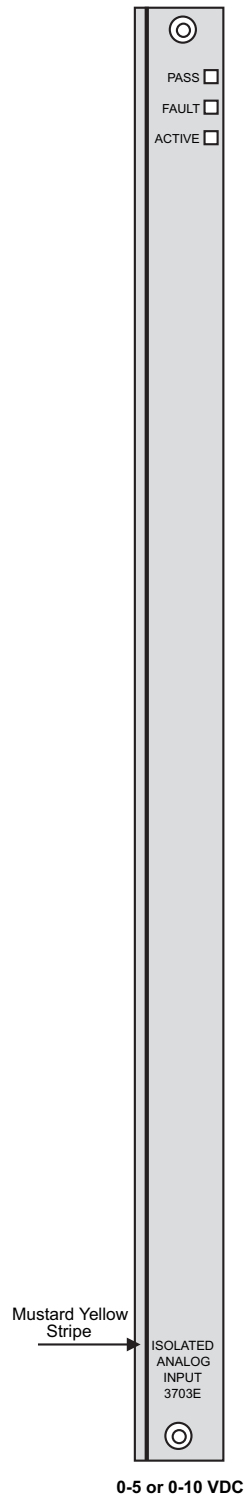


Figure 21 3703E Front Panel

3703E Specifications

This section includes specifications for model 3703E, which is an isolated TMR Analog Input Module.



If the common-mode voltage range of a channel is exceeded, Triconex does not guarantee proper operation of the module and accuracy of other channels.

Table 15 3703E Analog Input Specifications

Feature	Specification
Color code	Mustard yellow
Number of input signals	16 differential, isolated
Input update rate	< 50 ms
Resolution	12 bits
Accuracy	< 0.15% of FSR, from 0° to 60° C
Input resistance (load)	30 MΩ (DC) minimum
Input resistance @ power-off	30 MΩ (DC) minimum
Common mode rejection (typical)	-90 dB @ 60 Hz, minimum, -100 dB @ DC minimum
Common mode range	± 200 VDC maximum (channel-to-channel or channel-to-ground)
Channel-to-channel isolation	20 kΩ typical
Normal mode rejection	-3 dB @ 8 Hz -17 dB @ 60 Hz -23 dB @ 120 Hz
Input range voltage	0-5 VDC or 0-10 VDC, TriStation-configurable
Input over-range measurement	+6%, 0-5.3 VDC or 0-10.6 VDC
Logic power	< 15 watts
Input over-range protection	115 VAC continuous, 150 VDC continuous
Open detect	Upscale or downscale, TriStation-configurable
Input range current	0 - 20 mA with 250 Ω shunt resistor
Module status indicators	Pass, Fault, Active
Input diagnostic fault coverage ¹	
Minimum input change	0.5% of full scale
Input change sample period	1 scan or 50 ms, whichever is greater
Minimum period of mis-compares	256 samples

1. Rapidly or continuously changing inputs may cause mis-compare readings because the measured values of the three channels may differ by more than 0.5 percent of full scale, which can cause a fault to be declared in error. If the input readings differ by a minimum of 0.5 percent of full scale and continue for a minimum period of 256 input samples, the probability of a fault increases.

64-Point Single-Ended Analog Input Modules

This figure is a simplified schematic for model 3704E, which is a 64-point TMR Analog Input Module.

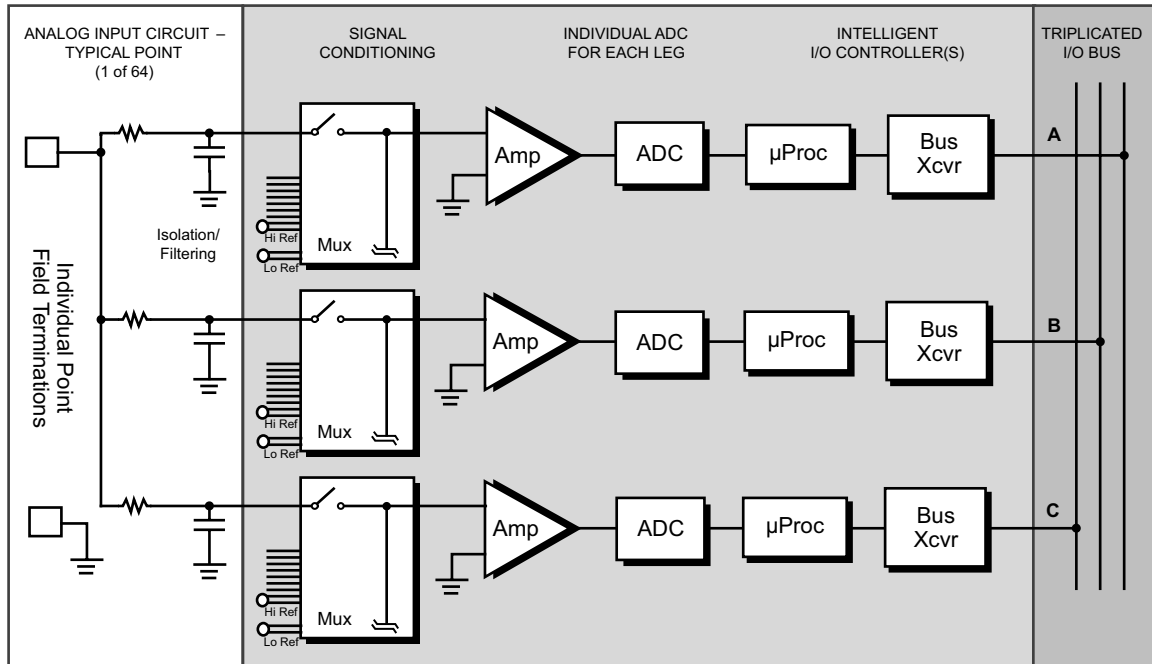


Figure 22 3704E Simplified Schematic

This figure is a simplified schematic for model 3720, which is a 64-point TMR Analog Input Module with field-to-system isolation.

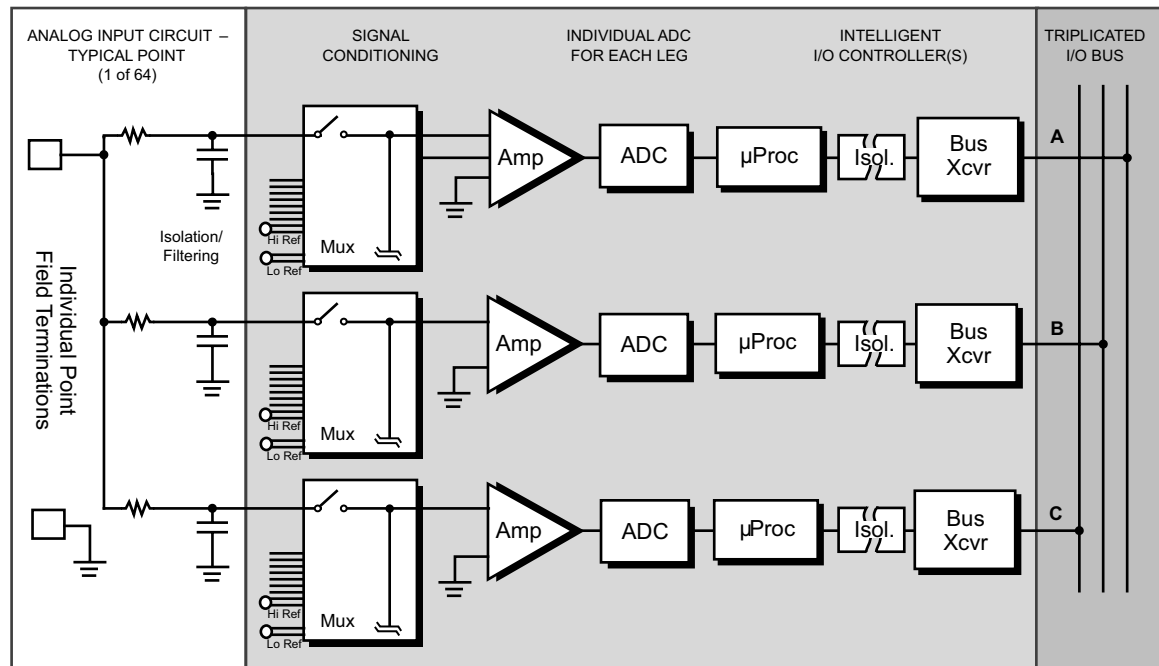


Figure 23 3720 Simplified Schematic

This figure shows the front panels of models 3704E and 3720.

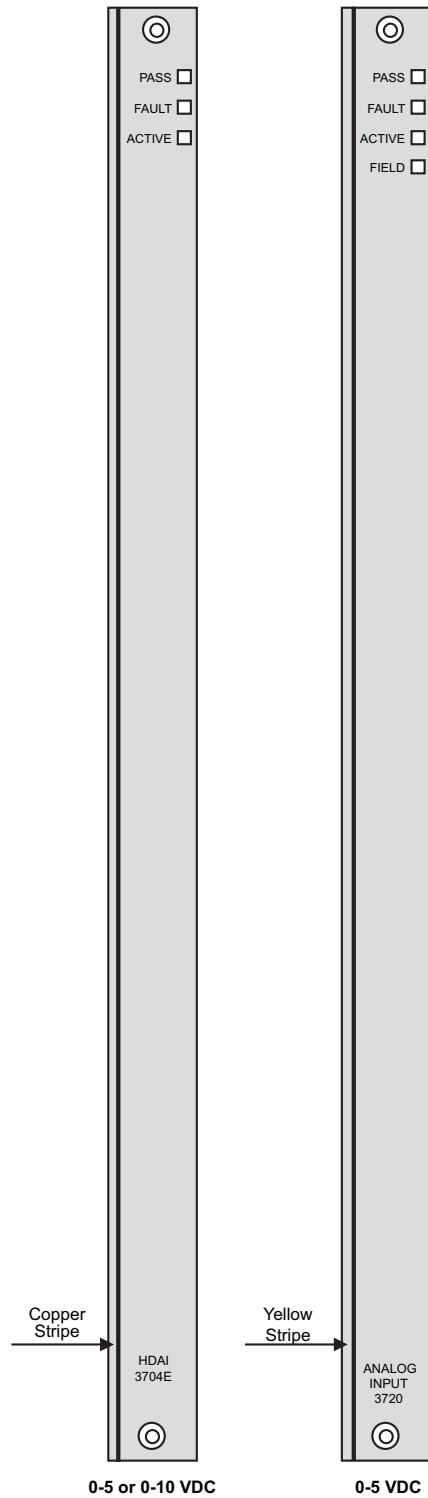


Figure 24 3704E and 3720 Front Panels

3704E Specifications

This section includes specifications for model 3704E, which is a TMR Analog Input Module with a voltage range of 0 to 5 VDC or 0 to 10 VDC.

Table 16 3704E Analog Input Specifications

Feature	Specification
Color code	Copper
Number of input signals	64, commoned, DC-coupled
Input update rate	75 ms
Resolution	12 bits
Accuracy	< 0.25% of FSR, from 0° to 60° C
Input resistance (load)	30 M Ω (DC) minimum
Input resistance @ power off	30 k Ω (DC) typical
Channel-to-channel isolation	200 k Ω typical
Normal mode rejection	-1 dB @ 8 Hz -12 dB @ 60 Hz -18 dB @ 120 Hz
Input range voltage	0 to 5 VDC or 0 to 10 VDC, (configured in TriStation)
Input over-range measurement	+6%, 0 to 5.3 VDC or 0 to 10.6 VDC
Logic power	< 10 watts
Input over-range protection	150 VDC continuous; 115 VAC continuous
Input range current	0 to 20 mA with 250 or 500 Ω shunt resistor
Module status indicators	Pass, Fault, Active
Input diagnostic fault coverage ¹	
Minimum input change	0.5% of full scale
Input change sample period	1 scan or 50 ms, whichever is greater
Minimum period of mis-compares	256 samples

1. Rapidly or continuously changing inputs may cause mis-compare readings because the measured values of the three channels may differ by more than 0.5 percent of full scale, which can cause a fault to be declared in error. If the input readings differ by a minimum of 0.5 percent of full scale and continue for a minimum period of 256 input samples, the probability of a fault increases.

3720 Specifications

This section includes specifications for model 3720, which is a TMR Analog Input Module with a voltage range of 0 to 5 VDC. The 3720 module can be installed only in Tricon v10.2 and later systems.

Table 17 3720 Analog Input Specifications

Feature	Specification
Color code	Yellow
Number of input signals	64, single-ended
Input update rate	10 ms
Resolution	12 bits or 14 bits programmable
Accuracy	< 0.15% of FSR from 0° to 60° C
Input resistance (load)	10 M Ω (DC), minimum
Input resistance at power off	140 k Ω (DC), typical
Channel-to-channel isolation	420 k Ω , typical
Normal mode rejection	-3 dB @ 8 Hz -17 dB @ 60 Hz -23 dB @ 120 Hz
Input voltage range	0 to 5 VDC
Input over-range measurement	+6%, 0 to 5.3 V, 0 to 10.6V
Logic power	< 12 watts
Input over-range protection	150 VDC continuous, 115 VAC continuous
Input current range	0 to 20 mA (plus 6% over-range) with 250 Ω shunt resistor
Field to system isolation	800 VDC minimum
Module status indicators	Pass, Fault, Active, Field
Input diagnostic fault coverage ¹	
Minimum input change	0.5% of full scale
Input change sample period	10 ms
Minimum period of mis-compares	25 samples

1. Rapidly or continuously changing inputs may cause the time to detect a fault to increase. If an input sample changes by more than 0.25% from the previous sample the readings will not be compared.

Note The 3720 can be installed in low-density systems that have been upgraded to v10.2.x or later. For more information, see Appendix I, Low-Density Chassis I/O Module Compatibility in the *Field Terminations Guide for Tricon v9–v10 Systems*.

Analog Output Modules

This section describes the Analog Output Modules available for use with Tricon v9–v10 systems. For installation instructions, see [Replacing I/O Modules on page 223](#).

Table 18 Analog Output Modules

Model	Module Description	Output Current	Type
3805E/H	Analog Output	8 outputs @ 4–20 mA	TMR
3806E	Analog Output	2 outputs @ 20–320 mA 6 outputs @ 4–20 mA	TMR
3807	BiPolar Analog Output	4 outputs @ –60 to +60 mA	TMR

Analog Output Modules receive output signals from the Main Processors on each of three channels. Each set of data is voted, and a healthy channel is selected to drive the outputs. The module monitors its own current outputs (as input voltages) and maintains an internal voltage reference that provides self-calibration and module health information.

Each channel on the analog output module has two independent current loopback circuits per point that are readable by the other channels. The information from these circuits is used as part of the hardware voting process. The first circuit verifies the accuracy and presence of the analog signal for each point, independent of the load presence or channel selection. The second circuit verifies the actual current flow for each point from the selected channel. If a current flow is detected from any point on a non-selected channel, that channel is immediately shutdown. The Load alarm status indicator is annunciated if the module cannot drive current from any point—for example, open load.

Analog Output Modules provide for the connection of redundant field loop power sources with individual indicators on the module called Pwr1 and Pwr2. Field loop power supplies for analog outputs must be provided externally. Connection of the field loop power supplies is made on the termination panel. A Status indicator activates if an open loop is detected on one or more output points. The Pwr1 and Pwr2 indicators are On if loop power is present.

Each module sustains complete and ongoing diagnostics for each channel. Failure of any diagnostic test on any channel activates the module Fault status indicator and the chassis alarm signal. The Fault status indicator points to a channel fault, *not* a module failure. The module is guaranteed to operate properly in the presence of a single fault and may continue to operate properly with multiple faults.

Analog Output Modules include the hot-spare feature which allows online replacement of a faulty module. Like all I/O modules, Analog Output Modules require a separate field termination assembly with a cable interface to the Tricon controller backplane. Each module is mechanically keyed to prevent improper installation in a configured chassis.

Analog Output Schematic

This figure is a simplified schematic for models 3805E, 3805H, and 3806E TMR Analog Output Modules.

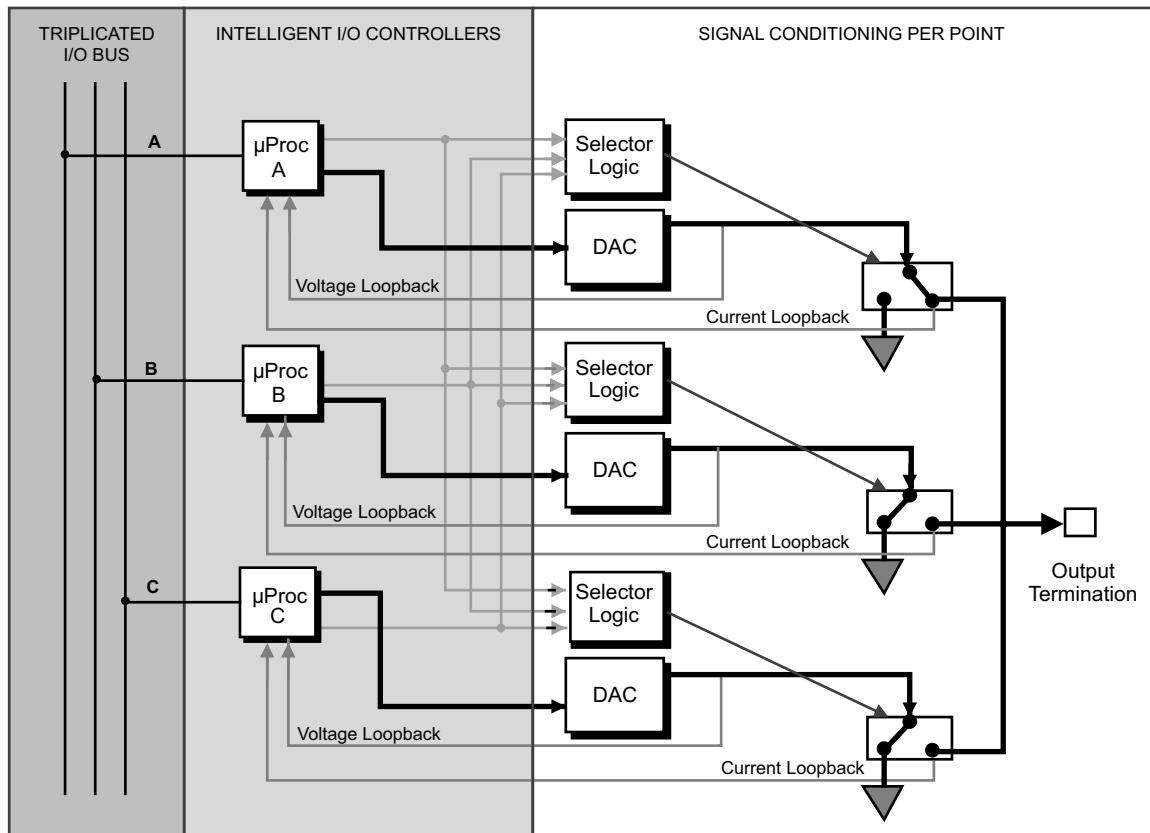


Figure 25 3805E, 3805H, and 3806E Simplified Schematic

This figure is a simplified schematic for the model 3807 TMR BiPolar Analog Output Module.

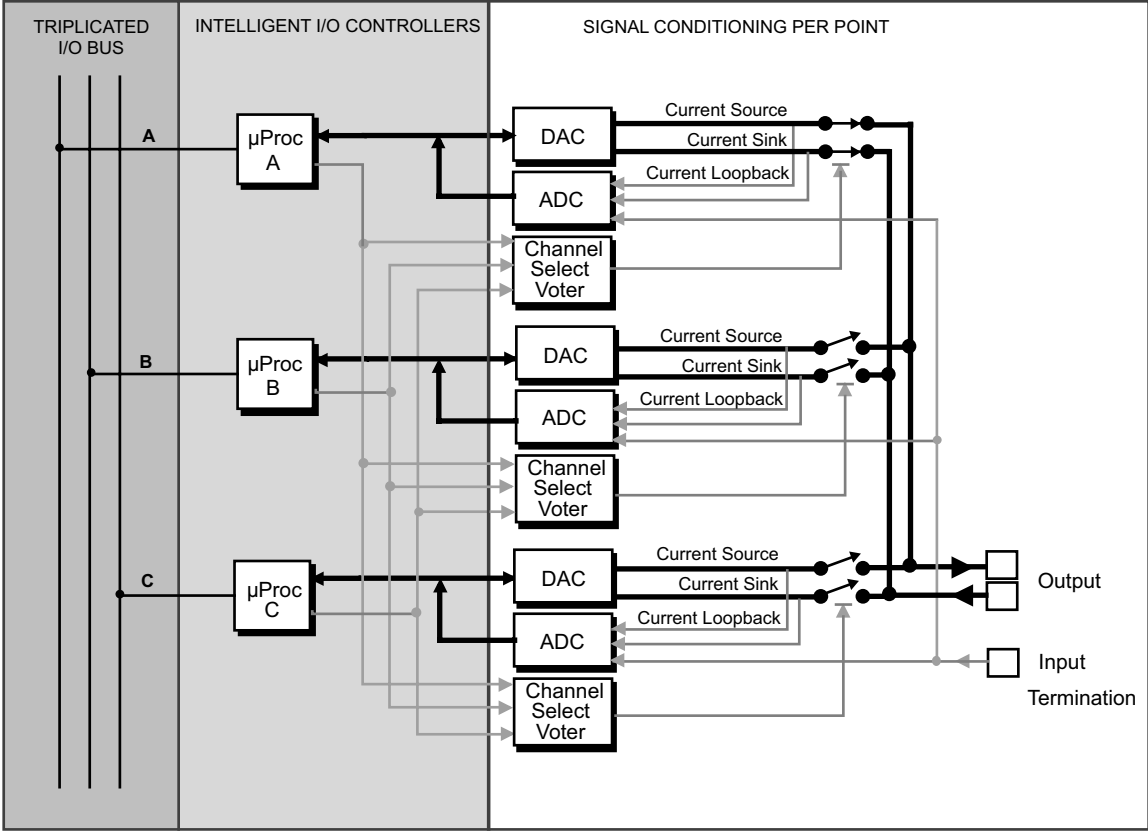


Figure 26 3807 Simplified Schematic

Analog Output Front Panels

This figure shows the front panels of models 3805E, 3805H, 3806E, and 3807.

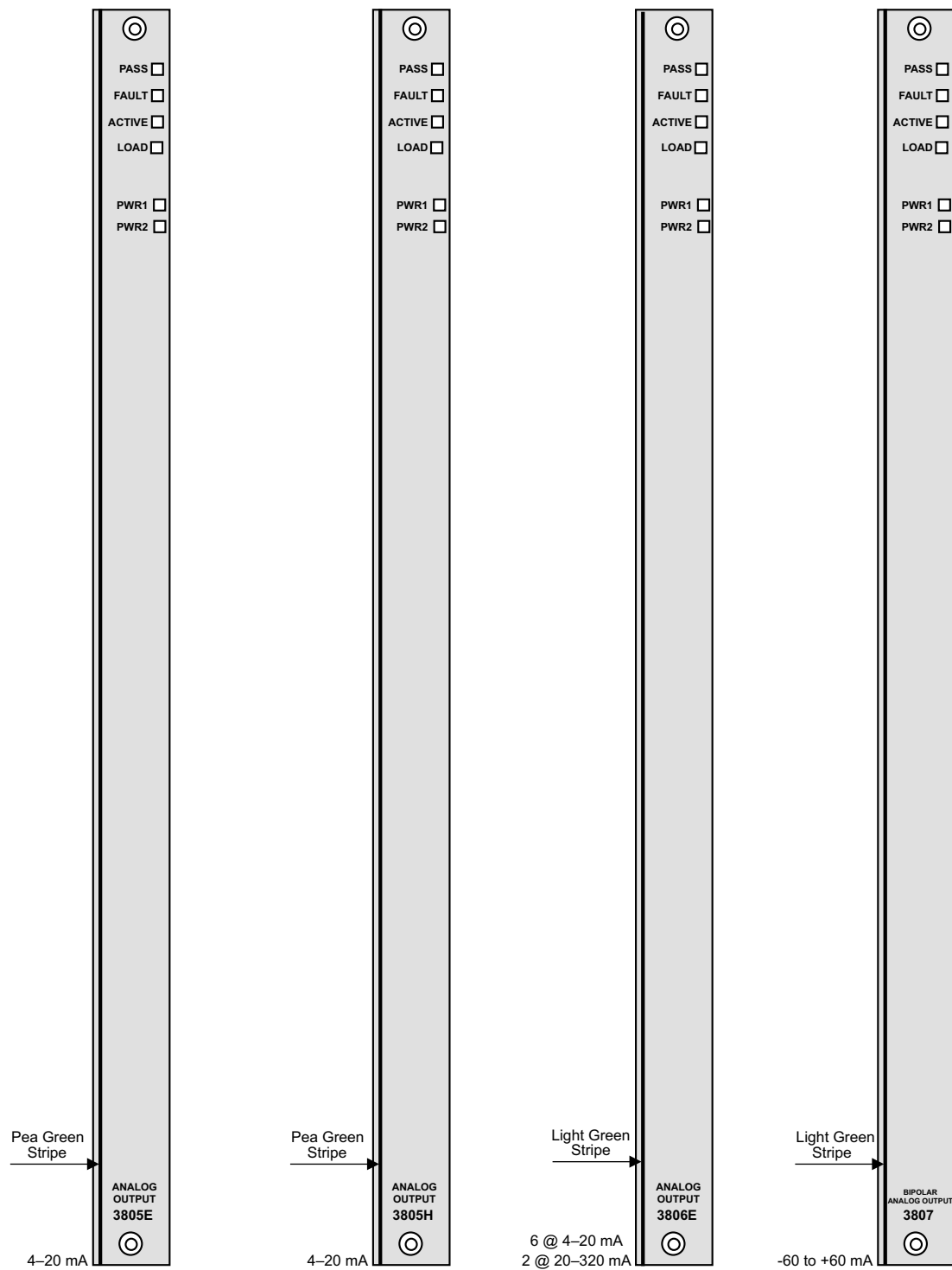


Figure 27 3805E, 3805H, 3806E, and 3807 Front Panels

3805E and 3805H Specifications

This table lists the specifications for the model 3805E and 3805H TMR Analog Output Modules.

Table 19 3805E and 3805H Analog Output Specifications

Feature	Specification
Color code	Pea green
Number of output points	8, output, commoned return, DC-coupled
Resolution	12 bits
Output current range	4–20 mA (+6% over-range)
Output over-range capability	2–21.2 mA
Output accuracy	< 0.25% (in range of 4–20 mA) of FSR (0–21.2 mA), from 0° to 60° C
External loop power (reverse voltage protected)	+42.5 VDC maximum +24 VDC nominal
Output loop power requirement: load	Required
Output loop power requirement: 250 Ω load	> 20V (1 A minimum)
Output loop power requirement: 500 Ω load	> 25V (1 A minimum)
Output loop power requirement: 750 Ω load	> 30V (1 A minimum)
Output loop power requirement: 1000 Ω load	> 35V (1 A minimum)
Output over-range protection	+42.5 VDC continuous, 0 VDC continuous
Switch time on channel failure	10 ms (typical), 20 ms (maximum)
Status indicator: Module status	Pass, Fault, Active, Load
Status indicator: Loop power status ¹	Pwr1, Pwr2
Output diagnostic fault coverage:	
Minimum input change	Not applicable
Output change sample period	Not applicable
Minimum period of mis-compares	Not applicable
Logic power	< 15 watts

1. The loop-power detectors which drive the Pwr1 and Pwr2 indicators identify the presence of loop power (greater than 20 VDC), and do not verify adequate loop power for the attached load.

Note The 3805H module has been modified to support increased inductive loads. It is fully compatible for use in all applications of the 3805E module.

3806E Specifications

This table lists the specifications for the model 3806E TMR Analog Output Module.

Table 20 3806E Analog Output Specifications

Feature	Specification
Color code	Light green
Number of output points	6 outputs @ 4–20 mA 2 outputs @ 20–320 mA, commoned return, DC-coupled
Resolution	12 bits
Recommended operating voltage range	24–32 VDC, 3 amp minimum
Extended operating voltage range	20–36 VDC, 3 amp minimum
Over-voltage protection	< 42.5 VDC continuous
Points 2-4 and 6-8, 4–20 mA output:	
Output current range	4–20 mA
Output over-range capability	2–21.2 mA (+6% over-range)
Output accuracy	< 0.25% (in normal range of 4–20 mA) of FSR (2–21.2 mA), from 0° to 60° C
Maximum load vs. external loop voltage	≤ 275 Ω @ 20 VDC ≤ 475 Ω @ 24 VDC ≤ 650 Ω @ 28 VDC ≤ 825 Ω @ 32 VDC
Points 1 and 5, 20–320 mA output:	
Output current range	20–320 mA
Output over-range capability	20–339.2 mA (+6% over-range)
Output accuracy	< 0.25% (in normal range of 20–320 mA) of FSR (20–339.2 mA), from 0° to 60° C
Maximum load vs. external loop voltage	≤ 15 Ω @ 20 VDC ≤ 25 Ω @ 24 VDC ≤ 40 Ω @ 28 VDC ≤ 50 Ω @ 32 VDC
External loop power (reverse voltage protected)	+42.5 VDC maximum; +24 VDC nominal
Temperature de-rating vs. total output current vs. loop voltage	
836 mA (all points @ maximum over-range output), 32 VDC loop voltage	≤ 104° F (≤ 40° C), ambient (measured at bottom of chassis)
836 mA (all points @ maximum over-range output), 28 VDC loop voltage	≤ 126.5° F (≤ 52.5° C), ambient (measured at bottom of chassis)

Table 20 3806E Analog Output Specifications (*continued*)

Feature	Specification
836 mA (all points @ maximum over-range output), 24 VDC loop voltage	≤ 140° F (≤ 60° C), ambient (measured at bottom of chassis)
774 mA (sum of all points), 28 VDC loop voltage	≤ 140° F (≤ 60° C), ambient (measured at bottom of chassis)
760 mA (all points @ maximum output), 28.5 VDC loop voltage	≤ 140° F (≤ 60° C), ambient (measured at bottom of chassis)
677 mA (sum of all points), 32 VDC loop voltage	≤ 140° F (≤ 60° C) C, ambient (measured at bottom of chassis)
602 mA (sum of all points), 36 VDC loop voltage	≤ 140° F (≤ 60° C), ambient (measured at bottom of chassis)
Status indicator: Module status	Pass, Fault, Active, Load
Status indicator: Loop power status ¹	Pwr1, Pwr2
Output diagnostic fault coverage:	
Minimum input change	Not applicable
Output change sample period	Not applicable
Minimum period of mis-compares	Not applicable
Switch time upon channel fault	10 ms (typical), 20 ms maximum
Logic power	< 15 watts

1. The loop-power detectors which drive the Pwr1 and Pwr2 indicators identify the presence of loop power (greater than 20 VDC), and do not verify adequate loop power for the attached load.

3807 Specifications and Description

This table lists the specifications for the model 3807 TMR BiPolar Analog Output Module (BPAO).

Table 21 3807 BiPolar Analog Output Specifications

Feature	Specification
Color code	Light green
Output points	4, bipolar outputs
Resolution	13 bits
Output current range	-60 to +60 mA
Output over-range capability	none
Output accuracy	< 0.25% (in range of -60 to 60 mA) of Full Scale Range (FSR), from 0° to 60° C. FSR = 120 mA.
Coil diagnostic input signals ¹	4 differential, DC-coupled
Coil diagnostic input resolution	12 bits
Coil diagnostic input normal-range measurement	± 10 V
External loop power range	24 VDC -15%/+20%, +5% ripple
Absolute external loop power range	19.2–30.0 VDC
Over-voltage protection	36 VDC continuous
External loop power current ²	3.5 amp minimum
Reverse voltage protected	-36 VDC continuous
Redundant loop power support	Yes
Compliance Voltage ³	-9 V minimum +9 V maximum
Resistive load operating range	150 ohm @ ± 60 mA 1 kohm @ ± 9 mA 9 kohm @ ± 1 mA
Inductive Load Operating Range – using standard termination with 300 Ω 680 nF snubber	0.0 H minimum 1.0 H maximum
Inductive Load Operating Range – using external 300 Ω 4.7 uF snubber ⁴	0.0 H minimum 2.6 H maximum
Capacitive load operating range	0 uF minimum 133 uF maximum, non-polar, with parallel resistor
Maximum glitch time, hourly switch to hot spare module	Less than 20 msec

Table 21 3807 BiPolar Analog Output Specifications (*continued*)

Feature	Specification
Maximum glitch time, current dropouts caused by the periodic rotation between channels driving the load. Channels rotate every 10 seconds.	Less than 1 msec
Status indicator: module status	Pass, Fault, Active, Load
Status indicator: Loop Power	Pwr1, Pwr2
Output diagnostic fault coverage:	
Minimum input change	Not applicable
Output change sample period	Not applicable
Minimum period of mis-compares	Not applicable
Logic power	< 20 watts

1. Four input points are used in the application program for coil diagnostic purposes.
2. The loop-power detectors which drive the Pwr1 and Pwr2 indicators identify the presence of loop power (greater than 19.2 VDC), but do not verify adequate loop power current for the attached load.
3. Compliance voltage is voltage developed across the load at the commanded current.
4. Contact the IPS Global Client Support (GCS) center or your regional support center for alternate snubber configurations.

The BPAO is designed to provide positive and negative drive current for position, velocity, and force in motion control applications. It should not be used in safety applications.

The BPAO includes analog input points, otherwise known as coil diagnostic inputs, intended for loopback measurement of the voltage developed across servo-valve coil/redundant coils as measured at the termination panel. These inputs are available to the application program.

Consider the following factors when developing an application program that uses loopback voltage measurement:

- The coil diagnostic inputs are directly tied to corresponding bipolar outputs on the termination panel
- The BPAO coil diagnostic inputs read the voltage at the termination panel, regardless of the length of the termination cable
- When calculating voltages read by the BPAO coil diagnostic inputs, consider the resistance of the termination cable wires plus the resistance of the wires from the termination panel to the load plus the resistance of the load itself
- Microphonic voltage generated by the coil from mechanical forces on the coil mechanics (torque motor)
- Back EMF voltage generated by the coil in response to current changes
- Commanded current variations from the control program
- Environmental background electromagnetic noise
- The delay of three to four scans that occurs between writing an output (commanded current) and reading the loopback voltage input

You should include a one-scan filter in the control program function to eliminate:

- Twenty-millisecond current dropouts caused by hourly board switch between the active and stand-by module (if installed).
- One-millisecond current dropouts caused by the rotation between channels driving the load. Channels rotate every 10 seconds.

The dropouts are asynchronous to the coil diagnostic input samples and may or may not be detected.

The Load alarm status indicator is activated if the module cannot drive current from any point. This condition can exist if the load is disconnected or if the loop power is missing (zero mA flowing out/in). However, if the output current is commanded to be at zero mA then the module internal diagnostics will not recognize an open loop or missing loop power. In this condition, the measured loop-back voltage may be used to detect an open circuit or missing loop power.

This table shows the relationship between the commanded current, the measured loop back input and the Load alarm status indication.

Table 22 3807 BiPolar Analog Output Field Fault Cases and Indications

Fault Case	Condition	Load Indicator Load Variable	Alarm	Loopback Input
Open load	Set current > 1ma	On	On	4095
Open load	-1ma < Set current < 1ma	Off	Off	Changing (all values)
Open load	Set current < -1ma	On	On	-4095
Shorted load	Set current > 1ma	Off	Off	-10 to +10 counts
Shorted load	Set current < -1ma	Off	Off	-10 to +10 counts

Each BPAO channel provides loop power current limiting to protect the external power supplies.

For more information, see these sections:

- [Installing Model 3807 BiPolar Analog Output Modules on page 194](#)
- [Performance Proof Testing Model 3807 BiPolar Analog Output Modules on page 219](#)

Digital Input Modules

This section describes the Digital Input Modules available for use with Tricon v9–v10 systems, which include TMR and Single (non-triplicated) modules. For installation instructions, see [Replacing I/O Modules on page 223](#).

Table 23 Digital Input Modules

Model	Voltage/Type	Points	Description
3501E/T	115 VAC/VDC	32	TMR, isolated, non-commoned
3502E	48 VAC/VDC	32	TMR, commoned in groups of 8, with a circuit stuck-On self-test feature.
3503E	24 VAC/VDC	32	TMR, commoned in groups of 8, with a circuit stuck-On self-test feature.
3504E	24/48 VDC	64	TMR, commoned, high density, DC-coupled, with a circuit stuck-On or stuck-Off self-test feature. Configured in TriStation as 24 or 48 VDC.
3505E	24 VDC	32	TMR, commoned, low threshold, with a circuit stuck-On or stuck-Off self-test feature.
3564	24 VDC	64	Single, commoned

Each Digital Input Module has three independent channels which process all data input to the module. On each channel, a microprocessor scans each input point, compiles data, and transmits it to the Main Processors upon demand. Then input data is voted at the Main Processors before processing to ensure the highest integrity.

All Digital Input Modules sustain complete, ongoing diagnostics for each channel. Failure of any diagnostic on any channel activates the Fault indicator which in turn activates the chassis alarm signal. The Fault indicator points to a channel fault, *not* a module failure. The module is guaranteed to operate properly in the presence of a single fault and may continue to operate properly with certain kinds of multiple faults.

Digital Input Modules include the hot-spare feature which allows online replacement of a faulty module. Like all I/O modules, Digital Input Modules require a cable interface to a remotely located external termination panel. Each module is mechanically keyed to prevent improper installation in a configured chassis.

Self-Test Feature

The Self-Test feature continuously verifies the ability of the Tricon controller to detect the transition of a circuit. This feature is available in two versions:

- 1) Models 3502E, 3503E, and 3505E include a circuit stuck-On self-test feature that verifies the ability to detect transitions from a normally energized circuit to the Off state.
- 2) Models 3504E and 3564 include a circuit stuck-On or stuck-Off self-test feature that verifies the ability of a Tricon controller to detect transitions to the opposite state – either from On to Off or from Off to On.

Single Digital Input Module

Model 3564 is a Single Digital Input Module, which is optimized for safety-critical applications where low cost is more important than maximum availability. On Single modules, only those portions of the signal path that are required to ensure safe operation are triplicated. Self-test circuitry detects all stuck-On and stuck-Off fault conditions within the non-triplicated signal conditioners in less than 500 milliseconds. This is a mandatory feature of a fail-safe system, which must detect all faults in a timely manner and upon detection of a fault, force the measured input value to the safe state. Because the Tricon controller is optimized for de-energize-to-trip applications, detection of a fault in the input circuitry forces to Off (the de-energized state) the value reported to the Main Processors by each channel. Although this module is fail-safe, it does not offer the same level of availability and reliability as a TMR module.

115 VAC/VDC Digital Input Modules

This figure is a simplified schematic for models 3501E and 3501T, which are 16-point TMR Digital Input Modules without a self-test feature.

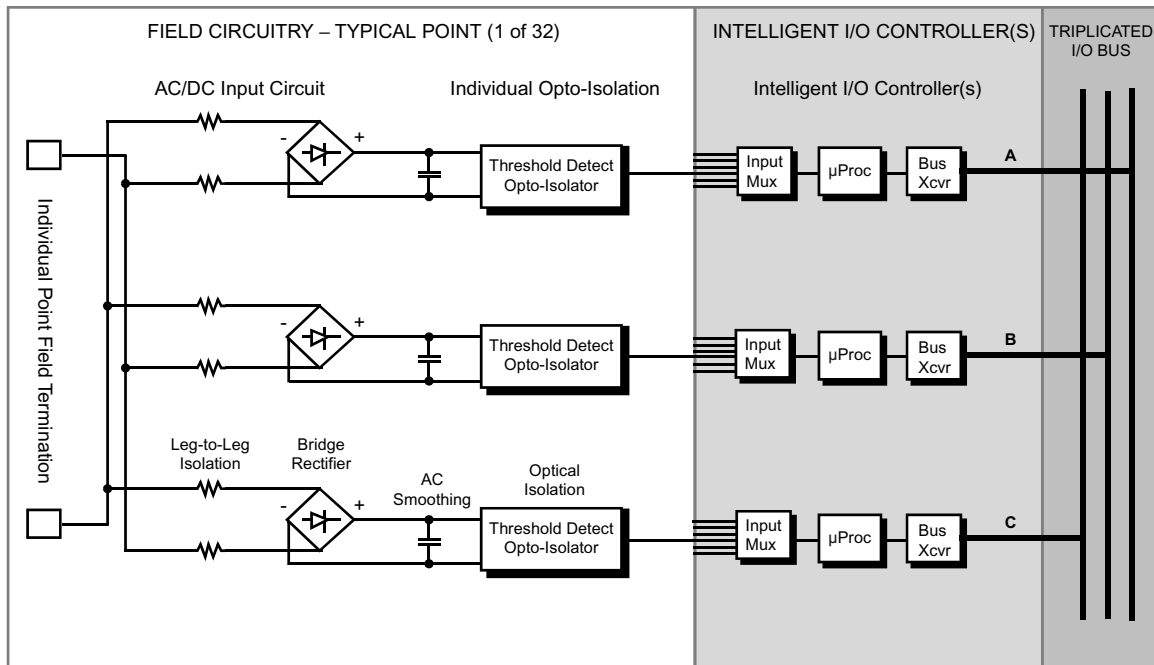


Figure 28 3501E and 3501T Simplified Schematic

This figure shows the front panels of models 3501E and 3501T.

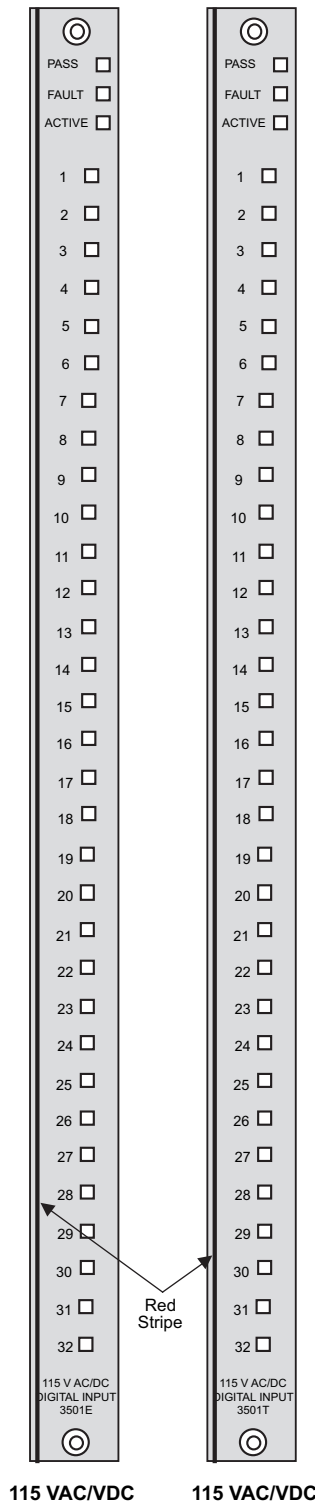


Figure 29 3501E and 3501T Front Panels

3501E and 3501T Specifications

This table lists the specifications for models 3501E and 3501T, which are 16-point TMR Digital Input Modules with a nominal input voltage of 115 VAC/VDC. Model 3501T has a higher point isolation minimum than model 3501E.

Table 24 3501E and 3501T Digital Input Specifications

Feature	Specification
Color code	Red
Number of input points	32, non-commoned, isolated
Input frequency range	DC or 47-63 Hz
Recommended input range	90-155 VAC/VDC
Maximum voltage	155 VAC/VDC
Switching level: Off to On	69 VAC/VDC typical, 86 VAC/VDC worst-case
Switching level: On to Off	36 VAC/VDC typical, 28 VAC/VDC worst-case
Typical hysteresis	32 VAC/VDC
Nominal turn-on	6 mA to 9 mA
Input impedance	> 8.5 k Ω nominal
Input delay: Off to On	< 8 ms
Input delay: On to Off	< 15 ms
Point isolation, opto-isolated: 3501E	1000 VAC minimum, 1500 VDC minimum
Point isolation, opto-isolated: 3501T	1780 VAC minimum, 2500 VDC minimum
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Logic power	< 10 watts
Nominal field power load	1.5 watts per On point, 2.9 watts @ maximum field voltage
Leakage current to chassis @ 60 Hz	1 mA maximum per On point
Input diagnostic fault coverage: ¹	
Maximum input toggle rate	Every 100 ms
Minimum input toggle rate	Every 3 months (manually toggled by the user)
Diagnostic glitch duration	Not applicable

1. The maximum input toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.

24 to 48 VAC/VDC Digital Input Modules

This figure is a simplified schematic for models 3502E, 3503E, and 3505E, which are 24 to 48 VAC/VDC, 32-point TMR Digital Input Modules with a self-test feature. The self-test feature continuously verifies the ability of a Tricon controller to detect the transition of a normally energized circuit to the Off state.

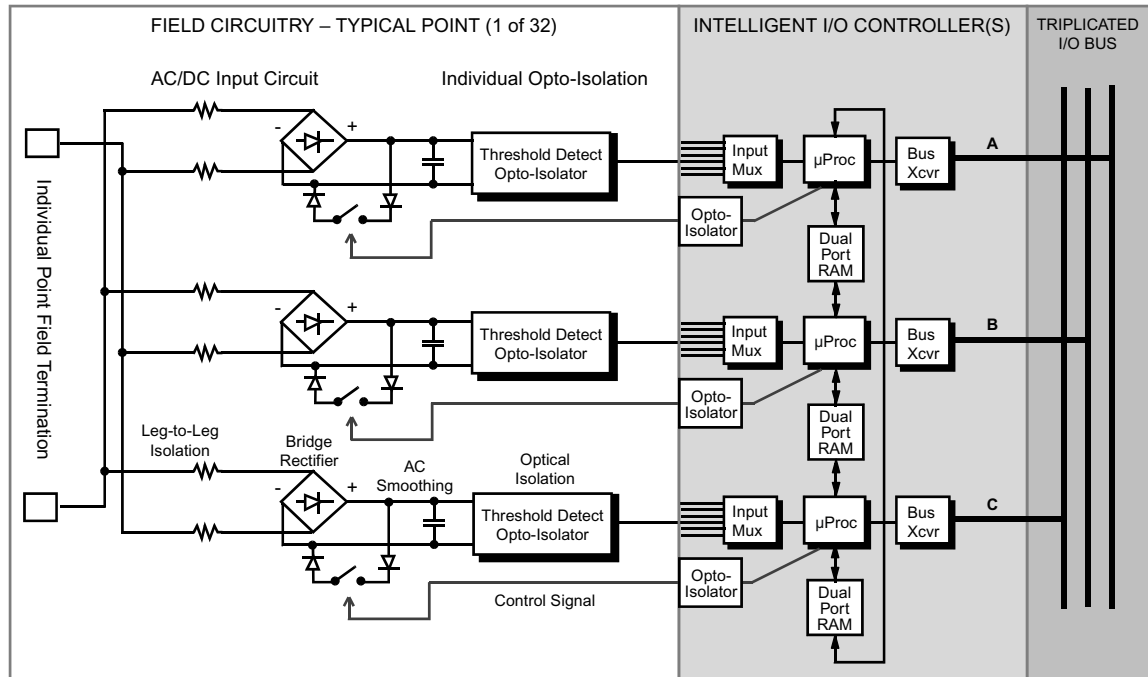


Figure 30 3502E, 3503E, and 3505E Simplified Schematic

This figure shows the front panels of models 3502E, 3503E, and 3505E.

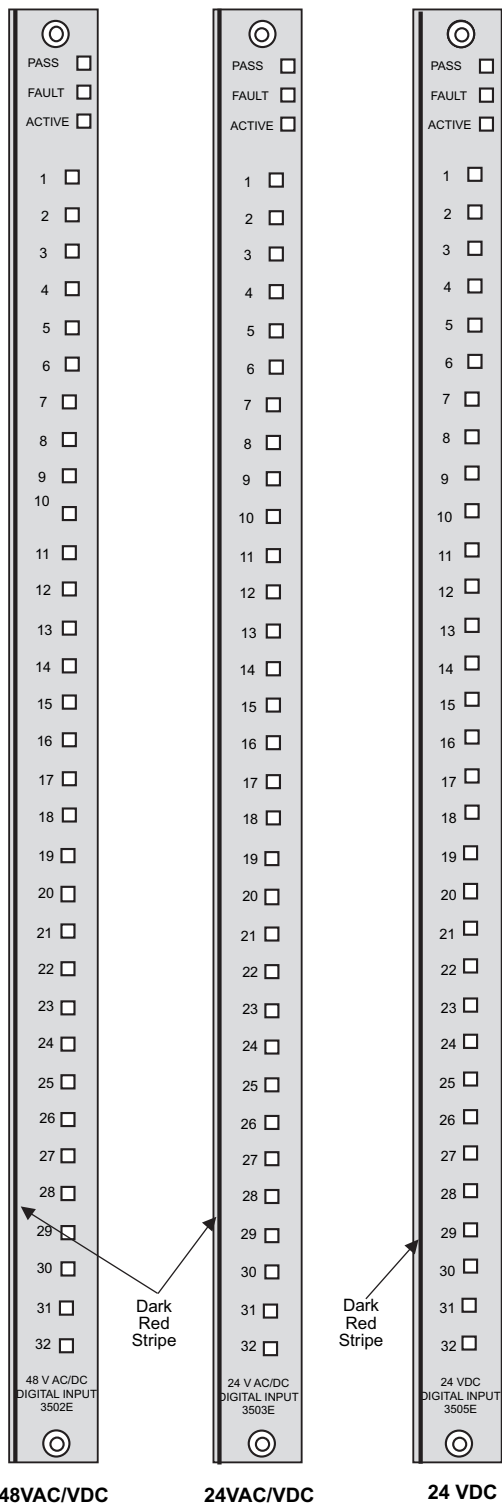


Figure 31 3502E, 3503E, and 3505E Front Panels

3502E Specifications

This table lists the specifications for model 3502E, which is a TMR Digital Input Module with a nominal input voltage of 48 VAC/VDC and a self-test feature.

Table 25 3502E Digital Input Specifications

Feature	Specification
Color code	Dark red
Number of input points	32, commoned in groups of 8
Input frequency range	DC or 47-63 Hz
Recommended input range	35-95 VAC/VDC
Maximum voltage	95 VAC/VDC
Switching level: Off to On	27 VAC/VDC typical, 32 VAC/VDC worst-case
Switching level: On to Off	14 VAC/VDC typical, 11 VAC/VDC worst-case
Typical hysteresis	7 VAC/VDC
Nominal turn-on	6 mA to 9 mA
Input impedance	> 2.9 k Ω nominal
Input delay: Off to On	< 8 ms
Input delay: On to Off	< 15 ms
Point isolation, opto-isolated	1000 VAC minimum, 1500 VDC minimum
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Logic power	< 10 watts
Nominal field power load	1.0 watts per On point, 3.2 watts @ maximum field voltage
Leakage current to chassis @ 60 Hz	0.5 mA maximum per On point
Input diagnostic fault coverage ¹ : Maximum input toggle rate	Every 100 ms
Input diagnostic fault coverage ¹ : Minimum input toggle rate, On state	Not required
Input diagnostic fault coverage ¹ : Minimum input toggle rate, Off state	Every 3 months (manually toggled by the user)
Diagnostic glitch duration ²	20 ms typical
Output voltage	< 1/2V _{IN}
Output impedance	< 4.22 k Ω

1. The maximum input toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
2. V_{IN} is the voltage applied to an energized point. Output voltage is noticeable on an adjacent de-energized point for the duration of the diagnostic glitch. Be advised that the glitch output may falsely energize the paralleled input of another piece of equipment.

3503E Specifications

This table lists the specifications for model 3503E, which is a TMR Digital Input Module with a nominal input voltage of 24 VAC/VDC and a self-test feature.

CAUTION

This model is not recommended for use with shunt-diode intrinsic safety barriers. For these applications, Triconex recommends the model 3505E.

Table 26 3503E Digital Input Specifications

Feature	Specification
Color code	Dark red
Number of input points	32, commoned in groups of 8
Input frequency range	DC or 47-63 Hz
Recommended input range	20–42.5 VDC
Maximum voltage	42.5 VAC/VDC
Switching level: Off to On	15 VAC/VDC typical, 18 VAC/VDC worst-case
Switching level: On to Off	8 VAC/VDC typical, 6 VAC/VDC worst-case
Typical hysteresis	4 VAC/VDC
Nominal turn-on	6 mA to 9 mA
Input impedance	> 1.25 k Ω nominal
Input delay: Off to On	< 8 ms
Input delay: On to Off	< 15 ms
Point isolation, opto-isolated	1000 VAC minimum, 1500 VDC minimum
Status indicator: On or Off State	1 per point
Status indicator: Module status	Pass, Fault, Active
Logic power	< 10 watts
Nominal field power load	0.5 watts per On point ¹ 1.5 watts @ maximum field voltage
Leakage current to chassis @ 60 Hz	0.25 mA maximum per On point
Input diagnostic fault coverage ² :	
Maximum input toggle rate	Every 100 ms
Minimum input toggle rate, On state	Not required
Minimum input toggle rate, Off state	Every 3 months (manually toggled by the user)
Diagnostic glitch duration ³	20 ms typical
Output voltage	< 1/2 V _{IN}
Output impedance	< 1.87 k Ω

1. When used with a typical shunt-diode intrinsic safety barrier, the nominal field power per On point is approximately 350 milliwatts @ 24 VDC.

2. The maximum input toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. V_{IN} is the voltage applied to an energized point. Output voltage is noticeable on an adjacent de-energized point for the duration of the diagnostic glitch. Be advised that the glitch output may falsely energize the paralleled input of another piece of equipment.

3505E Specifications

This table lists the specifications for model 3505E, which is a low-threshold TMR Digital Input Module.

Table 27 3505E Digital Input Specifications

Feature	Specification
Color code	Dark red
Number of input points	32, commoned in groups of 8
Recommended input range	20–42.5 VDC
Maximum voltage	42.5 VDC
Switching level: Off to On	10 VDC typical, 12 VDC worst-case
Switching level: On to Off	5 VDC typical, 4 VDC worst-case
Typical hysteresis	2 VDC
Nominal turn-on	3 mA to 5 mA
Input impedance	> 1.25 k Ω nominal
Input delay: Off to On	< 8 ms
Input delay: On to Off	< 15 ms
Point isolation, opto-isolated	1000 VAC minimum, 1500 VDC minimum
Status indicator: On or Off State	1 per point
Status indicator: Module status	Pass, Fault, Active
Logic power	< 10 watts
Nominal field power load	0.5 watts per On point ¹ 1.5 watts @ maximum field voltage
Leakage current to chassis @ 60 Hz	0.25 mA maximum per On point
Input diagnostic fault coverage ² :	
Maximum input toggle rate	Every 100 ms
Minimum input toggle rate, On state	Not required
Minimum input toggle rate, Off state	Every 3 months (manually toggled by the user)
Diagnostic glitch duration ³	20 ms typical
Output voltage	< 1/2 V_{IN}
Output impedance	< 1.87 k Ω

1. When used with a typical shunt-diode intrinsic safety barrier, the nominal field power per On point is approximately 350 milliwatts @ 24 VDC.
2. The maximum input toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. V_{IN} is the voltage applied to an energized point. Output voltage is noticeable on an adjacent de-energized point for the duration of the diagnostic glitch. Be advised that the glitch output may falsely energize the paralleled input of another piece of equipment.

24 to 48 VDC Digital Input Modules

This figure is a simplified schematic for model 3504E, which is a high-density TMR Digital Input Module.

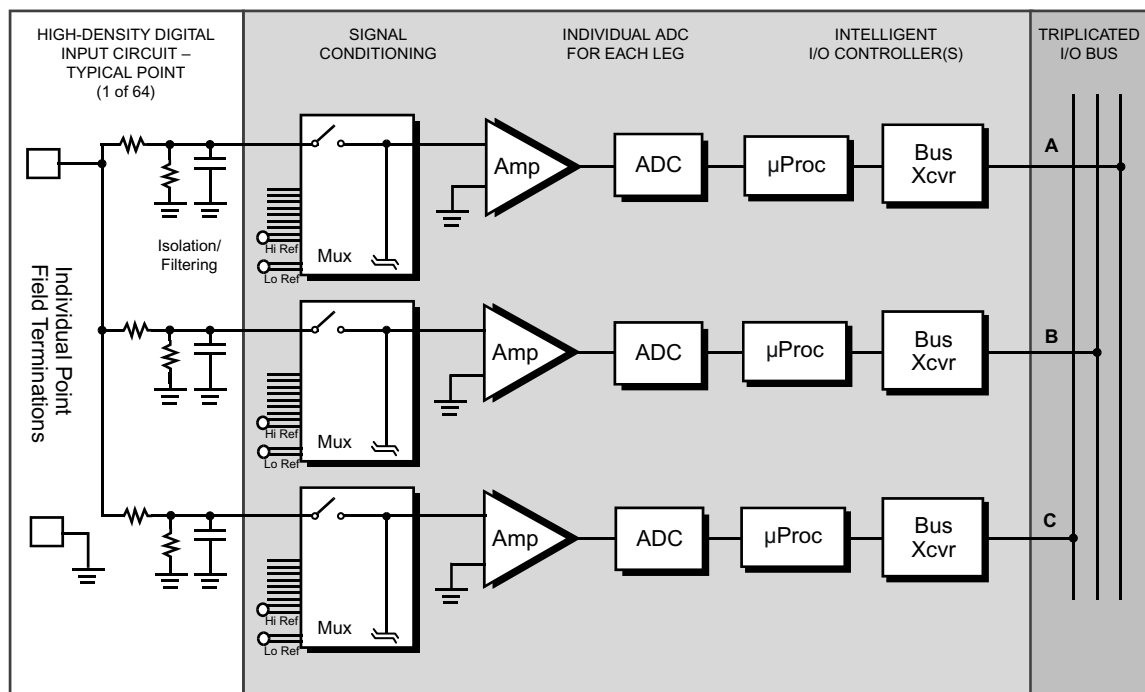


Figure 32 3504E Simplified Schematic

This figure shows the front panel of model 3504E.

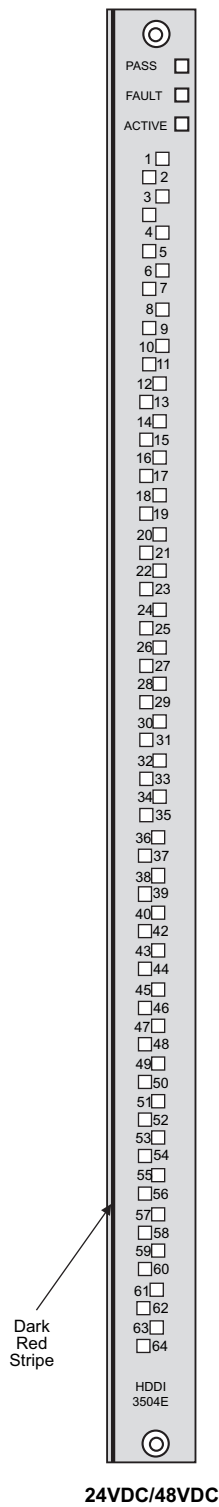


Figure 33 3504E Front Panel

3504E Specifications

This table lists the specifications for model 3504E, which is a high-density TMR Digital Input Module with an nominal input voltage of 24 or 48 VDC.

Table 28 3504E Digital Input Specifications

Feature	Specification
Color code	Dark red
Number of input points	64, commoned, DC-coupled
Input voltage range: 24 VDC ¹	20–36 VDC
Input voltage range: 48 VDC ¹	40–72 VDC
Input over-range protection	115 VAC continuous, 150 VDC continuous
Switching level for 24 VDC: Off to On	15 VDC typical, 18 VDC worst-case, 4 VDC typical hysteresis
Switching level for 24 VDC: On to Off	8 VDC typical, 6 VDC worst-case, 4 VDC typical hysteresis
Switching level for 48 VDC: Off to On	27 VDC typical, 32 VDC worst-case, 7 VDC typical hysteresis
Switching level for 48 VDC: On to Off	14 VDC typical, 11 VDC worst-case, 7 VDC typical hysteresis
Input delay: Off to On	< 10 ms
Input delay: On to Off	< 10 ms
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Input impedance ²	> 30 k Ω nominal
Logic power	< 10 watts
Input diagnostic fault coverage ³ :	
Maximum input toggle rate	Once every 100 ms
Minimum input toggle rate	Not required
Diagnostic glitch duration	1 ms every 2–3 seconds
Output voltage	0 VDC or 5 VDC typical
Output impedance	100 k Ω typical

1. Specified in the TriStation software.
2. A ballast resistor is installed on the external termination panel to lower the input impedance equivalent to other Triconex Digital Input Modules. For more information, see the *Field Terminations Guide for Tricon v9–v10 Systems*.
3. The maximum input toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.

24 VDC Single Digital Input Modules

This figure is a simplified schematic for model 3564, which is a Single Digital Input Module.

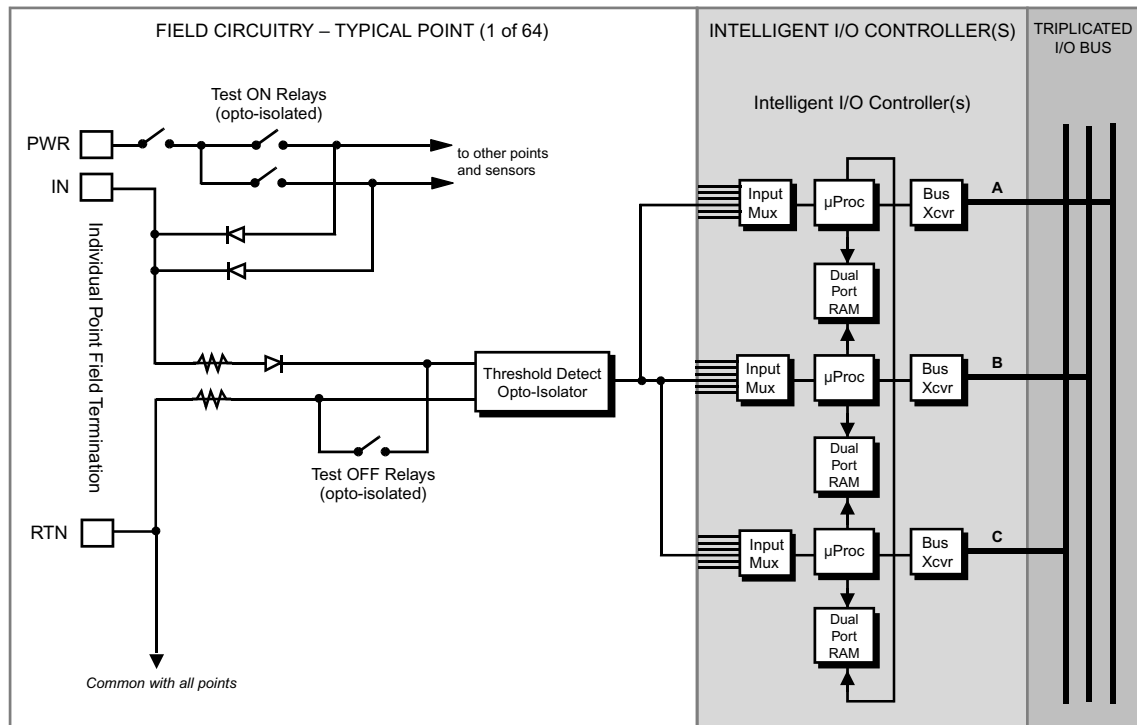


Figure 34 3564 Simplified Schematic

This figure shows the front panel of model 3564.

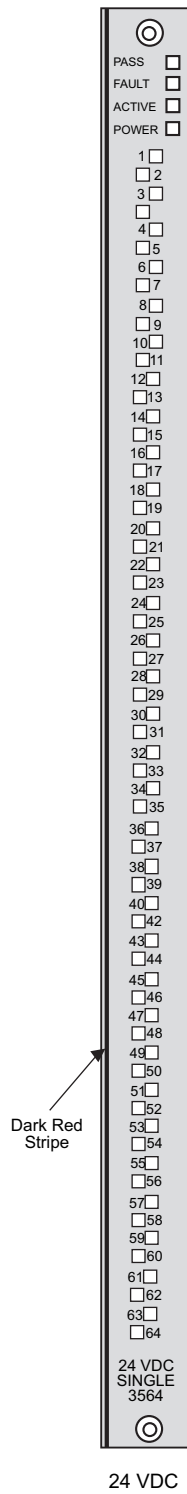


Figure 35 3564 Front Panel

3564 Specifications

This table lists the specifications for model 3564, which is a Single Digital Input Module with an nominal voltage range of 24 VDC. This module is fail-safe, however, it does not have the same level of availability and reliability as a TMR module.

CAUTION

If a hot-spare module is installed, a normal switch-over to the healthy module occurs in a few seconds. During this switch-over period, the input value is reported to the control program. The control program, within its own constraints, must handle this potential “glitch Off” condition in such a way as to maximize system availability.

Table 29 3564 Digital Input Specifications

Feature	Specification
Color code	Dark red
Number of input points	64, commoned
Recommended input range	15–30 VDC
Maximum voltage	36 VDC
Switching level: Off to On	12 VDC typical, 15 VDC worst-case
Switching level: On to Off	8 VDC typical, 6 VDC worst-case
Typical hysteresis	4 VDC
Nominal turn-on	2 mA to 3 mA
Input impedance	> 3.0 k Ω nominal
Input delay: Off to On	< 2 ms
Input delay: On to Off	< 2 ms
Point isolation, opto-isolated	1500 VDC minimum
Status indicator: On or Off State	1 per point
Status indicator: Module status	Pass, Fault, Active, Power
Logic power	< 10 watts
Nominal field power load	0.2 watts per On point, 0.5 watts @ maximum field voltage
Leakage current to chassis @ 60 Hz	Not applicable
Input toggle rates ¹ : Maximum	Every 100 ms
Input toggle rates ¹ : Minimum, On state	Not required
Input toggle rates ¹ : Minimum, Off state	Not required
On glitch of Off point ² : Duration	< 2 ms maximum
On glitch of Off point ² : Voltage	< V _{IN}
On glitch of Off point ² : Duty cycle	50%, typical
Impedance	< 10 Ω

Table 29 3564 Digital Input Specifications (*continued*)

Feature	Specification
Input behavior under fault conditions ³ : Input value, before fault	Input state, On or Off
Input behavior under fault conditions ³ : Input value, after fault	Unknown, depends on type of fault
Input behavior under fault conditions ³ : Input value, after 500 ms	Off, de-energized

1. The maximum input toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
2. V_{IN} is the field voltage. Output voltage is noticeable on the field circuit of an Off input point for the duration of the diagnostic glitch. Be advised that the glitched output may falsely energize the paralleled input of another piece of equipment.
3. Each channel of the Single DI module independently performs a complete set of diagnostics on each input point every 500 milliseconds. Upon detection of a fault, each point which does not pass 100% of the diagnostic tests is reported as Off to the Main Processor by each channel. Faults in the non-redundant input circuitry affect the value reported by all three channels, whereas faults that affect only one channel affect only the value reported by that channel.

Digital Output Modules

This section describes the Digital Output Modules available for use with Tricon v9–v10 systems, which include TMR and Single (non-triplicated) modules. For field wiring information, see [Digital Output Field Wiring Precautions on page 192](#).

Table 30 Digital Output Modules

Model	Voltage	Type
3601E/T	115 VAC	16-point TMR, Non-Commoned
3603B	120 VDC	16-point TMR, Non-Commoned
3603E/T	120 VDC	16-point TMR, Commoned
3604E	24 VDC	16-point TMR, Non-Commoned
3607E	48 VDC	16-point TMR, Non-Commoned
3611E	115 VAC	8-point TMR Supervised, Commoned
3613E	120 VDC	8-point TMR Supervised, Commoned
3614E	24 VDC	8-point TMR Supervised, Commoned
3615E	24 VDC	8-point TMR Supervised, Low Power, Commoned
3617E	48 VDC	8-point TMR Supervised, Commoned
3623/T	120 VDC	16-point TMR Supervised, Commoned
3624	24 VDC	16-point TMR Supervised, Commoned
3625 ¹	24 VDC	32-point TMR Supervised/Non-Supervised, Commoned
3636R/T	Relay, NO	32-point Non-Triplicated, Non-Commoned
3664	24 VDC	32-point Dual Output, Commoned
3674	24 VDC	32-point Dual Output, Commoned

1. The 3625 module can be installed only in Tricon v10.2 and later systems.

Each Digital Output Module houses the circuitry for three identical, isolated channels. Each channel includes an I/O microprocessor which receives its output table from the I/O communication processor on its corresponding Main Processor. All the Digital Output Modules, except the dual DC modules, use special quadruplicated output circuitry which votes on the individual output signals just before they are applied to the load. This voter circuitry is based on parallel-series paths which pass power if the drivers for Channels A and B, or Channels B and C, or Channels A and C command them to close – in other words, 2-out-of-3 drivers voted On. The dual Digital Output Modules provide a single parallel or series path, with the 2-out-of-3 voting process applied individually to each switch.

The quadruplicated output circuitry provides multiple redundancy for all critical signal paths, guaranteeing safety and maximum availability. The dual output module provides just enough redundancy to ensure safe operation. Dual modules are optimized for those safety-critical applications where low cost is more important than maximum availability.

Digital Output Modules include the hot-spare feature which allows online replacement of a faulty module. Like all I/O modules, Digital Output Modules require a separate field termination assembly with a cable interface to the Tricon controller backplane. Each module is mechanically keyed to prevent improper installation in a configured chassis.

Digital Output Modules are designed to source the current to field devices. Field power must be wired to each output point on a field termination module.

OVD (Output Voter Diagnostics)

Each type of Digital Output Module executes a particular type of Output Voter Diagnostic for every point. In general, during OVD execution the commanded state of each point is momentarily reversed on one of the output drivers, one after another. Loop-back on the module allows each microprocessor to read the output value for the point to determine whether a latent fault exists within the output circuit. Because OVD forces a simulated failure, it glitches the attached load.

Triconex guarantees that an OVD-forced glitch has the following durations:

- For AC modules, no longer than 1/2 AC cycle.
- For DC modules, less than 2 milliseconds (typically 500 microseconds), which is a period that is tolerated well by electro-mechanical devices such as relays, solenoids and contactors.

If required by the controlled process, OVD can be disabled, however it must be periodically cycled to both the On and Off states to ensure 100 percent fault coverage. For devices that cannot tolerate a signal transition of any length, OVD on both AC and DC voltage Digital Output Modules can be disabled.

For more information, see [Disabling Output Voter Diagnostics on DO Modules on page 214](#).

AC Voltage Digital Output Modules

On AC voltage Digital Output Modules, a fault switch identified by the OVD process causes the output signal to transition to the opposite state for a maximum of 1/2 an AC cycle. This transition may not be transparent to all field devices. Once a fault is detected, the module discontinues further iterations of OVD. If required by the controlled process, OVD can be disabled, however it must be periodically cycled to both the On and Off states to ensure 100 percent fault coverage.

DC Voltage Digital Output Modules

DC voltage Digital Output Modules are specifically designed to control devices which hold points in one state for long periods of time. The OVD strategy for a DC voltage Digital Output Module ensures full fault coverage even if the commanded state of the points never changes. On this type of module, the output signal transition normally occurs during OVD execution, but is guaranteed to be less than 2.0 milliseconds (500 microseconds is typical) and is transparent to most field devices. If required by the controlled process, OVD can be disabled, however it must be periodically cycled to both the On and Off states to ensure 100 percent fault coverage.

Relay Output Modules

Relay Output (RO) Modules are non-triplicated modules for use on non-critical points which are not compatible with *high-side* solid-state output switches, such as annunciator panels. Relay Output Modules receive output signals from the Main Processors on each of three channels. The three sets of signals are then voted, and the voted data is used to drive the 32 individual relays. Each output has a loopback circuit which verifies the operation of each relay switch independently of the presence of a load. Ongoing diagnostics test the operational status of the RO Module, which is not intended for use on critical points or switching of field loads.

Supervised Digital Output Modules

Supervised Digital Output (SDO) Modules provide both voltage and current loopback, allowing complete fault coverage for both energized-to-trip and de-energized-to-trip conditions. SDO modules supervise the field circuit so these field faults can be detected: loss of power or blown fuse, open or missing load, field short resulting in the load being energized in error, and shorted load in the de-energized state. Any loss of field load is annunciated by the module.

115 VAC Digital Output Modules

This figure is a simplified schematic for models 3601E and 3601T, which are TMR Digital Output Modules.

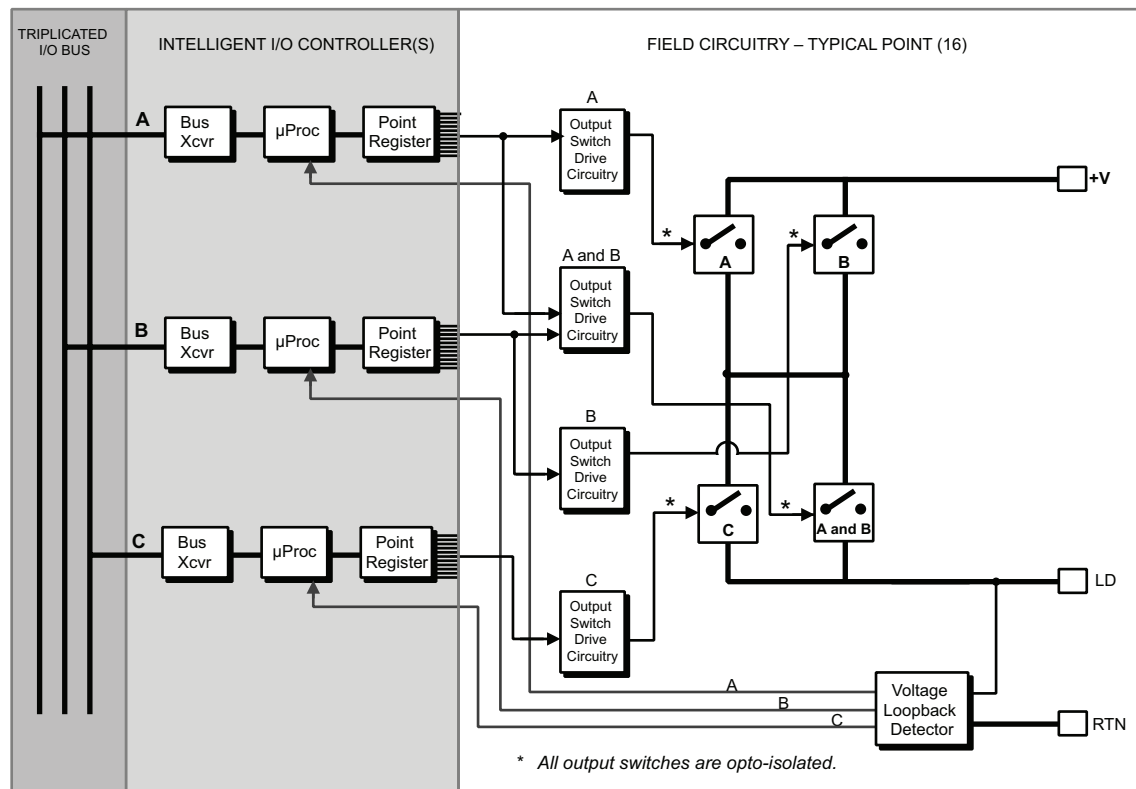


Figure 36 3601E and 3601T Simplified Schematic

This figure shows the front panels of models 3601E and 3601T.

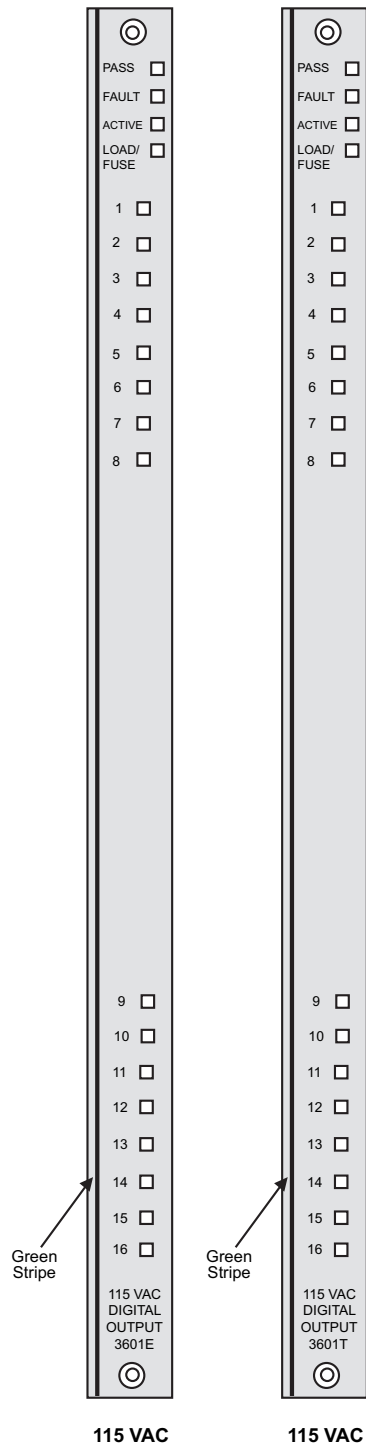


Figure 37 3601E and 3601T Front Panels

3601E and 3601T Specifications

This table lists the specifications for models 3601E and 3601T, which are 16-point, opto-isolated TMR Digital Output Modules with an nominal voltage of 115 VAC. Model 3601T has a higher point-isolation minimum.

Table 31 3601E and 3601T Digital Output Specifications

Feature	Specification
Color code	Green
Number of output signals	16, non-commoned
Input frequency range	47-63 Hz
Voltage range	80-155 VAC
Logic power	< 10 watts
Current ratings, maximum	2 amps/point, 12 amps surge/cycle
Leakage current to load @ 60 Hz	2 mA maximum @ 60 Hz
Leakage current to chassis @ 60 Hz	4 mA maximum @ 60 Hz
Fuses (on field termination module)	1 per output, 3 amps, fast-acting
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Load/fuse
Point isolation: 3601E	1000 VAC minimum, 1500 VDC minimum
Point isolation: 3601T	1780 VAC minimum, 2500 VDC minimum
Output diagnostic fault coverage ² : Maximum output toggle rate	Every 100 ms plus one scan
Output diagnostic fault coverage ² : Minimum output toggle rate	Every 3 months
Diagnostic glitch duration ³	1/2 AC cycle maximum
On-state voltage drop: At backplane	< 2 VAC typical @ 100mA < 3 VAC maximum @ 2A
On-state voltage drop: With external termination, 10-foot cable	< 3 VAC typical @ 100mA < 5 VAC maximum @ 2A
On-state voltage drop: With external termination, 99-foot cable	< 4 VAC typical @ 100mA < 11 VAC maximum @ 2A
Inductive kick-back protection (reverse EMF)	Zero-crossing TRIACs

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. Diagnostic glitching can be disabled by using the OVD disable function.

24 to 120 VDC Digital Output Modules

This figure is a simplified schematic for models 3603B, 3603E, 3603T, 3604E, and 3607E, which are TMR Digital Output Modules.

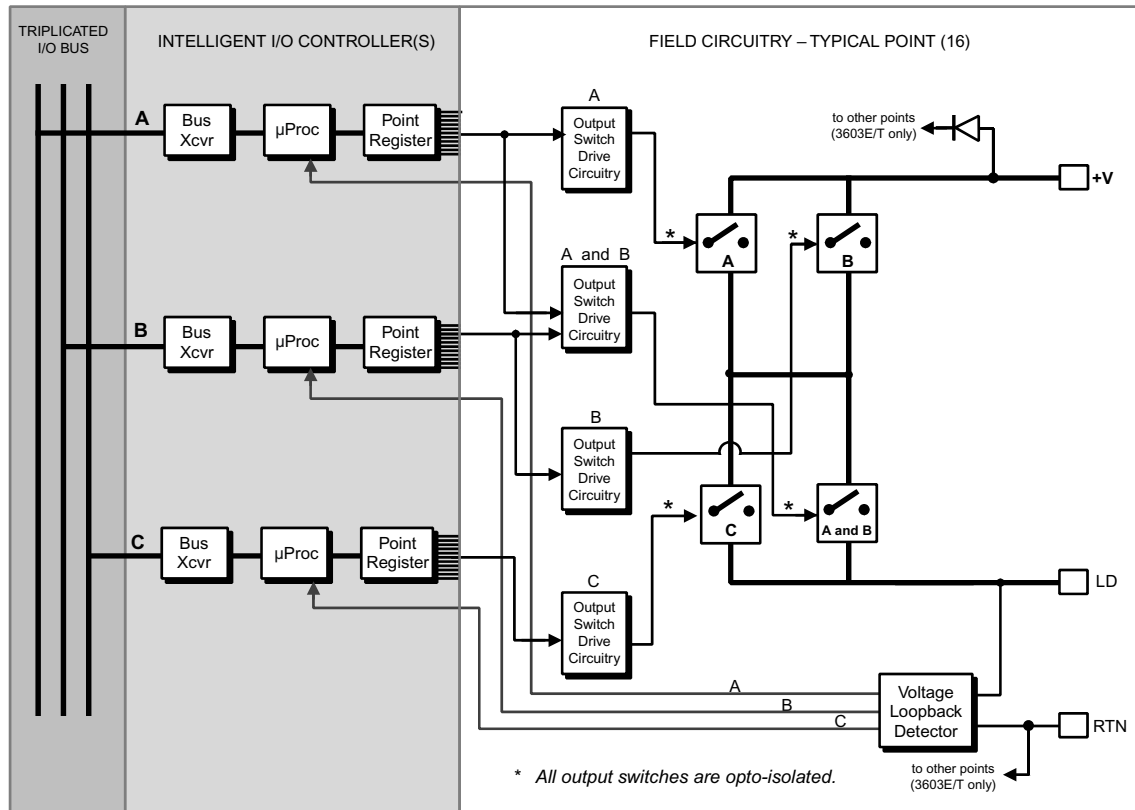


Figure 38 3603B, 3603E, 3603T, 3604E, and 3607E Simplified Schematic

This figure shows the front panels of models 3603B, 3603E, 3603T, 3604E, and 3607E.

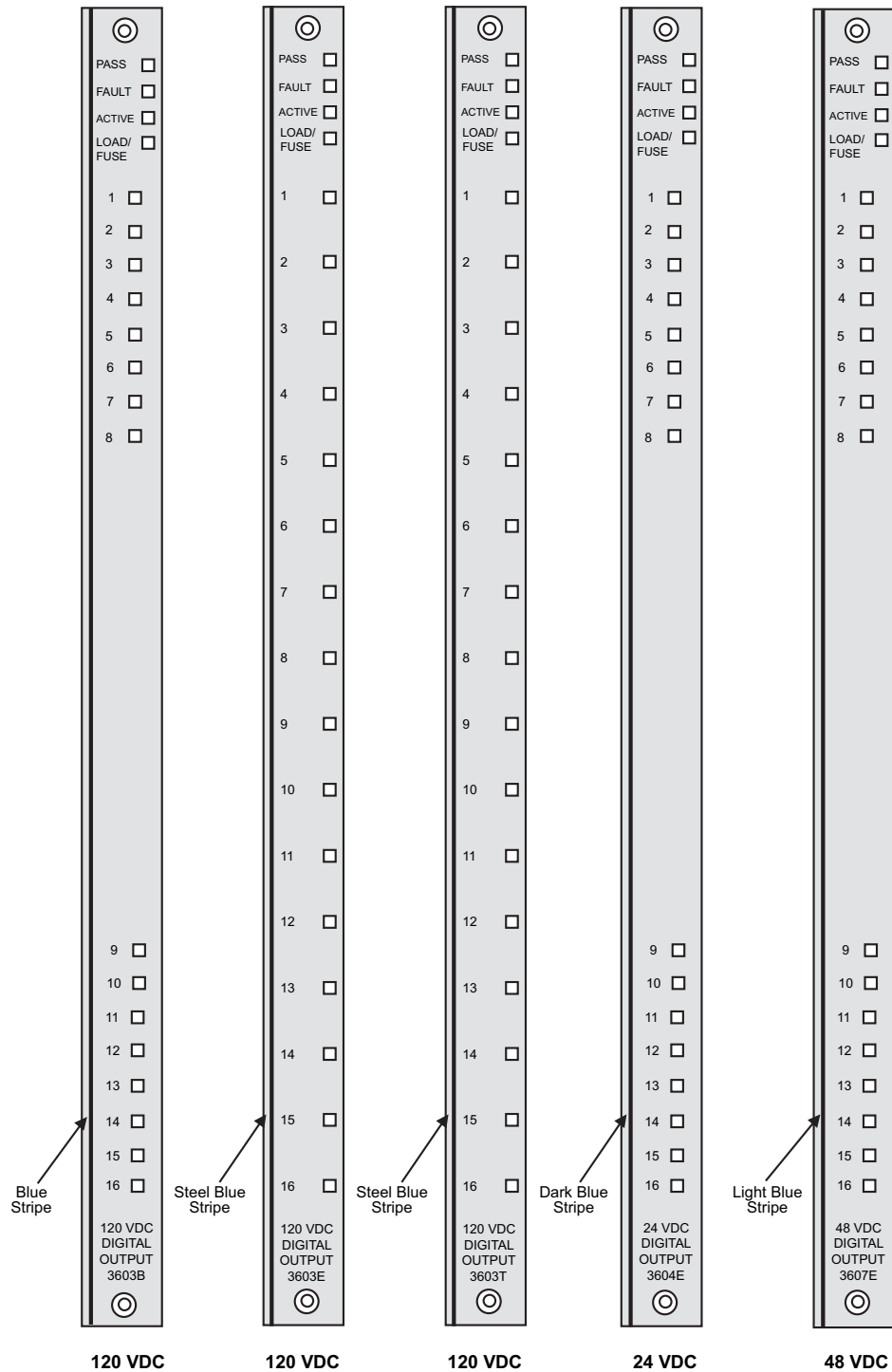


Figure 39 3603B, 3603E, 3603T, 3604E, and 3607E Front Panels

3603B Specifications

This table lists the specifications for model 3603B which is a TMR Digital Output Module with a nominal output voltage of 120 VDC.

CAUTION

Model 3603B, 3603E, and 3603T Digital Output Modules should not be mixed in the same logical slot.

Table 32 3603B Digital Output Specifications

Feature	Specification
Color code	Blue
Number of output signals	16, non- commoned
Minimum load required	20 k Ω , installed as standard on all field termination modules
Voltage range	99–155 VDC
Power module load	< 10 watts
Current ratings, maximum	0.8 amps/point, 4 amps surge/10 ms
Leakage current to load	2 mA, maximum
Fuses, field termination module	1 per output, 1 amp, fast-acting
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Load/Fuse
Point isolation	1000 VDC minimum
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not required
Diagnostic glitch duration ³	2 ms, maximum
On-state voltage drop:	< 0.5 VDC typical @ 250mA
At backplane	< 0.5 VDC maximum @ 1A
On-state voltage drop:	< 2 VDC typical @ 250mA
With external termination, 10-foot cable	< 3 VDC maximum @ 1A
On-state voltage drop:	< 3 VDC typical @ 250mA
With external termination, 99-foot cable	< 6 VDC maximum @ 1A
Inductive kick-back protection (reverse EMF)	Reverse diode on I/O module

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. Diagnostic glitching can be disabled by using the OVD disable function.

3603E and 3603T Specifications

This table lists the specifications for models 3603E and 3603T, which are TMR Digital Output Modules with a nominal voltage of 120 VDC.

CAUTION

Model 3603B, 3603E, and 3603T Digital Output Modules should not be mixed in the same logical slot.

Triconex highly recommends that you perform compatibility testing before selecting the model 3603T module for use in applications that have any of the following:

- field wiring lengths over 328 feet (100 meters)
- cable that is not twisted pair
- atypical loads such as smart devices, strobe lights, or klaxons

Model 3603T may experience Output Voter Diagnostic (OVD) failures when used with a 1600 meter cable and a low-watt solenoid.

Table 33 3603E and 3603T Digital Output Specifications

Feature	Specification
Color code	Steel blue
Number of output signals	16, commoned
Voltage range	90–150 VDC
Maximum voltage	160 VDC
Logic power	< 10 watts
Current ratings, maximum	0.8 amp/point, 4 amps surge/10 ms
Leakage current to load	2 mA, maximum
Fuses (field termination module)	1 per output (1 amp, fast-acting)
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Load/Fuse
Point isolation: 3603E	1500 VDC minimum
Point isolation: 3603T	2500 VDC minimum
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not required
Diagnostic glitch duration ³	2 ms, maximum, 500 μsec, typical
On-state voltage drop:	< 0.5 VDC typical @ 250mA
At backplane	< 0.5 VDC maximum @ 1A

Table 33 3603E and 3603T Digital Output Specifications (continued)

Feature	Specification
On-state voltage drop:	< 1.5 VDC typical @ 250mA
With external termination, 10-foot cable	< 2.5 VDC maximum @ 1A
On-state voltage drop:	< 2.5 VDC typical @ 250mA
With external termination, 99-foot cable	< 5.5 VDC maximum @ 1A
Inductive kick-back protection (reverse EMF)	Reverse diode on I/O module

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. Diagnostic glitching can be disabled by using the OVD disable function.

3604E Specifications

This table lists the specifications for model 3604E, which is a TMR Digital Output Module with a nominal voltage of 24 VDC.

Table 34 3604E Digital Output Specifications

Feature	Specification
Color code	Dark blue
Number of output signals	16, non-commoned
Voltage range	22–45 VDC
Logic power	< 10 watts
Current ratings, maximum	2 amps/point, 10 amps surge/10 ms
Leakage current to load	2 mA, maximum
Fuses (field termination module)	1 per output (2.5 amps fast-acting)
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Load/Fuse
Point isolation	1500 VDC minimum
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not applicable
Diagnostic glitch duration ³	2 ms maximum, 500 μ s typical
On-state voltage drop:	< 3 VDC typical @ 500mA
At backplane	< 3 VDC maximum @ 2A

Table 34 3604E Digital Output Specifications (continued)

Feature	Specification
On-state voltage drop:	< 4 VDC typical @ 500mA
With external termination, 10-foot cable	< 5 VDC maximum @ 2A
On-state voltage drop:	< 6 VDC typical @ 500mA
With external termination, 99-foot cable	< 11 VDC maximum @ 2A
Inductive kick-back protection (reverse EMF)	Reverse diode on I/O module

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. Diagnostic glitching can be disabled by using the OVD disable function.

3607E Specifications

This table lists the specifications for model 3607E, which is TMR Digital Output Module with a nominal voltage of 48 VDC.

Table 35 3607E Digital Output Specifications

Feature	Specification
Color code	Light blue
Number of output signals	16, non-commoned
Voltage range	44–80 VDC
Logic power	< 10 watts
Current ratings, maximum	1 amp/ point, 5 amps surge/10 ms
Leakage current to load	2 mA, maximum
Fuses (field termination module)	1 per output (1.25 amps fast-acting)
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Load/Fuse
Point isolation	1500 VDC minimum
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 100 ms
Minimum output toggle rate	Not applicable
Diagnostic glitch duration ³	2 ms maximum, 500 μ s typical
On-state voltage drop:	< 2 VDC typical @ 250mA
At backplane	< 3 VDC maximum @ 1A
On-state voltage drop:	< 3 VDC typical @ 250mA
With external termination, 10-foot cable	< 4 VDC maximum @ 1A

Table 35 3607E Digital Output Specifications (continued)

Feature	Specification
On-state voltage drop:	< 4 VDC typical @ 250mA
With external termination, 99-foot cable	< 7 VDC maximum @ 1A
Inductive kick-back protection (reverse EMF)	Reverse diode on I/O module

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. Diagnostic glitching can be disabled by using the OVD disable function.

24 to 120 VDC Supervised Digital Output Modules

This figure is a simplified schematic for models 3623, 3623T, and 3624, which are TMR Supervised Digital Output Modules.

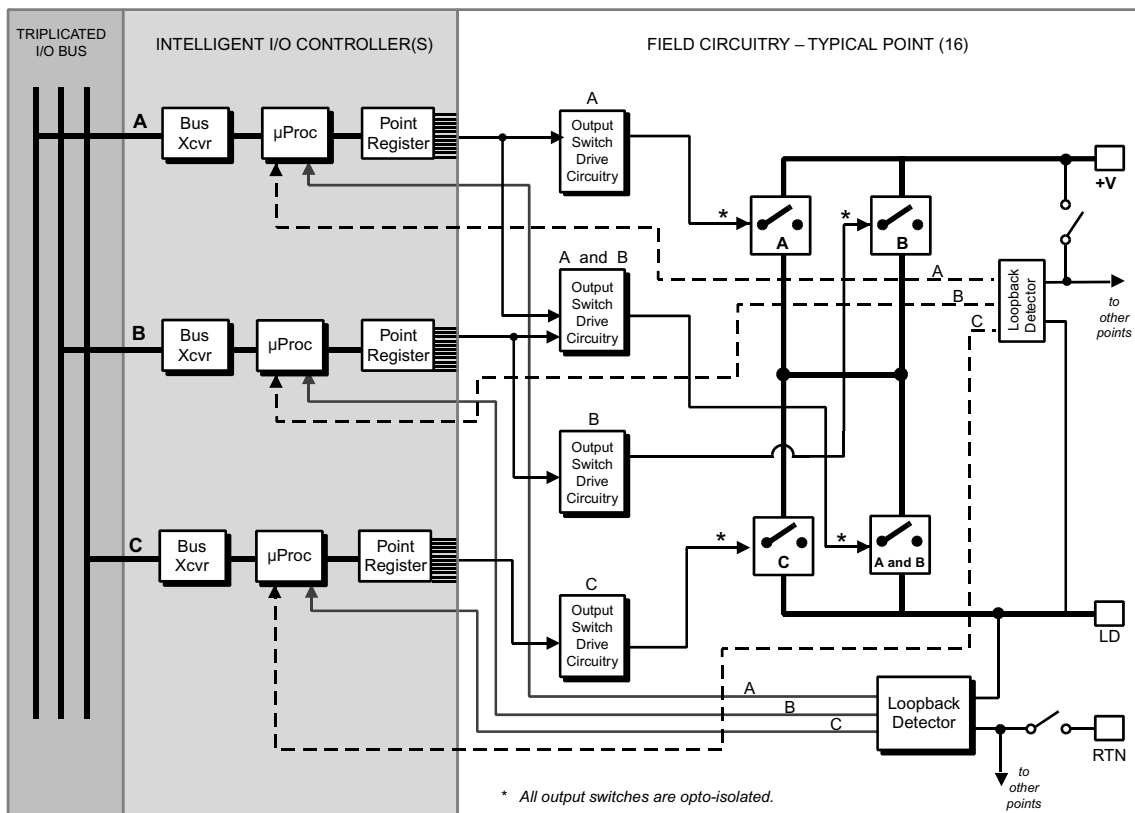


Figure 40 3623, 3623T, and 3624 Simplified Schematic

This figure shows the front panels of models 3623, 3623T, and 3624.

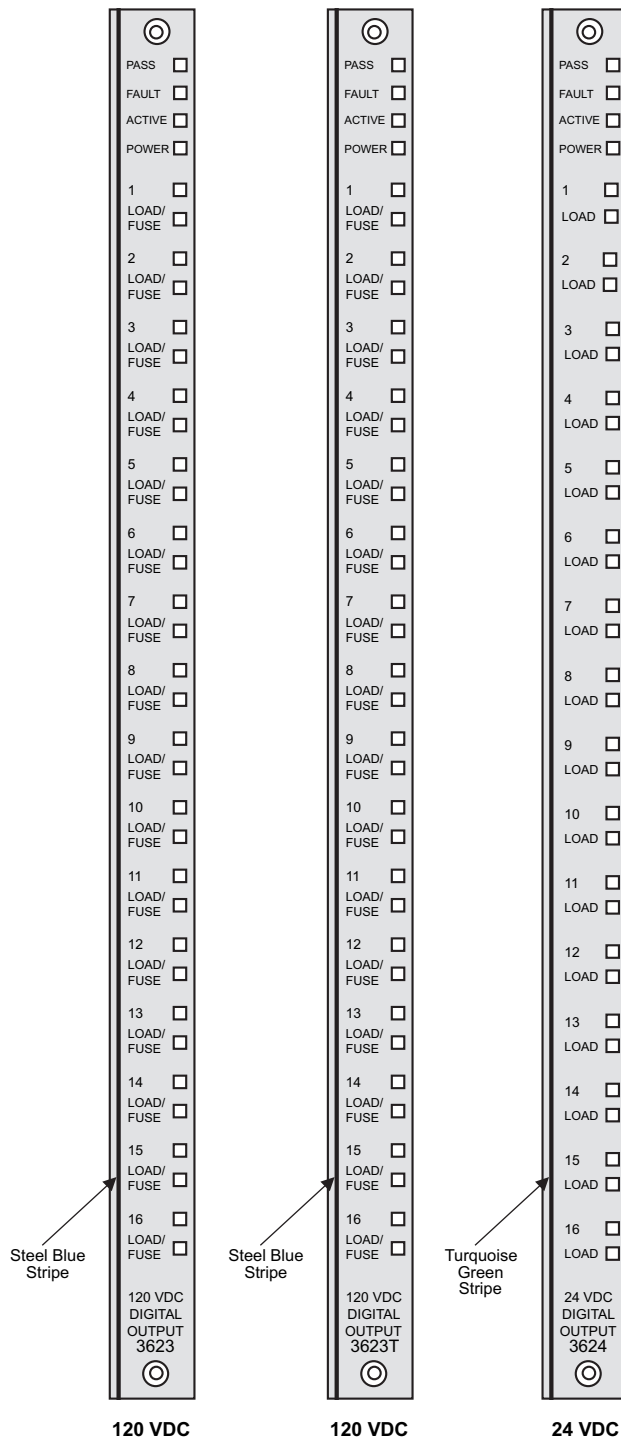


Figure 41 3623, 3623T, and 3624 Front Panels

Note The Model 3623, 3623T, and 3624 modules will not assert point LEDs for both primary and spare modules. Only the primary module will assert point LEDs.

3623 and 3623T Specifications

This table lists the specifications for models 3623 and 3623T, which are TMR Supervised Digital Output Modules with a nominal voltage of 120 VDC. Model 3623 has a point isolation of 1,500 VDC; model 3623T has a point isolation of 2,500 VDC.

CAUTION

Triconex highly recommends that you perform compatibility testing before selecting the model 3623T module for use in applications that have any of the following:

- field wiring lengths over 328 feet (100 meters)
- cable that is not twisted pair
- atypical loads such as smart devices, strobe lights, or klaxons

Table 36 3623 and 3623T Supervised Digital Output Specifications

Feature	Specification
Color code	Steel blue
Number of output signals	16, commoned
Recommended voltage range	90–150 VDC
Maximum voltage	160 VDC
Logic power	< 10 watts
Current ratings, maximum	0.8 amps/point, 4 amps surge/10 ms
Minimum required load	30 mA
Leakage current to load	4 mA, maximum
Fuses (field termination)	1 per output (1 amp, fast-acting)
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Power, Load/Fuse (1 Per Point)
Point isolation: 3623	1500 VDC minimum
Point isolation: 3623T	2500 VDC minimum
Short-circuit detection threshold in Off state	< 24 Ω
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 100 ms
Minimum output toggle rate	Not applicable
Diagnostic glitch duration ³	2 ms maximum, 500 μ sec typical
On-state voltage drop:	< 1.0 VDC typical @ 250mA
At backplane	< 1.0 VDC maximum @ 1A
On-state voltage drop:	< 2.0 VDC typical @ 250mA
With external termination, 10-foot cable	< 2.5 VDC maximum @ 1A

Table 36 3623 and 3623T Supervised Digital Output Specifications (*continued*)

Feature	Specification
On-state voltage drop:	< 2.5 VDC typical @ 250mA
With external termination, 99-foot cable	< 6.0 VDC maximum @ 1A
Inductive kick-back protection (reverse EMF)	Reverse diode on I/O module

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. OVD glitching cannot be disabled.

3624 Specifications

This table lists the specifications for model 3624, which is a TMR Supervised Digital Output Module with a nominal voltage of 24 VDC.

Table 37 3624 Supervised Digital Output Specifications

Feature	Specification
Color code	Turquoise green
Number of output signals	16, commoned
Recommended voltage range	16–30 VDC
Maximum voltage	36 VDC
Logic power	< 10 watts
Current ratings, maximum	0.7 amps/point, 4.8 amps surge/10 ms
Minimum required load	30 mA
Leakage current to load	4 mA, maximum
Fuses (field termination)	Not required; output switches are self-protected against over-voltage, over-temperature, and over-current
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Power, Load (1 per point)
Point isolation	1500 VDC minimum
Short-circuit detection threshold in Off state	< 5 Ω
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not required
Diagnostic glitch duration ³	2 ms maximum, 500 μ s typical

Table 37 3624 Supervised Digital Output Specifications (continued)

Feature	Specification
On-state voltage drop: At backplane	< 1.0 VDC typical @ 500mA < 1.0 VDC @ 1A
On-state voltage drop: With external termination, 10-foot cable	< 2.0 VDC typical @ 500mA < 2.5 VDC @ 1A
On-state voltage drop: With external termination, 99-foot cable	< 2.5 VDC typical @ 500mA < 6.0 VDC @ 1A
Inductive kick-back protection (reverse EMF)	Reverse diode on I/O module

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
3. OVD glitching cannot be disabled.

115 VAC Supervised Digital Output Modules

This figure is a simplified schematic for model 3611E, which is a TMR Digital Output Module with a nominal voltage range of 115 VAC.

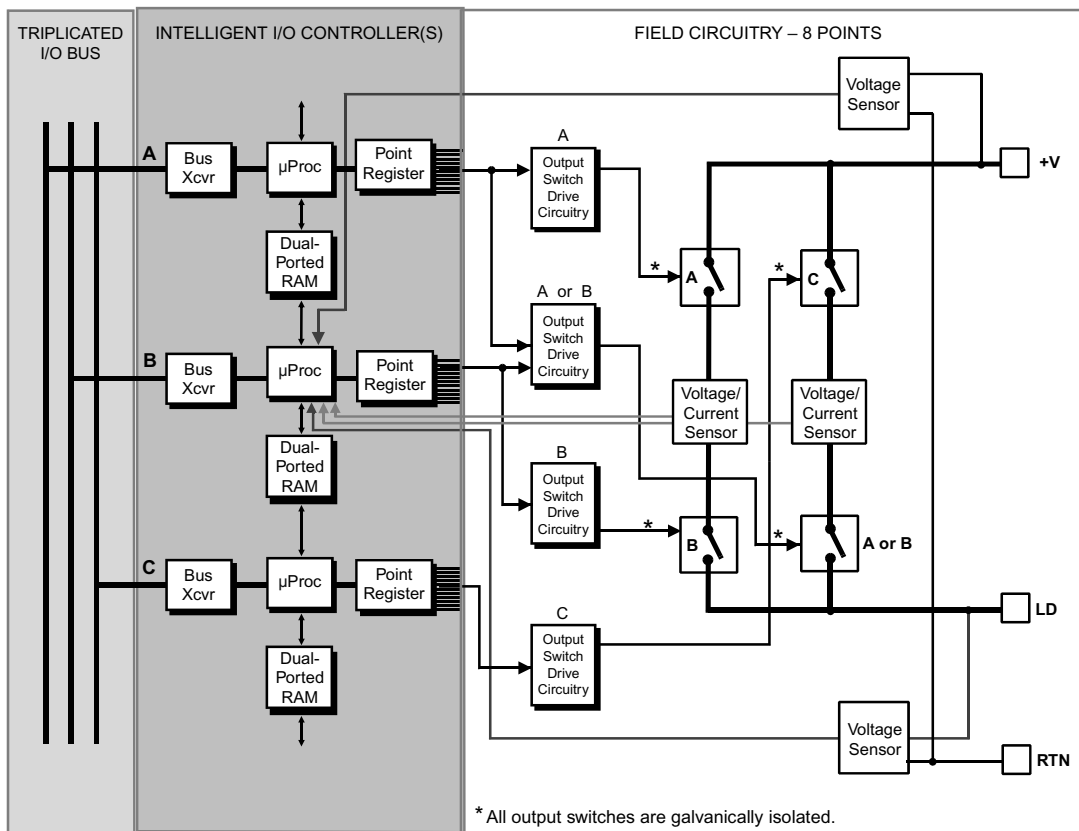


Figure 42 3611E Simplified Schematic

This figure shows the front panel of model 3611E.

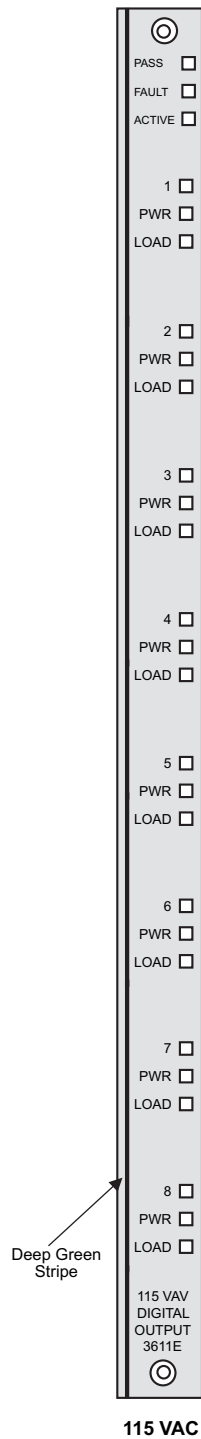


Figure 43 3611E Front Panel

3611E Specifications

This table lists the specifications for model 3611E, which is a TMR Digital Output Module with a nominal voltage of 115 VDC.

Switching Power

When switching reactive loads, you should de-rate the switching power of the outputs to 25 percent of maximum, which is 500 VAC applications. This restriction does not apply to inductive loads because all supervised digital outputs are protected against inductive kick-back (reverse EMF).

When switching incandescent lamps, the inrush current can be 10 to 15 times the rated nominal load current of the lamp. The inrush current must be used when calculating the required output switching power. For detailed specifications regarding inrush amplitude and duration, contact the lamp manufacturer.

Table 38 3611E Digital Output Specifications

Feature	Specification
Color code	Deep green
Number of output signals	8, commoned
Input frequency range	47-63 Hz
Voltage range	90-155 VAC
Carry current ratings, maximum	2 amps/point, 10 amps surge/ 1 AC cycle
Switching power, maximum See Switching Power on page 104	2000 VA (resistive)
Maximum output cycle rate	< 20 cycles per second
Expected life at maximum rated load	> 10,000 cycles
Minimum required load ¹	50 mA
Leakage current to load (Off state)	4 mA maximum
Leakage current to chassis @ 60 Hz	1 mA maximum
Fuses (on field termination module)	1 per output (2.5 amps fast-acting)
Status indicator: On or Off state per point	Point
Status indicator: Power alarm per point	Power
Status indicator: Load alarm per point	Load
Status indicator: Module status	Pass, Fault, Active
Point isolation	1500 VDC minimum
Logic power	< 15 watts
Shorted load detection in Off state	Not applicable

Table 38 3611E Digital Output Specifications (*continued*)

Feature	Specification
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not applicable
Diagnostic glitch duration	Not applicable
On-state voltage drop:	< 2 VAC typical @ 100m
With external termination, 10-foot cable	< 6 VAC maximum @ 2A
On-state voltage drop:	< 3 VAC typical @ 100m
With external termination, 99-foot cable	< 12 VAC maximum @ 2A
Inductive kick-back protection (reverse EMF)	Tranzorb on termination panel

1. Proper operation of this module can be assured only if all installation guidelines and restrictions are observed. For more information, see Application Note 8, *Supervised Digital Output Modules* available from the IPS Global Client Support (GCS) center.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.

28–120 VDC Supervised Digital Output Modules

This figure is a simplified schematic for 8-point TMR Supervised Digital Output Modules.

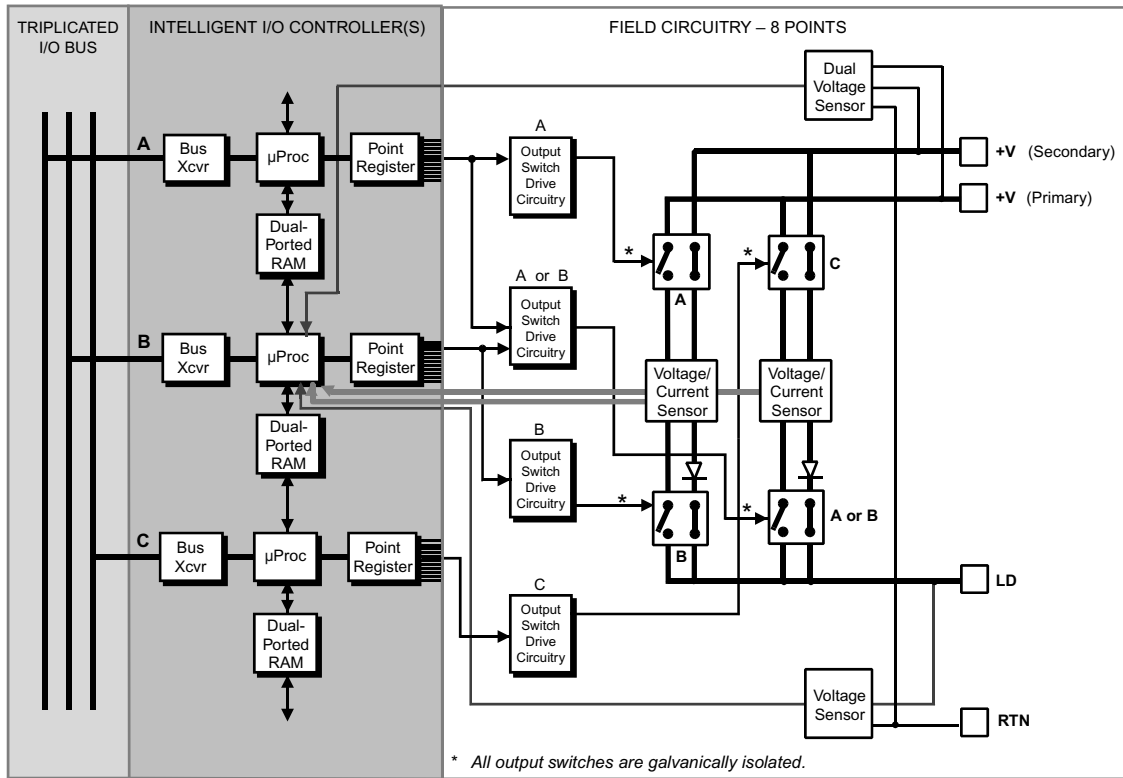


Figure 44 3613E, 3614E, 3615E, and 3617E Simplified Schematic

This figure shows the front panels of models 3613E, 3614E, 3615E, and 3617E.

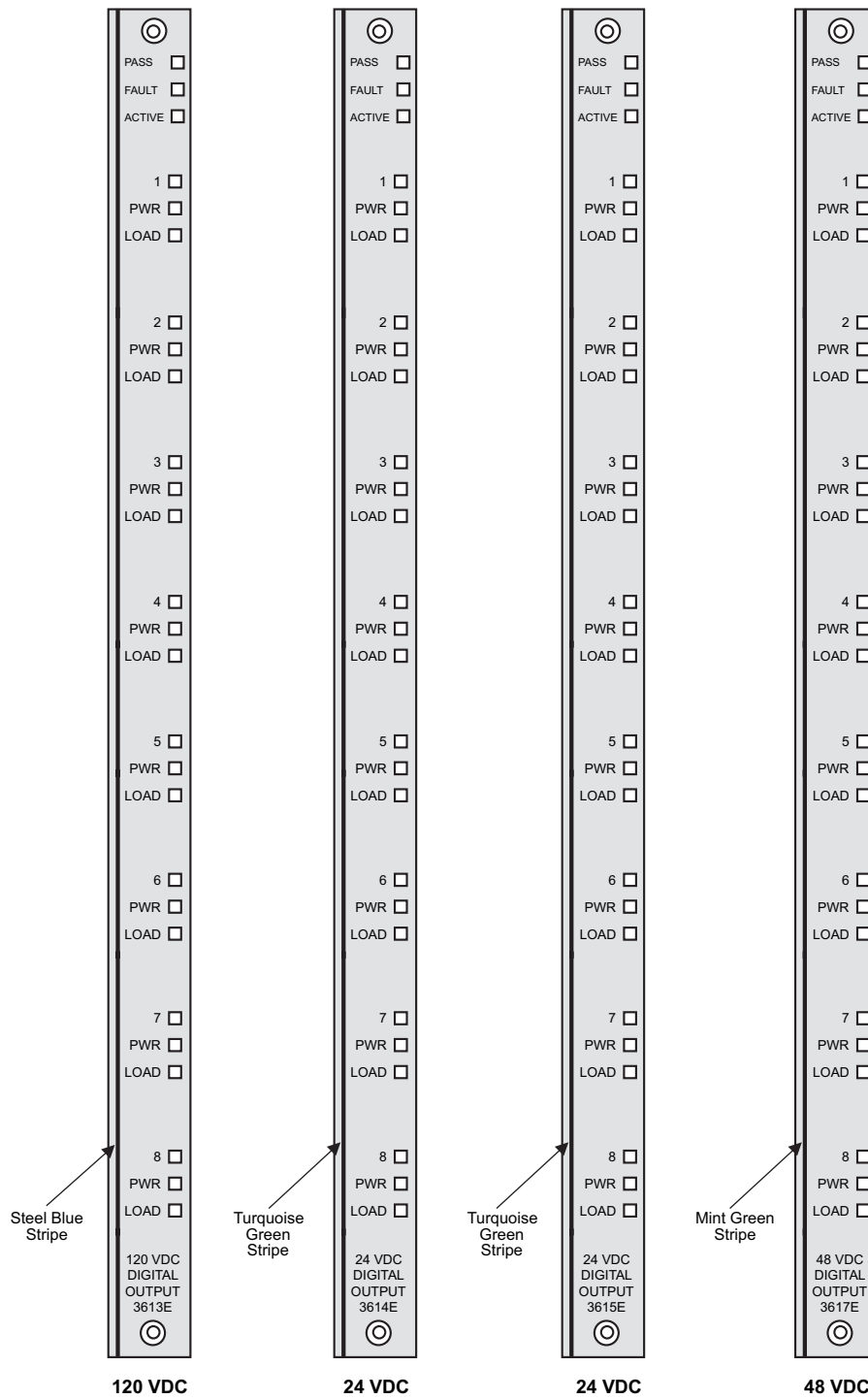


Figure 45 3613E, 3614E, 3615E, and 3617E Front Panels

3613E Specifications

This table lists the specifications for model 3613E, which is a TMR Supervised Digital Output Module with a nominal range of 120 VDC.

Switching Power

When switching reactive loads, you should de-rate the switching power of the outputs to 25 percent of maximum, which is 37.5 watts for DC applications. When switching incandescent lamps, the inrush current can be 10 to 15 times the rated nominal load current of the lamp. For detailed specifications regarding inrush amplitude and duration, contact the lamp manufacturer. The inrush current must be used when calculating the required output switching power.

Table 39 3613E Supervised Digital Output Specifications

Feature	Specification
Color code	Steel blue
Number of output signals	8, commoned
Voltage range	90 to 155 VDC
Carry current ratings, maximum	0.5 amps/ point, 4 amps surge/10 ms
Switching power, maximum See Switching Power on page 108	150 watts (resistive)
Maximum output cycle rate	< 20 cycles per second
Expected life at maximum rated load	> 10,000 cycles
Minimum required load ¹	50 mA
Leakage current to load (Off state without secondary power supply)	4 mA maximum
Primary fuse on field termination module (2 per output)	1.0 amp, fast-acting
Secondary fuse on field termination module (2 per output)	0.125 amp, fast-acting
Status indicator: On or Off state per point	Point
Status indicator: Power alarm per point	Power
Status indicator: Load alarm per point	Load
Status indicator: Module status	Pass, Fault, Active
Point isolation	1500 VDC, minimum
Logic power	< 15 watts
Short-circuit detection threshold in Off state ²	< 24 Ω , with installation of secondary field power supply
Voltage range of secondary power supply	5.00 VDC \pm 0.25 VDC
Current range of secondary power supply	3 amps minimum

Table 39 3613E Supervised Digital Output Specifications (*continued*)

Feature	Specification
Output diagnostic fault coverage ³ :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not applicable
On-state voltage drop:	< 2 VDC typical @ 100mA
With external termination, 10-foot cable	< 4 VDC maximum @ 0.5A
On-state voltage drop:	< 3 VDC typical @ 100mA
With external termination, 99-foot cable	< 6 VDC maximum @ 0.5A
Inductive kick-back protection (reverse EMF)	Reverse diode on termination panel

1. Proper operation of this module can be assured only if all installation guidelines and restrictions are observed. For more information, see Application Note 8, *Supervised Digital Output Modules* available from the IPS Global Client Support (GCS) center.
2. To select short-circuit detection for an SDO module, a module name which includes the abbreviation SCD must be included in the hardware configuration in the TriStation project.
3. The maximum output toggle rate allows proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.

3614E Specifications

This table lists the specifications for model 3614E, which is a TMR Supervised Digital Output Module with a nominal range of 24 VDC.

Note The model 3614E is not recommended for use with shunt-diode intrinsic safety barriers. For these applications, Triconex recommends the model 3615E.

Switching Power

When switching reactive loads, you should de-rate the switching power of the outputs to 25 percent of maximum, which is 37.5 watts for DC applications. When switching incandescent lamps, the inrush current can be 10 to 15 times the rated nominal load current of the lamp. For detailed specifications regarding inrush amplitude and duration, contact the lamp manufacturer. The inrush current must be used when calculating the required output switching power.

Table 40 3614E Supervised Digital Output Specifications

Feature	Specification
Color code	Turquoise green
Number of output signals	8, commoned
Voltage range	20 to 36 VDC
Carry current ratings, maximum	0.5 amps/point, 4 amps surge/10 ms
Switching power, maximum	150 watts (resistive)
See Switching Power on page 109	

Table 40 3614E Supervised Digital Output Specifications (*continued*)

Feature	Specification
Maximum output cycle rate	< 20 cycles per second
Expected life at maximum rated load	> 10,000 cycles
Minimum required load ¹	50 mA
Leakage current to load (Off state, without secondary power supply)	4 mA maximum
Primary fuse on field termination module (2 per output)	0.5 amp, fast-acting
Secondary fuse on field termination module (2 per output)	0.125 amp, fast-acting
Status indicator: On or Off state per point	Point
Status indicator: Power alarm per point	Power
Status indicator: Load alarm per point	Load
Status indicator: Module status	Pass, Fault, Active
Point isolation	1500 VDC, minimum
Logic power	< 15 watts
Short-circuit detection in Off state ²	< 24 Ω , with installation of secondary field power supply
Voltage range of secondary power supply ²	5.00 VDC \pm 0.25 VDC
Current range of secondary power supply	3 amps, minimum
Output diagnostic fault coverage ³ :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not applicable
On-state voltage drop:	< 2 VDC typical @ 100mA
With external termination, 10-foot cable	< 4 VDC maximum @ 0.5A
On-state voltage drop:	< 3 VDC typical @ 100mA
With external termination, 99-foot cable	< 6 VDC maximum @ 0.5A
Inductive kick-back protection (reverse EMF)	Reverse diode on termination panel

1. Proper operation of this module can be assured only if all installation guidelines and restrictions are observed. For more information, see Application Note 8, *Supervised Digital Output Modules* available on the IPS Global Client Support Web Site at <http://support.ips.invensys.com>.
2. To select short-circuit detection for an SDO module, you must select a module name which includes the abbreviation "SCD" in the hardware configuration for the TriStation project.
3. The maximum output toggle rate allows proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.

3615E Specifications

This table lists the specifications for model 3615E, which is a low-power TMR Supervised Digital Output Module with a nominal range of 24 VDC.

Switching Power

When switching reactive loads, you should de-rate the switching power of the outputs to 25 percent of maximum, which is 37.5 watts for DC applications. When switching incandescent lamps, the inrush current can be 10 to 15 times the rated nominal load current of the lamp. For detailed specifications regarding inrush amplitude and duration, contact the lamp manufacturer. The inrush current must be used when calculating the required output switching power.

Table 41 3615E Supervised Digital Output Specifications

Feature	Specification
Color code	Turquoise green
Number of output signals	8, commoned
Voltage range	20–36 VDC
Carry current ratings, maximum	0.1 amp/point, 2 amps surge/10 ms
Switching power, maximum See Switching Power on page 111	150 watts (resistive)
Maximum output cycle rate	< 20 cycles per second
Expected life at maximum rated load	> 10,000 cycles
Minimum required load ¹	10 mA
Leakage current to load (Off state, without secondary power supply)	4 mA maximum
Primary fuse on field termination module (2 per output)	0.5 amp, fast-acting
Secondary fuse on field termination module (2 per output)	0.125 amp, fast-acting
Status indicator: On or Off state per point	Point
Status indicator: Power alarm per point	Power
Status indicator: Load alarm per point	Load
Status indicator: Module status	Pass, Fault, Active
Point isolation	1500 VDC, minimum
Logic power	< 15 watts
Short-circuit detection threshold in Off state ²	< 24 Ω , with installation of secondary field power supply
Voltage range of secondary power supply ²	5.00 VDC \pm 0.25 VDC
Current range of secondary power supply	3 amp minimum

Table 41 3615E Supervised Digital Output Specifications (continued)

Feature	Specification
Output diagnostic fault coverage ³ :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not applicable
On-state voltage drop:	< 1 VDC typical @ 30mA
With external termination, 10-foot cable	< 3 VDC maximum @ 100mA
On-state voltage drop:	< 1 VDC typical @ 30mA
With external termination, 99-foot cable	< 4 VDC maximum @ 100mA
Inductive kick-back protection (reverse EMF)	Reverse diode on termination panel

1. Proper operation of this module can be assured only if all installation guidelines and restrictions are observed. For more information, see Application Note 8, *Supervised Digital Output Modules* available on the IPS Global Client Support Web Site at <http://support.ips.invensys.com>.
2. To select short-circuit detection for an SDO module, a module name which includes the abbreviation SCD must be included in the hardware configuration in the TriStation project.
3. The maximum output toggle rate allows proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.

3617E Specifications

This table lists the specifications for model 3617E, which is a TMR Supervised Digital Output Module with a nominal range of 48 VDC.

Switching Power

When switching reactive loads, you should de-rate the switching power of the outputs to 25 percent of maximum, which is 37.5 watts for DC applications. When switching incandescent lamps, the inrush current can be 10 to 15 times the rated nominal load current of the lamp. For detailed specifications regarding inrush amplitude and duration, contact the lamp manufacturer. The inrush current must be used when calculating the required output switching power.

Table 42 3617E Supervised Digital Output Specifications

Feature	Specification
Color code	Mint green
Number of output signals	8, commoned
Voltage range	36-72 VDC
Carry current ratings, maximum	1 amp/point, 5 amps/surge 10 ms
Switching power, maximum See Switching Power on page 112	150 watts (resistive)
Maximum output cycle rate	< 20 cycles per second
Expected life at maximum rated load	> 10,000 cycles

Table 42 3617E Supervised Digital Output Specifications (continued)

Feature	Specification
Minimum required load ¹	100 mA
Leakage current to load (Off state, without secondary power supply) ¹	4 mA maximum
Primary fuse on field termination module (2 per output)	1.25 amps, fast-acting
Secondary fuse on field termination module (2 per output)	0.125 amp, fast-acting
Status indicator: On or Off state per point	Point
Status indicator: Power alarm per point	Power
Status indicator: Load alarm per point	Load
Status indicator: Module status	Pass, Fault, Active
Point isolation	1500 VDC, minimum
Logic power	< 15 watts
Short-circuit detection threshold in Off state ²	< 24 Ω , with installation of secondary field power supply
Voltage range of secondary power supply ²	5.00 VDC \pm 0.25 VDC
Current range of secondary power supply	3 amps minimum
Output diagnostic fault coverage ³ :	
Maximum output toggle rate	Every 100 ms
Minimum output toggle rate	Not applicable
Diagnostic glitch duration	Not applicable
On-state voltage drop:	< 2 VDC typical @ 250mA
With external termination, 10-foot cable	< 4 VDC maximum @ 1A
On-state voltage drop:	< 3 VDC typical @ 250mA
With external termination, 99-foot cable	< 7 VDC maximum @ 1A
Inductive kick-back protection (reverse EMF)	Reverse diode on termination panel

1. Proper operation of this module can be assured only if all installation guidelines and restrictions are observed. For more information, see Application Note 8, *Supervised Digital Output Modules* available on the IPS Global Client Support Web Site at <http://support.ips.invensys.com>.
2. To select short-circuit detection for an SDO module, a module name which includes the abbreviation SCD must be included in the hardware configuration in the TriStation project.
3. The maximum output toggle rate allows proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.

24 VDC Supervised or Non-Supervised Digital Output Modules

This figure is a simplified schematic for model 3625, which is a 32-point TMR Supervised or Non-Supervised Digital Output Module with a nominal range of 24 VDC.

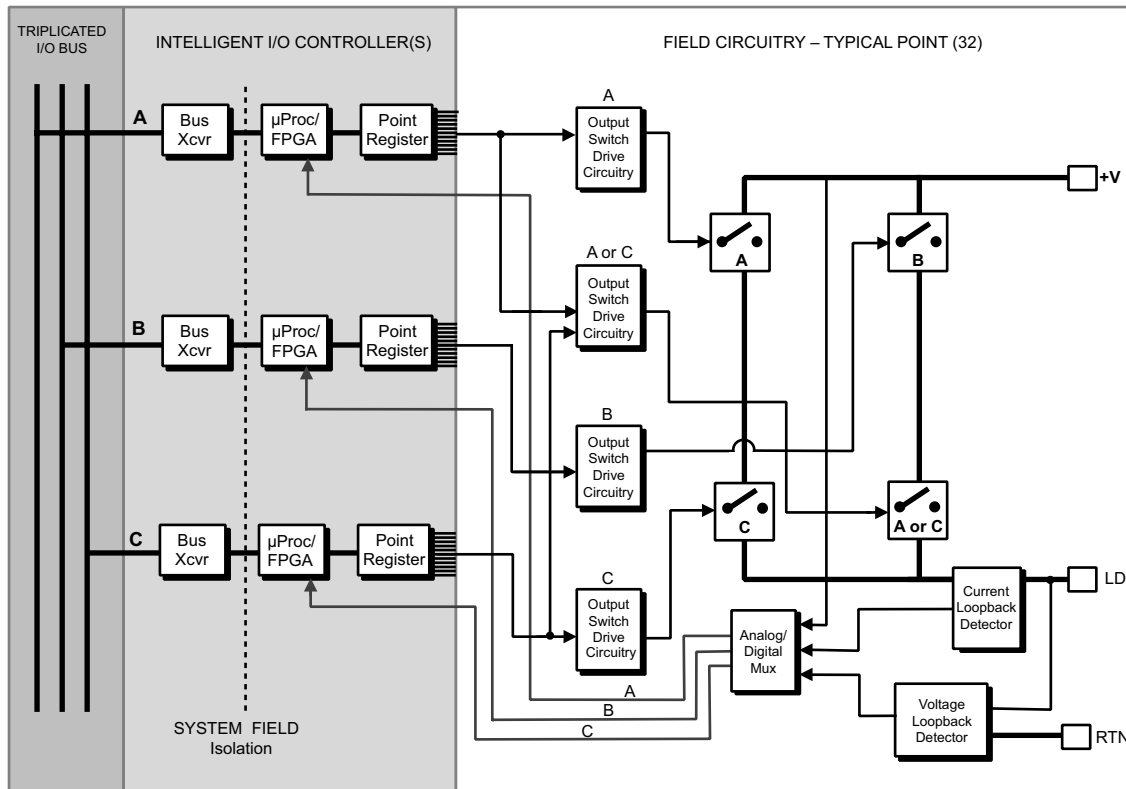


Figure 46 3625 Simplified Schematic

This figure shows the front panel of model 3625.

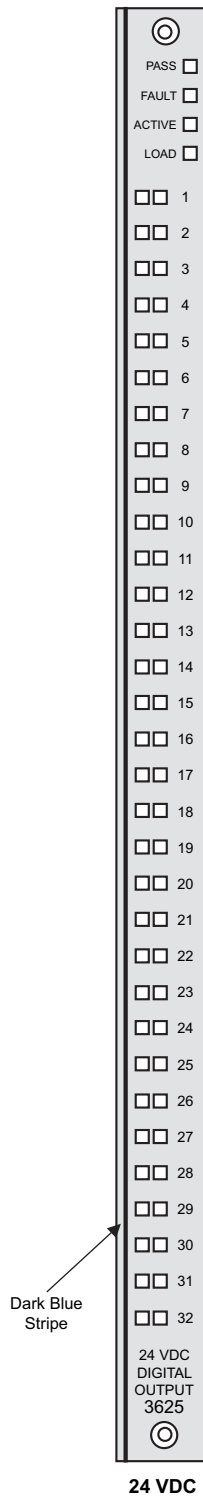


Figure 47 3625 Front Panel

3625 Specifications

This table lists the specifications for model 3625, which is a 32-point TMR Supervised or Non-Supervised Digital Output Module. This module is compatible with 16-point commoned field termination panels, and is intended for energize-to-trip and de-energize-to-trip applications. The 3625 module can be installed only in Tricon v10.2 and later systems.

Table 43 3625 Digital Output Specifications

Feature	Specification
Color code	Dark blue
Number of output signals	32, commoned
Recommended voltage range	16–32 VDC
Nominal voltage	24 VDC
Maximum voltage	36 VDC
Logic power	< 13 watts
Current ratings, maximum	1.70 ± 10% amps/point, 5 amps surge/7 ms
Total module output current (all points)	10 amps/termination panel
Minimum required load	10 mA
Leakage current to load	4 mA, maximum
Fuses (field termination module)	Not required; output switches are self-protected against over-voltage, over-temperature, and over-current
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Load, Active
Status indicator: Field alarm ¹	Load (1 per point)
System-to-field isolation	1500 VDC minimum
Point supervision	Can be programmed per point
Short/Open circuit detection threshold	Programmable per supervised point
Output diagnostic fault coverage ² :	
Maximum output toggle rate	Every 60 ms
Diagnostic glitch duration	2 ms maximum, 200 μs typical
On-state voltage drop:	< 0.25 VDC typical @ 250mA
At backplane	< 1.7 VDC @ 1.7A
On-state voltage drop:	< 1.25 VDC typical @ 250mA
With external termination, 10-foot cable	< 4.7 VDC @ 1.7A
On-state voltage drop:	< 2.25 VDC typical @ 250mA
With external termination, 99-foot cable	< 6.7 VDC @ 1.7A
Inductive kick-back protection (reverse EMF)	Output switches are self-protected

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults.

Note The 3625 can be installed in low-density systems that have been upgraded to v10.2.x or later. For more information, see Appendix I, Low-Density Chassis I/O Module Compatibility in the *Field Terminations Guide for Tricon v9–v10 Systems*.

32-Point Relay Output Modules

This figure is a simplified schematic for models 3636R and 3636T, which are non-triplicated Relay Output Modules.

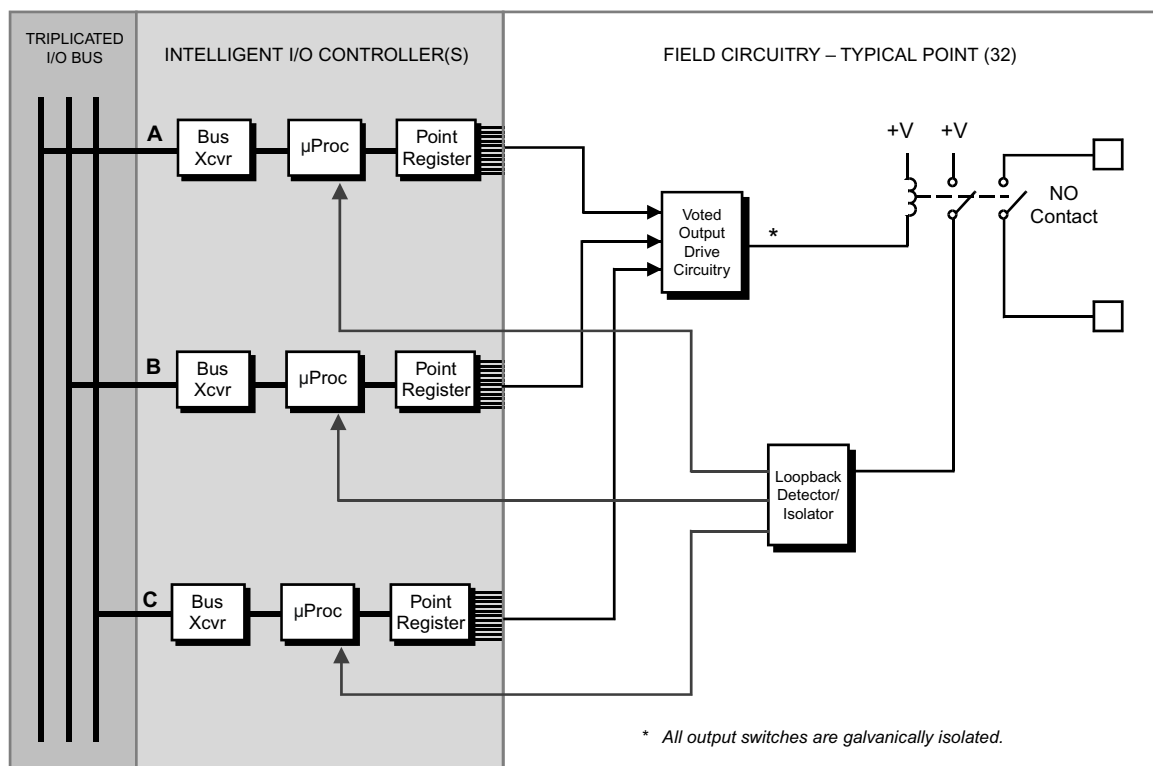


Figure 48 3636R and 3636T Simplified Schematic

This figure shows the front panels of models 3636R and 3636T.

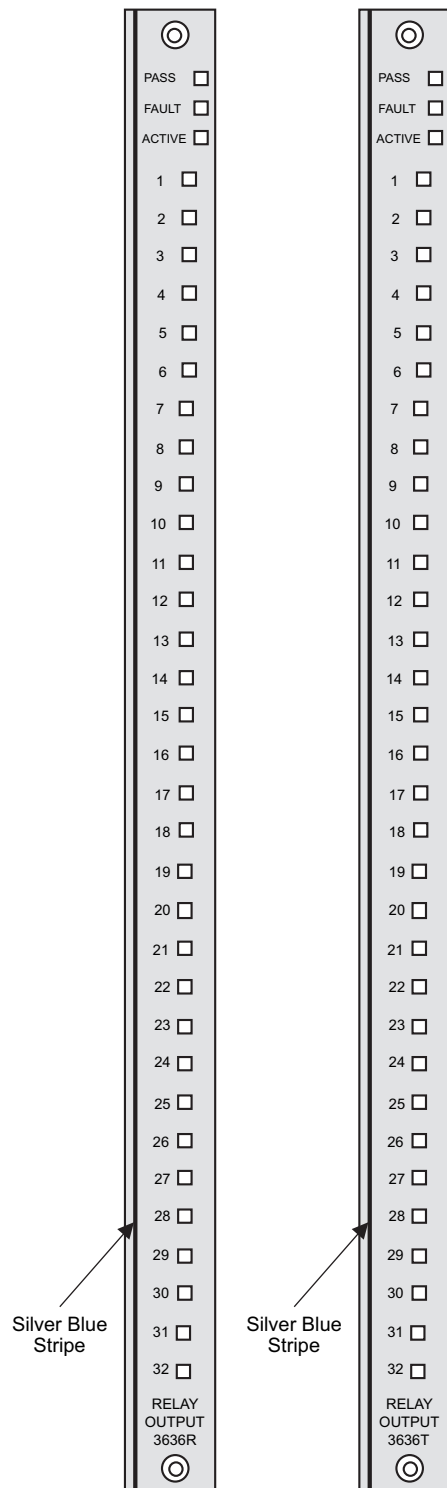


Figure 49 3636R and 3636T Front Panels

Note The Model 3636R and 3636T modules will not assert point LEDs for both primary and spare modules. Only the primary module will assert point LEDs.

3636R and 3636T Specifications

This table lists the specifications for models 3636R and 3636T, which are Non-Triplicated Relay Output Modules. Point isolation varies by model: model 3636R is 1,500 VDC; model 3636T is 2,500 VDC.

Switching Power

When switching reactive loads, you should de-rate the switching power of the outputs to 25 percent of maximum, which is 37.5 watts for DC applications. When switching incandescent lamps, the inrush current can be 10 to 15 times the rated nominal load current of the lamp. For detailed specifications regarding inrush amplitude and duration, contact the lamp manufacturer. The inrush current must be used when calculating the required output switching power.

Table 44 3636R and 3636T Specifications

Feature	Specification
Output contact	NO, normally open
Color code	Silver blue
Number of output points	32, non-commoned
Voltage range	155 VAC/VDC, maximum
Current load	2 amps maximum
Switching power, resistive See Switching Power on page 119	2000 VA, 150 watts maximum
Maximum output cycle rate	< 30 cycles per second
Expected life at maximum rated load	> 10,000 cycles
Fuses	1 per output, 2.5 amps fast-acting
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Point isolation: 3636R	1500 VDC minimum
Point isolation: 3636T	2500 VDC minimum
Logic power: All points Off	< 10 watts
Logic power: All points On	< 20 watts

24 VDC Dual Digital Output Modules

This figure is a simplified schematic for models 3664 and 3674, which are Digital Output Modules.

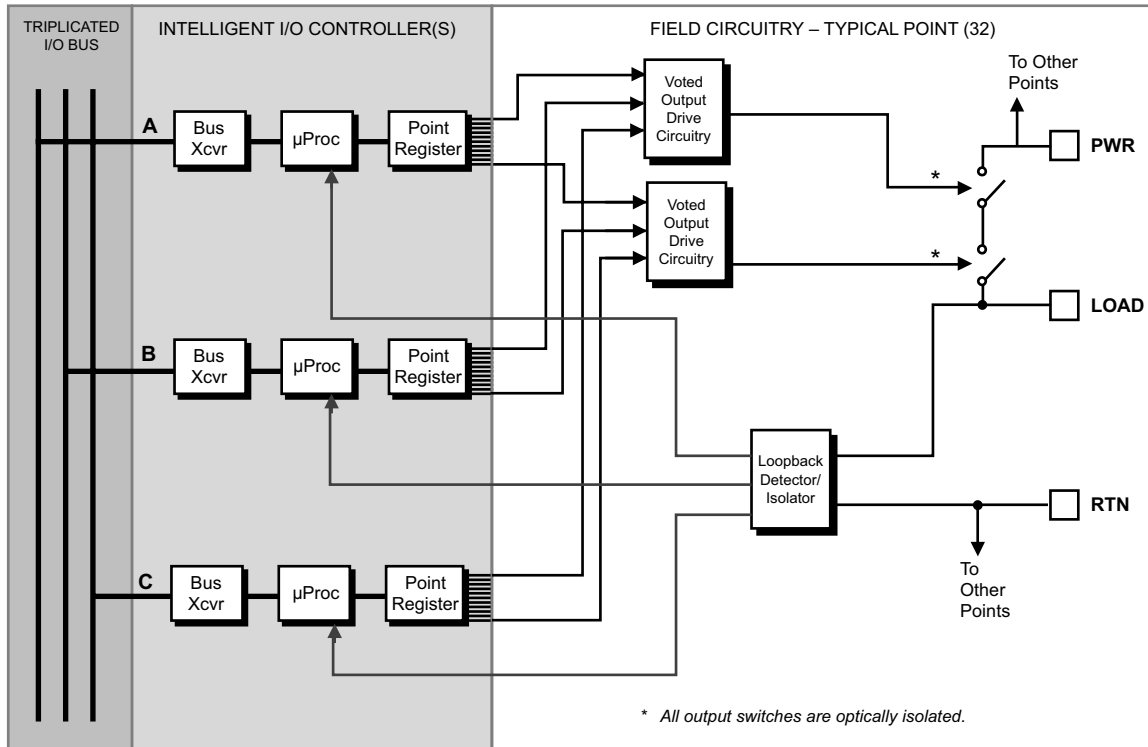


Figure 50 3664 and 3674 Simplified Schematic

This figure shows the front panels of models 3664 and 3674.

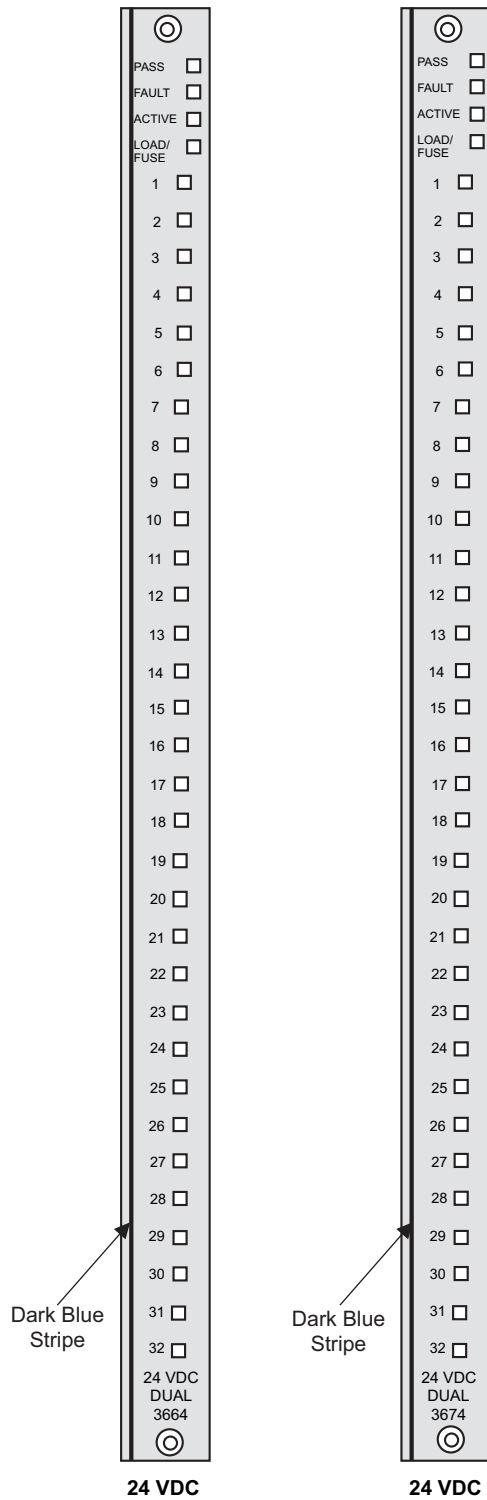


Figure 51 3664 and 3674 Front Panels

3664 and 3674 Specifications

This table lists the specifications for models 3664 and 3674, which are Dual Digital Output Modules with a nominal voltage range of 24 VDC.

Note Models 3664 and 3674 are not recommended for use in energize-to-trip applications because specific hardware faults may cause its outputs to be stuck-Off (de-energized).

Table 45 3664 and 3674 Dual Digital Output Specifications

Feature	Specification
Color code	Dark blue
Number of output signals	32, commoned
Output Configuration	Dual, serial
Recommended voltage range	16–30 VDC
Maximum voltage	36 VDC
Logic power	< 10 watts
Current ratings, maximum	2 amps/point, 10 amps surge/10 ms
Leakage current to load	2 mA, maximum
Fuses (field termination)	Not required; output switches are self-protected against over-voltage, over-temperature, and over-current
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Status indicator: Field alarm ¹	Load/fuse
Point isolation	1500 VDC minimum
Diagnostic glitch duration ²	2 ms maximum, 500 μ s typical
Output diagnostic fault coverage ³ :	
Maximum output toggle rate	Every 100 ms plus one scan
Minimum output toggle rate	Not required
Output behavior under <i>fault</i> conditions ⁴ :	
Output value before fault	Commanded state – On or Off
Output value after stuck-On fault	Commanded state – On or Off
Output value after stuck-Off fault ⁵	Off (de-energized)
Output value after all other faults	Commanded state – On or Off
Output behavior under <i>field fault</i> conditions:	
Load alarm, output stuck-On: (model 3664)	Stuck point On, all others commanded state – On or Off
Load alarm, output stuck-On: (model 3674)	Stuck point On, all others Off (de-energized)

Table 45 3664 and 3674 Dual Digital Output Specifications (*continued*)

Feature	Specification
Load alarm, output stuck-Off: (models 3664 and 3674)	Stuck point Off, all others commanded state – On or Off
On-state voltage drop: At backplane	< 0.5 VDC typical @ 500mA < 0.5 VDC maximum @ 2A
On-state voltage drop: With external termination, 10-foot cable	< 1.5 VDC typical @ 500mA < 2.5 VDC maximum @ 2A
On-state voltage drop: With external termination, 99-foot cable	< 3.5 VDC typical @ 500mA < 8.5 VDC maximum @ 2A
Inductive kick-back protection (reverse EMF)	Output switches are self-protected

1. Power must be supplied to all points, including unused points on non-commoned panels.
2. Diagnostic glitching can be disabled by using the OVD disable function.
3. The maximum output toggle rate enables proper operation of I/O diagnostics and detection of all normally detectable faults. The minimum toggle rate provides fault coverage of normally undetectable faults within 10% of the calculated mean-time-between-faults (MTBF) for the module.
4. The Dual DO module performs a complete set of diagnostics on each output point periodically. All faults are 100% detectable and are independently reported to the Main Processor by each channel. Specific faults in the output circuitry can force the output to the Off (de-energized) state.
5. A stuck-Off fault results in both a Load/Fuse alarm and a fault in the Dual DO Module. If a Load/Fuse alarm is detected by the Dual DO Module, normal switch-over to a hot-spare module is disabled. This action prevents the output from being forced Off by a stuck-Off fault and then forced back On after the switch-over a few seconds later. To allow switch-over to a healthy module, re-seat the spare module.

Pulse Input Modules

This section describes the Pulse Input Modules available for use with Tricon v9–v10 systems. For important operational restrictions, see [Pulse Input Installation and Operation on page 192](#).

Table 46 Pulse Input Modules

Model	Points	Type	Module Description
3510	8	TMR	Pulse Input
3511	8	TMR	Pulse Input

Pulse Input Modules provide eight very sensitive, high-frequency inputs, which are used with non-amplified magnetic speed sensors common on rotating equipment such as turbines or compressors. The module senses voltage transitions from magnetic transducer input devices. The transitions are accumulated during a selected window of time (rate measurement), and the resulting count is used to generate a frequency or RPM which is transmitted to the Main Processors. The pulse count is measured to 1 microsecond resolution.

The type of speed sensor typically used with the Pulse Input Module consists of an inductive coil and rotating teeth. The sensor is physically close to the teeth of a gear on the rotating shaft. As the shaft rotates and the teeth move past the sensor, the resulting change in the magnetic field causes a sinusoidal signal to be induced in the sensor. The magnitude of the output voltage depends on how fast the teeth pass the sensor, the distance between the sensor and the teeth, and the construction of the sensor. A typical gear has 30 to 120 teeth spaced at equal distances around its perimeter. The output frequency is proportional to the rotational speed of the shaft and the number of teeth.

CAUTION

Pulse Input Modules use fully differential, input-signal-conditioning circuitry which are AC-coupled and of high bandwidth. The circuitry is designed for high-frequency operation and is sensitive to any type of waveform distortion which could result in erroneous measurements. The modules count transitions by examining only one edge of each pulse, which means that ringing on the input signal can result in many additional transitions being counted. The module is capable of counting over 20,000 transitions per second.

Pulse Input Modules have three isolated input channels. Each input channel independently processes all data input to the module and passes the data to the Main Processors, where it is voted just prior to processing to ensure the highest integrity.

Each module provides complete ongoing diagnostics on each channel. Failure of any diagnostic on any channel activates the module's Fault indicator, which in turn activates the chassis alarm signal. The Fault indicator points to a channel fault, *not* a module failure. The module is guaranteed to operate properly in the presence of a single fault and may continue to operate properly with certain kinds of multiple faults.

Pulse Input Modules include the hot-spare feature and require a separate field termination (a cable interface to a remotely located External Termination Panel). Each Pulse Input Module is mechanically keyed to prevent improper installation in a configured chassis.

Pulse Input Schematic

This figure is a simplified schematic for models 3510 and 3511, which are Pulse Input Modules.

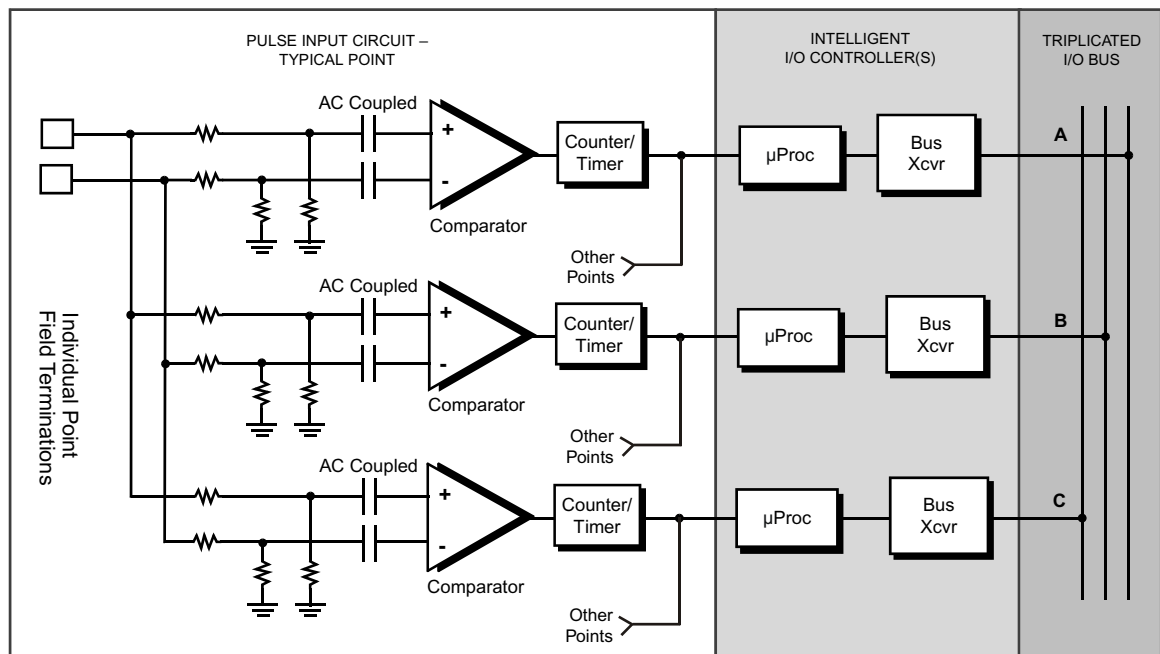


Figure 52 3510 and 3511 Simplified Schematic

Pulse Input Front Panels

This figure shows the front panels of models 3510 and 3511.

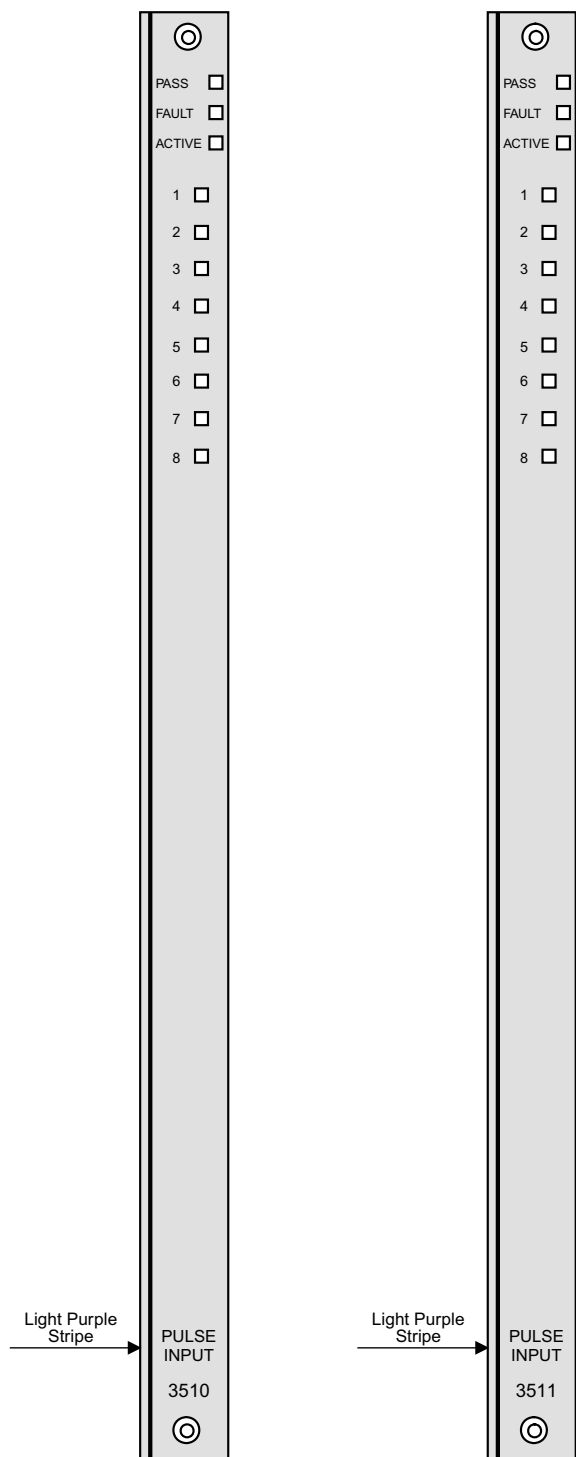


Figure 53 3510 and 3511 Front Panels

3510 Specifications

This table lists the specifications for model 3510, which is a Pulse Input Module. Although the input frequency range for the module is 20 to 20,000 hertz, operation below 20 hertz and above 20,000 hertz is possible. For expected accuracy and input sensitivity, contact the IPS Global Client Support (GCS) center.

CAUTION

- Rapidly or continuously changing inputs may cause mis-compare readings because the measured values of the three channels may in fact be different by more than 0.5 percent of full scale, which can sometimes cause a fault to be declared in error.
- If the input readings differ by a minimum of 0.5 percent of full scale and continue for a minimum period of 10 input samples, the probability of a fault increases.

Table 47 3510 Pulse Input Specifications

Feature	Specification
Color code	Light purple
Number of input signals	8, non-commoned
Input frequency range	20 Hz to 20,000 Hz
Accuracy: @ 1,000 Hz to 20,000 Hz	±0.01%
Accuracy: @ 100 Hz to 999 Hz	±0.1%
Accuracy: @ 20 Hz to 99 Hz	±1.0%
Input diagnostic fault coverage	
Minimum input change	0.5% of full scale
Input change sample period	1 scan or 210 ms, whichever is greater
Minimum period of mis-compares	10 samples
Status indicator: Input activity	1 per point
Status indicator: Module status	Pass, Fault, Active
Logic power	< 20 watts
Input characteristics (AC-coupled, balanced differential)	
Update rate	50 ms, typical
Load impedance	> 8 kΩ, 20K typical
Common mode range	-100V to +100V peak-to-peak
Normal mode range	2.0 V to 200 V peak-to-peak, below 20 Hz 1.5 V to 200 V peak-to-peak, 20 Hz to 15000 Hz 2.0 V to 200 V peak-to-peak, above 15000 Hz
Over-range protection	±150 VDC continuous
Hysteresis	150 millivolts, typical

3511 Specifications

This table lists the specifications for model 3511, which is a Pulse Input Module. Although the input frequency range for the module is 20 to 20,000 hertz, operation below 20 hertz and above 20,000 hertz is possible. For expected accuracy and input sensitivity, contact the IPS Global Client Support (GCS) center.

CAUTION

- Rapidly or continuously changing inputs may cause mis-compare readings because the measured values of the three channels may in fact be different by more than 0.5 percent of full scale, which can sometimes cause a fault to be declared in error.
- If the input readings differ by a minimum of 0.5 percent of full scale and continue for a minimum period of 10 input samples, the probability of a fault increases.

Table 48 3511 Pulse Input Specifications

Feature	Specification
Color code	Light purple
Number of input signals	8, non-commoned
Input frequency range	20 Hz to 20,000 Hz
Accuracy:@ 1,000 Hz to 20,000 Hz	±0.01%
Accuracy:@ 100 Hz to 999 Hz	±0.1%
Accuracy:@ 20 Hz to 99 Hz	±1.0%
Input diagnostic fault coverage	
Minimum input change	0.5% of full scale
Input change sample period	1 scan or 210 ms, whichever is greater
Minimum period of mis-compares	10 samples
Status indicator: Input activity	1 per point
Status indicator: Module status	Pass, Fault, Active
Logic power	< 20 watts
Input characteristics (AC-coupled, balanced differential)	
Update rate	25 ms, typical
Load impedance	> 8 kΩ, 20K typical
Common mode range	-100V to +100V peak-to-peak
Normal mode range	1.5V to 200V peak-to-peak
Over-range protection	±150 VDC continuous
Hysteresis	150 millivolts, typical
Sensitivity	Typical: 0.5V peak-to-peak, sine wave Worst case: 1.5V peak-to-peak, sine wave

Pulse Totalizer Input Module

This section describes the Pulse Totalizer Input Module available for use with Tricon v9-v10 systems. For important operational restrictions, see [Pulse Input Totalizer Installation and Operation on page 193](#).

Table 49 Pulse Totalizer Input Modules

Model	Voltage	Points	Type	Module Description
3515	24 VDC	32	TMR	Pulse Totalizer Input

The model 3515 Pulse Totalizer Input (PTI) Module includes 32 individual 31-bit counters that each operate independently. The counters are used with active-flow sensors or per-unit sensors to measure a quantity (count) which is transmitted to the Main Processors. At the time specified by the control program, the Main Processors can clear a single counter or all counters. Typically, the PTI module is used for batch processes. To avoid counter overflow, the control program should clear each counter before the start of each batch.

The PTI module has three isolated input channels. Each input channel independently processes all input data and passes the data to the Main Processors, where it is voted before processing to ensure the highest integrity.

Each PTI module provides complete ongoing diagnostics on each channel, including channel-to-channel count comparison. Failure of any diagnostic on any channel activates the module's Fault indicator, which in turn activates the chassis alarm. The Fault indicator points to a channel fault, not a module failure. The PTI module is guaranteed to operate properly in the presence of a single fault, and may continue to operate with certain kinds of multiple faults. The PTI module can operate with or without a hot-spare module. If you use a hot-spare module, it re-educates all counter values from the active module.

Pulse Totalizer Schematic

This figure is a simplified schematic for model 3515, which is a Pulse Totalizer Input Module.

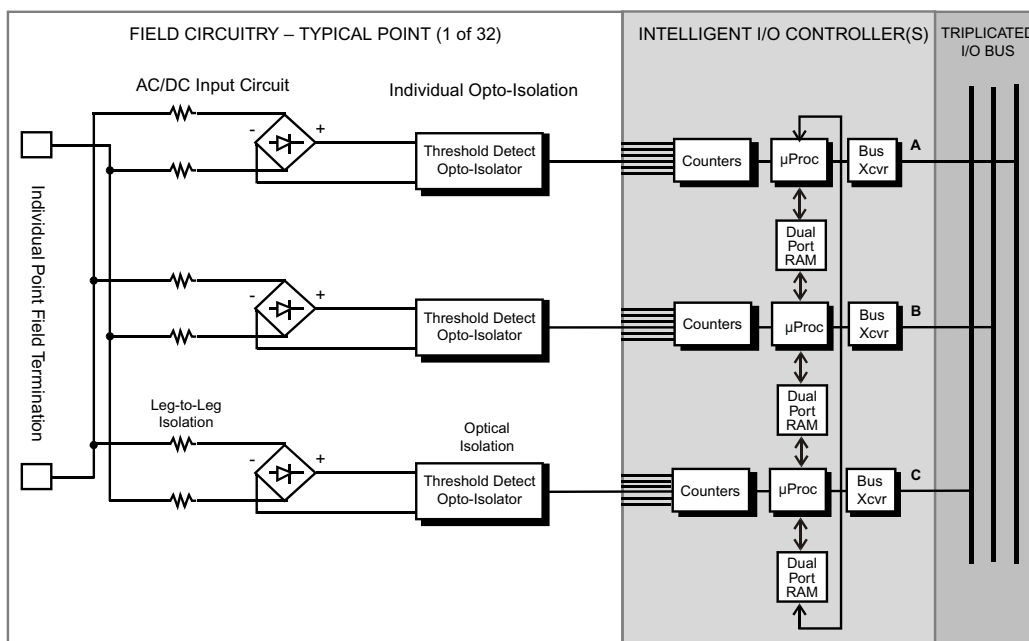


Figure 54 3515 Simplified Schematic

Pulse Totalizer Input Front Panel

This figure shows the front panel of model 3515.

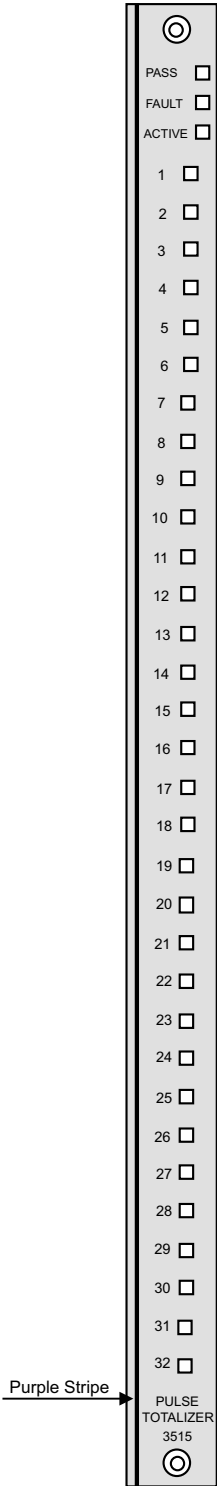


Figure 55 3515 Front Panel

3515 Specifications

This table lists the specifications for model 3515, which is a Pulse Totalizer Input Module.

Table 50 3515 Pulse Totalizer Input Specifications

Feature	Specification
Color Code	Purple
Number of input points	32, non-commoned
Input frequency range	0 Hz to 1 KHz
Minimum input pulse width	300 μ s
Accuracy: Active module	+/- 2 counts
Accuracy: Hot-spare module, maximum error counts during hot replacement	1-10 \geq 100 Hz 0-1 \leq 100 Hz
Maximum count	2147483647 ($2^{31} - 1$)
Counter overflow (worst case @ 1 KHz)	596 hours (24 days)
Count overflow indication	Count goes to negative integer
Count reset	Individual reset per counter
Recommended input voltage range	20-42.5 VDC
Maximum input voltage	42.5 VDC
Count up switching level	Rising edge, Off to On
Switching voltage: Off to On	15 VDC typical, 18 VDC worst case
Switching voltage: On to Off	8 VDC typical, 6 VDC worst case
Typical hysteresis	4 VDC
Normal turn-on current	6 mA to 9 mA
Count input delay	< 15 ms
Point isolation, opto-isolated	1000 VAC minimum 1500 VDC minimum
Status indicator: On or Off state	1 per point
Status indicator: Module status	Pass, Fault, Active
Logic power	< 10 watts
Nominal field power load	0.5 watts per On point, 1.5 watts @ maximum field voltage

Thermocouple Input Modules

This section describes the Thermocouple Input Modules available for use with Tricon v9–v10 systems. For important operational restrictions, see [Thermocouple Input Installation and Operation on page 194](#).

Table 51 Thermocouple Input Modules

Model	Module Description	Type
3706A	Non-Isolated Thermocouple Input	TMR
3708E	Isolated Thermocouple Input	TMR

A thermocouple input module has three independent input channels. Each input channel receives variable voltage signals from each point, performs thermocouple linearization and cold-junction compensation, and converts the result to degrees Celsius or Fahrenheit. Each channel then transmits 16-bit signed integers representing 0.125 degrees per count to the three Main Processors on demand. To ensure correct data for every scan, a value is selected using a mid-value selection algorithm.

Each module is configured by TriStation for the thermocouple type and engineering units you select. Each module can support one of a variety of thermocouple types, as indicated in the specifications. Engineering units are in Celsius or Fahrenheit.

TriStation programs the Isolated Thermocouple Module for upscale or downscale burnout detection depending on the hardware specification in the TriStation control program. The Non-Isolated Thermocouple Module provides upscale or downscale burnout detection depending on the field termination selected. If a thermocouple burnout occurs, or if the thermocouple input voltage is out of range, the Main Processors receive the integer value +32,767 for upscale burnout detection or -32,767 for downscale.

Tripllicated temperature transducers residing on the field termination module support cold-junction compensation. Each channel of a thermocouple module performs auto-calibration and reference-junction compensation every five seconds using internal-precision voltage references. On the Isolated Thermocouple Module, a cold-junction indicator announces the failure of a cold-junction transducer. On the Non-Isolated Thermocouple Module, a Fault indicator announces a transducer fault.

Sensing of each thermocouple input is performed in a manner which prevents a single failure on one channel from affecting another channel. Each module performs complete ongoing diagnostics on each channel.

Thermocouple Modules include the hot-spare feature which allows online replacement of a faulty module. Like all I/O modules, Thermocouple Modules require a cable interface to a remotely located external termination panel. Each module is mechanically keyed to prevent improper installation in a configured chassis.

32-Point Thermocouple Modules

This figure is a simplified schematic for model 3706A, which is a non-isolated Thermocouple Input Module.

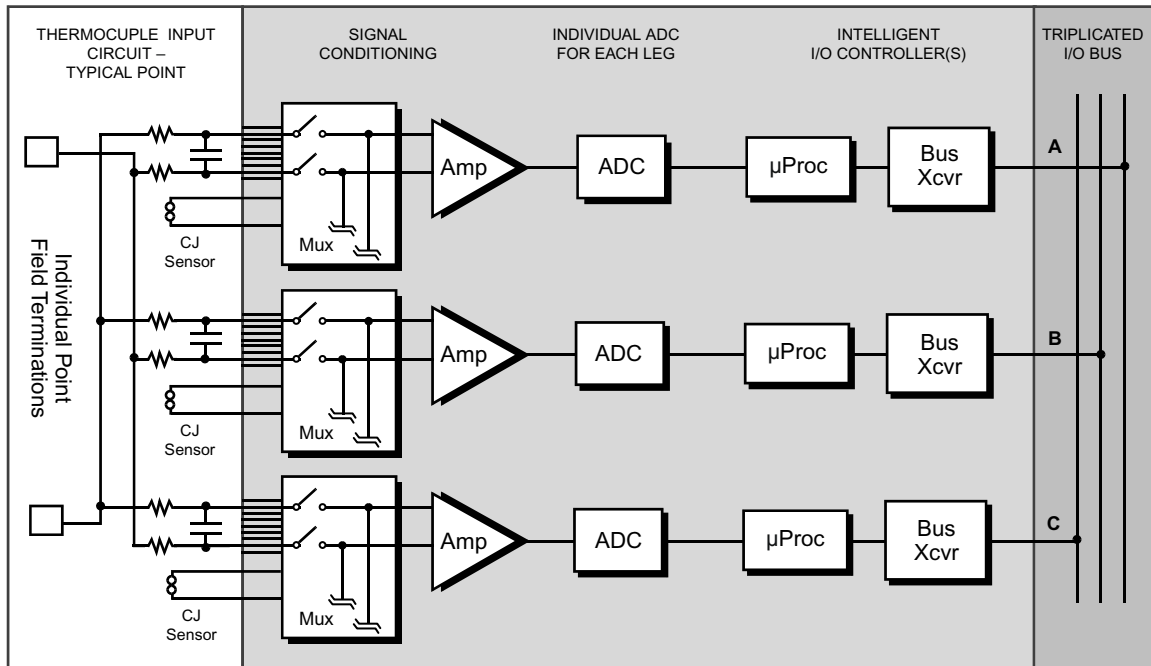


Figure 56 3706A Simplified Schematic

This figure shows the front panel of model 3706A.

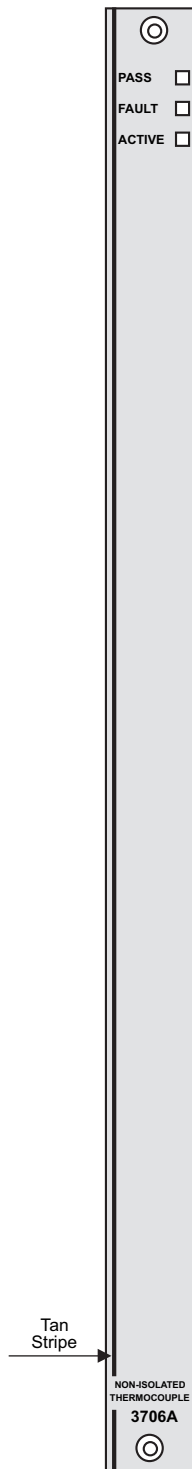


Figure 57 3706A Front Panel

3706A Specifications

This table lists the specifications for model 3706A, which is a Thermocouple Input Module.



If the common mode voltage range of a channel is exceeded, Triconex does not guarantee proper operation of the module and accuracy of other channels.



Rapidly or continuously changing inputs may cause mis-compare readings because the measured values of the three channels may be different by more than 0.5 percent of full scale, which may cause a fault to be declared in error.

Table 52 3706A Thermocouple Input Specifications

Feature	Specification
Color code	Tan
Thermocouple types supported	J, K, T
Open detect	Upscale/downscale selected on termination module
Number of input signals	32 differential, DC-coupled
Input update rate ¹	50 ms maximum
Accuracy of thermocouple types and temperature ranges supported	See table, 3706A Accuracy on page 137 .
Input resistance (load)	22 M Ω (DC), typical
Input point protection	110 VAC continuous without damage
Noise rejection: Common mode	-85 dB @ 0 - 60 Hz minimum -95 dB @ 60 Hz typical
Noise rejection: Normal mode	-17 dB @ 60 Hz
Common mode range (See Warning)	± 10 VDC maximum (channel-to-channel or channel-to-ground)
Channel-to-channel isolation	200 k Ω , typical
Reference-junction compensation range	32° to 140° F (0° to 60° C)
Module status indicators	Pass, Fault, Active
Input diagnostic fault coverage ²	
Minimum input change	0.5% of full scale
Input change sample period	50 milliseconds
Minimum period of mis-compares	256 samples
Logic power	< 10 watts

1. Later versions of NITC firmware (Meta 4873 or greater) freeze inputs for 1 second upon detection of hot-spare insertion.
2. If the input readings differ by a minimum of 0.5 percent of full scale and continue for a minimum period of 256 input samples, the probability of a fault increases.

3706A Accuracy

Accuracy specifications account for errors related to reference-junction compensation but do not account for errors caused by temperature gradients between the temperature transducers and thermocouple terminations. Customers are responsible for maintaining a uniform temperature across the Thermocouple Field Termination Module.

Table 53 Accuracy of Model 3706A Thermocouple Types

TC Type	Temperature Range	Accuracy @ 32° to 140° F (0° to 60° C)	
		Ta=77° F (25° C)	Ta=32° to 140° F (0° to 60° C)
		Typical	Maximum
J	-250° to 32° F (-157° to 0° C)	± 5.0° F (2.8° C)	± 7.0° F (3.9° C)
	>32° to 2000° F (0° to 1093° C)	± 4.0° F (2.3° C)	± 5.0° F (2.8° C)
K	-250° to 32° F (-157° to 0° C)	± 6.0° F (3.4° C)	± 9.0° F (5.0° C)
	>32° to 2500° F (0° to 1371° C)	± 4.0° F (2.3° C)	± 6.0° F (3.4° C)
T	-250° to 32° F (-157° to 0° C)	± 5.0° F (2.8° C)	± 9.0° F (5.0° C)
	>32° to 752° F (0° to 400° C)	± 3.0° F (1.7° C)	± 5.0° F (2.8° C)

16-Point Isolated Thermocouple Modules

This figure is a simplified schematic for model 3708E, which is an isolated Thermocouple Input Module.

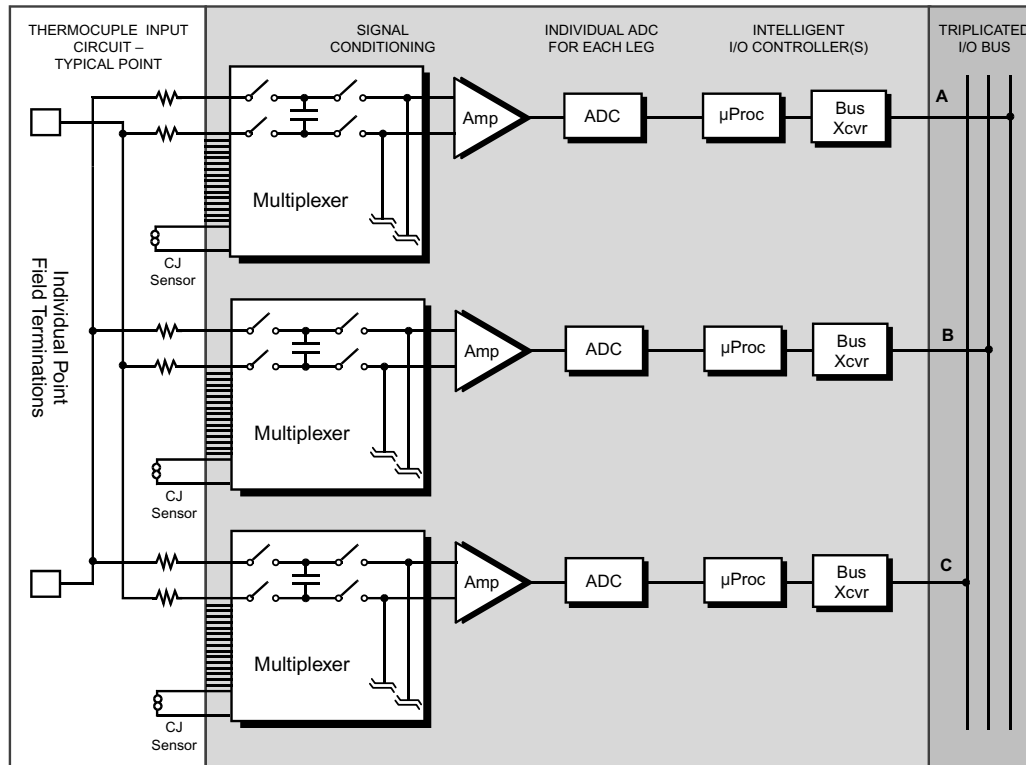


Figure 58 3708E Simplified Schematic

This figure shows the front panel of model 3708E.

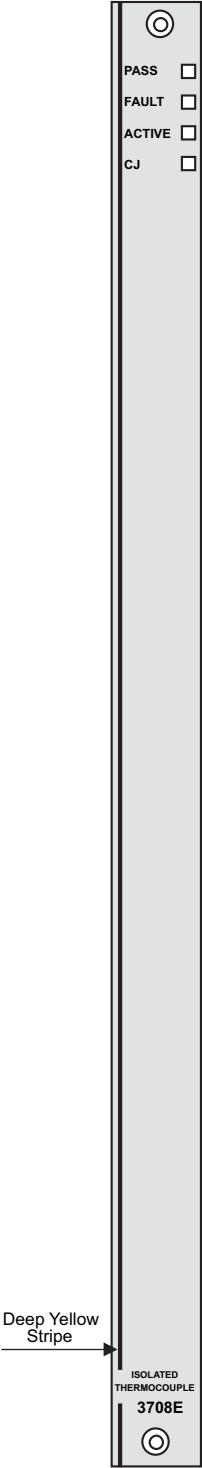


Figure 59 3708E Front Panel

3708E Specifications

This table lists the specifications for model 3708E, which is an isolated TMR Thermocouple Input Module.

CAUTION

- If the common-mode voltage range of a channel is exceeded, Triconex does not guarantee proper operation of the module and accuracy of other channels.
- If the input readings differ by a minimum of 0.5 percent of full scale and continue for a minimum period of 256 input samples, the probability of a fault increases.

Table 54 3708E Thermocouple Input Specifications

Feature	Specification
Color code	Deep yellow
Thermocouple types supported	J, K, T, E
Open detect	Upscale, Downscale, (TriStation-configured)
Number of input signals	16 differential, isolated
Input update rate	50 ms maximum
Accuracy of thermocouple types and temperature ranges supported	See table, 3708E Accuracy on page 141 .
Input resistance (load)	30 M Ω (DC) minimum
Input point protection	110 VAC continuous without damage
Noise rejection: Common mode	-100 dB @ DC minimum -90 dB @ 60 Hz minimum
Noise rejection: Normal mode	-3 dB @ 8 Hz typical -17 dB @ 60 Hz typical
Common mode range	\pm 200 VDC maximum (channel-to-channel or channel-to-ground)
Channel-to-channel isolation	20 k Ω , typical
Reference-junction compensation range	32° to 140° F (0° to 60° C)
Status indicator: Module status	Pass, Fault, Active
Status indicator: Cold Junction sensor status	CJ (On = CJ Fault)
Input diagnostic fault coverage	
Minimum input change	0.5% of full scale
Input change sample period	50 ms
Minimum period of mis-compares	256 samples
Logic power	< 15 watts

3708E Accuracy

Accuracy specifications account for errors related to reference-junction compensation but do not account for errors caused by temperature gradients between the temperature transducers and thermocouple terminations. The customer is responsible for maintaining a uniform temperature across the thermocouple termination module.

Table 55 Accuracy of Model 3708E Thermocouple Types

TC Type	Temperature Range	Accuracy @ 32° to 140° F (0° to 60° C)	
		Ta=77° F (25° C)	Ta=32° to 140° F (0-60° C)
		Typical	Maximum
J	-238° to 32° F (-150° to 0° C) >32° to 1400° F (0° to 760° C)	± 3.0° F (1.7° C)	± 9.0° F (5.0° C) ± 5.5° F (3.1° C)
K	-238° to 32° F (-150° to 0° C) >32° to 2284° F (0° to 1251.1° C)	± 4.0° F (2.3° C)	± 8.0° F (4.5° C) ± 7.0° F (3.9° C)
T	-250° to 32° F (-161° to 0° C) >32° to 752° F (0° to 400° C)	± 3.0° F (1.7° C)	± 8.5° F (4.8° C) ± 4.5° F (2.5° C)
E	-328° to 32° F (-200° to 0° C) >32° to 1830° F (0° to 999° C)	± 3.0° F (1.7° C)	± 8.0° F (4.5° C) ± 5.0° F (2.8° C)

HART Interface Modules

This section describes HART interface modules available for use with Tricon v10.4 or later systems.

HART is an industry standard field bus that superimposes a Frequency Key Shifted (FSK) signal onto the 4-20 mA loop. The Tricon 2071H HART Multiplexer Module that is incorporated into each of the HART Interface Modules capacitively couples the HART signal to the AI or AO signals. The HART signals are approximately ± 0.5 mA at 1200 and 2200 Hz. These frequencies are high enough that the low-bandwidth loop is unaffected and the HART electronics can impose and extract the HART signals easily.

HART communication through the HART multiplexer is separate from the Tricon system and is certified not to interfere with the 4-20 mA safety signals of the Analog Input and Analog Output modules.

Table 56 HART Interface Modules

Model	Interface Module Description	Compatible I/O Modules	Type
2770H	HART Analog Input Interface Module	3700A, 3721	TMR
2870H	HART Analog Output Interface Module	3805E, 3805H	TMR

For installation information, see [Installing HART Interface Modules in the Model 8121 Enhanced Low Density Expansion Chassis on page 195](#) and [Installing HART Interface Modules in Systems Upgraded from v6–v8 on page 199](#).

Chassis Requirements for HART Communication

Only Tricon v10.4.x and later systems can use HART interface modules; earlier Tricon systems must upgrade to Tricon v10.4.x. The chassis requirements for using HART interface modules in a system upgraded to Tricon v10.4.x differ depending on the original system version, as described in this table.

Table 57 Tricon Chassis Usage for HART Communication

If Your Original System Version Is...	Upgrade to...	Install HART Interface Modules in Chassis...
Tricon v10.4.x or later (High-Density)	n/a	<ul style="list-style-type: none"> Model 8121 Enhanced Low-Density Expansion Chassis
Tricon v10.0.x – 10.3.x (High-Density)	Tricon v10.4.x	<ul style="list-style-type: none"> Model 8121 Enhanced Low-Density Expansion Chassis
Tricon v9.x (High-Density)	Tricon v10.4.x	<ul style="list-style-type: none"> Model 8121 Enhanced Low-Density Expansion Chassis
Tricon v6.x – v10.x (Low-Density)	Tricon v10.4.x	<ul style="list-style-type: none"> Model 8100-x Main Chassis Model 8101 Low-Density Expansion Chassis Model 8102 Low-Density RXM Chassis Model 8121 Enhanced Low-Density Expansion Chassis

HART Analog Input Interface Modules

This is a simplified schematic of the Model 2770H HART Analog Input Interface Module from the field device to the HART controller.

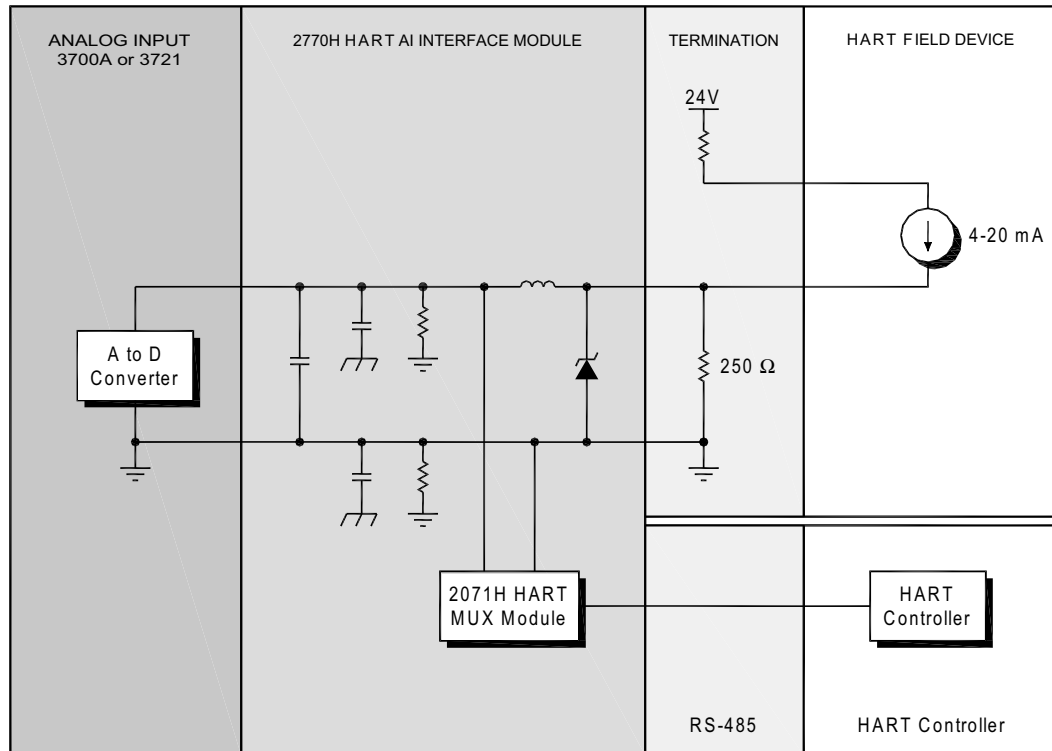


Figure 60 2770H Simplified Schematic

This figure shows the front panel of the Model 2770H HART Analog Input Interface Module.

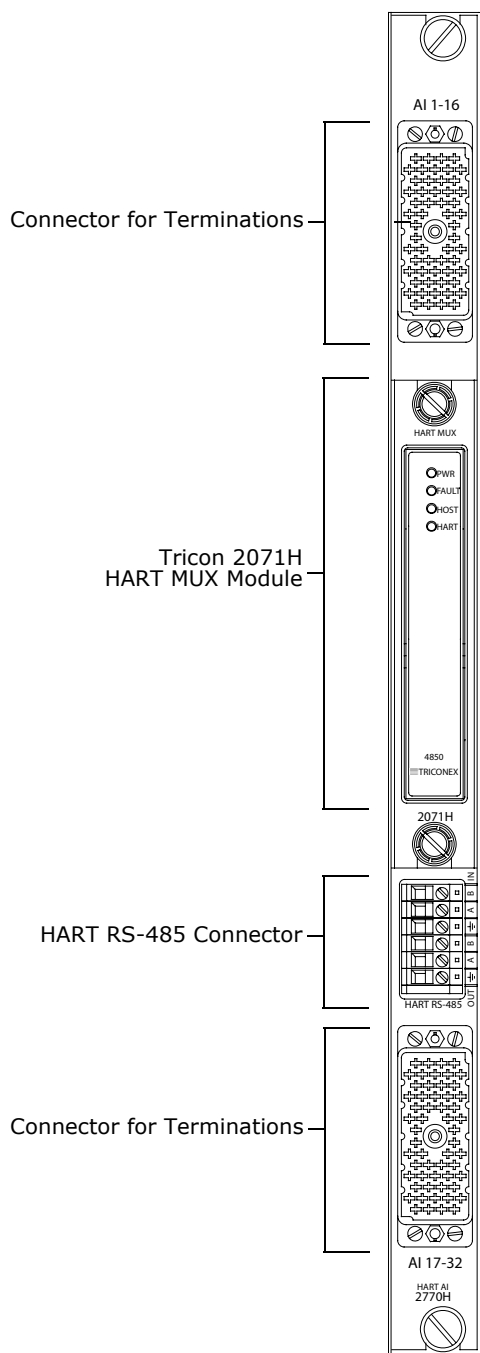


Figure 61 2770H Front Panel

2770H Specifications

This section includes specifications for model 2770H, which is an Analog Input Interface Module that provides HART communication to field devices connected to 3700A and 3721 Analog Input Modules.

Table 58 2770H HART Analog Input Interface Module Specifications

Feature	Specification
Compatible Analog Input Modules	3700A, 3721
Number of input signals	32
Input type	4-20 mA, 0 to 5 VDC
HART MUX Module ¹	2071H (includes the Triconex 4850 HART Multiplexer)
Status indicator: HART MUX module ¹	PWR, FAULT, HOST, HART
HART protocol	HART Field Communication Protocol, Revision 5.0-7.0
Logic power	< 5 Watts

1. For more information about the Triconex 4850 HART Multiplexer, including PC software installation and configuration, see the *Triconex 4850 HART Multiplexer Instruction Manual, INM4850-TR*.

HART Analog Output Interface Modules

This is a simplified schematic of the Model 2870H HART Analog Output Interface Module from the AO module to the field device.

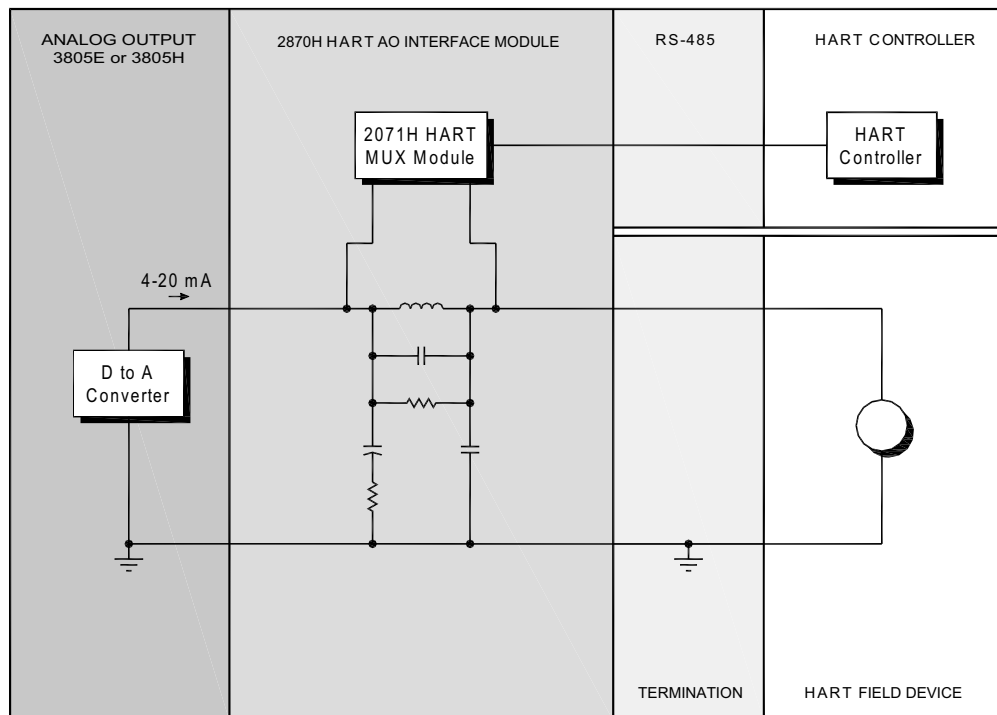


Figure 62 2870H Simplified Schematic

This figure shows the front panel of the Model 2870H HART Analog Output Interface Module.

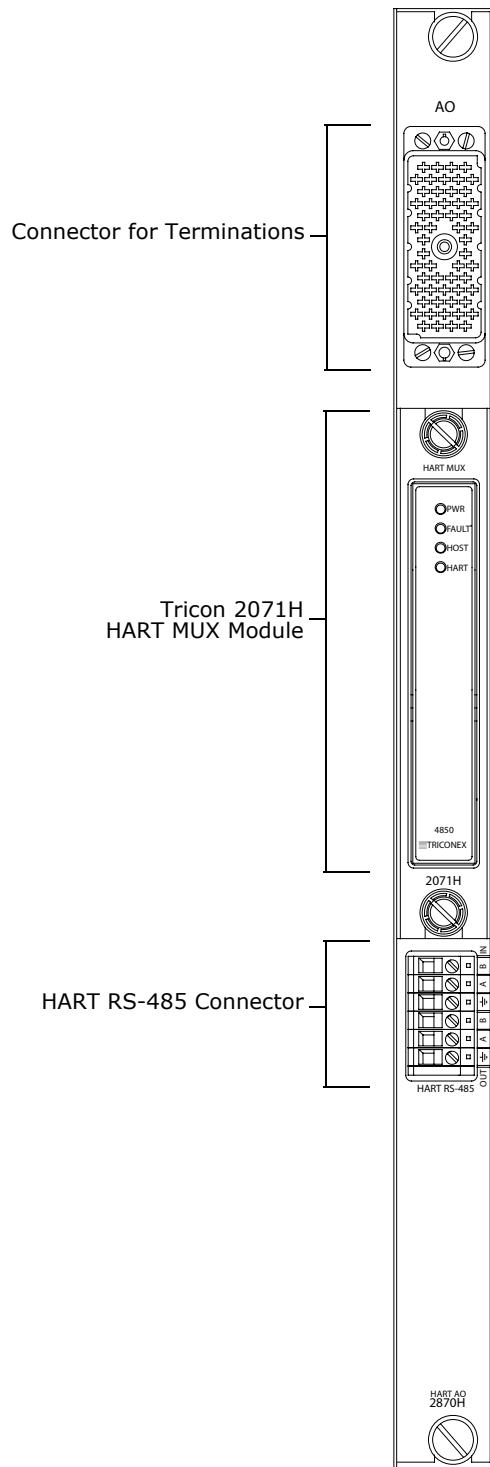


Figure 63 2870H Front Panel

2870H Specifications

This section includes specifications for model 2870H, which is an Analog Output Interface Module that provides HART communication to field devices connected to 3805E or 3805H Analog Output Modules.

Table 59 2870H HART Analog Output Interface Module Specifications

Feature	Specification
Compatible Analog Output Modules	3805E, 3805H
Number of output signals	8
Output type	4-20 mA, 0 to 5 VDC
HART MUX Module ¹	2071H (includes the Triconex 4850 HART Multiplexer)
Status indicator: HART MUX module ¹	PWR, FAULT, HOST, HART
HART protocol	HART Field Communication Protocol, Revision 5.0-7.0
Logic power	< 5 Watts

1. For more information about the Triconex 4850 HART Multiplexer, including PC software installation and configuration, see the *Triconex 4850 HART Multiplexer Instruction Manual, INM4850-TR*.

Advanced Communication Module (ACM)

The ACM (Advanced Communication Module) acts as an interface between a Tricon controller and a Foxboro Intelligent Automation (I/A) Series DCS, appearing to the Foxboro system as a safety node on the I/A Series Nodebus. The ACM communicates process information at full network data rates for use anywhere on the I/A Series DCS, transmitting all Tricon controller aliased data (including system variables and system aliases) and diagnostic information to operator workstations in display formats that are familiar to Foxboro operators.

The ACM includes these features:

- Handling of critical I/O points and passing of results to the I/A Series system using the Object Management Database (OMDB).
- Processing of Tricon alarms and propagation to user-defined I/A Series destinations, such as consoles and printers.
- Propagation of Tricon alarms as I/A Series messages.
- Reading and writing of aliased data to satisfy I/A Series system requests.
- Enabling of Time Synchronization from the I/A Series environment.
- Retrieval of Tricon sequence of events (SOE) data.
- Display of Tricon diagnostic data on I/A Series workstations.
- Write protection to lock out changes to the Tricon safety system from all I/A Series sources.
- Hot-spare module capability for redundant communication with the I/A Series Nodebus.

For more information, see the *ACM User's Guide* and *Communication Guide for Tricon v9-v10 Systems*. For additional requirements, see [Replacing ACMs on page 225](#).

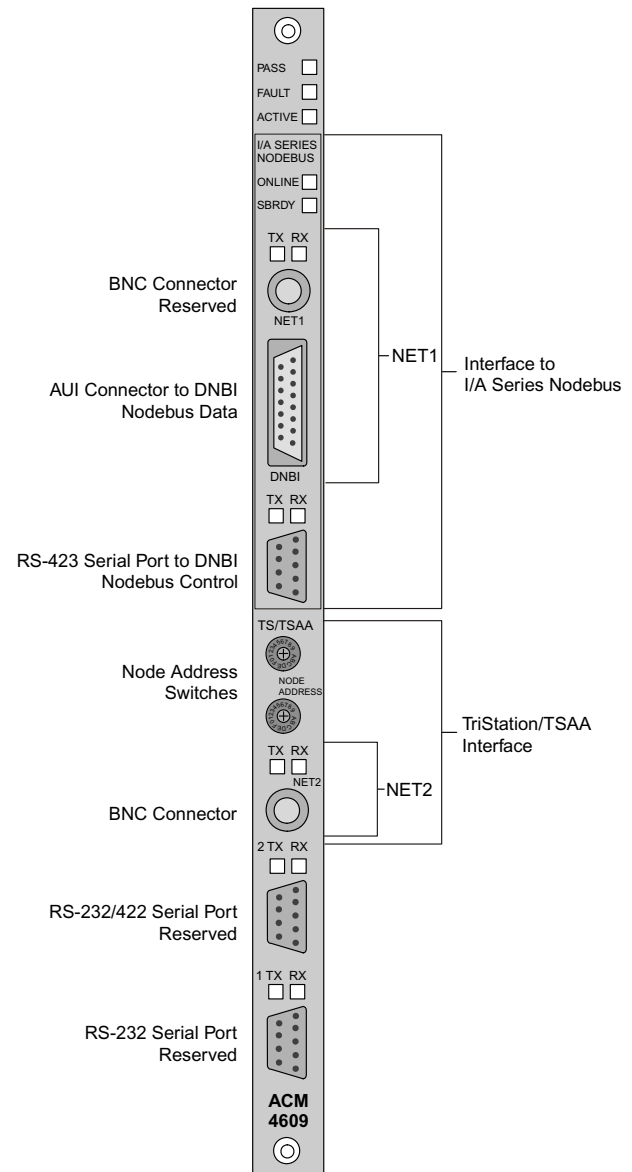


Figure 64 ACM Front Panel

ACM and I/A Series Connection

The ACM connection to the I/A Series Nodebus is through two dedicated ports – one for Nodebus data and one for Nodebus control. The ACM also includes a network port labeled TS/TSAA, which can be used for communication with a TriStation PC.



- Triconex strongly recommends that you install a hot-spare for each ACM in your Tricon controller. Because the ACM is not a TMR module, a single fault can cause a momentary loss of communication with the distributed control system (DCS) – until the spare ACM becomes active. Without a spare, communication can be lost until the ACM is replaced and initialized from the DCS. (Failure of the ACM does not compromise the operation of the rest of the Tricon controller.)
- In hazardous indoor locations, apparatus used with the ACM must be FM-certified for Class I, Division II.

For more information about communication setup, see the *Communication Guide for Tricon v9–v10 Systems*.

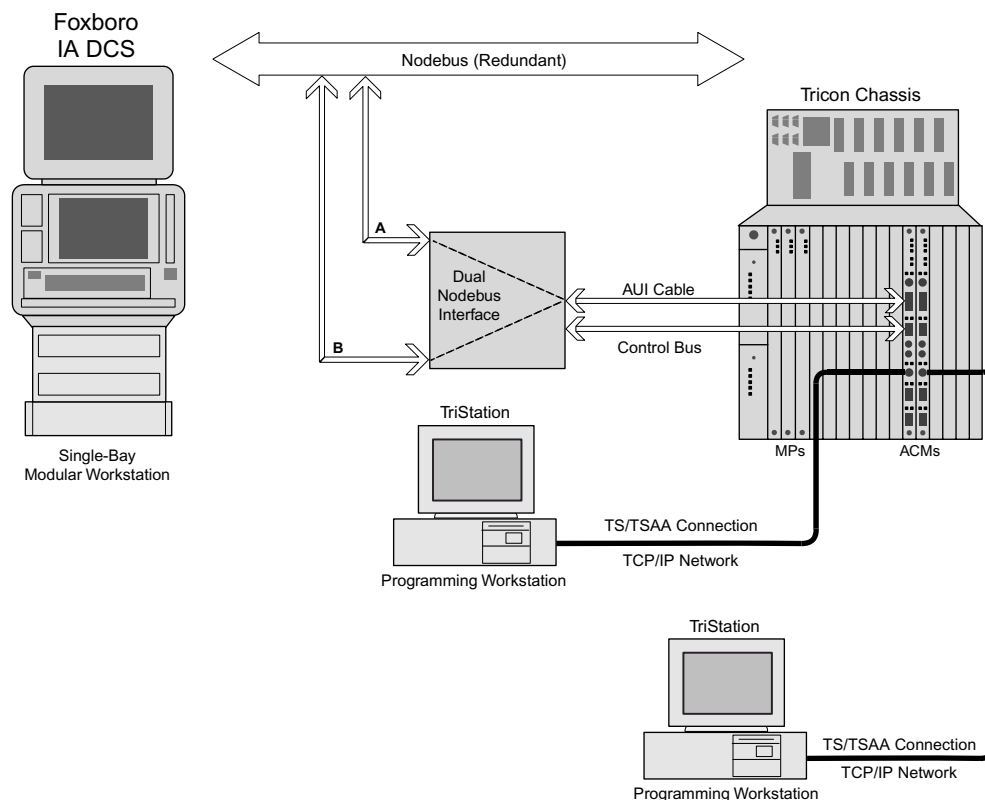


Figure 65 Tricon ACM and Foxboro I/A DCS Interface

4609 Specifications

This table lists the specifications for the ACM model 4609.

Table 60 4609 ACM Specifications

Feature	Specification
Nodebus port: BNC connector	1 for RG58, 50-ohm thin cable (reserved)
Nodebus port: 15-pin D connector	1 for AUI cable to DNBI
Nodebus port: 9-pin RS-423 connector	1 for Control Bus to DNBI
TS/TSAA port	1 BNC connector for RG58, 50-ohm thin cable to network
Serial port (reserved): 9-pin serial ports	RS-232/RS-422 (reserved)
Serial port (reserved): Port isolation	500 VDC (network and RS-232 ports)
Communication speed: BNC connectors	10 megabits
Communication speed: 15-pin D connector	10 megabits
Communication speed: 9-pin Nodebus connector	2400 baud
Status indicator: Module status	Pass, Fault, Active
Status indicator: Nodebus activity	ONLINE
Status indicator: Nodebus spare	SBRDY
Status indicator: Port activity	TX (Transmit) – 1 per port RX (Receive) – 1 per port
Logic power	< 20 watts

Enhanced Intelligent Communication Module (EICM)

The Enhanced Intelligent Communication Module (EICM) enables a Tricon controller to communicate with Modbus devices (masters or slaves), with a TriStation PC, and with a printer. A single Tricon High-Density controller supports up to two EICM modules which reside in one logical slot. This arrangement provides a total of six Modbus ports, two TriStation ports, and two printer ports. (The hot-spare feature is not available for the EICM, though you *can* replace a faulty EICM while the controller is online.)

Each EICM has four serial ports and one parallel port which can operate concurrently. The four serial ports are uniquely addressed and support either the Modbus or TriStation interface. Modbus communication can be performed in either RTU or ASCII mode. The parallel port provides a Centronics interface to a printer.

Each EICM supports an aggregate data rate of 57.6 kilobits per second, which means the total data rate for all four ports must be less than or equal to 57.6 kilobits per second.

Any standard Modbus device can communicate with a Tricon controller using the EICM provided that aliases are assigned to the tagnames (points) used in the control program. For more information, see the *TriStation Developer's Guide*.

For additional information, see the *Communication Guide for Tricon v9-v10 Systems* and [Replacing EICMs](#) on page 226.

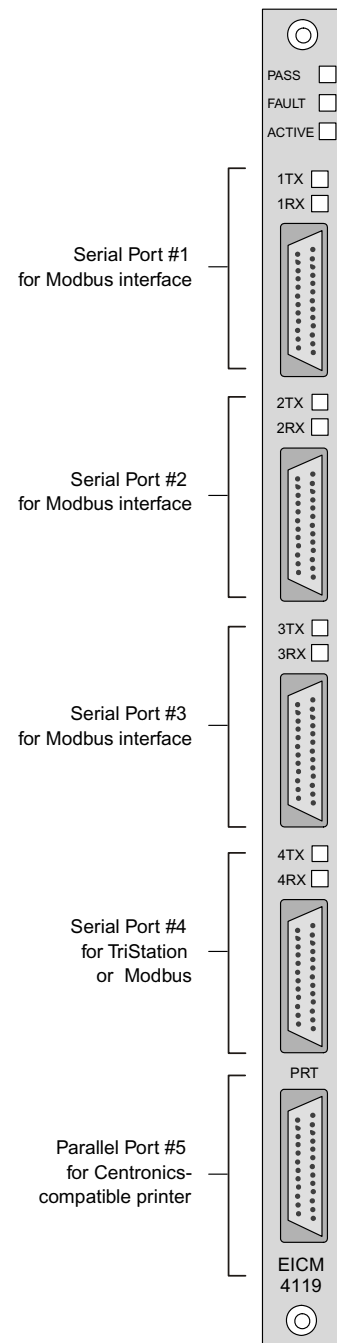


Figure 66 EICM Front Panel

4119 and 4119A Specifications

This table lists the specifications for model 4119 and 4119A EICM.

Table 61 4119 and 4119A EICM Specifications

Feature	Specification
Serial port	RS-232, RS-422 or RS-485, isolated to 500 VDC
Parallel ports	Centronics, isolated to 500 VDC
Protocol	TriStation, Modbus
Modbus function supported: 01	Read Coil status
Modbus function supported: 02	Read input status
Modbus function supported: 03	Read holding registers
Modbus function supported: 04	Read input registers
Modbus function supported: 05	Modify coil status
Modbus function supported: 06	Modify Register content
Modbus function supported: 07	Read exception status
Modbus function supported: 08	Loopback diagnostic test
Modbus function supported: 15	Force multiple coils
Modbus function supported: 16	Preset multiple registers
Communication speed	1200, 2400, 9600 or 19,200 baud
Status indicator: Module status	Pass, Fault, Active
Status indicator: Port activity	TX (Transmit) – 1 per port RX (Receive) – 1 per port
Status indicator: Logic power	< 10 watts

Hiway Interface Module (HIM)

The HIM (Hiway Interface Module) acts as an interface between a Tricon controller and a Honeywell TDC-3000 control system by means of the Hiway Gateway and Local Control Network (LCN). The HIM can also interface with a Honeywell TDC-2000 control system by means of the Data Hiway.

The HIM enables higher-order devices on the LCN or Data Hiway, such as computers and operator workstations, to communicate with a Tricon controller. The HIM module allows redundant BNC connections directly to the Data Hiway and has the same functional capacity as up to four extended Data Hiway Port (DHP) addresses.

The HIM provides eight Hiway addresses, implements the same slot structure as the DHP, and typically refreshes all data in less than 0.5 seconds. Although the HIM is not a TMR module, it fully supports the hot-spare feature, which allows online replacement of a faulty module.

For more information, see the *HIM User's Guide*.

For additional information, see [Replacing HIMs on page 227](#).

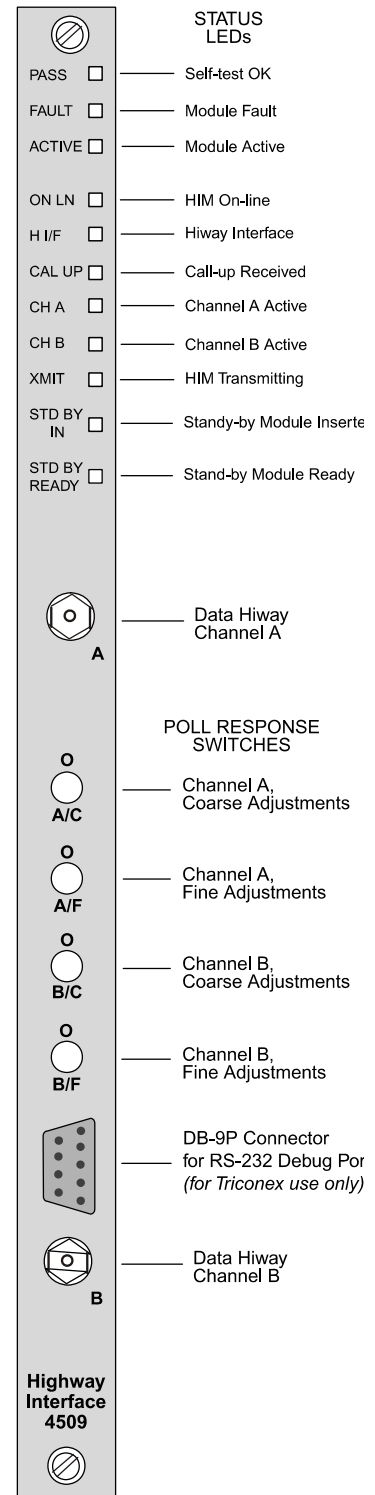


Figure 67 HIM Front Panel

4509 Specifications

This table lists HIM model 4509 specifications.

Table 62 HIM Model 4509 Specifications

Feature	Specification
Data hiway channels	2 isolated (AC-coupled)
Poll response switches	2 per channel
Baud rate	250 Kbaud
Status indicator: Module status	Pass, Fault, Active
Status indicator: HIM on-line	On Ln
Status indicator: Hiway interface	H I/F
Status indicator: Call-up received	Cal Up
Status indicator: Channel A active	Ch A
Status indicator: Channel B active	Ch B
Status indicator: HIM transmitting	Xmit
Status indicator: Standby module inserted	Std By In
Status indicator: Standby module ready	Std By Ready
Power Module load	< 10 watts
Isolation	500 VDC

Network Communication Module (NCM)

The Network Communication Module (NCM) enables a Tricon controller to communicate with other Tricons and with external devices on an Ethernet network. The NCM provides two BNC connectors as ports: NET 1 supports Peer-to-Peer and Time Synchronization protocols for safety networks comprised of Tricons only. NET 2 supports open networking to external systems using Triconex applications such as TriStation, SOE, OPC Server, and DDE Server or user-written applications.

The NCMG module has the same functionality as the NCM as well as the ability to synchronize time based on a GPS system.

The NCM is compatible with the Ethernet (IEEE 802.3 electrical interface) and operates at speeds up to 10 megabits. The NCM and the host computer can be connected by coaxial cable (RG58) at typical distances up to 607 feet (185 meters). Distances up to 2.5 miles (4,000 meters) are possible using repeaters and standard (thick-net) cabling. For more information, contact the IPS Global Client Support (GCS) center.

Two NCMs can be placed in one logical slot of the Tricon controller chassis, but they function independently, *not* as hot-spare modules.

The Main Processors typically refresh data on the NCM once per scan.

For additional information, see the *Communication Guide for Tricon v9-v10 Systems* and [Replacing NCMs](#) on page 228.

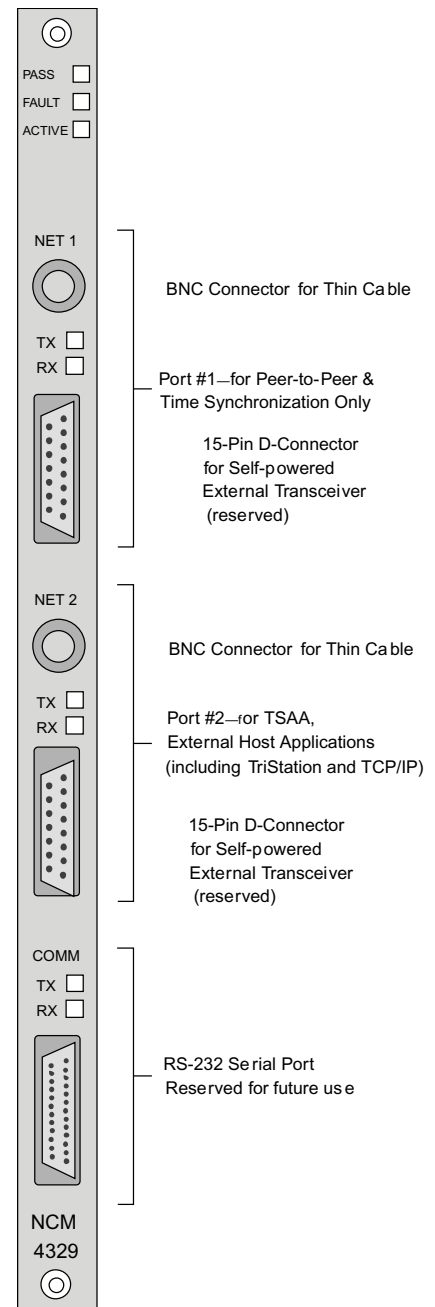


Figure 68 NCM Front Panel

4329 and 4329G Specifications

This table lists specifications for NCM models 4329 and 4329G.

Table 63 NCM Model 4329 and 4329G Specifications

Feature	Description
Network ports	Two BNC connectors using RG58 50-ohm thin cable
External transceiver ports	Not used
Serial port	One RS-232-compatible port
Port isolation	500 VDC, network and RS-232 ports
Protocols supported	Peer-to-Peer, Time Synchronization, TriStation, and TSAA
Communication speed	10 megabits
Status indicator: Module status	Pass, Fault, Active
Status indicator: Port activity	TX (Transmit) – 1 per port RX (Receive) – 1 per port
Logic power	< 20 watts

Safety Manager Module (SMM)

The SMM (Safety Manager Module) acts as an interface between a Tricon controller and a Honeywell Universal Control Network (UCN), which is one of three principal networks of the TDC-3000 Distributed Control System.

The SMM appears to the Honeywell system as a safety node on the UCN and communicates process information at full network data rates for use anywhere on the TDC-3000. The SMM transmits all Tricon controller aliased data (including system variables and system aliases) and diagnostic information to operator workstations in display formats that are familiar to Honeywell operators.

For supported TDC-3000 release levels, contact the IPS Global Client Support (GCS) center or the Honeywell Tac Center. For more information, see the *SMM User's Guide*.

The SMM includes these features:

- Handles critical I/O points and passes results to the DCS
- Processes Tricon controller alarms and propagates them to user-defined DCS destinations
- Reads/writes aliased data to satisfy DCS requests
- Reads Tricon controller diagnostics for display by the DCS
- Write protection to lock out changes to the Tricon controller from all TDC-3000 sources
- Time Synchronization from the DCS
- Peer-to-Peer communication for plants with many Tricon controllers, each containing an SMM – the DCS can use shared data to alert downstream Tricon controllers of significant process changes
- Sequence of Events – transmits Tricon controller event data to Universal Stations for display or History Modules for recording, to help determine the cause of plant trips and increase process up-time
- Hot-spare capability for uninterrupted communication with Honeywell networks

For additional requirements, see [Replacing SMMs on page 229](#).

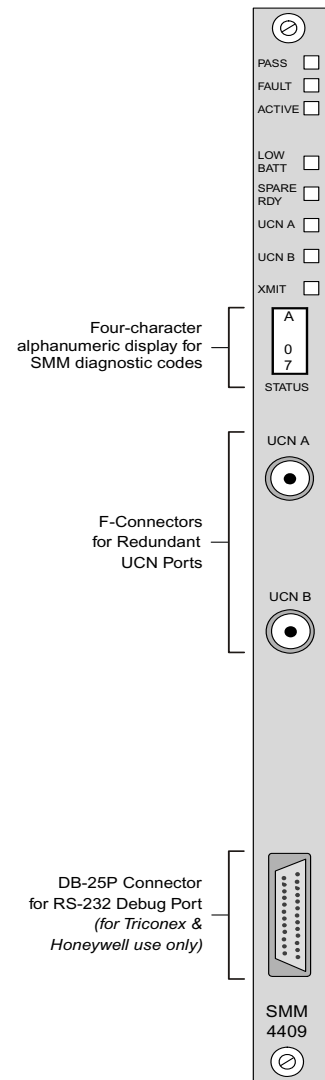


Figure 69 SMM Front Panel

4409 Specifications

This table lists the SMM model 4409 specifications.

Table 64 4409 SMM Specifications

Feature	Description
UCN ports	2 isolated, AC-coupled
UCN data rate	5 MB per second
Status indicator: Module status	Pass, Fault, Active
Status indicator: Low Battery	Fault Batt
Status indicator: Hot-spare ready	Spare Rdy
Status indicator: Port activity	UCN A, UCN Port A Active UCN B, UCN Port B Active
Status indicator: SMM transmitting	Xmit
Status indicator: Module node and diagnostic information	Status
Logic power	< 20 watts
Isolation (all ports)	500 VDC
Battery backup for database memory	6 months, typical

Tricon Communication Module (TCM)

The Tricon Communication Module (TCM), which is compatible with only Tricon v10.0 and later systems, allows the Tricon to communicate with TriStation, other Tricon or Trident controllers, Modbus master and slave devices, and external hosts over Ethernet networks.

Each TCM contains four serial ports, two network ports, and one debug port (for Triconex use).

Each serial port is uniquely addressed and can be configured as a Modbus master or slave. Serial port 1 supports either the Modbus or the Trimble GPS interface. Serial port 4 supports either the Modbus or the TriStation interface. Each TCM supports an aggregate data rate of 460.8 kilobits per second, for all four serial ports.

Programs for the Tricon use variable names as identifiers but Modbus devices use numeric addresses called *aliases*. Therefore an alias must be assigned to each Tricon variable name that will be read by or written to a Modbus device. An alias is a five-digit number which represents the Modbus message type and the address of the variable in the Tricon. An alias number is assigned in TriStation.

Any standard Modbus device can communicate with the Tricon through the TCM, provided that aliases are assigned to the Tricon variables. Alias numbers must also be used when host computers access the Tricon through other communication modules, such as the NCM.

TCM models 4353 and 4354 have an embedded OPC server, which allows up to ten OPC clients to subscribe to data collected by the OPC server. The embedded OPC server supports the Data Access standard and the Alarms and Events standard.

Each TCM contains two network ports—NET 1 and NET 2. Models 4351, 4351A, 4351B, and 4353 have two copper Ethernet ports. Models 4352, 4352A, 4352B, and 4354 have two fiber-optic Ethernet ports. See [Table 67](#) for the list of supported protocols on the TCM network ports.

A single Tricon system supports a maximum of four TCMs, which must reside in two logical slots located in chassis 1 or chassis 2 only. Different TCM models cannot be mixed in one logical

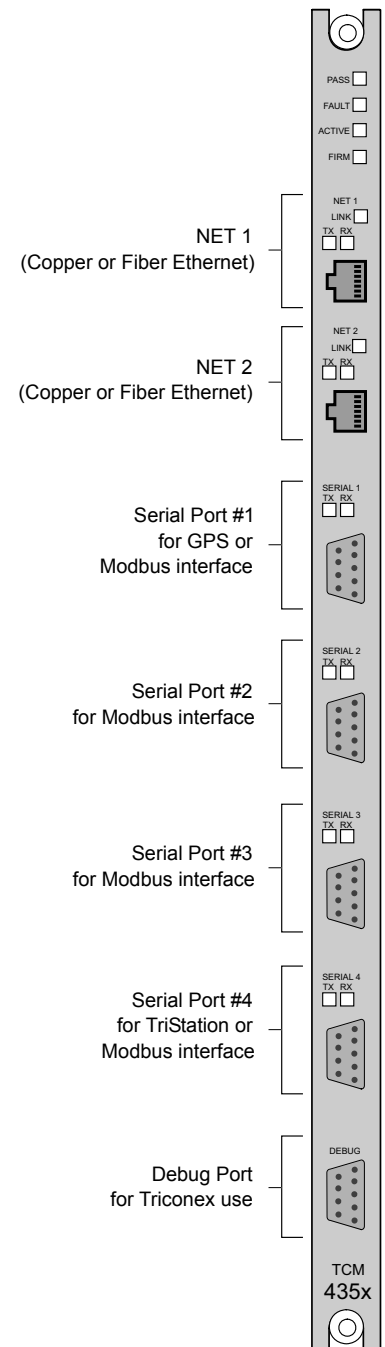


Figure 70 TCM Front Panel

slot. Each Tricon system supports a total of sixteen Modbus masters or slaves – this total includes network and serial ports. The hot-spare feature is not available for the TCM, though you can replace a faulty TCM while the controller is online.

This table describes TCM model and Tricon system version compatibility.

Table 65 TCM Model and Tricon System Version Compatibility

Tricon System Version	Compatible TCM Models
10.0	4351, 4352
10.1–10.2	4351A, 4352A
10.3 or later	4351B, 4352B, 4353, 4354

For additional information, see the *Communication Guide for Tricon v9–v10 Systems* and [Replacing TCMs on page 230](#).

TCM Specifications

This table lists specifications for TCM models 4351, 4351A, 4351B, 4352, 4352A, 4352B, 4353, and 4354.

CAUTION

Different TCM models cannot be mixed in the same logical slot. Additionally, models 4351A, 4351B, 4352A, 4352B, 4353, and 4354 TCMs cannot be installed into a system with 4351 or 4352 TCMs, even if they are installed in different chassis.

Table 66 TCM Specifications

Feature	Description										
Serial ports	4, RS-232/RS-485 ports, DB-9 connectors										
Network ports	2, 10/100BaseT Ethernet ports, RJ-45 connectors (models 4351, 4351A, 4351B, and 4353) 2, fiber-optic mode Ethernet ports, MT-RJ connectors with 62.5/125 um fiber cables (models 4352, 4352A, 4352B, and 4354)										
Port isolation	500 VDC										
Communication protocols	TriStation, Embedded OPC Server (models 4353 and 4354), Modbus, Modbus TCP, TCP/IP, SNTP, TSAA (with support for IP Multicast), Trimble GPS, Peer-to-Peer, Triconex Time Synchronization, Jet Direct (network printing)										
Modbus functions supported	<table border="0"> <tr> <td>01 – Read Coil Status</td> <td>06 – Modify Register Content</td> </tr> <tr> <td>02 – Read Input Status</td> <td>07 – Read Exception Status</td> </tr> <tr> <td>03 – Read Holding Registers</td> <td>08 – Loopback Diagnostic Test</td> </tr> <tr> <td>04 – Read Input Registers</td> <td>15 – Force Multiple Coils</td> </tr> <tr> <td>05 – Modify Coil Status</td> <td>16 – Preset Multiple Registers</td> </tr> </table>	01 – Read Coil Status	06 – Modify Register Content	02 – Read Input Status	07 – Read Exception Status	03 – Read Holding Registers	08 – Loopback Diagnostic Test	04 – Read Input Registers	15 – Force Multiple Coils	05 – Modify Coil Status	16 – Preset Multiple Registers
01 – Read Coil Status	06 – Modify Register Content										
02 – Read Input Status	07 – Read Exception Status										
03 – Read Holding Registers	08 – Loopback Diagnostic Test										
04 – Read Input Registers	15 – Force Multiple Coils										
05 – Modify Coil Status	16 – Preset Multiple Registers										

Table 66 TCM Specifications (continued)

Feature	Description
Communication speed	Copper Ethernet ports: 10/100 Mbps (model 4353 only supports 100 Mbps connections) Fiber Ethernet ports: 100 Mbps Serial ports: up to 115.2 Kbps per port, aggregate data rate of 460.8 Kbps for all four ports
Status indicators	PASS, FAULT, ACTIVE, FIRM LINK – 1 per network port TX (Transmit) – 1 per port RX (Receive) – 1 per port
Logic power	< 10 watts

This table lists the protocols and standards supported on TCM ports for models 4351, 4351A, 4351B, 4352, 4352A, 4352B, 4353, and 4354.

Table 67 TCM Protocols/Standards

Protocol or Standard	Network Ports (Models 4351 and 4352)	Network Ports (Models 4351A, 4351B, 4352A, and 4352B)	Network Ports (Models 4353 and 4354)	Serial Ports (All Models)
TriStation	NET 2	NET 1, NET 2	NET 1, NET 2	Port 4
TSAA (UDP/IP)	NET 2	NET 1, NET 2	NET 1	–
TSAA with IP Multicast (UDP/IP)	– ¹	NET 1, NET 2 (models 4351B and 4352B)	NET 1	–
Peer-to-Peer (UDP/IP)	NET 1	NET 1, NET 2	NET 1	–
Peer-to-Peer (DLC)	NET 1	NET 1	NET 1	–
Embedded OPC Server (OPC Data Access and OPC Alarms and Events)	–	–	NET 2	–
Modbus Slave (ASCII or RTU)	–	–	–	Any port
Modbus Master (RTU)	–	–	–	Any port
Modbus Master or Slave (TCP)	NET 2	NET 1, NET 2	NET 1	–
GPS Time Synchronization	–	–	–	Port 1
Triconex Time Synchronization via DLC	NET 1	NET 1	NET 1	–
Triconex Time Synchronization via UDP/IP	NET 1	NET 1, NET 2	NET 1	–

Table 67 TCM Protocols/Standards (*continued*)

Protocol or Standard	Network Ports (Models 4351 and 4352)	Network Ports (Models 4351A, 4351B, 4352A, and 4352B)	Network Ports (Models 4353 and 4354)	Serial Ports (All Models)
SNTP Triconex Time Synchronization	NET 2	NET 1, NET 2	NET 1, NET 2	—
Network Printing using Jet Direct	NET 2	NET 1, NET 2	NET 1	—

1. — means the protocol or standard is not supported on these ports.

Fiber-Optic Cables

If you are installing a TCM with fiber connectors (model 4352, 4352A, 4352B, or 4354), you will need to provide your own fiber-optic cables. You cannot purchase fiber-optic cables from Triconex.

The fiber cable you purchase should have these qualities:

- be a multimode 62.5/125 um cable
- have a maximum length of 1.24 miles (2 kilometers)
- comply with ANSI/TIA/EIA-568-B.3 standards

3

Installation and Maintenance

System Configuration	164
Installation Guidelines	168
Chassis and Module Installation	178
RXM Chassis Installation	203
Controller Grounding	208
Implementation and Maintenance	214
Module Replacement	220

System Configuration

This section includes specifications for a Tricon system, which includes a Main Chassis and additional Expansion or Remote Expansion (RXM) Chassis, as required.

Topics include:

- Configuration Specifications on page 164
- Communication Configuration on page 165
- Planning Power for a Tricon System on page 166

Configuration Specifications

This table includes specifications for determining the number and types of components that can be installed in a Tricon high-density and low-density system. A low-density system uses a pre-v9 chassis, which means fewer I/O modules can be included in a system.

Table 68 Configuration Guidelines

Component	High-Density Configuration	Low-Density Configuration
Maximum number of chassis	15	15
Maximum number of I/O and communication modules	118 <ul style="list-style-type: none"> • Main Chassis = 6 modules with hot-spares and 1 communication module • Expansion Chassis = 8 modules with hot-spares • RXM Chassis = 6 modules with hot-spares 	76 <ul style="list-style-type: none"> • Main Chassis = 4 modules with hot-spares • Expansion Chassis = 5 modules with hot-spares • RXM Chassis = 4 modules with hot-spares
Communication modules	Must be installed in the Main Chassis or Chassis 2. Chassis 2 must be an Expansion or Primary RXM Chassis.	
Maximum I/O Bus length	100 feet (30 meters)	100 feet (30 meters)
Analog Input points (includes Thermocouple Input and Pulse Totalizer Input points)	1024	1024
Analog Output points	512	512
Digital Input points	2048	2048
Digital Output points	2048	2048
Pulse Input points	80	80

Communication Configuration

This table describes rules and guidelines for using communication modules. For more information, including installation and configuration instructions, see the *Communication Guide for Tricon v9–v10 Systems*.

Table 69 Communication Rules

Component	Description
Chassis	<p>At least one communication module (TCM, ACM, EICM, or NCM) must be included in the Main Chassis or in Chassis 2, because these modules enable the TriStation PC to communicate with the Tricon controller.</p> <ul style="list-style-type: none"> • If communication modules are housed in Chassis 2, this chassis must be an I/O Expansion Chassis or a primary RXM Chassis that is connected directly to the Main Chassis using I/O communication cables (model 9001) rather than standard I/O bus cables. • You cannot install an NCM and a TCM in the same Tricon system. You also cannot install an EICM and a TCM in the same system.
COM Slot	The COM slot can only be used for a TCM, EICM, or NCM.
TCM	Up to two logical slots can be configured for TCMs. Matched pairs of TCMs can be installed in the left and right positions of each logical slot, and they can be located in the main chassis or Chassis 2. Model 4351A, 4351B, 4352A, and 4352B TCMs cannot be installed into a system with model 4351 or 4352 TCMs, even if they are installed in different chassis.
NCM	Up to two logical slots can be configured for NCMs. Matched pairs of NCMs can be installed in the left and right positions of each logical slot. If only one logical slot is used, the slot can be in the Main Chassis or Chassis 2. If two logical slots are used, they must be Slot 6 and 7 in the Main Chassis, and Peer to Peer cannot be used.
EICM and ACM	One logical slot is available for EICMs or ACMs, respectively. Matched pairs of these modules can be installed in both the left and right positions of one logical slot.
HIM	Up to two logical slots can be configured for HIMs. Both slots must be in the Main Chassis.
SMM	Up to three logical slots can be configured for SMMs. A matched pair of SMMs can be installed in the left and right positions of each logical slot. All three slots must be in the Main Chassis or Chassis 2.

Planning Power for a Tricon System

The Tricon Power Modules provide adequate support for most controller configurations, however, limitations may apply to a Main Chassis containing multiple communication modules because these modules consume more power than others. This section explains how to determine the logic power consumption and cooling requirements of a Tricon controller.

Data in this section is based on a fault condition where only one of the redundant Power Modules is operational. Under normal operating conditions, both Power Modules share the load.



Do not use the model 8312 Power Module in Tricon systems that are located in hazardous locations and must meet ATEX requirements. If you have 230 V line voltage and your system must meet ATEX requirements, use the model 8311 24 VDC Power Module along with the ATEX-certified 24 VDC power supply from Phoenix Contact – part number QUINT-PS-100-240AC/24DC/10/EX.

Determining Logic Power for Tricon Controller Chassis

Logic power refers to the number and kinds of modules that the Power Modules of a chassis can support without being overloaded. [Table 70 \(on page 167\)](#) identifies the logic power for each module. The total cannot exceed 175 watts, because each Power Module supplies a maximum of 175 watts at the rated maximum temperature of 140° F (60° C).

This calculation is based on the assumption that only one of the redundant Power Modules is operational. Under normal operating conditions, both Power Modules share the load and make more power available at all temperatures. This load-sharing allows the Power Modules to normally run at less than 50 percent of their rated maximum output thereby significantly increasing their service lifetime.



Avoid putting multiple high-power I/O modules into a Main Chassis. Each Main Chassis must house three Main Processors and a communication module which means multiple high-power I/O modules could exceed logic power limitations.

To determine logic power, add:

- logic power for primary modules
- logic power for hot-spare modules

Determining Cooling Requirements

Cooling requirements are determined by calculating the heat load dissipated by all the Tricon modules in the system. Table 70 (on page 167) identifies logic and field power usage for each module. For maximum reliability of the Tricon controller, the ambient temperature must be below 104° F (40° C). Please contact Triconex for further assistance with cooling needs.

To determine cooling requirements, add:

- logic power and field power for all the primary modules
- field power for all hot-spare modules

Table 70 Logic and Field Power of Tricon Modules

Type	Model No.	Maximum Logic Power (Watts) ¹	Maximum Field Power Primary/Spare (Typical) ²
Main Processor	3008	10	
	3006/3007	15	
Power Modules	8310, 8311, 8312	—	30 (15) ³
RXM Modules	420x, 421x	5	
Analog Input	370x/A	10	Negligible
Analog Input (High-Density)	3704E	10	Negligible
Analog Input (Isolated)	3703E	15	Negligible
Analog Input	3720, 3721	10	Negligible
Analog Output	3805E/H	15	22 (6) / 22 (6)
Analog Output	3806E	15	27 (12) / 27 (12)
Analog Output, BiPolar	3807	20	27 (12) / 27 (12)
Digital Input (High-Density)	3504E	10	Negligible
Digital Input (Single)	3564	10	39 (16) / 39 (16)
Digital Input (TMR)	350xE/T	10	96 (48) / 96 (48)
Digital Output (AC)	360xE/T	10	112 (20) / 32 (10)
Digital Output (DC)	360xE/T	10	112 (20) / 32 (10)
Digital Output (Dual)	3664	10	52 (16) / 20 (8)
Digital Output (Supervised, 16 points)	3624	10	32 (16) / Negligible
Digital Output (Supervised, 8 points)	361xE	10	26 (8) / 10 (4)
Digital Output (Supervised or Non-Supervised, 32 points)	3625	13	110
Pulse Input	351x	20	Negligible
Pulse Totalizer Input	3515	10	96 (24) / 96 (24)
Relay Output	3636R/T	15	Negligible
Thermocouple (Isolated)	3708E	15	Negligible
Thermocouple (Non-Isolated)	3706A	10	Negligible
HART Analog Input Interface	2770H	5	Negligible

Table 70 Logic and Field Power of Tricon Modules (*continued*)

Type	Model No.	Maximum Logic Power (Watts) ¹	Maximum Field Power Primary/Spare (Typical) ²
HART Analog Output Interface	2870H	5	Negligible
Advanced Communication Module	4609	15	
Enhanced Intelligent Communication Module	4119, 4119A	10	
Hiway Interface Module	4509	10	
Network Communication Module	4329, 4329G	20	
Safety Manager Module	4409	20	
Tricon Communication Module	4351, 4351A, 4351B, 4352, 4352A, 4352B, 4353, 4354	7	

1. To convert watts to British thermal units, use the formula: BTU = watts x 3.414.
2. Hot-spare Digital Output Modules consume less field power than primary Digital Output Modules.
3. Represents power loss internal to the Power Modules.

Installation Guidelines

This section includes installation guidelines for the Tricon controller.

Topics include:

- [General Installation Guidelines on page 168](#)
- [Plant Power and Grounding on page 169](#)
- [Tricon Field, Power, and Ground Wiring on page 170](#)
- [Application-Specific Installation Guidelines on page 172](#)

General Installation Guidelines

Due to the critical applications the Tricon is typically used in, it has been designed to operate under worst-case conditions in the harsh environments typically found in industrial environments.

To ensure adequate operational margins are maintained even under these worst-case conditions, the Tricon should be installed in a controlled environment per the general guidelines contained in:

IEC 61131, Part 4, Programmable controllers, User Guidelines

Section 7 of this standard includes checklists to help control the following environmental conditions:

- Temperature
- Contaminants

- Shock and vibration
- Electromagnetic interference

Typical guidelines include:

- Locate the Tricon away from obvious sources of heat: space heaters, solar radiation, etc.
- Locate or isolate the Tricon from obvious sources of corrosive gases or dust.
- Locate or isolate the Tricon from obvious sources of shocks or periodic vibrations: rotating machinery, engines, compressors, presses, etc.
- Locate or isolate the Tricon from obvious sources of electromagnetic interference: large motors or motor controllers, power converters, radio controlled equipment, welding equipment, etc.

Plant Power and Grounding

All plant and control room power distribution and safety grounding (protective earthing) must be done per the applicable national electric codes, typical examples include:

IEC 60364, Electrical Installations of Buildings

National Fire Protection Association, 2002 Edition of the National Electrical Code Handbook

For new construction, or where simple retrofits are feasible, the plant and/or control room safety grounding system should employ a supplemental Zero Reference Signal Plane or Grid (ZRSG). Installation of such a system for the plant or control room is not required for a successful Tricon application, but does represent modern best industry practice and should be followed wherever possible. Even when not implemented at the plant or control room level, the concepts of a modern ZRSG should be included in the Tricon cabinet and interconnecting cable routing. The ZRSG implementation should be extended to include all equipment racks and interconnecting cable paths: metal conduits, cable trays, wireways, etc. Detailed installation guidelines can be found in:

EPRI TR- 102400, Volume 2, Handbook for Electromagnetic Compatibility of Digital Equipment in Power Plants, Implementation Guide for EMI Control

IEC 61000, Part 5, Section 2, Electromagnetic compatibility (EMC), Installation and mitigation guidelines, Earthing and cabling

IEEE Std 1100-1999, IEEE Recommended Practice for Powering and Grounding Electronic Equipment

Tricon Field, Power, and Ground Wiring

All Tricon power distribution and safety grounding (protective earthing) must be done per the applicable national electric codes, plus the information contained in this manual, typical examples include:

IEC 60364, Electrical Installations of Buildings

National Fire Protection Association, 2002 Edition of the National Electrical Code Handbook

Typically, the Tricon will be installed in an equipment rack or cabinet located in a control room. All wiring internal to that cabinet and leading to from that cabinet should be segregated into different types and bundled accordingly, for example:

- Measurement signals - typically very sensitive, low voltage signals from sensors: RTDs, TCs, speed or flow sensors, etc. These signals will typically require shielded twisted pair cabling.
- Measurement and low power control signals - typically sensitive, low voltage signals to/from intelligent sensors or control devices: 4-20 ma loops, 24 VDC discrete signals, etc. These signals will typically require twisted pair cabling.
- High power control signals and conditioned power distribution - typically not sensitive, higher voltage signals: 48-120 volt discrete signals, 24-120 VDC I/O power distribution, etc. These signals should always use twisted pair cabling.
- Input coming power and misc. circuits - typically noisy, higher power circuits - 115 VAC discrete signals, AC power distribution, cabinet fans or lights, etc. These signals should always use twisted pair cabling, and the Grounding Electrode Conductor (the green wire) should be twisted along with the power leads wherever possible.
- Earth bonding connections.

All cable routing and installation should be done to minimize EMI, detailed guidelines can be found in:

EPRI TR- 102400, Volume 2, Handbook for Electromagnetic Compatibility of Digital Equipment in Power Plants, Implementation Guide for EMI Control

IEC 61000-5-2, Electromagnetic compatibility (EMC), Installation and mitigation guidelines, Earthing and cabling

IEEE Std 1100-1999, IEEE Recommended Practice for Powering and Grounding Electronic Equipment

Typical guidelines include the following:

- Use ferrous metal cabinets, cable trays, and conduits.
- When the RS-485 I/O Bus is used to connect to a remote Expansion Chassis, the I/O Bus cables must be routed in dedicated metallic conduit or equivalently isolated from other noise sources.
- Electrically bond all surfaces of the cabinet and it's contents together with multiple conductive metal strapping, not simple wire. Particular attention should be paid to doors, and removable panels. In turn the cabinet must be bonded to the control room or plant safety ground system or ZRSG.

- Routinely use twisted pair cabling; use shielded twisted pair cabling for all sensitive signals. Allow the minimum amount of un-twisted wire that accommodates connection.
- Signals of different types should never be bundled together.
- Bundles of different types should be separated by a minimum of 10 times the largest lead diameter.
- Bundles of different types of signals should only cross at right angles to each other.
- All wires and/or bundles should be routed along the ZRSG; for example, along the cabinet walls, within a cable tray or conduit, along building steel or the floor ground grid.
- Where an inline filter or power conditioning is used, the input and output leads should never be routed in the same bundle.
- Maintain shield continuity and ensure that shield leads are not broken. Allow the minimum amount of unshielded wire that accommodates connection. Terminate the shield at both ends, use capacitive coupling at one end if potential ground loops are suspected.
- Where ferrites or line filters are to be installed on signals or cables entering or leaving the cabinet, they must be installed as close to the cabinet egress point as possible. Cables must be routed to minimize coupling between the filtered and non-filtered signals. The non-filtered wire lengths in the cabinet must be minimized to the maximum extend possible.

CAUTION

For applications with uninterruptible power supplies (UPS) that use AC inverters, Triconex recommends that you install an AC line filter at the cabinet power entry point for each AC power source. Select the size of the filter based on the worst-case AC load in the cabinet, and install the filter according to the [Tricon Field, Power, and Ground Wiring on page 170](#) guidelines. Suitable filters include the Schaffner FN 350 series, or the Corcom SK series.

WARNING

Always turn field power off before removing ELCO connectors from the backplane of the Tricon chassis. Dangerous voltage may be present when field power is on and can cause damage to the Tricon backplane and termination panel.

Application-Specific Installation Guidelines

The following guidelines apply when installing the Tricon in application-specific locations.

Class 1 Division 2 Hazardous Locations

For North American hazardous location applications, the Tricon and associated equipment must be mounted in an enclosure that provides protection from fire and from personal injury resulting from access to live parts. The enclosure must require access via a tool, and if non-metallic, have the appropriate flammability rating.

The chassis alarm contacts must not be used in hazardous locations.

The replacement of batteries, fuses, I/O Modules, Main Processors, Power Modules, Communications Modules, or I/O Interface cables must not be attempted unless the area is known to be free of ignitable gas concentrations.

All communication cabling connected to the Main Processor and Communications modules must be nonincendive as described in Appendix D, Nonincendive Circuit Parameters. Communication cabling that extends through a hazardous area must be certified as being nonincendive.

Only these components, which are approved for use in Class 1 Division 2 hazardous locations, can be used:

- 2770H, HART Analog Input Interface Module
- 2870H, HART Analog Output Interface Module
- 3006, Main Processor
- 3008, Main Processor
- 3502E, 48V Digital Input Module
- 3503E, 24V Digital Input Module
- 3504E, 24V H.D. Digital Input Module
- 3505E, 24V Low Threshold. Digital Input Module
- 3511, Pulse Input Module
- 3515, Pulse Totalizer Module
- 3564, Single 24V Digital Input Module
- 3604E, 24VDC Digital Output Module
- 3607E, 48VDC Digital Output Module
- 3614E, 24VDC Supervised Digital Output Module
- 3615E, 24VDC Low Power Supervised Digital Output Module
- 3617E, 48VDC Supervised Digital Output Module
- 3624, 24VDC Supervised Digital Output Module
- 3625, 24VDC Supervised/Non-Supervised Digital Output Module

- 3664, 3674; 24V Dual Digital Output Module
- 3700A, 0-5V Analog Input Module
- 3701, 0-10V Analog Input Module
- 3703E, Isolated Analog Input Module
- 3704E, 0-5/0-10VDC Analog Input
- 3706A, TC Input Module
- 3708E, Isolated TC Input Module
- 3720, 3721; Analog Input Module
- 3805E/H, Analog Output Module
- 3806E, H.C. Analog Output Module
- 3807, BiPolar Analog Output Module
- 4119A, Enhanced Intelligent Communications Module
- 4200, 4201; Fiber Optic Remote Extender Module
- 4210, 4211; Single Mode Fiber Optic Remote Extender Module
- 4329, 4329G; Network Communications Module
- 4351, 4351A, 4351B, 4352, 4352A, 4352B, 4353, 4354; Tricon Communication Module
- 4409, Safety Manager Module
- 4509, Highway Interface Module
- 4609, Advanced Communication Module
- 8110, Main Chassis
- 8112, RXM Chassis
- 8111, Expansion Chassis
- 8121, Enhanced Low Density Expansion Chassis
- 8310, 120 V Power Module
- 8311, 24 VDC Power Module
- 8312, 230 VAC Power Module
- v9 External Termination Panels compatible with the above I/O modules



You must take additional explosion protection measures for field circuits when the field apparatus are in a hazardous area.

Zone 2 European Hazardous Locations

For European (ATEX) hazardous location applications, the Tricon and associated equipment must be installed in an enclosure that provides an IP54 minimum degree of protection per the requirements of EN 60529, Specification of protection provided by enclosures (IP Code). Simply stated, the enclosure must provide protection against dust and splashing water.

Additionally, the enclosure must meet the applicable requirements of EN 60079-15 or EN 50021. The following points must be taken into account:

- Mechanical strength
- Non-metallic enclosures and non-metallic parts of enclosures
- Earthing or equipotential bonding connection facilities

The following warning label must be placed on the outside of the enclosure:

DO NOT REMOVE OR REPLACE MODULES OR CABLES WHILE ENERGIZED UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITABLE GAS CONCENTRATIONS.

All connecting screws must be securely tightened, so that loosening and separating are prevented.

The chassis alarm contacts must not be used in hazardous locations.

Male ELCO connectors must have a gasket installed, and it must be replaced before the end of its five-year life span. (Triconex part number 3000793-001 is a kit containing 25 gaskets.)

The replacement of batteries, fuses, I/O Modules, Main Processors, Power Modules, Communications Modules, or I/O Interface cables must not be attempted unless the area is known to be free of ignitable gas concentrations.

All communication cabling connected to the Main Processor and Communications modules must be nonincendive as described in Appendix D, Nonincendive Circuit Parameters. Communication cabling that extends through a hazardous area must be certified as being nonincendive.

Only these components, which are approved for use in Zone 2 hazardous locations, can be used:

- 2770H, HART Analog Input Interface Module
- 2870H, HART Analog Output Interface Module
- 3008, Main Processor
- 3503E, 24V Digital Input Module
- 3504E, 24V H.D. Digital Input Module
- 3505E, 24V Low Threshold Digital Input Module
- 3511 Pulse Input Module
- 3515, Pulse Totalizer Module
- 3564, Single 24V Digital Input Module
- 3604E, 24VDC Digital Output Module
- 3624, 24VDC Supervised Digital Output Module

- 3625, 24VDC Supervised/Non-Supervised Digital Output Module
- 3664, 3674; 24V Dual Digital Output Module
- 3700A, 0-5V Analog Input Module
- 3703E, Isolated Analog Input Module
- 3706A, TC Input Module
- 3708E, Isolated TC Input Module
- 3720, 3721; Analog Input Module
- 3805E/H, Analog Output Module
- 3806E, H.C. Analog Output Module
- 3807, BiPolar Analog Output Module
- 4119A, Enhanced Intelligent Communications Module
- 4200, 4201; Fiber Optic Remote Extender Module
- 4210, 4211; Single Mode Fiber Optic Remote Extender Module
- 4351, 4351A, 4351B, 4352, 4352A, 4352B, 4353, 4354; Tricon Communication Module
- 4329, 4329G; Network Communications Module
- 4409, Safety Manager Module
- 4509, Highway Interface Module
- 4609, Advanced Communication Module
- 8110, Main Chassis
- 8112, RXM Chassis
- 8111, Expansion Chassis
- 8121, Enhanced Low Density Expansion Chassis
- 8310, 120 V Power Module
- 8311, 24 VDC Power Module
- v9 External Termination Panels compatible with the above I/O modules



- You must take additional explosion protection measures for field circuits when the field apparatus are in a hazardous area.
- When the Model 8121 Enhanced Low Density Expansion Chassis is used in Zone 2 hazardous locations, the signal ground and the chassis ground must be bridged together.
- In Zone 2 hazardous locations, an isolator must be used with the Model 2870H HART Analog Output Interface Module.

European Union Applications

To ensure compliance with European Low Voltage and EMC Directives, follow these installation guidelines:

- Any Tricon chassis containing an SMM or SRXM must be installed in an EMI/RFI shielded cabinet, and EMI/RFI filtering must be installed on all cables entering or leaving those cabinets. All other chassis can be installed in standard metal enclosures.
- Field power supplies must be approved for use in safety extra-low-voltage (SELV) circuits according to the requirements of EN 61010-1, Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements.

Acceptable EMI/RFI cabinets and cable filters include the following:

- Rittal PS or TS cabinet with EMI/RFI shielding (for example, TS8), or equivalent
- Fair-Rite Products snap-on ferrite suppression cores (type 43 material) or equivalent (a separate snap-on filter is required for each cable entering or leaving the EMI/RFI cabinet)

Fire and Gas Detection Applications

For all fire and gas detection applications, refer to the Tricon *Safety Considerations Guide for Tricon v9-v10 Systems* for additional installation guidelines.

For fire and gas detection applications, redundant field and system power sources and/or supplies must be used.

Functional Safety Applications

For all functional safety applications, refer to the Tricon *Safety Considerations Guide for Tricon v9-v10 Systems* for additional installation guidelines.

Nuclear 1E Applications

For all nuclear 1E applications, contact the IPS Global Client Support (GCS) center for the latest detailed installation instructions.

Only those modules qualified for nuclear 1E applications can be used; contact the IPS Global Client Support (GCS) center for the latest items on the Nuclear Qualified Equipment List (NQEL).

Semiconductor Manufacturing - Health and Safety Applications

For semiconductor manufacturing applications, compliance with these additional installation guidelines is highly recommended:

- Field and logic power supplies should be approved for use in safety extra-low-voltage (SELV) circuits according to the requirements of IEC 61010-1.
- For installations with voltages greater than 30 Vrms/36 VDC, the controller and associated equipment must be installed in a locked cabinet restricting access to trained personnel only, with a hazardous-voltage warning label attached prominently.
- For installations with ambient temperatures exceeding 94° F (35° C), the controller and associated equipment should be installed in a locked cabinet restricting access to trained personnel only, with a hot-surface warning label attached prominently.
- For applications in which continuous, correct system operation must be assured, the controller and associated equipment should be installed in a locked cabinet restricting access to trained personnel only, with a general-hazard warning label attached prominently.

For a physical description of labels, see [Appendix C, Warning Labels](#).

Chassis and Module Installation

This section explains how to mount the chassis, modules, and other Tricon components. When unpacking the Tricon controller, check the items in the package against the shipping list to verify that everything you ordered is included. Keep the boxes and packing materials in case you need to return items to Triconex for any reason.



For ATEX applications, male ELCO connectors must have a gasket installed, and it must be replaced before the end of its five-year life span. (Triconex part number 3000793-001 is a kit containing 25 gaskets.)



The Tricon controller can be repaired while operating. However, the integrity of the controller can only be assured if the operator follows repair procedures correctly. If in doubt about the procedures, the operator should take whatever steps are necessary to ensure the safety of the plant and personnel, then call Triconex for assistance in implementing the repair procedures.

Topics include:

- [Rear-Mounting the Chassis on page 179](#)
- [Rack-Mounting the Chassis on page 179](#)
- [Dimensions and Clearances for Installation on page 180](#)
- [Allowing for Convection Cooling on page 181](#)
- [Connecting Multiple Chassis on page 181](#)
- [Using Slot Covers on page 181](#)
- [I/O Bus Address of Chassis on page 182](#)
- [Power Module Installation on page 184](#)
- [Slot Keys for Modules on page 186](#)
- [Setting the MP Node Setting on page 191](#)
- [Installing Modules on page 192](#)
- [Digital Output Field Wiring Precautions on page 192](#)
- [Pulse Input Installation and Operation on page 192](#)
- [Pulse Input Totalizer Installation and Operation on page 193](#)
- [Thermocouple Input Installation and Operation on page 194](#)
- [Installing Model 3807 BiPolar Analog Output Modules on page 194](#)
- [Installing HART Interface Modules in the Model 8121 Enhanced Low Density Expansion Chassis on page 195](#)
- [Installing HART Interface Modules in Systems Upgraded from v6-v8 on page 199](#)
- [Enclosing the Chassis on page 202](#)

Rear-Mounting the Chassis

Commonly, one or more Tricon chassis are rear-mounted on a subplate with the mounting brackets installed at the rear of the chassis. The subplate is then put into a 20 inches (51 centimeters) deep industrial enclosure built to NEMA Type 12 specifications. A Tricon chassis (either the Main Chassis or an Expansion Chassis) requires a footprint of 19 inches wide by 22.75 inches high (48.3 centimeters wide by 57.8 centimeters high) on a subplate or panel.

Rack-Mounting the Chassis

A Tricon chassis can be rack-mounted on a standard 19 inches (47.5 centimeters) EIA (Electronics Industries Association) Standard #RS-310-C rack by installing the mounting brackets at the front of the chassis. When there is more than one Tricon chassis in an enclosure, Triconex recommends having at least 1.75 inches (4.45 centimeters) vertical clearance between them for cables. [Figure 71](#) shows dimensions and clearances for Tricon chassis installation.

Triconex offers auxiliary Chassis Mounting Brackets (model 8405) for rack-mounted installations. This pair of brackets provides additional rear support to the chassis during shipment of pre-mounted chassis enclosure controllers.

CAUTION

- Auxiliary mounting brackets are intended only to provide additional support at the rear of a front rack-mounted chassis. Do not use auxiliary brackets in place of Triconex-supplied standard chassis-mounting brackets.
- Do not tighten the hex head screws securing the adjustable mounting brackets to the rear of the chassis until you have fully secured the chassis by the front mounting brackets and secured the auxiliary brackets to the rear mounting rails. Failure to comply with this procedure could result in a deformed chassis which can cause improper seating of modules.

Dimensions and Clearances for Installation

This figure shows the dimension of the chassis and the required clearances. When mounting a chassis into vented or unvented enclosures, sufficient clearance must be provided so that the ambient temperature of the Tricon controller is not exceeded. For more information, see [Allowing for Convection Cooling on page 181](#).

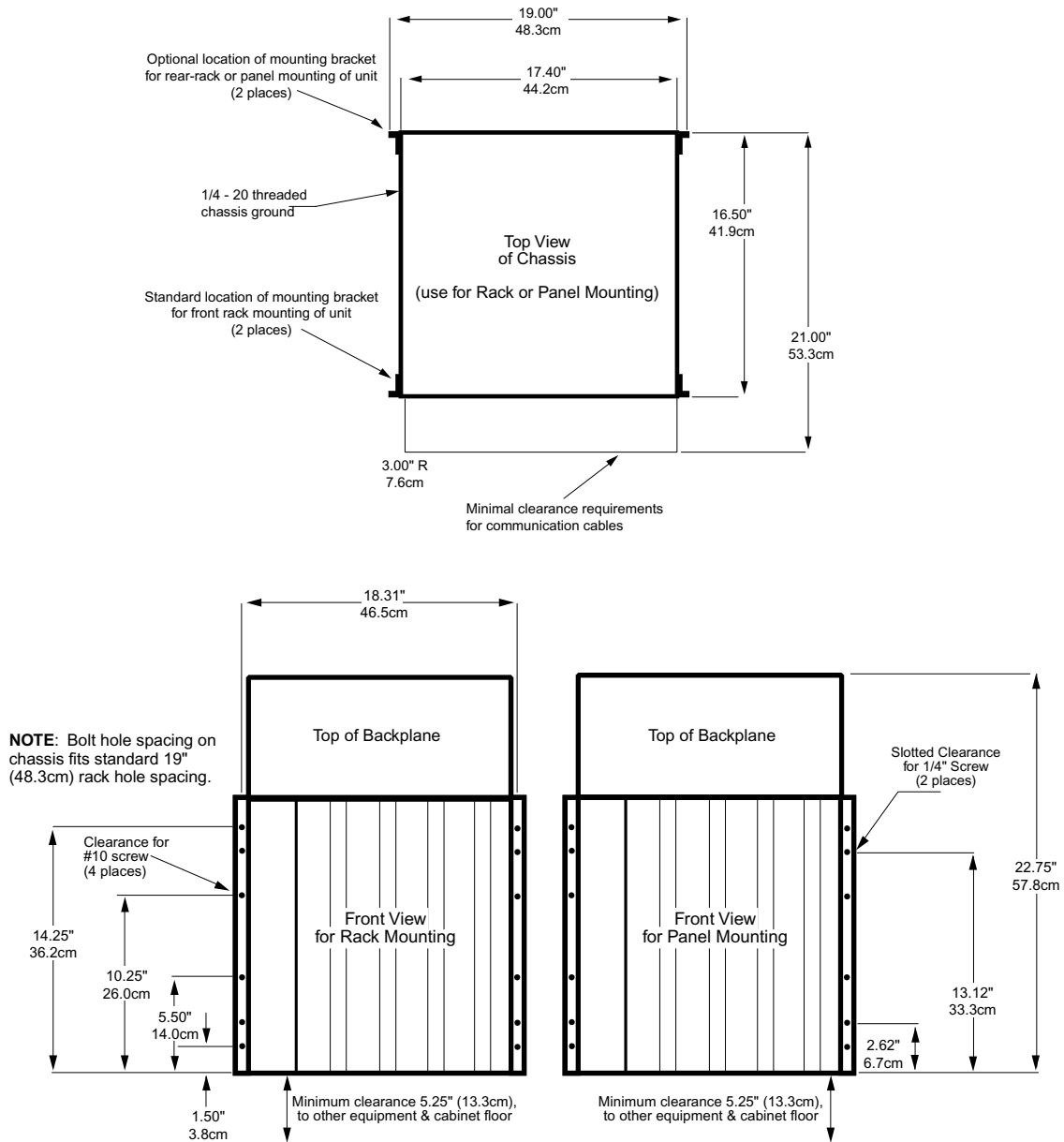


Figure 71 Dimensions and Clearances for Chassis Installation

Allowing for Convection Cooling

Whether the chassis is rack-mounted or panel-mounted, allow at least 5.25 inches (13.3 centimeters) between the outer panels of the Tricon chassis and the top and bottom panels of the enclosure. This space allows adequate convection cooling for all the chassis in the enclosure, and an acceptable ambient temperature for the Tricon chassis located at the top of the enclosure. Except under extraordinary circumstances, such as an ambient temperature above 140° F (60° C), no additional cooling or fans are required.

When mounting a chassis into vented or unvented enclosures, you must provide for heat management so that the specified ambient temperature of the Tricon controller is not exceeded.

For additional information about cooling, please contact the IPS Global Client Support (GCS) center.

Connecting Multiple Chassis

When a system requires more than a Main Chassis, each additional chassis must be connected by using a set of three cables that allow a physical extension of the triplicated I/O bus. Each chassis includes six I/O ports, which means each chassis can be connected to two other chassis. The communication speed between the I/O ports is 375 kilobits per second, which is the same rate as the internal Tricon controller I/O bus. This means the three control channels are physically and logically extended to the Expansion Chassis without sacrificing performance.

These cables can be used:

- Model 9000 is the I/O Bus Expansion Cable used to connect Expansion Chassis or a primary RXM Chassis to the Main Chassis.
- Model 9001 is the I/O COMM Bus Expansion Cable used when communication modules are housed in Expansion Chassis 2. The I/O communication cables are available only in a length of six feet.

If the distance between chassis is greater than 100 feet (30 meters), fiber-optic cables can be used to connect to an RXM Chassis.

Using Slot Covers

All unused chassis slots should be covered with Blank I/O Slot Panels (model 8105) to minimize exposure to dust and other particulate matter.

I/O Bus Address of Chassis

The I/O bus address identifies the chassis number in a Tricon system and is set with jumpers on the backplane. Typically, each Tricon chassis shipped from the factory has a different address for each chassis based on the sales order.

The address of the Main Chassis is always set to 1 and should not be changed. The address of an Expansion or RXM Chassis can be from 2 to 15. If necessary, Triconex recommends the chassis be returned to the factory to change the setting.

This figure shows the location of the jumpers on the backplane and an example of the jumper settings. [Table 71 \(on page 183\)](#) shows the binary addresses and jumper settings for each address.

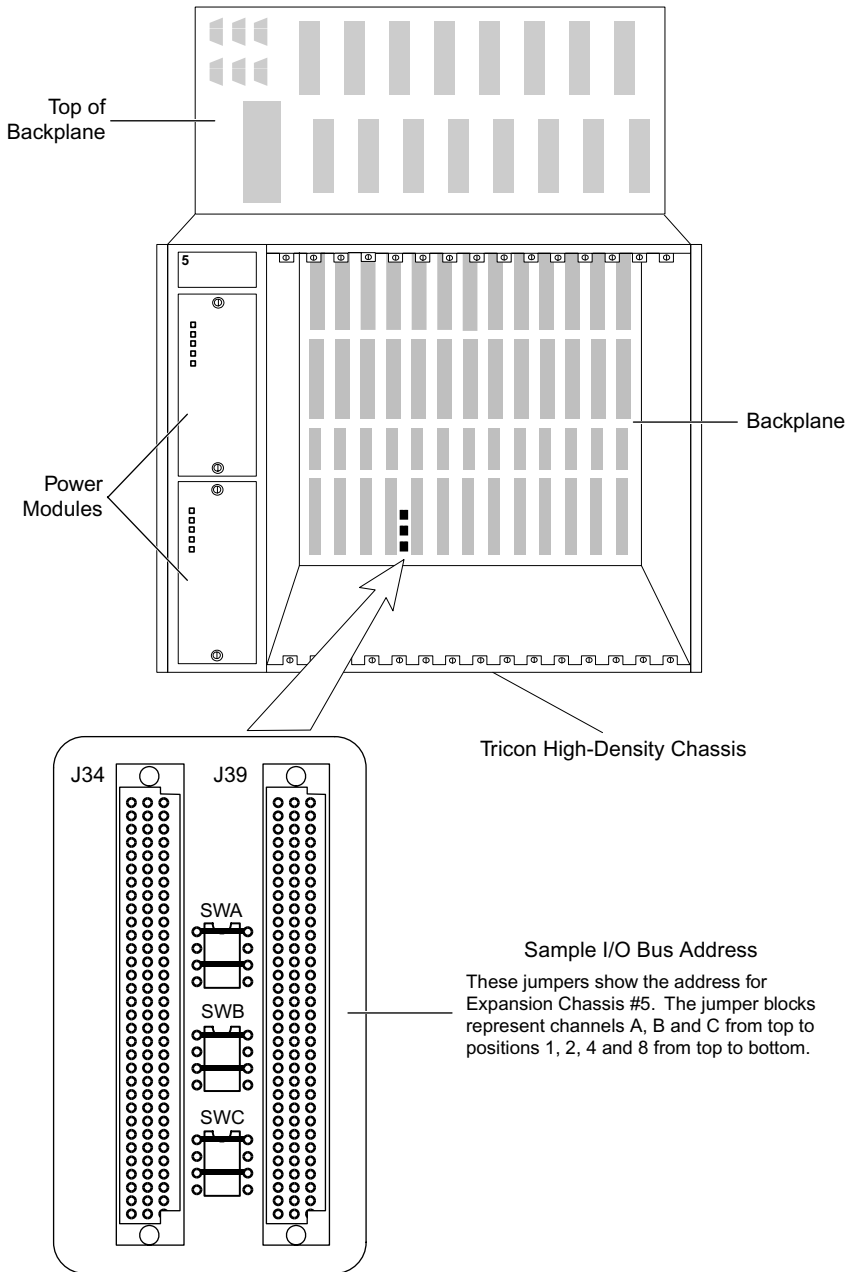

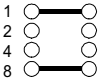

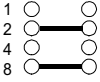

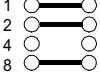

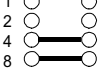

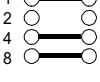

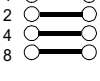

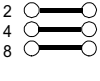



Figure 72 Example of I/O Bus Address for Chassis 5

Jumper Settings for the I/O Bus Address

The I/O bus address is represented as a binary number which is set on three jumper blocks on the backplane of the chassis. This table lists the binary number for each chassis address and shows the jumper installation for the setting.

Table 71 I/O Bus Address in Binary and as a Jumper Setting

Chassis Address	Address in Binary	Jumper Setting	Chassis Address	Address in Binary	Jumper Setting
1	0001		9	1001	
2	0010		10	1010	
3	0011		11	1011	
4	0100		12	1100	
5	0101		13	1101	
6	0110		14	1110	
7	0111		15	1111	
8	1000				

Power Module Installation

Each Tricon chassis (Main, Expansion, and RXM) includes two Power Modules, which can be any combination of models (8310, 8311, or 8312). Under normal circumstances, both Power Modules are active, and each contributes power to the Tricon controller; only the Pass and Status indicators are On. Either Power Module is capable of running the Tricon controller for an indefinite length of time.

If one of the Power Modules or its supporting power line fails, the second module increases its output to maintain power for the Tricon controller. If incoming power is interrupted or if one of the modules fails, its Fault indicator goes On. You can disconnect a failed Power Module from field power, remove it from the Tricon controller chassis, and replace it without shutting down the Tricon controller.

A minimum of 240 watts of incoming power is required for each Power Module in a chassis.

CAUTION

To maintain the security and integrity, source each Power Module separately, and provide independent circuit breakers or switches for each circuit.

Alarm Circuitry on Power Modules

The alarm circuitry on each Power Module operates independently. You should wire the warning system in a dual-redundant configuration, so that activation does not depend upon power from only one power source. This figure provides an example of this type of wiring.

WARNING

Do not use alarm contacts in hazardous locations.

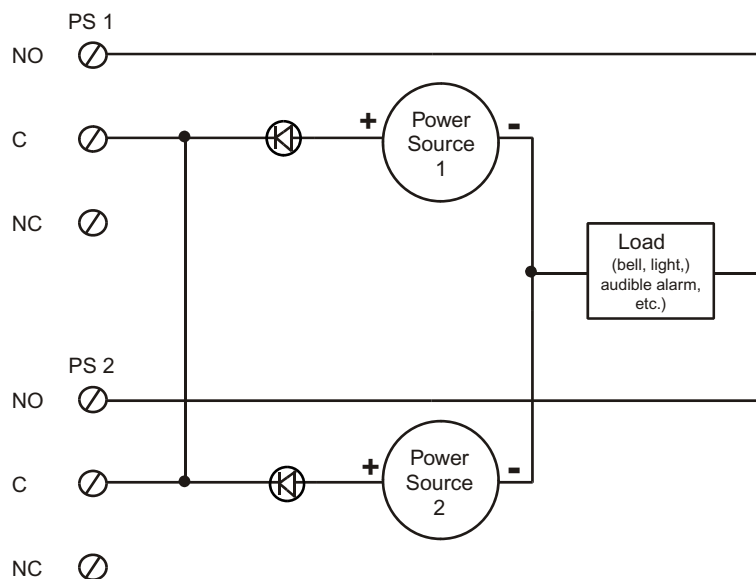


Figure 73 Alarm Sample Wiring

For specifications, see [Power Modules on page 33](#).

Wiring to Separate Power Source

To ensure the advantages of dual redundant and independent Power Modules, each Power Module should be wired to a separate power source. Wiring to a separate power source permits the replacement of one Power Module, without interrupting field power to the other, so that the Tricon controller can continue operations without a break in service.

The terminals for incoming power and alarm applications are on the backplane above the Power Modules.

Each independent power source, equipped with its own fuse and switch, can be shared by multiple Tricon controller chassis. You should connect every chassis to two independent power sources.

Wiring to a UPS

In critical applications, it is best to connect at least one Power Module to an Uninterruptible Power Supply (UPS) which can be shared by multiple Tricon chassis. The UPS must be rated for the total number of chassis to be powered, and for the duration of the maximum expected down time.

Supply Wiring Specifications

Supply wiring should be sized according to applicable local electrical codes, taking into account the current ratings (as specified in [120 Volt Power Module Specifications on page 36](#)), temperatures, wiring lengths, and other applicable considerations.



Do not operate the Tricon controller without a safety earth.

Alarm Wiring

Each system includes two sets of redundant alarm contacts, one per Power Module, that can be specified as needed. Typically, alarm wiring is connected to a local or remote annunciator. These devices can be wired in parallel with the alarm wiring so that the designated alarm goes off whenever either Power Module signals an alarm condition.



Do not use alarm contacts in hazardous locations.

These are the alarm contacts:

- Normally open contact
- Common
- Normally closed contact

This figure shows typical power wiring.

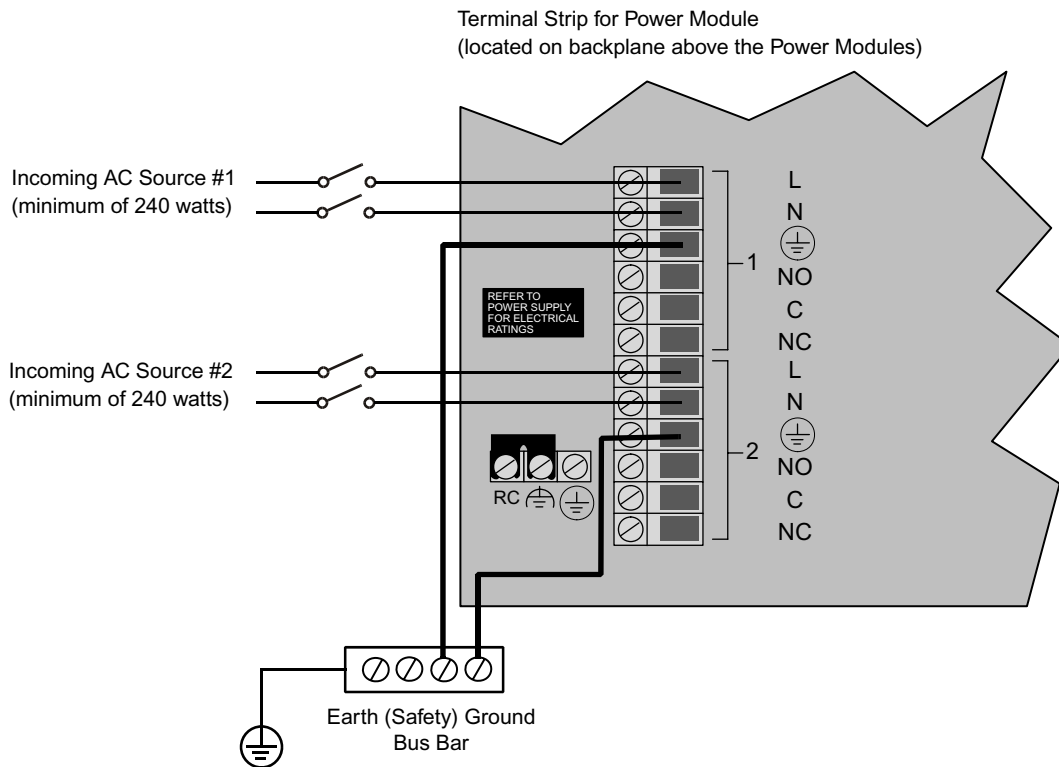


Figure 74 Typical Power Module Wiring

Slot Keys for Modules

Each slot in the Tricon chassis is fitted with metal slot keys to restrict the type of module that can be installed. The keys correspond to slotted spaces on each module. The spacers are located about 2 inches (5 centimeters) in from the module front panel between the aluminum spine and the printed circuit board. All modules of a particular type, for example, all 24-volt Digital Input Modules, are identically keyed.

If you try to install a module in an incorrect slot, the module does not slide the last 5 cm (2 in) into the chassis. *Do not apply force to overcome the obstruction caused by the keys.*

Installing Power Module Keys

Each Power Module slot is fitted at the top with a key that allows only one type of module to be installed. If you replace the installed Power Modules with a different voltage model, you must install the appropriate keys for the new modules. To do so, remove the screws for the existing keys and pull the keys off their shelves. Then place each new key onto its shelf, insert the two screws, and screw them upward from the bottom of the shelf.

Table 72 Power Module Key Positions

Model	Module Name	Top Key
8310	120 VAC/VDC Power Module	001
8311	24 VDC Power Module	003
8312	230 VAC Power Module	004

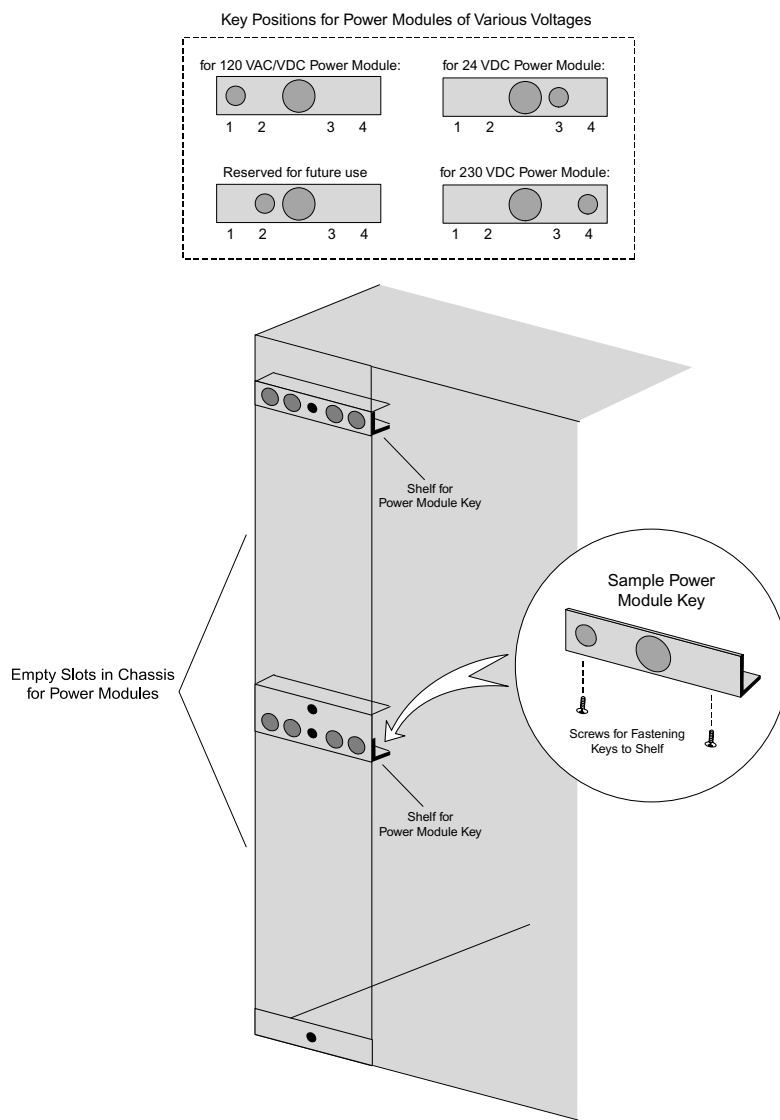


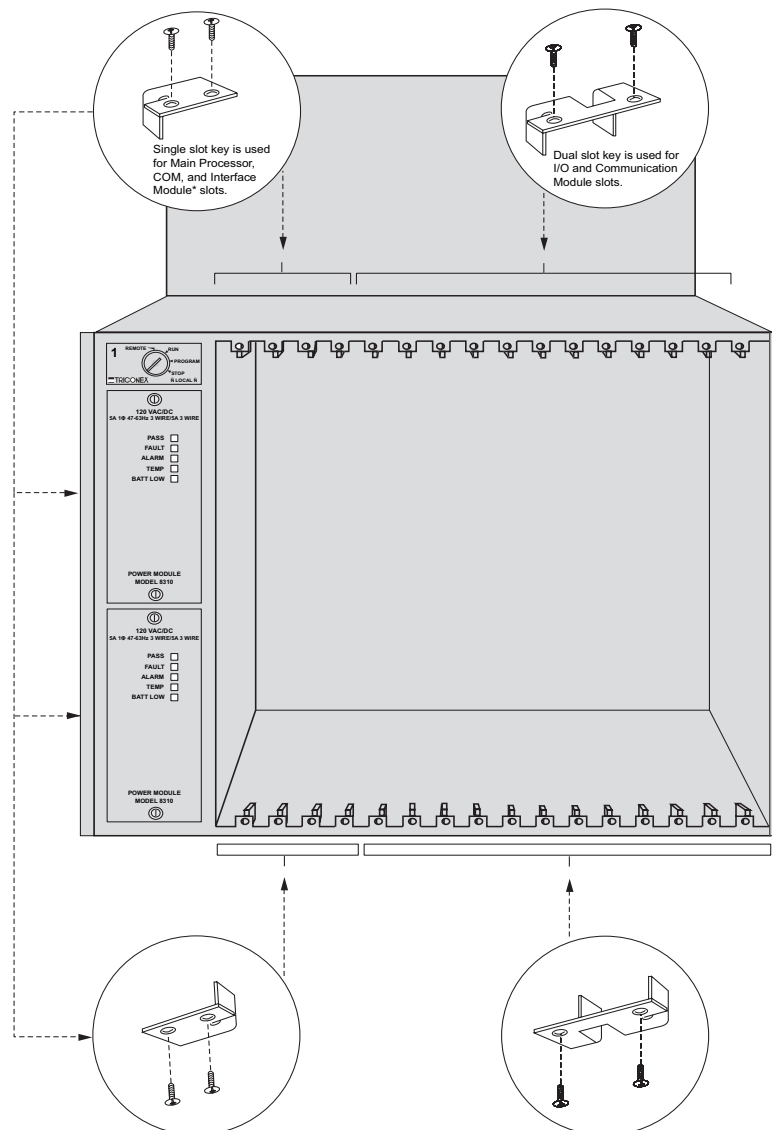
Figure 75 Power Module Key Positions

Installing Single and Dual Keys

Each Main Processor slot, COM slot, and Interface Module slot is fitted at the top and bottom with single keys. Each I/O and Communication Module slot is fitted at the top and bottom with dual keys.

To install a new module that uses different keys, remove the screws for the existing keys, then install the keys that come with the new module. Screw the keys for the top of the slot downward through the top of the chassis; screw the keys for the bottom of the slot upward from the bottom of the chassis, as shown in this figure.

For slot key numbers by module, see [Slot Key Numbers on page 189](#).



*Interface Modules cannot be installed in a Model 8110 Main Chassis—they are mentioned in this figure for illustrative purposes only. See the "HART Interface Modules" section for chassis compatibility.

Figure 76 Keys for Single and Dual Slots

Slot Key Numbers

This table lists the keys for Main Processors and the COM (used for TCM, EICM, or NCM) slots.

Table 73 Main Processor, COM, and Blank Slot Keys

Model	Module Name	Top Key	Bottom Key
3008	Main Processor (MP) Module	007	002
3006, 3007	Main Processor (MP) Module	007	007
	COM Slot (TCM, EICM, or NCM)	001	003
	Blank Logical Slot ¹	001	008

1. Use this key combination or part number 2000508-001 to prevent the insertion of modules into any unused slots in your controller.

This table lists the keys for I/O and communication module slots.

Table 74 I/O and Communication Module Slot Keys

Model	Module Name	Top Key	Bottom Key
3501E/T	115 VAC/DC Digital Input (TMR)	004	004
3502E	48 VAC/DC Digital Input with Self-Test (TMR)	004	005
3503E	24 VAC/DC Digital Input with Self-Test (TMR)	004	006
3504E	24 VDC /48 VDC High Density Digital Input (TMR)	004	007
3505E	24 VDC Low Threshold Digital Input with Self-Test (TMR)	004	006
3510	Pulse Input, AC Coupled (TMR)	004	001
3511	Pulse Input, AC Coupled (TMR)	004	001
3515	Pulse Totalizer Input	004	002
3564	24 VDC Digital Input (Single)	004	006
3601E/T	115 VAC Digital Output (TMR)	006	004
3603B	120 VDC Digital Output (TMR), non-commoned	006	006
3603E/T	120 VDC Digital Output (TMR), commoned	006	006
3604E	24 VDC Digital Output (TMR)	006	007
3607E	48 VDC Digital Output (TMR)	006	003
3611E	115 VAC Supervised Digital Output (TMR)	005	002
3613E	120 VDC Supervised Digital Output (TMR)	005	005
3614E	24 VDC Supervised Digital Output (TMR)	005	004
3615E	24 VDC Low-Power Supervised Digital Output (TMR)	005	004
3617E	48 VDC Supervised Digital Output (TMR)	005	003
3623/T	120 VDC Supervised Digital Output (TMR)	005	005

Table 74 I/O and Communication Module Slot Keys (continued)

Model	Module Name	Top Key	Bottom Key
3624	24 VDC Supervised Digital Output (TMR)	005	004
3625	24 VDC Supervised or Non-Supervised Digital Output (TMR)	006	007
3664/3674	24 VDC Digital Output (Dual)	006	007
3636R	Relay Output, N0 (SIMPLEX)	006	002
3700	0-5 VDC Analog Input (TMR)	003	004
3700A	0-5 VDC Analog Input (TMR)	003	006
3701	0-10 VDC Analog Input (TMR)	003	003
3703E	0-5, 0-10 VDC Isolated Analog Input (TMR)	005	006
3704E	0-5, 0-10 VDC High Density Analog Input (TMR)	006	008
3706A	Non-Isolated Thermocouple Input (TMR)	003	002
3708E	Isolated Thermocouple Input (TMR)	005	007
3720	0-5 VDC Single-Ended Analog Input (TMR)	006	008
3721	0 to 5 or -5 to +5 VDC Differential Analog Input (TMR)	003	004
3805E/H	4-20 mA Analog Output (TMR)	003	008
3806	6 outputs @ 4-20mA, 2 outputs @ 8-320 mA, Analog Output (TMR)	003	008
3807	-60 to +60 mA BiPolar Analog Output (TMR)	003	008
4119	Enhanced Intelligent Communication (EICM)	001	003
4119A	Enhanced Intelligent Communication (EICM)	001	003
4200-3	Primary RXM Multi-Mode Fiber-Optic Module Set	002	003
4201-3	Remote RXM Multi-Mode Fiber-Optic Module Set	002	003
4210-3	Primary SRXM Single-Mode Fiber-Optic Module Set	002	003
4211-3	Remote SRXM Single-Mode Fiber-Optic Module Set	002	003
4329, 4329G	Network Communication (NCM) and NCMG (GPS)	001	003
4351, 4351A, 4351B, 4352, 4352A, 4352B, 4353, 4354	Tricon Communication Module (TCM)	001	003
4409	Safety Manager Module (SMM)	001	003
4509E	Hiway Interface Module (HIM)	001	004
4609	Advanced Communication Module (ACM)	001	003

This table lists the keys for interface module slots.

Table 75 Interface Module Slot Keys

Model	Module Name	Top Key	Bottom Key
2770H	HART Analog Input Interface Module	005	006
2870H	HART Analog Output Interface Module	005	004

Setting the MP Node Setting

The SW1 and SW0 settings on the front panel of the MP identify the node of the controller on a network. The factory setting is node 1, which is SW1=0 and SW0=1. The setting can be from 1 to 31. The MP node setting must match the node setting for the communication module (ACM or NCM). You must also ensure the node setting is configured in TriStation. TCMs automatically obtain the node setting from the MP.

CAUTION

The node setting for the MP, ACM, or NCM, and TriStation configuration must match.

This table identifies the possible node settings.

Table 76 Main Processor Node Settings

Node Number	SW1	SW0	Node Number	SW1	SW0
1	0	1	17	1	1
2	0	2	18	1	2
3	0	3	19	1	3
4	0	4	20	1	4
5	0	5	21	1	5
6	0	6	22	1	6
7	0	7	23	1	7
8	0	8	24	1	8
9	0	9	25	1	9
10	0	A	26	1	A
11	0	B	27	1	B
12	0	C	28	1	C
13	0	D	29	1	D
14	0	E	30	1	E
15	0	F	31	1	F
16	1	0			

Installing Modules

This procedure explains how to install a module.

Procedure



Do not install more than one module at the same time. You must push the first module in and wait until the Active indicator goes on, then install the next module.

- 1 Ensure that the slots have been fitted for the appropriate module. For details, see [This table lists the keys for I/O and communication module slots. on page 189.](#)
- 2 Install the module and push the module in until it is firmly seated. Tighten the retractable fasteners of the module to 10 inch-pounds.
- 3 If using a redundant module, install an identical type module in the empty slot and push the module in until it is firmly seated. Tighten the retractable fasteners of the module to 10 inch-pounds.

Digital Output Field Wiring Precautions

When installing field wiring for Digital Output Modules, Triconex recommends that you do not make parallel connections or series connections to digital output points. These types of connections can cause the commanded state and the measured state of points to disagree, resulting in Load/Fuse alarms and limited effectiveness of Output Voter Diagnostics (OVD).

For more information about OVD, see [Disabling Output Voter Diagnostics on DO Modules on page 214.](#)

Pulse Input Installation and Operation

Pulse Input Modules include these requirements for proper operation.

Installation Requirements

- Wire each point with individually shielded, twisted-pair cable. Keep the wire as short as possible. Connect the shield to earth ground at the sensor *or* the controller. Where possible, route the cable away from all noise sources.
- To minimize signal reflections, put a termination resistor (1 to 10 kilohms) on each input signal. Mount the termination resistor at the termination panel across the positive (+) and negative (-) input terminals.
- Short together the positive (+) and negative (-) terminals of all unused inputs.

Using with Amplified Sensors or Laboratory Pulse Generators

- Where possible, use an amplifier or pulse generator with a fully balanced output (an isolated output stage). When using an amplified speed sensor, a lower-value termination resistor is acceptable (50 to 150 ohms).

- If the output stage of the amplifier is not isolated, use a dedicated power source to power the amplifier allowing the output of this supply to float with respect to ground. This simulates an amplifier with an isolated output.

If you cannot obtain a floating output, you must assure a solid signal-ground connection between the amplifier and the module. Connect the return side of the amplifier power source (its signal return point) to the PS1- terminal on the external termination panel.

Pulse Input Totalizer Installation and Operation

Pulse Totalizer Input Modules include these requirements for proper operation.

Installation Requirements

- Initially, the control program must clear the counters before you can obtain accurate counts. The initial power-up count is 2147479552. However, this does not apply to your hot-spare module, which re-educates its count from the active module.
- Connect each point with individually shielded, twisted-pair cable, keeping the cable as short as possible. Connect the shield to earth ground at the sensor or at the Tricon controller chassis. Where possible, route the cable away from all noise sources.
- If possible, avoid unshielded, multi-twisted-pair cable with an overall outer shield only. If this type of cable is used, cable length should be limited to 50 feet to minimize point-to-point cross-talk that can occur inside the cable bundle.
- The PTI module is designed to count pulses up to 1 KHz, which is in the frequency range of some types of EMI, such as lightning. Excessive EMI, coupled directly into the PTI point inputs or coupled through poorly grounded cable shields may cause inaccurate count readings and false indications of PTI module faults. This type of fault can be cleared by issuing a counter reset from the control program and then using the TriStation Diagnostic Panel to clear the fault.
- Short together the positive (+) and negative (-) terminals of all unused inputs, or keep unused counters cleared by means of control program instructions.
- Connect PTI module points to solid state sensors, preferably the push-pull output type. Do not connect PTI module points to mechanical relay or switch contacts, because mechanical contact bounce may cause inaccurate count readings and false indications of faults.
- If you use high-side or low-side solid state switches to drive PTI module points instead of a push-pull output, the maximum count frequency may be reduced in proportion to the cable length.
- Do not exceed the maximum count rate by more than 10% or induce glitches to the points. Excessive frequency or glitches cause inaccurate count readings and false indication of faults.

Proof Testing for Counter Overflow

When a counter overflows, its value becomes negative. You can test this condition quickly by installing the PTI module in a Tricon controller chassis without a hot-spare module and not allowing the control program to reset the counter values to zero. After the PTI module powers up and passes its self-test, it initializes its counters to 2147479552 – only 4096 counts away from overflow.

Thermocouple Input Installation and Operation

Thermocouple Modules include these requirements for proper operation.



- Proper operation of a Thermocouple Input Module requires that you install and connect its field termination panel. Otherwise, fault conditions occur. Unused thermocouple inputs should be shorted.
- On the Non-Isolated Thermocouple Module, a Fault condition may be caused by a faulty cold-junction transducer. If the fault is not fixed by replacing the module, then replace the field termination module.

For fault indicators, see [CJ \(Cold Junction\) Indicator](#) on page 238.

Installing Model 3807 BiPolar Analog Output Modules

The 3807 BiPolar Analog Output Module includes this requirement for proper operation.



If the I/O cable (the cable that connects the termination panel to the Tricon backplane) is routed outside the cabinet that houses the Tricon chassis, the I/O cable should be routed in a metal conduit.

Installing HART Interface Modules in the Model 8121 Enhanced Low Density Expansion Chassis

To prepare the Model 8121 Enhanced Low Density Expansion Chassis for installation of HART interface modules, mount, power, and ground the chassis the same as you would for any other Tricon chassis, as described throughout this chapter.

Use the Model 9000 I/O Bus Expansion Cable to connect the I/O bus between chassis.



The Model 9001 I/O COMM Buss Expansion Cable *cannot* be used in the 8121 Low Density Expansion Chassis. HART Interface Modules use channel C COMM bus lines for RS-485 communication and connecting them outside the chassis will interfere with the COMM bus and HART communication.

This figure shows an example of HART Communication using HART Interface Modules installed in the Model 8121 Enhanced Low Density Expansion Chassis.

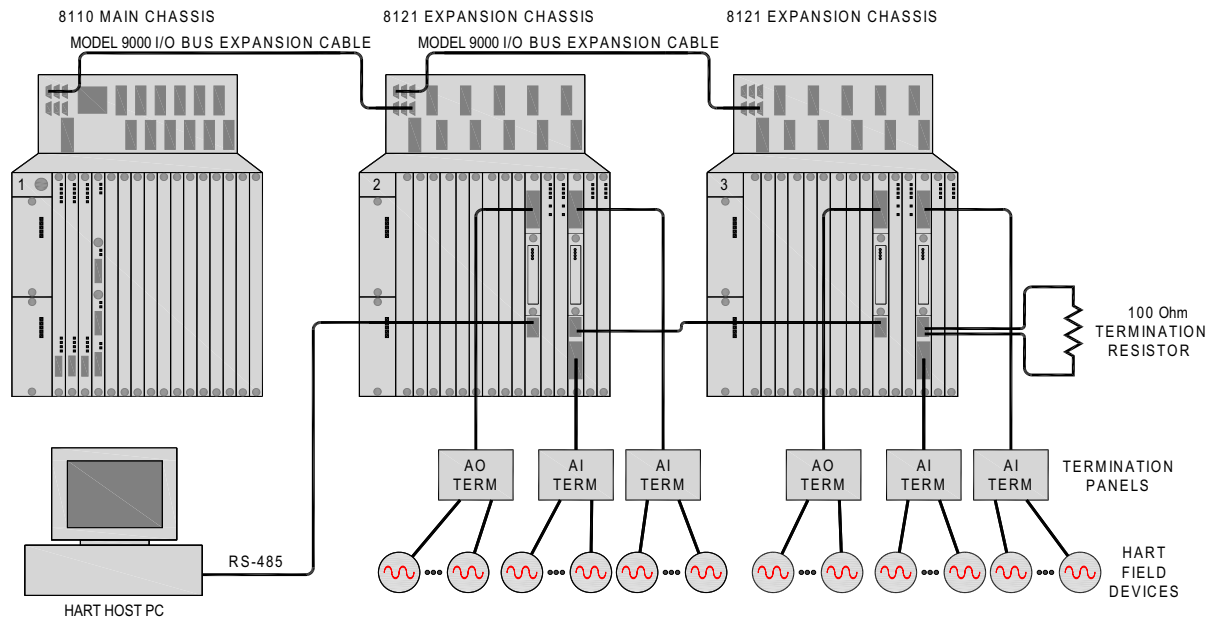


Figure 77 Typical HART Installation Using Model 8121 Enhanced Low Density Expansion Chassis

Attach interface cables from termination panels to the ELCO connectors on the front of the HART Interface Modules.

Note Analog Input Interface modules in Model 8101 Low Density Expansion Chassis used an Amp connector. To allow for the replacement of Model 8101 Low Density Expansion Chassis with Model 8121 Enhanced Low Density Expansion Chassis with no modifications to existing wiring, an adapter cable (4000171-002) is available.

CAUTION

The ELCO connectors at the top of the chassis will provide a connection for the 4-20 mA signals to and from the AI and AO modules; however, they will not provide a path for HART communication. Always make field connections to the front of the HART Interface Modules for HART communication.

WARNING

For ATEX applications, male ELCO connectors must have a gasket installed, and it must be replaced before the end of its five-year life span. (Triconex part number 3000793-001 is a kit containing 25 gaskets.)

As shown in [Figure 77](#), communication with the HART host PC is made using an RS-485 connection to the first HART Interface Module in the first expansion chassis, a connection between all subsequent chassis, and a terminating resistor on the final chassis. No interconnection between HART Interface Modules in the same chassis is needed because the RS-485 connection is made over the Model 8121 Enhanced Expansion Chassis backplane.

The RS-485 connector on HART Interface Modules has 6 contacts; A, B and RS-485 ground for input and output. Connect the RS-485 ground to chassis ground unless there is a potential difference between the chassis ground and the RS-485 ground of the HART controller.

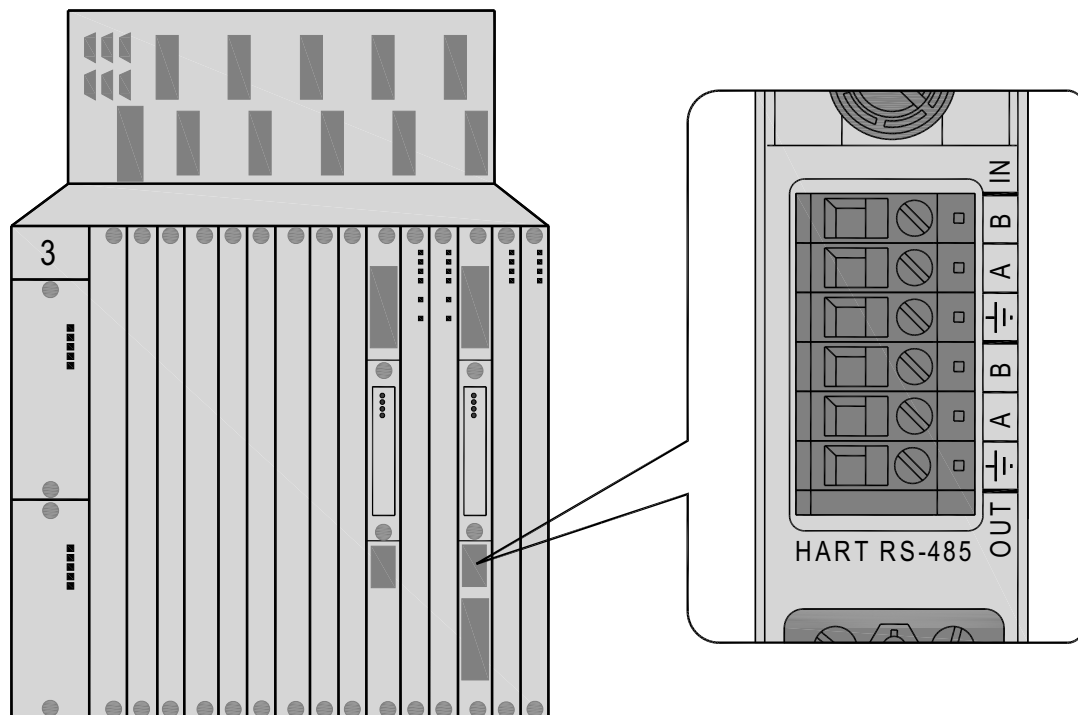


Figure 78 HART Interface Module RS-485 Connector

When using the Model 8121 Enhanced Expansion Chassis, the RS-485 port address of the HART host PC is determined by the number of the Expansion Chassis (see [I/O Bus Address of Chassis on page 182](#)) and the slot number that the connected HART Interface Module is in.

Port addresses may only be in the range of 0-63 and a Tricon system may accommodate a maximum of 70 HART interface modules, so it is not possible for a single RS-485 network to

accommodate all of the chassis in a full Tricon system. Table 77 (on page 197) shows that the addresses for chassis 1-7 are repeated in chassis 9-15.

Table 77 RS-485 Port Addresses

Chassis Number	Slot Number	Port Address	Chassis Number	Slot Number	Port Address
1 ¹	1	8	8	4	3
1 ¹	2	9	8	5	4
1 ¹	3	10	9	1	8
1 ¹	4	11	9	2	9
1 ¹	5	12	9	3	10
2 ²	1	16	9	4	11
2 ²	2	17	9	5	12
2 ²	3	18	10	1	16
2 ²	4	19	10	2	17
2 ²	5	20	10	3	18
3	1	24	10	4	19
3	2	25	10	5	20
3	3	26	11	1	24
3	4	27	11	2	25
3	5	28	11	3	26
4	1	32	11	4	27
4	2	33	11	5	28
4	3	34	12	1	32
4	4	35	12	2	33
4	5	36	12	3	34
5	1	40	12	4	35
5	2	41	12	5	36
5	3	42	13	1	40
5	4	43	13	2	41
5	5	44	13	3	42
6	1	48	13	4	43
6	2	49	13	5	44
6	3	50	14	1	48
6	4	51	14	2	49
6	5	52	14	3	50

Table 77 RS-485 Port Addresses (*continued*)

Chassis Number	Slot Number	Port Address	Chassis Number	Slot Number	Port Address
7	1	56	14	4	51
7	2	57	14	5	52
7	3	58	15	1	56
7	4	59	15	2	57
7	5	60	15	3	58
8	1	0	15	4	59
8	2	1	15	5	60
8	3	2			

1. In a Tricon v10.x system that contains a Model 8110 Main Chassis, chassis 1 is available only as a main chassis with no physical slots for interface modules. In a system that has been upgraded from v6-v8 and contains an older main chassis, the main chassis *does* have logical slots with physical slots for interface modules and can accept HART Interface Modules.
2. Chassis 2 may be used with HART Interface modules unless it contains communication modules.

**WARNING**

If RS-485 port addresses are duplicated on a network there will be failures in communication with the HART controller. Be sure to design a Tricon system with HART Interface Modules that do not duplicate port addresses. Note that the addresses for chassis 1 through 7 are repeated in chassis 9 through 15.

For information on HART communication and the Triconex 4850 HART Multiplexer (a component in the HART Interface Modules), including PC software installation and configuration, see the Triconex 4850 HART Multiplexer Instruction Manual.

If you are using HART communication in a safety-related application, see the *Safety Considerations Guide for Tricon v9-v10 Systems* for more information.

Installing HART Interface Modules in Systems Upgraded from v6-v8

In Tricon systems that have been upgraded from v6-v8, these chassis are compatible with HART Interface Modules:

- Model 8100-x Main Chassis
- Model 8101 Low Density Expansion Chassis
- Model 8102 RXM Expansion Chassis

Throughout this section, the chassis above are referred to as “HART compatible chassis.”

The HART compatible chassis provide only power, ground, and field connections to interface modules. They do not connect the RS-485 signal over the backplane, so each HART Interface Module must have a connection from the previous module and a connection to the next module as shown in this figure.

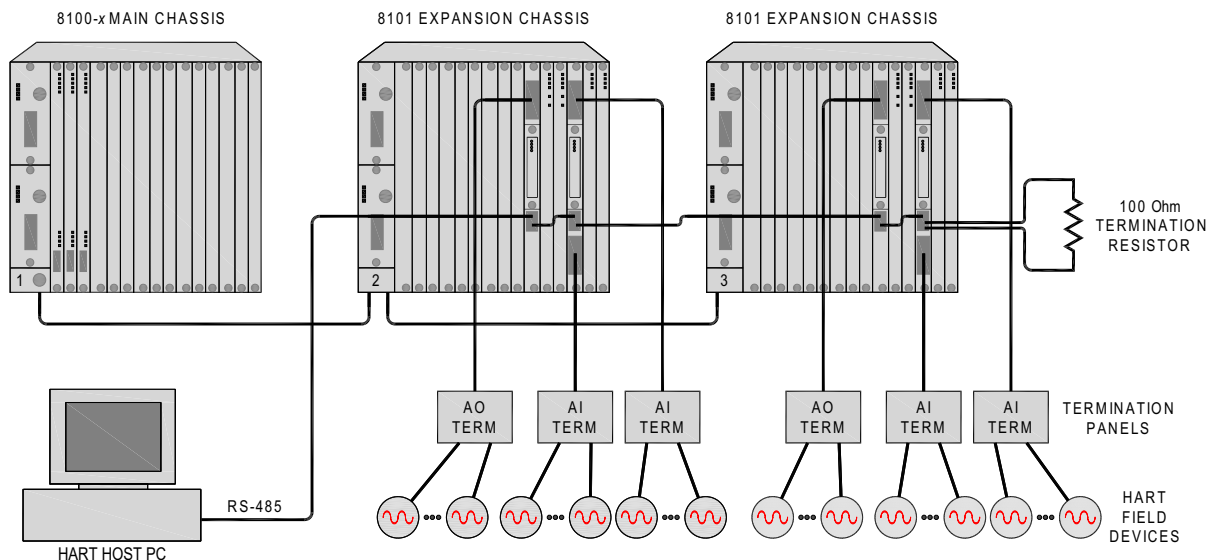


Figure 79 Typical HART Installation Using Model 8101 Low Density Expansion Chassis

There are no restrictions on the type of chassis or the type of modules that may share a chassis with the HART Interface Modules because the COMM bus is not connected to the HART Interface Modules. Also, there are no restrictions on the type of cable that may interconnect chassis.

The HART compatible chassis do not provide interface modules with the chassis and slot addresses for determining the RS-485 port address for the HART multiplexer (MUX). In these chassis, the chassis and slot addresses are set with DIP switches on the 2071H HART MUX Module, a removable sub-component of the HART Interface Module. The DIP switches are set correctly at the factory, but if a MUX Module needs to be replaced, the DIP switches can be set by the user.

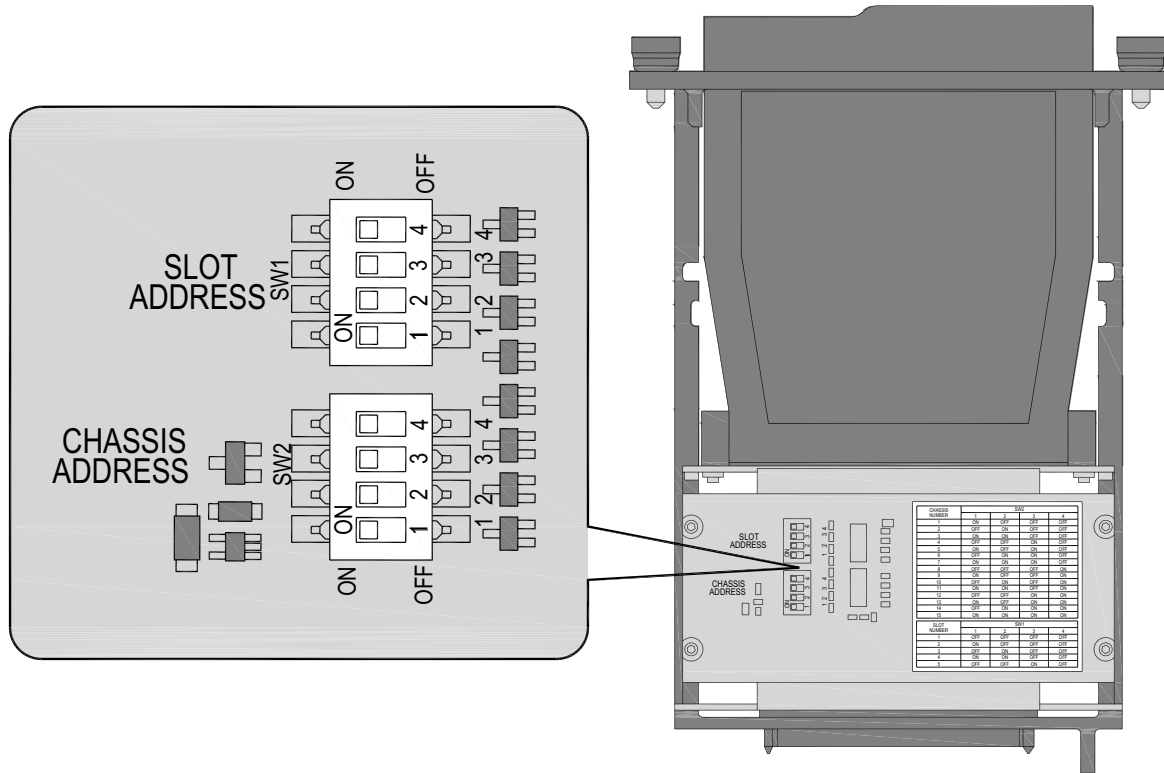


Figure 80 2071H HART MUX Module Slot and Chassis Addressing

There are two DIP switches in the HART MUX Module; one sets the slot address and one sets the chassis address. On the circuit board, the slot address DIP switch is marked “SW1” and “SLOT ADDRESS” and the chassis address DIP switch is marked “SW2” and “CHASSIS ADDRESS.” Each DIP switch has four switches numbered 1 through 4. The “ON” and “OFF” directions for the switches are marked on the switch itself and on the circuit board next to each switch.

Table 78 (on page 201) shows the correct slot address switch settings and Table 79 (on page 201) shows the correct chassis address switch settings. Once the DIP switches are set correctly the RS-485 port address will be as indicated in Table 77 (on page 197).

Table 78 Slot Address DIP Switch Settings

Slot Address	SW1			
	1	2	3	4
1	OFF	OFF	OFF	OFF
2	ON	OFF	OFF	OFF
3	OFF	ON	OFF	OFF
4	ON	ON	OFF	OFF
5	OFF	OFF	ON	OFF

Table 79 Chassis Address DIP Switch Settings

Chassis Address	SW2			
	1	2	3	4 ¹
1	ON	OFF	OFF	OFF
2	OFF	ON	OFF	OFF
3	ON	ON	OFF	OFF
4	OFF	OFF	ON	OFF
5	ON	OFF	ON	OFF
6	OFF	ON	ON	OFF
7	ON	ON	ON	OFF
8	OFF	OFF	OFF	ON
9	ON	OFF	OFF	ON
10	OFF	ON	OFF	ON
11	ON	ON	OFF	ON
12	OFF	OFF	ON	ON
13	ON	OFF	ON	ON
14	OFF	ON	ON	ON
15	ON	ON	ON	ON

1. At the time of this writing, DIP switch 4 is not used for RS-485 port addressing but Triconex recommends that you set it to ON for chassis 8 through 15.



- If RS-485 port addresses are duplicated on a network there will be failures in communication with the HART controller. Be sure to design a Triconex system with HART Interface Modules that does not duplicate port addresses. Note that the addresses for chassis 1 through 7 are repeated in chassis 9 through 15.
- The RS-485 port addresses are determined by the slot address switches and switches 1, 2, and 3 of the chassis address.

For information on HART communication and the Triconex 4850 HART Multiplexer (a component in the HART Interface Modules), including PC software installation and configuration, see the Triconex 4850 HART Multiplexer Instruction Manual.

If you are using HART communication in a safety-related application, see the *Safety Considerations Guide for Tricon v9-v10 Systems* for more information.

Enclosing the Chassis

Triconex will mount Tricon chassis in any of the industry-standard enclosures listed below. Please contact Triconex regarding other enclosures, available for additional engineering and documentation charges.

Table 80 Chassis Enclosures

Type	Width	Depth	Height
Rittal NEMA 12	31.5 inches (800 mm)	31.5 inches (800 mm)	86.0 inches (2,200 mm)
	31.5 inches (800 mm)	31.5 inches (800 mm)	78.0 inches (2,000 mm)
MarkHon NEMA 1	31.5 inches (800 mm)	31.5 inches (800 mm)	85.0 inches (2,160 mm)

RXM Chassis Installation

This section describes how to install an RXM Chassis (model 8112), which is typically used to extend the system to remote locations. Each RXM Chassis must include a set of RXM Modules, which include three identical modules that extend the Tricon controller I/O bus and provide ground loop isolation. An RXM Chassis with a Primary RXM Set must be connected no more than 100 feet (30 meters) from the Main Chassis. From this Primary RXM Chassis, RXM Chassis with Remote RXM Sets can be located as far away as 1.2 miles (2 kilometers) from the Main Chassis, and RXM chassis with Remote SRXM Sets can be located as far away as 7.5 miles (12 kilometers) from the Main Chassis.



Each RXM Chassis must include at least one I/O module, otherwise a faulty power supply in that chassis will not be detected.

This figure depicts a typical configuration in which additional RXM or Expansion Chassis are connected to an RXM Chassis which is connected to the Main Chassis. For information on other configurations, contact the IPS Global Client Support (GCS) center.

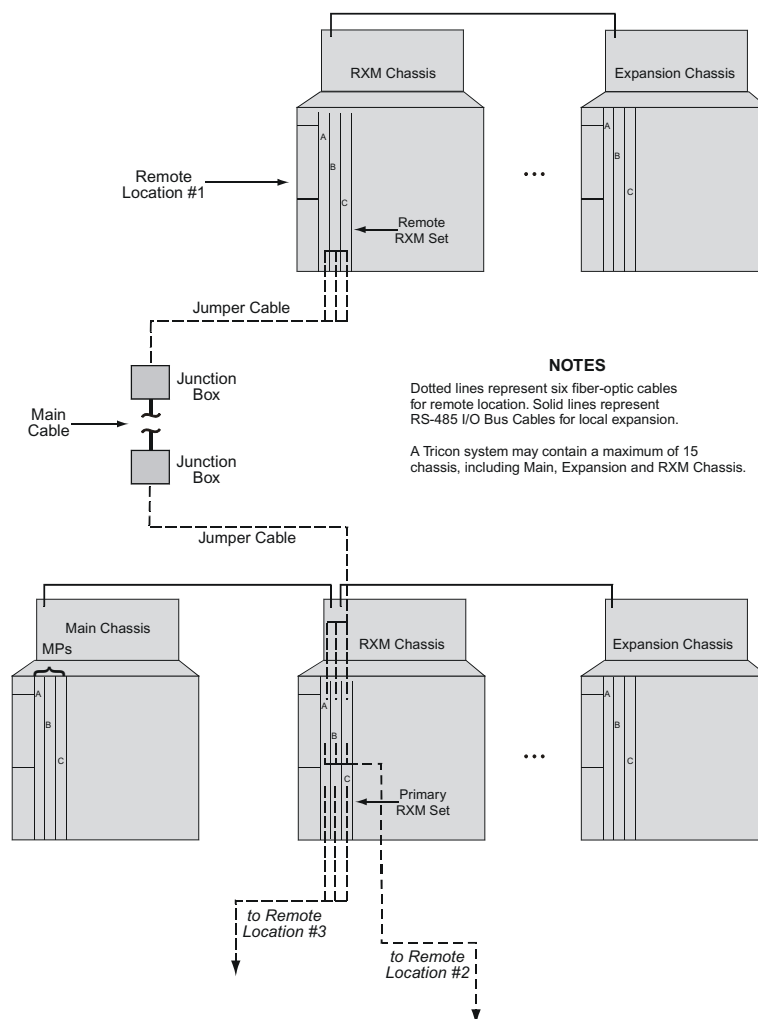


Figure 81 Typical Configuration for Remote Locations

Each RXM Chassis can include:

- A Primary RXM Set (model 4200-3 or 4201-3) or Remote RXM Set (model 4210-3 or 4211-3).
- Two Power Modules.
- Six I/O module slot sets. (Each RXM Chassis must include at least one I/O module.)

This table includes the specifications for I/O Bus cabling used with RXM Chassis.

Table 81 RXM Chassis Cable Specifications

Item	Specification
I/O Bus Cabling	
Local Expansion	Multi-drop twisted-pair cabling RS-485 ports
Remote Expansion	Point-to-point fiber-optic cabling Fiber-optic modem ports
I/O Bus Length	
Standard RS-485	100 feet (30 meters) maximum
Optional RS-485 ¹	1,000 feet (300 meters) maximum
Multi-mode fiber-optic	1.2 miles (2 kilometers) maximum
Single-mode fiber-optic	7.5 miles (12 kilometers) maximum

1. Contact the IPS Global Client Support (GCS) center for restrictions and requirements of bus terminations.

Typical Fiber-Optic Components

This section describes typical components in a fiber-optic installation, which include:

- Guidelines for Fiber-Optic Cables on page 205
- Main Fiber-Optic Cable on page 205
- Junction Boxes on page 205
- Jumper Cables on page 206
- Connectors on page 206

Guidelines for Fiber-Optic Cables

The selection and installation of the fiber-optic cabling used with RXM and SRXM Modules requires special knowledge, training and tools. In the United States, Canada and Western Europe, fiber-optic cabling is widely used in the telecommunications industry, and a wide choice of vendors is available to aid in the selection and installation of it. For example, in the United States, AT&T Network Services has been used with great success in many Tricon controller installations.

Triconex recommends that, whenever possible, the services of a qualified vendor should be utilized for the selection and installation of fiber-optic cabling. The *Directory of Instrumentation* published by the Instrumentation Society of America (ISA) provides a list of United States vendors specializing in industrial applications which is distributed annually to ISA members.

Multi-Mode Fiber Alternatives

In parts of the world where the above services are not readily available, or in those installations where it is desirable to have in-house personnel install and maintain the cabling, other multi-mode fiber alternatives exist. For more information, contact the IPS Global Client Support (GCS) center.

Main Fiber-Optic Cable

Several types of cable core and sheath designs are available from various vendors. Selection of the cable sheath must be based on the physical and environmental requirements of the application. Indoor cable is available for general usage, riser and plenum applications. Outdoor cable is available for cable tray, aerial, underground, directly buried or underwater uses. Outdoor cable with protective over-sheath coverings for lightning and rodent protection is also available.

An RXM installation requires a total of six fibers (a Transmit and Receive for each channel) between the primary and remote locations. If you use a single primary cable, then you should select a cable with six fibers plus spares.

For very critical applications, where loss of communication to the remote location cannot be tolerated and the physical integrity of the RXM cable cannot be assured, use a separate cable for each channel. In this case, a total of three main cables is required, each having two fibers plus spares. Route each cable between the primary and remote location along a different path to provide additional protection.

Triconex recommends installing cables with spare fibers in all cases. The cost of additional fibers in a cable is small compared to the cost of installing a new cable in the event that a single fiber is accidentally damaged.

Junction Boxes

A junction box is typically used to terminate each end of the main cable. Each fiber in the cable must be individually mated to an ST connector. The type of junction box and the mounting location depend on the requirements of the application.

Jumper Cables

Use a general-purpose jumper cable with ST connectors on each end to make connections between the junction box and the RXM modules.

Connectors

Twelve ST connectors are required for each remote connection. Connectors should be bayonet type with a ceramic tip plug.

Installing an RXM Chassis

This procedure explains how to install a typical configuration which includes an RXM Chassis located near the Main Chassis and additional RXM and Expansion Chassis connected to this RXM Chassis. The configuration cannot exceed 15 chassis.



During installation of RXM modules and after each maintenance activity, make sure that all fiber-optic ST® connectors are fully seated and engaged. Because ST connectors from different manufacturers may exhibit minor variations, close inspection is necessary to verify proper engagement of the ST locking mechanism. Failure to properly secure a connector could result in unreliable operation of the Tricon controller and could ultimately lead to a false plant trip.

Procedure

- 1 For the RXM Chassis located near the Main Chassis, use I/O bus cables (model 9000) to connect to the I/O Bus Connectors on the backplanes of each chassis. The length between the chassis cannot exceed 100 feet (30 meters).
- 2 In this RXM Chassis, install a Primary RXM Set (model 4200-3 or 4210-3) immediately to the right of the Power Modules. Install I/O modules, as needed.
The primary RXM Set can support up to three RXM or Expansion Chassis. To set up more than three remote locations in a single Tricon controller, please contact a Triconex Field Service Engineer.
- 3 For each RXM Chassis at a remote location, install Remote RXM Sets (model 4201-3 or 4211-3). Install I/O modules, as needed.
- 4 Connect each RXM Chassis at remote locations with the RXM Chassis located near the Main Chassis using fiber-optic cables to connect to the Transmit and Receive paths for each channel. This connection can be as far as 7.5 miles (12 kilometers) from the Main Chassis. See [Figure 82](#) for a diagram of this wiring.
- 5 Install I/O modules, as needed.
- 6 Add Expansion Chassis as needed in both local and remote locations. The length between the chassis cannot exceed 100 feet (30 meters).
- 7 Ground the remote RXM chassis. See [Controller Grounding on page 208](#).

Fiber-Optic Wiring for RXM Modules

This figure shows the wiring between a primary RXM set and a remote RXM set, which connects a Receive (RX) to a Transmit (TX) for each channel.

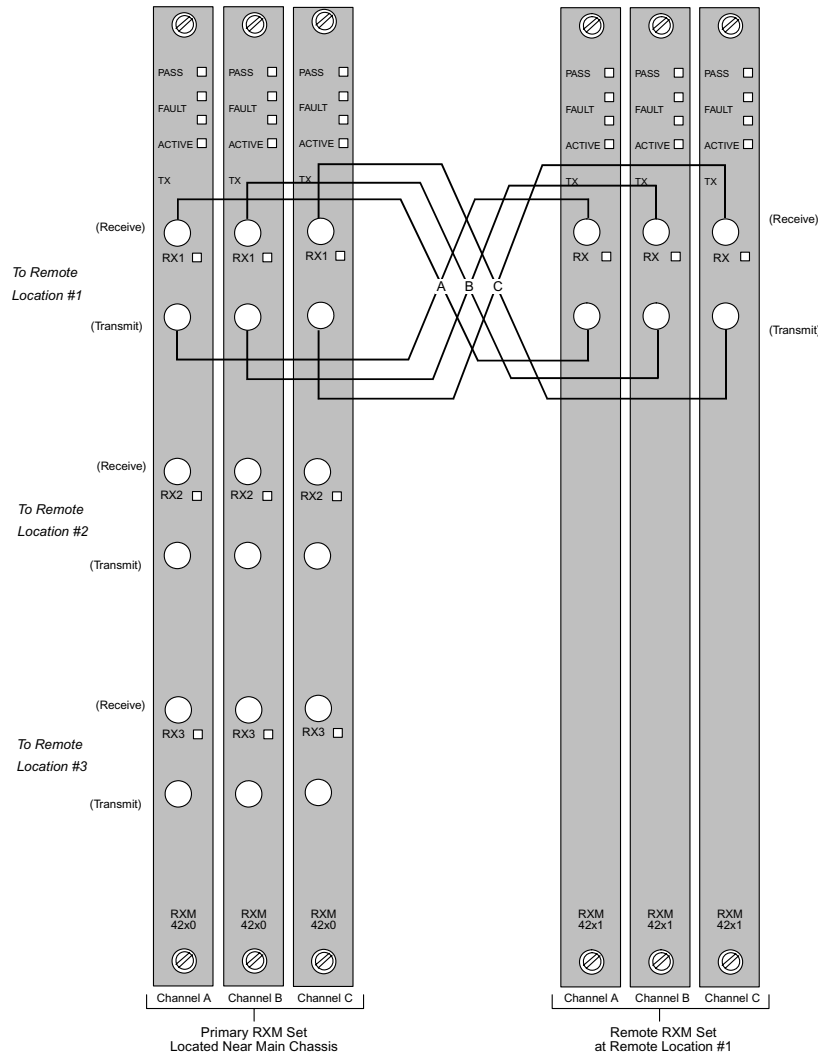


Figure 82 Simplified Fiber-Optic Wiring for One Remote Location

Controller Grounding

This section explains how to properly ground a Tricon controller, which is essential to the safety of plant personnel as well as to the proper operation and protection of the Tricon controller.

The Tricon controller includes three separate ground systems:

- Protective earth \oplus – safety or chassis ground
- Signal or instrument ground \ominus – a functional earth
- Shield ground \ominus – a functional earth



You must permanently connect the Tricon controller to safety ground to protect operations and maintenance personnel from electrical shock, and to protect the control system from damage caused by lightning or other electrical noise transients.

The digital and analog portions of each module use separate and isolated signal return paths which are connected together to form the Tricon controller signal ground. The chassis ground (sheet metal) of the Tricon controller acts as an electrostatic shield for the digital and analog circuitry. (All communication cable shields are terminated to the chassis ground.)

The sheet metal of the Tricon controller is connected to the safety ground. The Tricon controller is normally delivered with the safety ground connected to the signal ground by means of an resistor-capacitor (RC) network. This network can be disconnected to allow for alternative grounding implementations or *floating ground* applications. For guidelines when installing a Tricon controller as part of a floating system, see Application Note 14, *Floating DC Systems, Ground Fault Detectors and the Tricon* available on the IPS Global Client Support Web Site at <http://support.ips.invensys.com>.

Connecting a System to Safety Ground

This section explains how to make a permanent, redundant connect to safety ground. You can make a temporary connection to safety ground using the ground terminal on the panel portion of the chassis backplane.



Do not operate a Tricon controller without connecting each Main and Expansion Chassis to safety ground (protective earth) with a low-impedance cable. Improper grounding creates the potential for dangerous electrical shock – the Tricon controller can produce significant leakage currents which must be connected to earth.



To ensure that your Tricon controller and the equipment connected to it operate safely, you must follow all applicable local and national codes and standards. At a minimum, these include national fire and electrical codes. Since codes and standards vary geographically and change over time, it is your responsibility to determine which standards apply to your specific case, and comply with them. If necessary, please contact your local Fire Marshall and Electrical Inspector for assistance.

Procedure

- 1 For each Main Chassis and Expansion Chassis, connect a cable from the 1/4 inch bolt on the left side of the chassis. The cable should be a heavy solid or stranded, bare or insulated cable, such as 8-gauge (8.367 mm²) or larger, using a crimped ring lug. If you use an insulated cable, it should be green with a yellow stripe.
- 2 Connect the other end of the cable to a common tie point such as a copper bar.
- 3 Connect the copper bar to safety ground according to the applicable national and local electrical codes. You can use the same copper bar to provide a safety ground connection for the cabinet, field devices, and wiring in the control system.

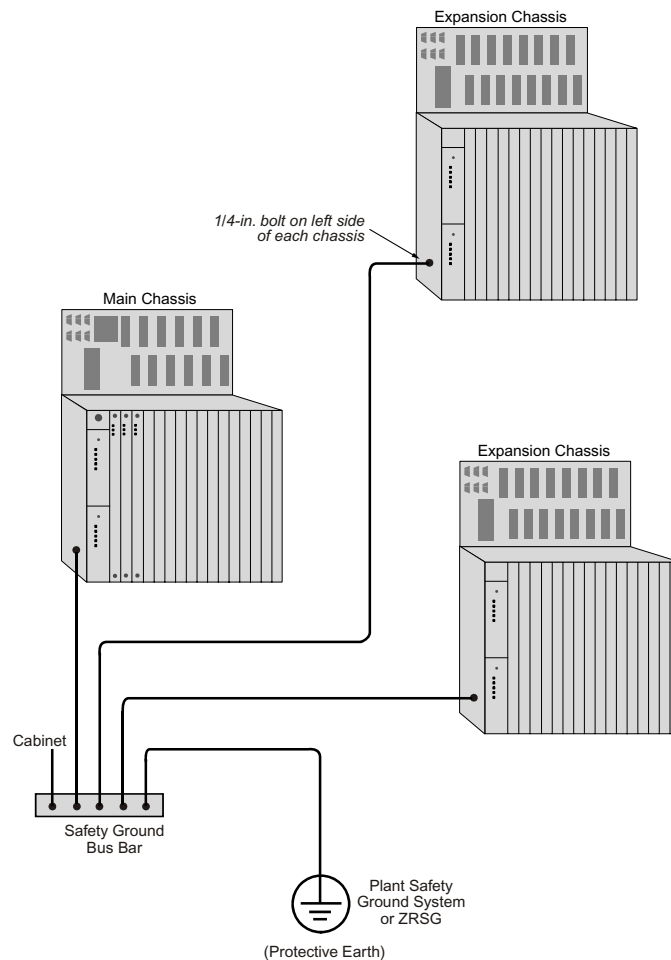


Figure 83 Connecting a Tricon System to Safety Ground

Connecting a System to Signal Ground

The signal ground (functional earth) for a Tricon controller is allowed to float with respect to the safety ground. Each Tricon controller Power Module is equipped with an internal RC network to limit the potential voltage differences between the signal ground and safety ground.

In most installations, it is best to tie the signal ground and safety ground together *at one and only one point*. These sections provide installation guidelines based on controller configurations.

- Single Controller with Only Digital Modules on page 210
- Single Controller with Only Analog or Digital Modules on page 211
- Controller Included in DCS on page 212

Single Controller with Only Digital Modules

If the controller configuration includes only digital modules, using the internally-supplied RC network is sufficient. No further grounding is required.

The RC network is connected when a jumper is installed between R and \oplus , as shown in this figure.

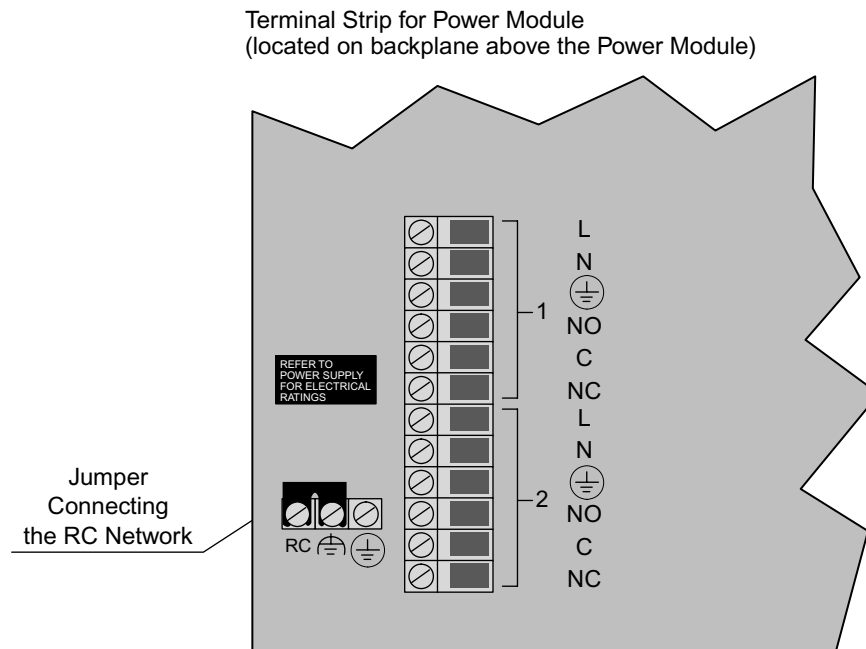


Figure 84 Connecting to Signal Ground Via the RC Network

Single Controller with Only Analog or Digital Modules

If the controller configuration includes only analog or analog and digital modules and a single controller, using the internally-supplied RC network is sufficient. No further action is required.

The analog loop power supplies are connected to the internal signal ground on the termination modules, as shown in Figure 85.

Optionally, you can make a connection between the Tricon controller signal ground and a dedicated instrument ground or the common tie point of a DCS, as shown in Figure 86.

Note To use the internal RC network, install the jumpers on the Power Module.

Note Isolated power supplies used for isolated digital points must be connected to a Safety Ground Bus Bar or similar means to the Plant Safety Ground System or ZRSG.

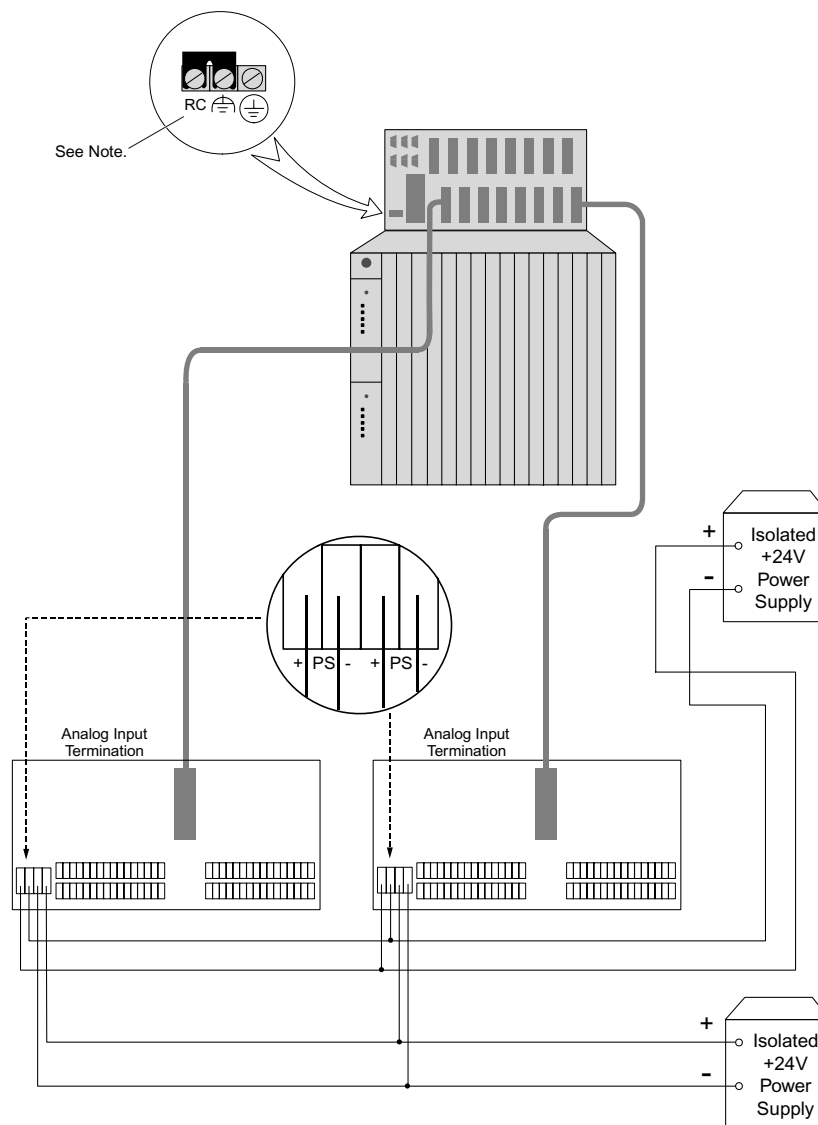


Figure 85 Connecting to Safety Ground Via the Internal RC Network

Controller Included in DCS

If the Tricon controller includes only digital modules, the internally supplied RC network is sufficient. No further action is required.

If the configuration includes a single Tricon controller with only analog or analog and digital modules, a connection must be made between the Tricon controller signal ground and the common tie point of the DCS signal ground, as shown in Figure 86.

Note The DCS common tie point may be the safety ground tie point of the control room. Use a separate wire – do not share a safety ground connection.

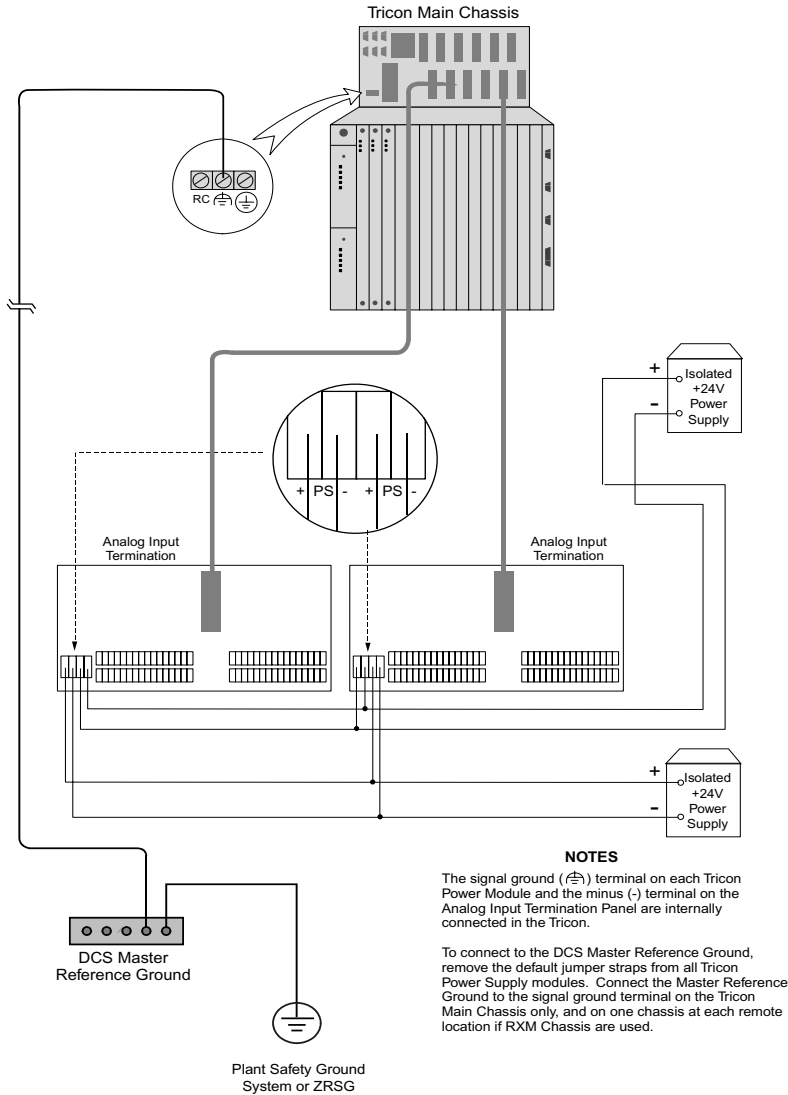


Figure 86 Connecting to Dedicated Earth or DCS Master Reference Ground

Connecting Shields to Earth Ground

For configurations that use analog modules, cable shields should be installed on one end of the cable, typically at the field device. If you must use the controller instead, you should provide a connection near the termination panel using an external shield bus bar. Such bus bars are available from Phoenix Contact or other terminal block suppliers. You must individually connect each shield bus bar to a suitable quiet ground point such as a dedicated earth ground or a DCS Master Reference Ground as shown in this figure.

For details on bus bar wiring, see the *Field Terminations Guide for Tricon v9-v10 Systems*, or contact the IPS Global Client Support (GCS) center.

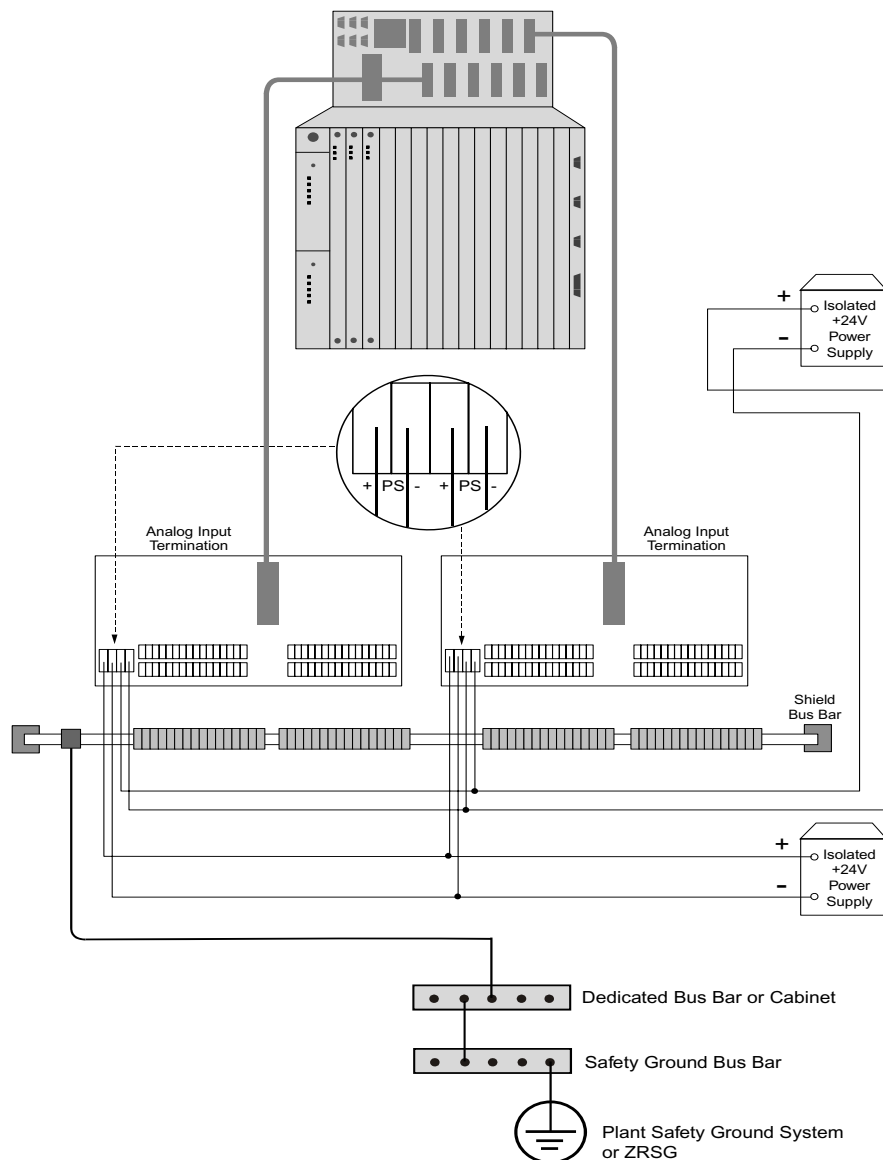


Figure 87 Connecting Shield Ground to Ground Point

Implementation and Maintenance

This section includes information about implementation and maintenance that should be considered when installing a Tricon system. To ensure maximum safety and long service, Triconex recommends you establish a schedule for routine maintenance at the time that the Tricon controller is installed and adhere to it.

Topics include:

- [Disabling Output Voter Diagnostics on DO Modules on page 214](#)
- [Checking Controller Power Sources on page 215](#)
- [Replacing the Main Chassis Batteries on page 217](#)
- [Enabling “Disabled” Output Voter Diagnostics on page 218](#)
- [Toggling Field I/O Points on page 219](#)
- [Verifying Spare Modules on page 219](#)
- [Performance Proof Testing Model 3807 BiPolar Analog Output Modules on page 219](#)

Disabling Output Voter Diagnostics on DO Modules

Output Voter Diagnostics (OVD) is a set of tests that detect failures in the quad-output voting mechanism of all Digital Output Modules except Relay Output Modules. Because of glitches caused by forcing simulated failures, OVD may affect the controlled process. If this is not acceptable, OVD can be disabled, but should be enabled every three months. To ensure safety, you should analyze the sensitivity of each load device attached to the Tricon controller for proper operation.



For safety programs, disabling the Output Voter Diagnostics is not recommended; however, if it is required due to process interference concerns, it can be done if, and only if, the DO is proof tested every three to six months.

Triconex guarantees that an OVD-forced glitch has the following durations:

- For AC modules, no longer than 1/2 AC cycle.
- For DC modules, less than 2 milliseconds, which is a period that is tolerated well by electro-mechanical devices such as relays, solenoids and contactors.

For assistance with load devices that might be sensitive to such glitches, please contact the IPS Global Client Support (GCS) center.

Procedure

- 1 From TriStation, disable OVD on all or on specific Digital Output Modules. For instructions, see the guide for the version of TriStation being used.
- 2 Log the date when OVD was disabled so that you can re-enable the OVDs for 10 minutes every three months. If this is not possible due to process concerns, do on of the following:

- Replace the module, while it is online, with one that has been operated without the OVDs disabled.
- Reserve a slot in a chassis as an OVD test slot and rotate modules through the OVD test slot every three months.

For information on OVD enabling, see [Enabling “Disabled” Output Voter Diagnostics](#) on page 218.

Checking Controller Power Sources

Typically, Tricon controllers use redundant sources to power the controller and field circuitry. Under normal operating conditions, the required power is shared between the two power sources. Under abnormal conditions, one of the power sources may be required to provide 100 percent of the controller power.

To verify the integrity of the power source and the Power Modules, you must periodically test each power source for its ability to provide power for the entire system when the redundant source is disabled.

This table describes the maximum recommended interval between proof tests of Model 8310 Power Modules.

Table 82 Model 8310 Power Module Proof Test Intervals

Year Shipped	For an RRF > 1000, the maximum recommended interval between proof tests is...	For an RRF > 100, the maximum recommended interval between proof tests is...
1996–1998	2 years	5 years
1999	1 year	2 years
2000–2005	5 years	—

This table describes the maximum recommended interval between proof tests of Model 8311 or 8312 Power Modules.

Table 83 Model 8311 or 8312 Power Module Proof Test Intervals

Year Shipped	For an RRF > 1000, the maximum recommended interval between proof tests is...	For an RRF > 100, the maximum recommended interval between proof tests is...
All years	2 years	5 years

Note RRF = Risk Reduction Factor. Although this is a simple economic calculation, an RRF of > 1000 is roughly equivalent to the risk reduction required for SIL3 safety applications. An RRF of > 100 is required for SIL2 applications.

Note Overall, the reliability of the 1996-1998 modules has proven to be approximately equal to the original design estimate, with a MTBF (mean-time-between-failure) of approximately 1 failure per million hours of operation. Later units have proven to be very reliable, with actual MTBF of > 8 million hours.

This procedure explains how to test the power sources used for the Tricon controller. Ideally, this test is performed when the controlled process is offline—for example, during a normally scheduled plant maintenance period.

Procedure

- 1 If possible, take the control process offline.
- 2 Turn off one of the power sources and leave it off for several minutes.
- 3 After restoring power, repeat the test for the other power source.
- 4 Turn on both power sources prior to restarting the controlled process.

For information on replacing Power Modules, see [Replacing Power Modules on page 222](#).

Replacing the Main Chassis Batteries

This procedure explains how to replace the Main Chassis batteries, which are located on the backplane next to the I/O expansion ports. If a total power failure occurs, these batteries can maintain data and programs for a cumulative time period of six months.

Each battery has a shelf-life of 8-10 years. Triconex recommends that the batteries be replaced either every 8-10 years or after they accumulate six months of use, whichever comes first. You should replace the batteries during scheduled, offline maintenance periods by using the following procedure.

For specifications and part numbers, see [Appendix E, Recommended Replacement Parts](#).



Replace a battery only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

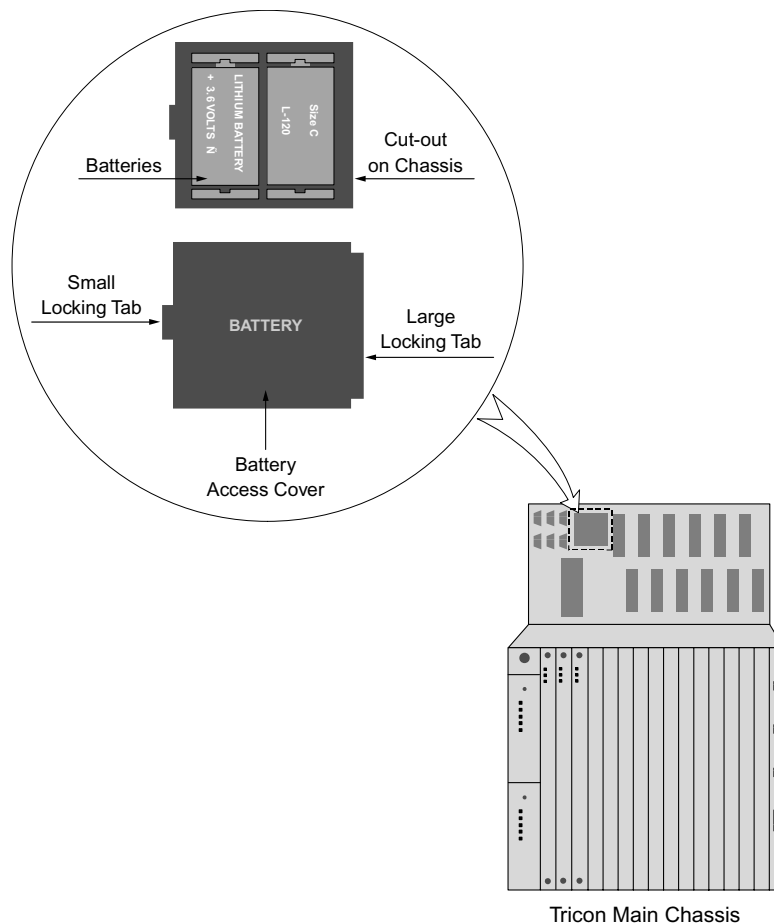


Figure 88 Battery Location and Access Cover

Procedure

- 1 Before starting, ensure you have a screwdriver.
- 2 Remove the battery access cover by squeezing the left side of the cover with your hand to detach the small locking tab.
- 3 Noting the orientation of the batteries, remove each one with your hand. If necessary, use a screwdriver to detach each battery from its position, then remove with your hand.
- 4 Insert the replacement batteries in the same orientation as the originals – with the positive terminal facing the top of the chassis. Snap each battery firmly in place.
- 5 Replace the battery access cover by:
 - Inserting the large locking tab under the right edge of the battery cut-out.
 - Squeezing the left side of the battery access cover with your hand and inserting the small locking tab into the left edge of the battery cut-out.
 - Pressing the cover firmly to ensure it is locked in place.

Enabling “Disabled” Output Voter Diagnostics

This procedure explains how to enable “disabled” Output Voter Diagnostics (OVD) used by Digital Output Modules. In some systems, these diagnostic can cause glitches that affect the controlled process. If OVD has been disabled, it should be enabled periodically.



For safety programs, disabling the Output Voter Diagnostics is not recommended; however, if it is required due to process interference concerns, it can be done if, and only if, the DO is proof tested every three to six months.

Procedure

- 1 Ensure the controlled process is shut down. (Do not stop the TriStation application from running.)
- 2 In TriStation, go to the Controller Panel and enable the disabled OVD modules.
- 3 Leave OVD enabled for several minutes to verify the stability of the modules.

This action provides 100 percent failure detection for all components, particularly those that remain in a single state for long periods of time. For example, if an output is always On, OVD cannot determine if faults are present that would prevent the output from being turned Off.

- 4 If required, disable OVD.

Toggling Field I/O Points

Once every three to six months, you should toggle the field points from the normal operational state to the opposite state to guarantee complete fault coverage of the digital circuitry. Leave each point in the opposite state for several minutes. Ideally, this type of testing is performed with the controlled process offline—for example, during a normally scheduled plant maintenance period. For instructions, see the *TriStation Developer's Guide*.

This table lists the Digital Input and Digital Output Modules that require toggling the field points for 100 percent fault coverage.

Model	Module Description
3501E/T	115 VAC/VDC Digital Input
3502E	48 VAC/VDC Digital Input, normally off points only
3503E	24 VAC/VDC Digital Input, normally off points only
3505E	24 VDC Digital Input, normally off points only
3601E	115 VAC Digital Output

Verifying Spare Modules

The controller automatically tests all modules installed in the system. The only action needed to guarantee the integrity of a spare module is to periodically install it in an online system. Spare I/O modules should be installed as hot-spare modules because the controller automatically shifts control between the active and hot-spare modules.

Control changes as follows:

- Periodically, approximately once an hour
- After a power failure
- After an MP re-education

Spare MP and I/O modules that are not installed in the system should be periodically rotated into an online system to ensure the integrity of spare inventory. A rotation schedule should be established so that a spare module is not allowed to sit on the shelf more than six months.

Performance Proof Testing Model 3807 BiPolar Analog Output Modules

Triconex recommends that BPAO modules used in critical control applications be performance proof tested during scheduled maintenance. The amount of time between proof tests should not exceed 10 years. To ensure TMR operation of the BPAO module, the test should check the accuracy of each output point by confirming that +60 mA and -60 mA output current values can be maintained for at least 60 seconds.

Module Replacement

This section explains how to replace modules after a system has been installed.

Topics include:

- Guidelines for Replacing Modules on page 220
- Replacing Main Processor Modules on page 221
- Replacing Power Modules on page 222
- Replacing I/O Modules on page 223
- Replacing RXMs on page 224
- Replacing ACMs on page 225
- Replacing EICMs on page 226
- Replacing HIMs on page 227
- Replacing NCMs on page 228
- Replacing SMMs on page 229
- Replacing TCMs on page 230

Guidelines for Replacing Modules

Follow these guidelines when replacing modules.



- Inserting modules with damaged pins may cause the controller to malfunction and may affect the controlled process. If the module has damaged pins, return it to Triconex for repair.
- If a controller has two faults, one in an MP and one in another type of module, replace the MP first.
- Do not install more than one module at the same time. You must push the first module in and wait until the Active indicator goes on, then install the next module.
- If an I/O module has a field fault and a module fault, resolve the field fault first. Try clearing the module fault by using TriStation 1131 or the Enhanced Diagnostic Monitor. If the I/O module fails to go to Pass or will not stay in Pass, replace it.
- When you replace a faulty module, seat it properly in its slot and screw it down. Do not overtighten – the recommended torque is 10 inch-pounds and the torque limit is 14 inch-pounds.
- For optimal performance, store spare I/O modules in vacant slots of the Tricon controller as hot-spare modules.
- Store any remaining, unused modules in their original shipping cartons.

Replacing Main Processor Modules

This procedure explains how to replace a Main Processor Module.



- If a controller has two faults, one in an MP and one in another type of module, replace the MP first. Wait until the Active indicator of the replacement module goes on, then replace the second faulty module.
- Do not install more than one module at the same time. You must push the first module in and wait until the Active indicator goes on, then install the next module.

To determine whether an MP has a fault, see [Main Processor Status Indicators on page 233](#).

Procedure

- 1 If the controlled process is online, verify that at least one MP has an Active indicator with a blinking yellow light.
- 2 Undo the retractable fasteners on the faulty MP, grasp the module by its fasteners, and slide the module out of the chassis.
- 3 Insert the replacement MP and seat it firmly. The Pass indicator should go on and stay on within 1 to 10 minutes.
- 4 Tighten the retractable fasteners to 10 inch-pounds.
If the module is not properly seated and its fasteners adequately tightened, the module may not operate properly.
- 5 The Active indicator on the replacement MP should go on and begin blinking at the same rate as the other MPs within 1 to 10 minutes.
- 6 For the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Replacing Power Modules

This procedure explains how to replace a Power Module. Before taking any action, keep in mind that the alarm contacts on the lower left side of the backplane may be wired to a beacon or audible alarm to alert maintenance personnel that a problem has arisen.

When servicing or replacing a single Power Module, you do not need to interrupt the control process.

Incoming power should be rated for a minimum of 240 watts per power source. The minimum power consumption of a Tricon controller chassis with three Main Processors and one Power Module is 50 watts. Additional power consumption is based on the I/O and communication modules installed in the chassis.

Wiring should be sized according to applicable local electrical codes, taking into account the current ratings, temperatures, wiring lengths, and other applicable considerations. For specifications, see [Power Modules on page 33](#).



- If a power module fails in an ATEX application, you *must* replace it immediately. If you cannot replace the failed module, you must shut down the Tricon. A Tricon with a failed power module can be running *only* in a location that is known to be free of ignitable gas concentrations. Power module failure is indicated on the Tricon by fault indicators (LEDs). Failure information is available at the operator workstation in the form of system variables and Triconex diagnostics information.
- Do not use alarm contacts in hazardous locations.
- Do not remove a power module unless incoming power is disabled and secondary power is performing normally.



If a Power Module has been removed for any reason, do not attempt to re-install for at least 60 seconds.

For fault indicators, see [Power Module Status Indicators on page 235](#).

Procedure

- 1 Before beginning, ensure you have a 1/4-inch flat-bladed screwdriver.
- 2 Verify that the secondary Power Module is connected to an active power source.
- 3 Use the screwdriver to undo the retractable fasteners of the faulty Power Module. Grasp the fasteners firmly, and slide the module out of the chassis.
- 4 Carefully slide the replacement Power Module into position, then push firmly to seat the module in the bus and tighten the fasteners.

If the module is not properly seated and its fasteners are not adequately tightened, the module may not operate properly.

The Status indicator should go on as soon as Power Module is inserted.

- 5 For the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Replacing I/O Modules

This procedure explains how to install an I/O module. If an I/O module has a field fault and a module fault, resolve the field fault first.



Before you remove a faulty I/O module, ensure the following are true:

- The Active indicator is illuminated on the hot-spare module.

–or–

The Active indicator is illuminated on the newly-inserted module if there was an open position in the logical slot and you inserted a replacement module.

- The Active indicator on the faulty module is off.

For fault indicators, see [I/O and Communication Module Indicators](#) on page 236.

Procedure

- 1 If a hot-spare module is installed and the Active indicator is on, remove the other (faulty) module by loosening the retractable fasteners, grasping the fasteners and sliding the module out of the chassis. In the unlikely event that neither module has an Active indicator on, contact the IPS Global Client Support (GCS) center.
- 2 Install an identical type module in the empty slot and push the module in until it is firmly seated. Tighten the retractable fasteners of the module to 10 inch-pounds.
For the replacement module, the Pass indicator should go on after about 1 minute; the Active indicator should go on within 1 to 2 minutes.
- 3 If the replacement module is not a hot-spare, wait until the Active indicator of the faulty module is off, then remove the module.
- 4 Identify the model and serial numbers on the faulty module. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Note In rare cases, a field device malfunction may cause a module to fault. If replacing the module does not resolve the problem, verify that the field device is properly connected and in good working order. If the problem is still not resolved, please contact the IPS Global Client Support (GCS) center for assistance.

Replacing RXMs

This procedure explains how to replace Remote Extender Modules (RXMs).

Procedure

- 1 Identify which communication cables (up to six) go to each connector on the RXM.
- 2 Disconnect all communication cables associated with the faulty module.
- 3 Undo the retractable fasteners of the RXM, grasp the fasteners firmly, and slide the module out of the chassis.
- 4 Install an identical type of module in the empty slot and push the module in until it is firmly seated. Tighten the retractable fasteners of the module to 10 inch-pounds.
For the replacement module, the Pass indicator should go on after about 1 minute; the Active indicator should go on within 1 to 2 minutes.
- 5 Reconnect all communication cables.
- 6 If replacing the RXM does not clear the Fault, check the fiber optic cables.
- 7 Identify the model and serial numbers on the faulty module. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Replacing ACMs

This procedure explains how to replace Advanced Communication Modules (ACMs). If the Fault indicator is on or the Pass indicator is off, the module should be replaced.



- Triconex strongly recommends that you install a hot-spare for every ACM in your Tricon controller. Because the ACM is not a TMR module, a single fault could cause up to a one-second loss of communication with the Distributed Control System (DCS) – until the spare ACM becomes active. If there is no spare, communication is lost until the ACM is replaced and initialized from the DCS. (Failure of the ACM does not compromise the operation of the rest of the Tricon controller.)
- If you have a hot-spare installed and the Active and Online indicators are off on both modules, contact the IPS Global Client Support (GCS) center.

For indicator information, see [ACM Indicators on page 240](#).

Procedure

- 1 Disconnect the communication cables from the faulty module. Do not break the cables or disconnect the terminations from the ends of the cables – doing this will disrupt communication with other devices. (Net1 DNBI cables are point-to-point and do not have external terminations.)
- 2 If a hot-spare module is installed and its ONLINE indicator is on and SBRDY indicator is off, remove the other (faulty) module by loosening the retractable fasteners, grasping the fasteners and sliding the module out of the chassis.

If a hot-spare module is not installed, go to [step 3](#).

- 3 Install an identical type module in the empty position of the slot and push the module in until it is firmly seated. Tighten the retractable fasteners of the module to 10 inch-pounds.
- 4 Connect the communication cables to the just-inserted module – the Pass indicator should go on after about 1 minute; the Active indicator should go on within 1 to 2 minutes.
- 5 If the just-inserted replacement module is not a hot-spare, wait until the Active and Online indicators on the other (faulty) module are off, then remove the module.
- 6 On the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Note In rare cases, faults in the I/ A Series system or in the DNBI cables might cause an ACM to fault. If following the above steps does not solve the problem, verify that the DNBI cables are properly connected and in good working order. If the problem is still not solved, contact the IPS Global Client Support (GCS) center for assistance.

Replacing EICMs

This procedure explains how to replace Enhanced Intelligent Communication Modules (EICMs). If the Fault indicator is on or the Pass indicator is off, the module should be replaced.



All communication through an EICM ceases when you remove the module from the system.

For indicator information, see [EICM Indicators on page 241](#).

Procedure

- 1 Disconnect all communication cables associated with the faulty module.
- 2 Undo the retractable fasteners of the module, grasp the fasteners, and slide the module out of the chassis.
- 3 On the replacement module, set the TriStation interface switches and the RS-232/422/485 switches to the same settings as on the faulty module.
- 4 Insert the replacement module into the chassis slot. Push the module in until it is firmly seated in the chassis.
- 5 Tighten the retractable fasteners of the replacement module to 10 inch-pounds.
- 6 The Pass indicator should go on within about 1 minute, and the Active indicator should go on within 1 to 2 minutes.
- 7 Reconnect all the communication cables.
- 8 On the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Replacing HIMs

This procedure explains how to replace Hiway Interface Modules (HIMs).



- Triconex strongly recommends that you install a hot-spare for every HIM in your Tricon controller. Because the HIM is not a TMR module, a single fault could cause up to a one-second loss of communication with the Distributed Control System (DCS) – until the spare HIM becomes active. If there is no spare, communication is lost until the HIM is replaced and initialized from the DCS. (Failure of the HIM does not compromise the operation of the rest of the Tricon controller.)
- If you have a hot-spare installed and the Active indicators are off on both modules, contact the IPS Global Client Support (GCS) center.

For indicator information, see [HIM Indicators on page 241](#).

Procedure

- 1 Disconnect the Data Hiway cables from the faulty module. Do not break the cables or disconnect the terminations from the ends of the cables – doing this will disrupt Data Hiway communication with other Hiway devices.
- 2 If a hot-spare module is installed and the Active indicator is on, remove the other (faulty) module by loosening the retractable fasteners, grasping the fasteners and sliding the module out of the chassis.
If a hot-spare module is not installed, go to [step 3](#).
- 3 Install an identical type module in the empty position of the slot and push the module in until it is firmly seated. Tighten the retractable fasteners of the module to 10 inch-pounds.
- 4 Connect the Data Hiway cables to the just-inserted module – the Pass indicator should go on after about 1 minute; the Active indicator should go on within 1 to 2 minutes.
- 5 If the just-inserted replacement module is not a hot-spare, wait until the Active indicator of the other (faulty) module is off, then remove the module.
- 6 On the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Note In rare cases, faults in the DCS or in both Data Hiway cables can cause an HIM to fault. If replacing the module does not solve the problem, verify the Data Hiway cables are properly connected and in good working order. If the problem is still not solved, contact the IPS Global Client Support (GCS) center for assistance.

Replacing NCMs

This procedure explains how to replace Network Communication Modules (NCMs). Two NCMs can be placed in one logical slot of the Tricon controller chassis, but they function independently, *not* as hot-spare modules.

For indicator information, see [NCM Indicators on page 243](#).



All communication through an NCM ceases when you remove the module from the system.

Procedure

- 1 Disconnect all communication cables from the faulty module. Do not break the cables or disconnect the terminations from the ends of the cables – doing this will disrupt communication with other devices on the network.
- 2 Remove the module by loosening the retractable fasteners of the module, grasping the fasteners, and sliding the module out of the chassis.
- 3 Identify the switch setting for the network address.
- 4 Set the switches on the replacement module to the same network address as the removed module. Insert the replacement module into the empty slot and push the module in until it is firmly seated in the chassis.
- 5 Tighten the retractable fasteners of the replacement module to 10 inch-pounds. The Pass indicator should go on within approximately 1 minute, and the Active indicator should go on within one to two minutes.
- 6 For the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Replacing SMMs

This procedure explains how to replace Safety Manager Modules (SMMs). If the Fault indicator is on or the Pass indicator is off, the module should be replaced.



- Triconex strongly recommends that you install a hot-spare for every SMM in your Tricon controller. Because the SMM is not a TMR module, a single fault could cause up to a one-second loss of communication with the Distributed Control System (DCS) – until the spare SMM becomes active. If there is no spare, communication is lost until the SMM is replaced and initialized from the DCS. (Failure of the SMM does not compromise the operation of the rest of the Tricon controller.)
- If you have a hot-spare installed and the Active indicators are off on both modules, contact the IPS Global Client Support (GCS) center.

For indicator information, see [SMM Indicators on page 243](#).

Procedure

- 1 Disconnect the Universal Control Network (UCN) cables from the faulty module.
- 2 If a hot-spare module is installed and the Active indicator is on, remove the other (faulty) module by loosening the retractable fasteners, grasping the fasteners and sliding the module out of the chassis.

If a hot-spare module is not installed, go to [step 3](#).

- 3 Install an identical type module in the empty position of the slot and push the module in until it is firmly seated. Tighten the retractable fasteners of the module to 10 inch-pounds.
- 4 Connect the UCN cables to the just-inserted replacement module – the Pass indicator should go on after about 1 minute; the Active indicator should go on within 1 to 2 minutes.
- 5 If the just-inserted replacement module is not a hot-spare, wait until the Active indicator of the other (faulty) module is off, then remove the module.
- 6 On the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

Note In rare cases, faults in the DCS or in both UCN cables can cause an SMM to fault. If replacing the module does not solve the problem, verify the UCN cables are properly connected and in good working order. If the problem is still not solved, contact the IPS Global Client Support (GCS) center for assistance.

Replacing TCMs

This procedure explains how to replace Tricon Communication Modules (TCMs). If the Fault indicator is on or the Pass indicator is off, the module should be replaced, which you can do while the controller is online. Two TCMs can be placed in one logical slot of the Tricon controller chassis, but they function independently, *not* as hot-spare modules.

For indicator information, see [TCM Indicators on page 245](#).



All communication through a TCM ceases when you remove the module from the system.

Procedure

- 1 Label all of the communication cables connected to the faulty module, and then disconnect the cables from the module.
- 2 Undo the retractable fasteners of the module, grasp the fasteners, and slide the module out of the chassis.
- 3 Insert the replacement module into the chassis slot. Push the module in until it is firmly seated in the chassis.
- 4 Tighten the retractable fasteners of the replacement module to 10 inch-pounds.
The Pass indicator should go on within about 1 minute, and the Active indicator should go on within 1 to 2 minutes.
- 5 Reconnect all the communication cables.
- 6 On the faulty module, identify the model and serial numbers. Contact the IPS Global Client Support (GCS) center to obtain a Returned Material Authorization (RMA) number. Then return the module to Triconex for repair.

4

Fault and Alarm Indicators

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Overview

Indicators are lights on the front panel of each module that identify the state of each module. Each module includes indicators that identify the general state of the module and other indicators related to the function of the module.

The types of indicators include:

- Status indicators which identify the processing state of the module. Each module includes a Pass, Fault, and Active indicator.
- Field power and power load indicators which identify whether a power problem has occurred. (Only on some I/O modules.)
- Communication indicators which identify the type of communication occurring. (Only on MP and communication modules.)
- Points indicators which identify whether the point is energized. (Not on Analog Input, Analog Output, or Thermocouple Modules.)

Identifying Fault and Alarm Indicators

Fault indicators identify potentially serious problems with a module. Alarm conditions identify abnormal field conditions such as loss of power and loss of communication.

If a fault or alarm indicator is on, you should consult the appropriate section of this chapter and take appropriate action. This action may include replacing a faulty module or repairing a faulty circuit or device.

You can identify alarm and fault conditions in these ways:

- By examining the indicators on the front panel of each module and comparing the indicators with the descriptions in this chapter.
- By using the Enhanced Diagnostic Monitor, TriStation 1131 Diagnostic Monitor, or the TriStation MSW Diagnostic screens.

Main Processor Status Indicators

The status indicators identify the processing state for the Main Processors. A fault indicator indicates that the processor has an internal fault.

Table 84 3008 Main Processor Status Indicator Conditions

Pass	Fault	Active	Maint1	Maint2	Description	Action
Green steady	No light	Yellow blinking	No light	No light	The module is operating normally. The Active indicator blinks once per scan when executing an application.	No action is required.
No light	Red steady	— ¹	—	—	The module has failed.	Replace the module.
No light	No light	—	—	—	The indicators/signal circuitry on the module are malfunctioning.	Replace the module.
Green steady	No light	No light	Red blinking	No light	The MP is re-educating. Allow 10 minutes for the PASS indicator to turn on, followed by the ACTIVE indicator	No action is required.
Green steady	No light	Yellow blinking	Red steady	No light	Minor Fault in noncritical portion of MP, such as the battery voltage, clock calendar not running, or temperature mismatch. For v10 and later, this may indicate that the module has excessively reset or re-educated in the last 100 days.	Extract a Tricon Event Log file and send it to the Invensys GCS for analysis.
Green steady	No light	Yellow blinking	No light	Red steady	The MP printed circuit board temperature is greater than 183° F (84° C) or less than 32° F (0° C).	Verify Temperature conditions within cabinet are normal. If so Replace the module.
No light	Red steady	No light	Red blinking	Red blinking	MP firmware does not match other MPs.	Replace the module with one that has matching firmware.

1. This symbol (—) means the indicator is not important for this condition.

Table 85 3006 Main Processor Status Indicator Conditions

Pass	Fault	Active	Maint1	Maint2	Description	Action
Green steady	No light	Yellow blinking	No light	No light	The module is operating normally. The ACTIVE indicator blinks once per scan when executing a control program.	No action is required.
Green steady	No light	No light	— ¹	—	No control program has been loaded into the MP, or a control program has been loaded into the MP but has not been started. This state also exists in a module that has just been installed and is being educated by the other MPs.	If the ACTIVE indicator does not go on within a few minutes, the module is faulty and must be replaced.
Off	Red steady	No light	Red blinking	No light	The MP is re-educating. Allow six minutes for the PASS indicator to turn on, followed by the ACTIVE indicator.	No action is required.
Off	Red steady	—	Red steady	—	The module has failed.	Replace the module.
Off	Off	—	—	—	The indicators/signal circuitry on the module are malfunctioning.	Replace the module.
Green steady	Off	—	No light	Red steady	The MP soft error count is very high.	Replace the module at the first opportunity.

1. This symbol (—) means the indicator is not important for this condition.

MP Communication Indicators

The Main Processors include indicators that identify the status of communication across the COMM bus and I/O bus. The 3008 Main Processor has additional indicators that identify the status of network communication.

Table 86 Communication Indicators for Main Processors

RX	TX	Description	Action
Yellow Blinking	Yellow Blinking	Normal response. MPs are communicating with the I/O and communication modules.	No action is required.
No light	No light	Problem: MPs are not communicating with modules.	Replace the module.

Power Module Status Indicators

The status indicators identify the state of the Power Modules and battery.

Note When powering up the system, the status indicators on the Power Modules may flicker momentarily if the input voltage is low and the chassis is fully loaded. If this problem persists, check the input voltage levels.

Table 87 Normal State for Power Modules

Pass	Fail	Alarm	Bat Low	Temp	Description	Action
Green steady	No light	No light	No light	No light	Module is operating normally.	Normal status. No action is required.

Table 88 Fault States for Power Modules

Pass	Fail	Alarm	Bat Low	Temp	Description	Action
Green steady	No light	Red steady	No light	Yellow steady	Module is operating normally, but the ambient temperature is too high for the Tricon controller greater than 140° F (60° C).	Correct the environmental problem or the Tricon controller may fail prematurely.
Green steady	No light	Red steady	Yellow steady	No light	Module is operating normally, but it does not have sufficient battery power to retain a program in RAM if power fails.	Replace the battery.
No light	Red steady	Red steady	— ¹	—	Module has failed or lost power. If incoming power has failed, restore the power.	If the module has failed, replace the module.
No light	No light	—	—	—	Indicators/signal circuitry are malfunctioning.	Replace the module.
No light	No light	Red steady	No light	No light	Module is operating normally, but another module in the chassis/controller is malfunctioning.	Identify the malfunctioning module by looking at the Pass/Fault indicators of other modules or by using Diagnostic Monitor or the TriStation Diagnostic Panel. Replace the faulty module.

1. This symbol (—) means the indicator is not important for this condition.

I/O and Communication Module Indicators

This section describes indicators for I/O modules and status indicators for communication modules.

Status Indicators

The status indicators identify the processing state for I/O, communication, and Remote Extender Modules. A fault indicator indicates that the module has an internal fault.

Table 89 Normal State for Modules

Pass	Fault	Active	Description	Action
Green steady	No light	Yellow steady	Module is operating normally.	No action is required.

Table 90 Fault States for Modules

Pass	Fault	Active	Description	Action
Green steady	No light	No light	Possible conditions include: Module is operational, but not active.	If this is the hot-spare module, no action is required.
			Module has just been installed and is currently running start-up diagnostics.	
No light	Red steady	Yellow steady	Module has detected a fault.	Replace module.
No light	No light	— ¹	Indicators/signal circuitry on the module are malfunctioning.	Replace module.

1. This symbol (—) means the indicator is not important for this condition.

Point Indicators

The Point indicators identify whether the field point is energized on I/O modules.

Table 91 Point Indicators for I/O Modules

Point Indicator	Description
Red steady	The field circuit is energized.
No light	The field circuit is not energized.

Power Indicators on AO Module

The Power (PWR1 and PWR2) indicators on AO Modules identify whether field power is missing.

Table 92 Power and Load Indicators on AO Modules

Power	Description	Action
Yellow steady	The field power is On.	No action is required.
No light	The field power is missing.	Connect to a viable power source or check fuses on ETPs.

Power Indicator on SDO Module

The Power indicator on SDO Modules identifies whether field power is missing.

Table 93 Power and Load Indicators on Supervised DO Modules

Power	Description	Action
No light	The field power is On.	No action is required.
Yellow steady	The field power is missing.	Connect to a viable power source or check fuses on ETPs.

Load Indicators

The Load indicators on AO and SDO Modules identify whether there is a fault in the field circuitry.

Table 94 Load Indicators

Load or Load/Fuse	Description	Action
No light	The field circuit is operating properly.	No action is required.
Yellow steady	A fault is detected in the field circuit or the load is not connected to one or more output points.	Check for shorted or open loads and fix. Connect all output points that are not connected.

Load/Fuse Indicator

The Load/Fuse indicators on TMR and Dual DO Modules identify whether the commanded state and measured state of points agree.

Table 95 Load/Fuse Indicators

Load/Fuse	Description	Action
No light	All load connections are functioning properly.	No action is required.
Yellow steady	On at least one point, the commanded state and the measured state do not agree.	Using TriStation, isolate the suspected point and determine the commanded state of the output point. Using a voltmeter, determine the actual state of the output point, then remove and replace the fuse or correct the problem in the external circuit. If these steps do not solve the problem, install a replacement module.

Note After a Load/Fuse alarm condition on a module has cleared, the Load/Fuse indicator may remain active (Yellow steady) for up to two minutes.

Dual DO Module

In the Dual DO Module, a stuck-Off fault results in both a Load/Fuse alarm and a fault. If a Load/Fuse alarm is detected by the Dual DO Module, normal switch-over to a hot-spare module is disabled. This action prevents the output from being forced Off by a stuck-Off fault and then forced back On after the switch-over a few seconds later. To allow switch-over to a healthy module, re-seat the spare module.

CJ (Cold Junction) Indicator

The CJ (Cold Junction) indicator identifies whether a Thermocouple Input Module has a cold-junction fault. The CJ indicator is not available on model 3706A.

Table 96 Cold Junction Indicator of Thermocouple Input Modules

CJ	Description	Action
No light	The module is free from cold-junction faults.	No action is required.
Yellow steady	Indicates a cold-junction fault.	Install a replacement module. Ensure that the field termination module (Internal or External) is installed and connected properly or fault conditions may occur. If replacing the module does not solve the problem, replace the field termination module.

Communication Module Indicators

Communication modules include TX (transmit) and RX (receive) indicators that identify whether the module is communicating with the Tricon controller, DCS, or a TriStation PC. When the indicators are blinking, communication is taking place.

Communication modules include:

- [ACM Indicators on page 240](#)
- [EICM Indicators on page 241](#)
- [HIM Indicators on page 241](#)
- [NCM Indicators on page 243](#)
- [SMM Indicators on page 243](#)
- [TCM Indicators on page 245](#)

For module status, see [I/O and Communication Module Indicators on page 236](#).

ACM Indicators

The ACM (Advanced Communication Module) includes indicators that identify the state of the module and communication.

For module status, see [I/O and Communication Module Indicators on page 236](#).

I/A Series Indicators

The I/A Series indicators identify whether the module is the primary or hot-spare module, and whether the module is communicating with the I/A Series Nodebus or DNBI.

Table 97 I/A Series Status Indicators

Online	Sbrdy	Description	Action
Green steady	No light	If the SBRDY (standby) indicator is not blinking and the TX and RX indicators are blinking, this is the primary module.	No action is required.
Green steady	Green steady	If the SBRDY (standby) indicator is blinking and the TX and RX indicators are blinking, this is the hot-spare module.	No action is required.
No light	Green steady	The module is communicating with the DNBI, but not with the Nodebus or I/A Series file server.	Contact the IPS Global Client Support (GCS) center
No light	No light	The modules are not configured or not connected to the I/A Series Nodebus.	Contact the IPS Global Client Support (GCS) center

Communication Indicators

The TX (transmit) and RX (receive) indicators identify whether data is being transmitted and received by the module. When the indicators are blinking, data is being communicated.

The ACM includes these indicators:

- NET1 Port: Indicates whether the ACM is communicating with the data bus of the A/I Nodebus.
- RS-423 Serial Port: Indicates whether the ACM is communicating with the control bus of the A/I Nodebus.
- NET2 Port: Indicates whether the ACM is communicating over a network.
- RS-232/422 Serial Port: Indicates whether the ACM is communicating over a serial interface.

EICM Indicators

The EICM (Enhanced Intelligent Communication Module) includes indicators that identify the state of the module and state of communication.

The TX (transmit) and RX (receive) indicators identify whether data is being transmitted and received by the port. When the indicators are blinking, data is being transmitted or received.

For module status, see [I/O and Communication Module Indicators on page 236](#).

HIM Indicators

The HIM (Hiway Interface Module) includes indicators that identify the state of the module and state of communication.

For module status, see [I/O and Communication Module Indicators on page 236](#).

Table 98 On-Line Indicator for HIM

On-In	Description	Action
Green steady	The module is online and processing the control elements that are defined for a given box. Either Channel A or B is active.	No action is required.
No light	The module is offline and not processing the control elements. Neither Channel A nor Channel B is active. The module is faulty, is not receiving polls from the Data Hiway, or is not configured.	If the module is faulty, install a replacement module. If the Data Hiway is faulty, see the Honeywell manual.
Green blinking	One or more of the boxes (non-preferred hardware devices on the Hiway) is disabled or has not been configured.	No action is required.

Table 99 Interface Indicator for HIM

H I/F	Description	Action
Red steady	The module is connected to the Data Hiway.	No action is required.
No light	The module is not connected to the Data Hiway.	Connect the module to the Data Hiway.

Table 100 Call-Up indicator for HIM

Cal Up	Description	Action
Red steady	A Call Up command has been received.	No action is required.
No light	A Call Up command has not been received. If this indicator remains Off during the polling adjustment procedure, either the module is faulty or the hiway is not sending a call-up command.	If the module is faulty, install a replacement module. If the Data Hiway is faulty, see the Honeywell manual.

Table 101 Channel Indicators for HIM

Ch A	Ch B	Description	Action
Red steady	No light	Channel A is active but Channel B is not.	No action is required.
No light	Red steady	Channel B is active but Channel A is not.	No action is required.
No light	No light	Neither channel is active. The module is faulty or it is not receiving polls from the Data Hiway.	If the module is faulty, install a replacement module. If the Data Hiway is faulty, see the Honeywell manual.

Table 102 Transmit Indicator for HIM

Xmit	Description	Action
Red blinking	Indicator flashes if the module is communicating with the Data Hiway.	No action is required.
No light	The module is not communicating with the Data Hiway. If communication is expected, then the module is faulty, is not receiving polls from the Data Hiway, or its poll response switches are set incorrectly.	If the module is faulty, install a replacement module. If the Data Hiway is faulty, see the Honeywell manual.
Red steady	Either the Cal Up switch is on, or a poll response switch is set incorrectly. (The Cal Up switch should be off for proper operation.) A less likely possibility is that the module is constantly being polled and is blinking so fast that the Xmit indicator appears to be on.	If the Honeywell Workstations Box Status does not report any problems, no action is required.

Table 103 Standby Indicators for HIM

Std By In	Std By Ready	Description	Action
No light	No light	No hot-spare (standby) module is installed.	No action is required.
Red steady	No light	Indicates that a hot-spare (standby) module has been installed.	No action is required.
Red steady	Red steady	Indicates that a hot-spare (standby) module is installed and ready for use.	Do not remove the primary module until the Standby Ready indicator is On.
No light	Red steady	The indicators/signal circuitry is malfunctioning.	Install a replacement module.

NCM Indicators

The NCM (Network Communication Module) includes indicators that identify the state of the module and state of communication.

The NET 1 and NET 2 network ports have TX (transmit) and RX (receive) indicators that identify whether data is being transmitted and received by the port. When the indicators are blinking, data is being transmitted or received.

For module status, see [I/O and Communication Module Indicators on page 236](#).

SMM Indicators

The SMM (Safety Manager Module) includes indicators that identify the state of the module and state of communication. The SMM has its own battery and does not use the battery located in the Power Module, which means the SMM can be housed in Chassis 2 of the Tricon system.

The SMM does not become active until the control program is downloaded and running in the Tricon controller, and the SMM software (personality) has been loaded from the TDC3000. For more information, see the *SMM User's Guide*.

For module status, see [I/O and Communication Module Indicators on page 236](#).

Table 104 Low Batt Indicator for the SMM

Low Batt	Description	Action
No light	The battery has enough power to sustain the SMM program and data in case of a power outage.	No action is required.
Yellow steady	The battery in the SMM is low and needs to be replaced.	Install a replacement module.

Table 105 Spare Rdy Indicator for the SMM

Spare Rdy	Description	Action
Green steady	A hot-spare module has been installed and is ready for use.	Do not remove the primary SMM until the SPARE RDY indicator is on.
No light	No hot-spare module is installed.	No action required.

Table 106 Port Activity Indicators for the SMM

UCN A	UCN B	Description	Action
Green steady	No light	The UCN A port is active but the UCN B port is not.	No action is required.
No light	Green steady	The UCN B port is active but the UCN A port is not.	No action is required.
No light	No light	Neither port is active. The module is faulty.	Replace the module.

Table 107 Transmit Indicator for the SMM

Xmit	Description	Action
No light	The module is not transmitting any messages to the UCN.	No action is required.
Green steady	The module is actively transmitting messages to the UCN.	No action is required.

Table 108 Four-character Alphanumeric Status Display

Status	Description	Action
A n n	<i>A</i> indicates <i>Alive</i> state and <i>nn</i> is the UCN node number. The module is waiting for the Universal Station to download the program and data.	No action is required.
B n n	<i>B</i> indicates <i>Backup</i> state and <i>nn</i> is the UCN node number.	No action is required.
	All characters are off at the first stages of start-up and during transition to software operation.	No action is required.
s s s s	<i>ssss</i> indicates a Software Crash Code. A large number of possible error codes exist. The SMM is in the Fail state.	Contact the Honeywell Technical Assistance Center (TAC) for help.
H e e	<i>H</i> indicates a hardware fault and <i>ee</i> is the error code. The SMM is in the Fail state. Contact the Honeywell Technical Assistance Center (TAC) for help with identifying causes for these failures.	Contact the Honeywell Technical Assistance Center (TAC) for help.
L n n	<i>L</i> indicates that the TDC 3000 is downloading software to the SMM.	No action is required.
I n n	<i>I</i> indicates the idle state and <i>nn</i> is the UCN node number. The module is waiting for the Universal Station to give the startup command.	No action is required.
R n n	<i>R</i> indicates the Run state and <i>nn</i> is the UCN node number. The module is processing point data normally.	No action is required.
T n n n	<i>T</i> indicates the Test state and <i>nnn</i> indicates the test where the SMM is active or stalled.	No action is required.
C F G ?	<i>CFG</i> indicates that the SMM is waiting for valid module configuration data from the Tricon controller.	Ensure that the SMM is properly configured.
T I n n	<i>TI</i> indicates the Tricon controller interface initialization and <i>nn</i> indicates the step number in the initialization process.	No action is required.

Table 108 Four-character Alphanumeric Status Display (continued)

Status	Description	Action
I N n n	<i>IN</i> indicates firmware initialization and <i>nn</i> indicates the step number in the initialization process.	No action is required.
B O O T	<i>BOOT</i> indicates that the SMM is booting up its personality (software). The SMM's Fault indicator may turn on during the boot, but this is no cause for alarm.	No action is required.

TCM Indicators

The TCM (Tricon Communication Module) includes indicators that identify the state of the module and the state of communication.

The TX (transmit) and RX (receive) indicators identify whether data is being transmitted and received by the port. When the indicators are blinking, data is being transmitted or received.

The FIRM indicator blinks while a firmware download is in progress.

For module status, see [I/O and Communication Module Indicators on page 236](#).

Table 109 TCM Indicators

Serial 1-4	NET 1		NET 2		Description
	Link	RX/TX	Link	RX/TX	
Green blinking	— ¹	—	—	—	Normal response. TCM is communicating with the attached Modbus master/slave device.
—	Green steady	Green blinking	—	—	TCM is communicating with TriStation or with an Ethernet device through the NET 1 port.
—	Green steady	Not blinking or rarely blinking	Green steady	Not blinking or rarely blinking	The port has a valid electrical connection to an Ethernet device but there is no communication. This can be caused by no communication being issued to and from the port, or a port configuration setup error.
—	No light	—	No light	—	The port does not have a valid electrical connection to an Ethernet device. This typically indicates a cable problem.
—	—	—	Green steady	Green blinking	TCM is communicating with TriStation or with an Ethernet device through the NET 2 port.

1. This symbol (—) means the indicator is not important for this condition.

A

Replacing Firmware EPROMs

Overview	248
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Location of EPROMs on Modules	250

Overview

This appendix provides information about EPROMS, which are read-only memory chips that store firmware – programs used with Tricon modules.



Never replace EPROMs on a module while a process is being controlled. Effective control cannot be guaranteed if firm-ware versions running in the machine are incompatible.

For more information about firmware versions, see the Product Release Notice for the version of Tricon being used or contact the IPS Global Client Support (GCS) center.

Handling EPROMs

To protect EPROMs from damage, follow these guidelines:

- Handle gently
- Avoid excessive handling
- When not in use, store in the container in which they were shipped



Take normal static precautions in the handling and installation of EPROMs to prevent damage and/or degradation which may be induced by electro-static discharge (ESD).

Identifying EPROMs

A label is affixed to each EPROM providing information in the following format:

- Identifier for the type of EPROM
- Triconex part number, including dash number
- Revision number

Replacing EPROMs

This procedure explains how to replace EPROMs on Tricon modules.

CAUTION

When you receive a Firmware Release package from Triconex, install all EPROMs included in the release. Old firmware and new firmware may not be compatible.

Procedure

- 1 Remove the existing EPROM with an OK IC Extractor (part number M125B002) or similar tool. Store the used EPROM in the conductive foam container in which the new one was shipped.
- 2 Inspect pins on the new EPROM. Straighten bent pins. If all the pins on one side lie at more than a 90° angle to the chip, press the pins gently on a flat surface until they lie at 90°.
- 3 To insert the new EPROM, align the notch (or other identifying mark) on the EPROM with the notch on the socket. This ensures that Pin 1 of the EPROM is in the correct position.
- 4 When the new EPROM is properly placed on the socket, pop it into the locked position.
- 5 Verify that all pins are fitted into the socket.

Location of EPROMs on Modules

The EPROMs that store firmware are accessible through cutouts in the side panel of each module.

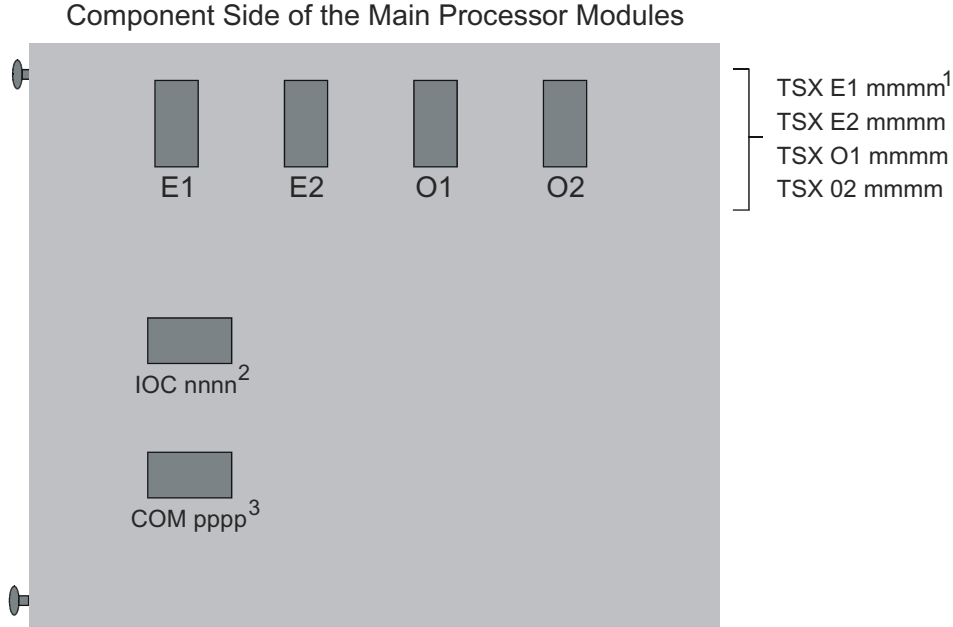
Note Firmware on TCMs is stored in Flash memory, which allows new firmware to be downloaded online through the Net1 port.

EPROMs are located on these modules:

- Main Processor Modules on page 251
- Remote Extender Modules on page 252
- Analog Input and Output Modules on page 253
- Digital Input Modules on page 254
- Digital Output Modules – Non-Supervised on page 255
- Digital Output Modules – Supervised on page 256
- Pulse Input Modules on page 257
- Pulse Totalizer Input Module on page 258
- Relay Output Module on page 259
- Thermocouple Modules on page 260
- ACM Communication Module on page 261
- EICM Communication Module on page 262
- HIM Communication Module on page 263
- NCM Communication Module on page 264
- SMM Communication Module on page 265

Main Processor Modules

This figure shows the EPROM locations on Main Processor Modules. Only models 3006 and 3007 use EPROMs.

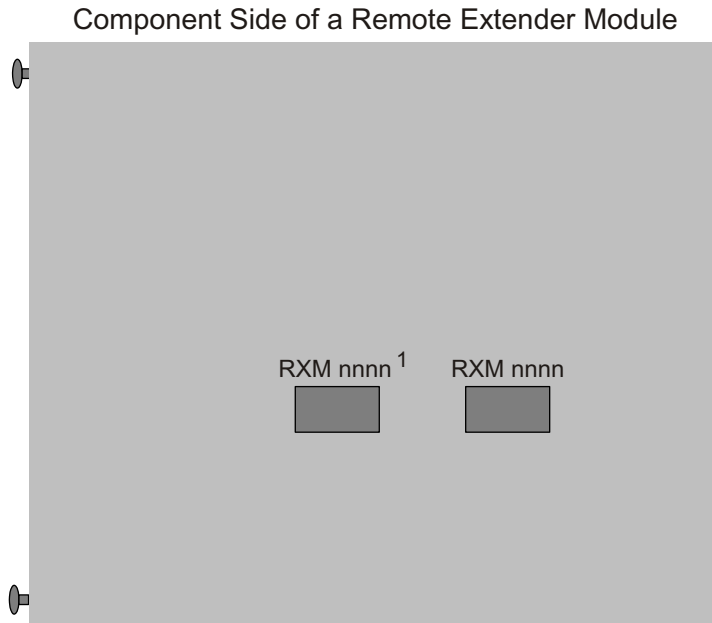


- 1 "mmmm" is the Software Revision Number for TSX firmware.
- 2 "nnnn" is the Software Revision Number for IOC firmware.
- 3 "pppp" is the Software Revision Number for COM firmware.

Figure 89 Main Processor Modules EPROM Locations

Remote Extender Modules

This figure shows the EPROM locations on Remote Extender Modules (RXM), which are the same for both primary and remote fiber-optic RXM sets.



1 "nnnn" is the Software Revision Number for RXM firmware.

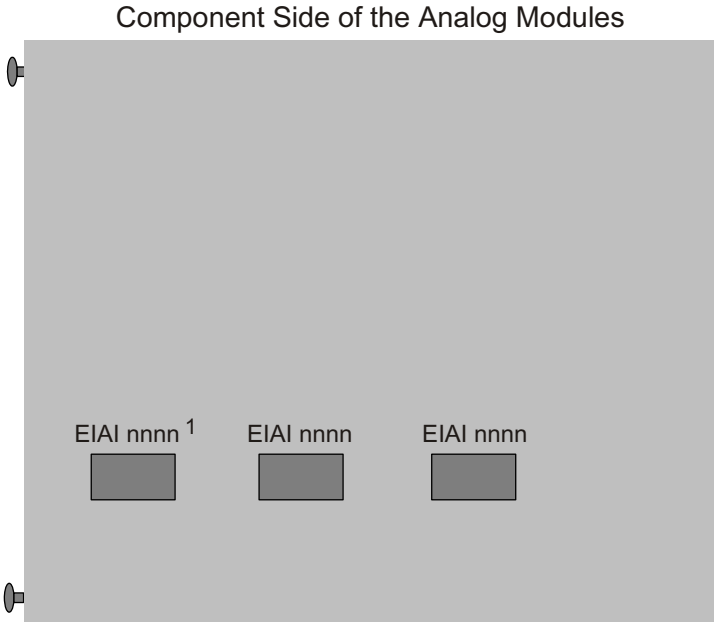
Figure 90 RXM EPROM Locations

Analog Input and Output Modules

This figure shows the EPROM locations on Analog Input and Analog Input Modules.

Identifiers are:

- EIAI: for Analog Input.
- EIAO: for Analog Output.



1 "nnnn" is the Software Revision Number for analog input firmware.

Figure 91 Analog Input and Output Modules EPROM Locations

Digital Input Modules

This figure shows the EPROM locations on all Digital Input Modules except model 3504E, which is shown in [Figure 93](#) on [page 254](#).

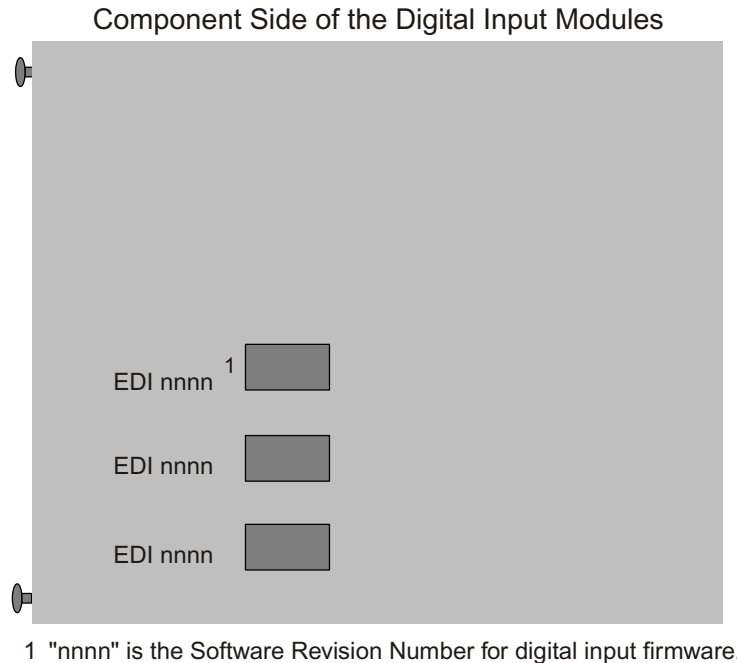


Figure 92 DI Modules (except 3504E) EPROM Locations

This figure shows the EPROM locations on High-Density Digital Input Modules, model 3504E.

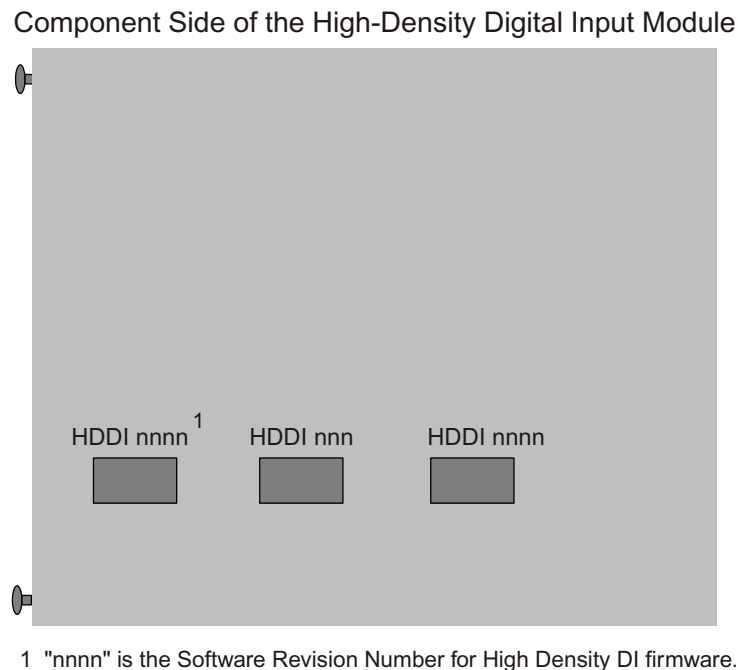
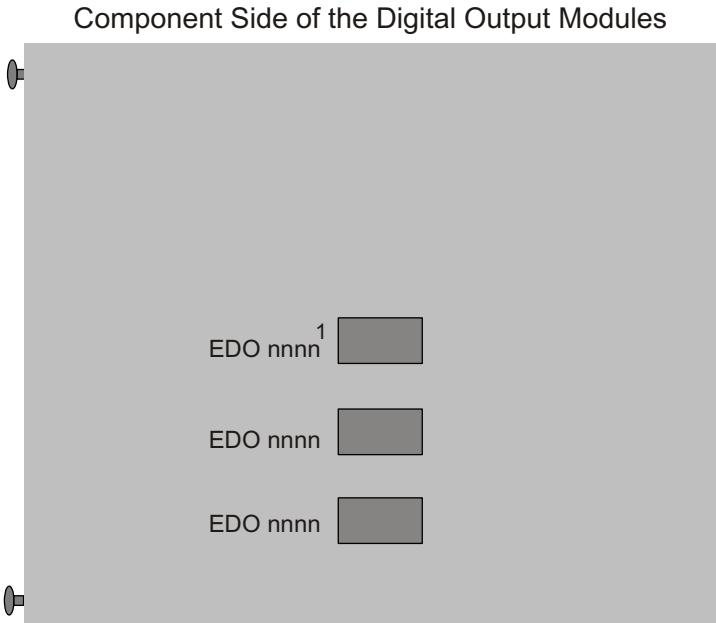


Figure 93 High-Density DI Module (3504E) EPROM Locations

Digital Output Modules—Non-Supervised

This figure shows the EPROM locations on Non-Supervised Digital Output Modules.



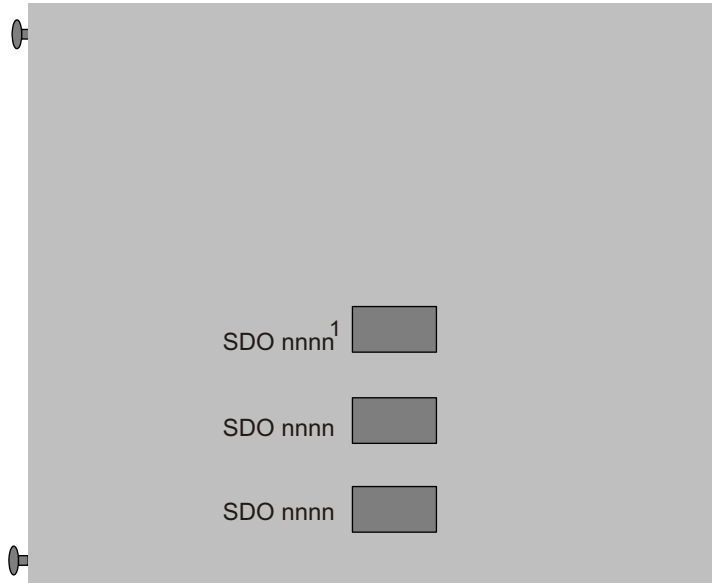
1 "nnnn" is the Software Revision Number for digital output firmware.

Figure 94 Non-Supervised DO Modules EPROM Locations

Digital Output Modules—Supervised

This figure shows the EPROM locations on Supervised Digital Output Modules.

Component Side of the Supervised Digital Output Modules



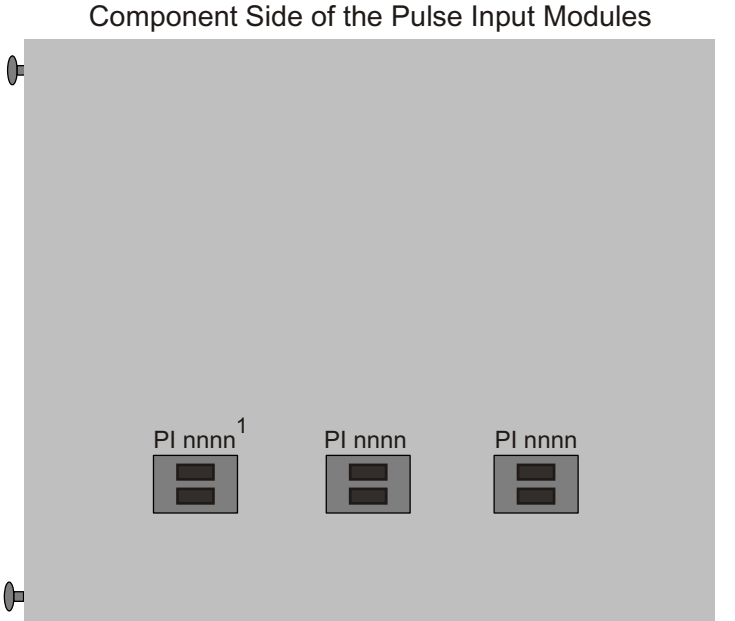
1 "nnnn" is the Software Revision Number for supervised DO firmware.

Figure 95 Supervised DO Modules EPROM Locations

Pulse Input Modules

This figure shows the EPROM locations on Pulse Input Modules.

Two sockets are located under each cutout on the component side of a Pulse Input Module. The bottom sockets hold the EPROMs containing PI firmware. When replacing firmware EPROMs, use the bottom sockets.

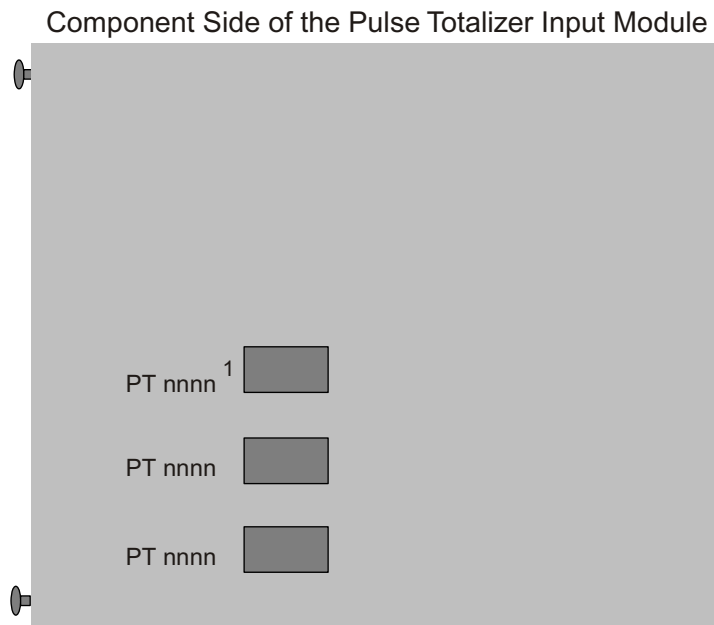


1 "nnnn" is the Software Revision Number for Pulse Input firmware.

Figure 96 Pulse Input Modules EPROM Locations

Pulse Totalizer Input Module

This figure shows the EPROM locations on Pulse Totalizer Input Modules.

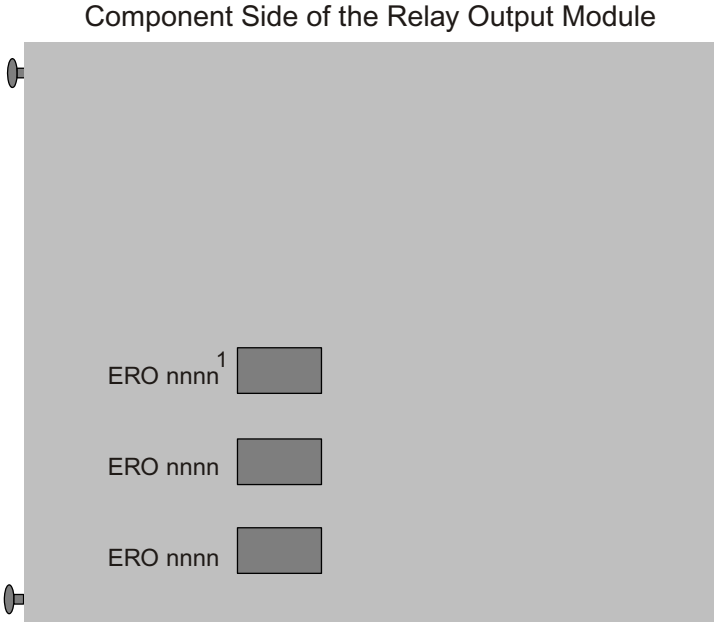


1 "nnnn" is the Software Revision Number for pulse totalizer input firmware.

Figure 97 Pulse Totalizer Input Modules EPROM Locations

Relay Output Module

This figure shows the EPROM locations on Relay Output Modules.



1 "nnnn" is the Software Revision Number for relay output firmware.

Figure 98 Relay Output Modules EPROM Locations

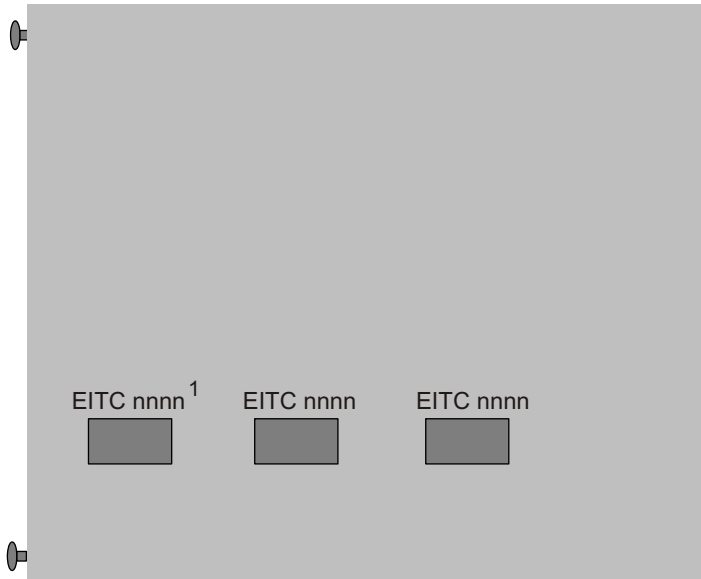
Thermocouple Modules

This figure shows the approximate EPROM locations on Thermocouple Modules.

Identifiers are:

- EITC: for Isolated Thermocouple Input.
- NITC: for Non-Isolated Thermocouple Input.

Component Side of the Thermocouple Input Modules



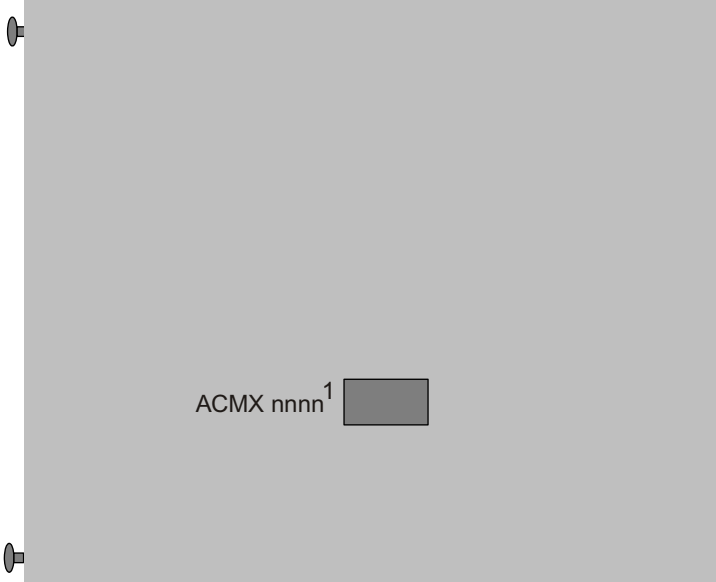
¹ "nnnn" is the Software Revision Number for thermocouple firmware.

Figure 99 Thermocouple Input Modules EPROM Locations

ACM Communication Module

This figure shows the EPROM locations on ACM Modules.

Component Side of the Advanced Communication Module



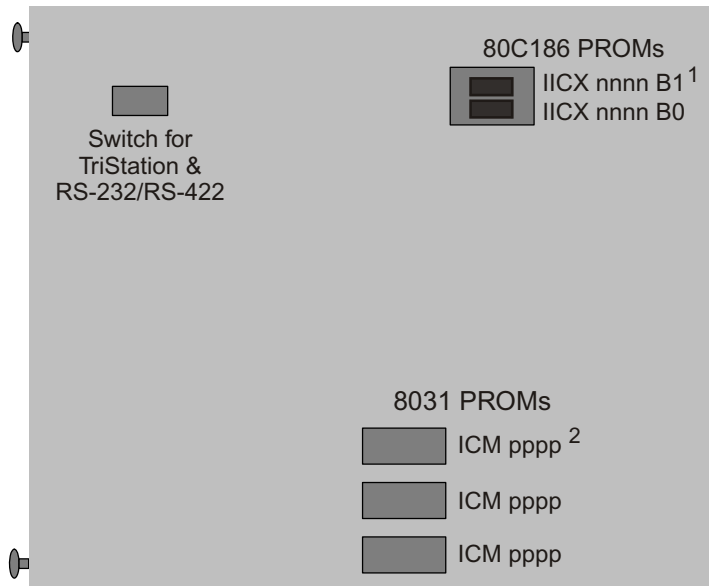
1 "nnnn" is the Software Revision Number for the 68040 firmware.

Figure 100 ACM EPROM Location

EICM Communication Module

This figure shows the EPROM locations on EICM Modules.

Component Side of the Enhanced Intelligent Communication Module

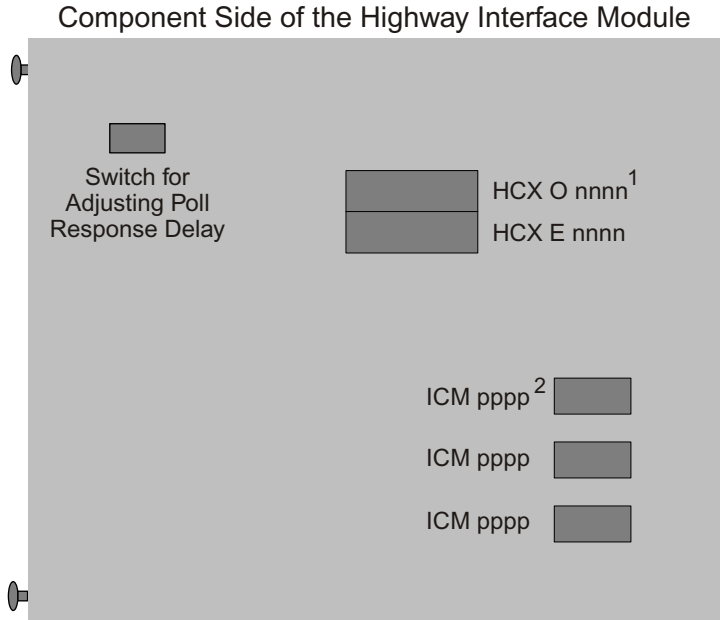


1 "nnnn" is the Software Revision Number for 80C186 firmware.
 2 "pppp" is the Software Revision Number for 8031 firmware.

Figure 101 EICM EPROM Locations

HIM Communication Module

This figure shows the EPROM locations on HIM Modules.



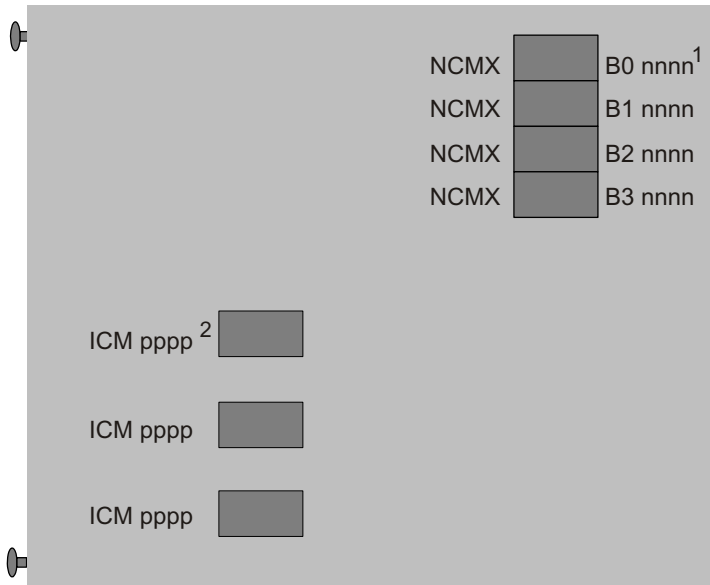
1 "nnnn" is the Software Revision Number for 68020 firmware.
2 "pppp" is the Software Revision Number for 8031 firmware.

Figure 102 HIM EPROM Locations

NCM Communication Module

This figure shows the EPROM locations on NCM Modules.

Component Side of the Network Communication Module



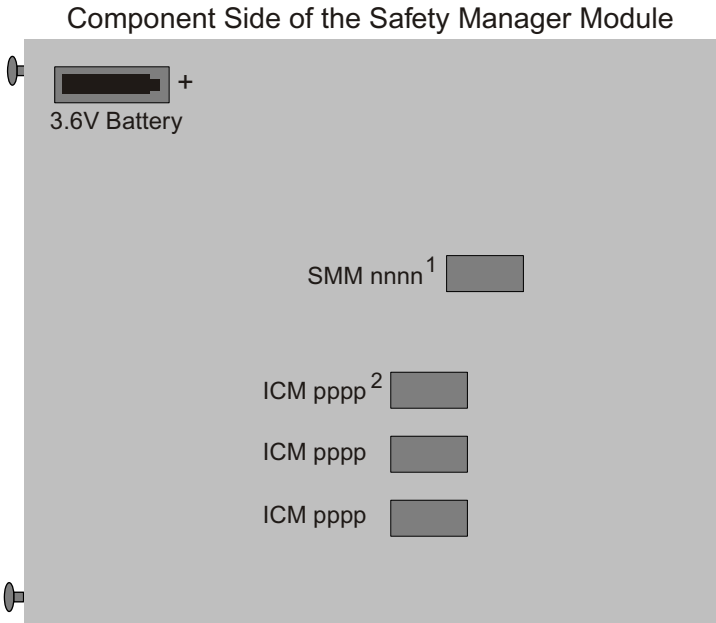
1 "nnnn" is the Software Revision Number for 68020 firmware.

2 "pppp" is the Software Revision Number for 8031 firmware.

Figure 103 NCM EPROM Locations

SMM Communication Module

This figure shows the EPROM locations on SMM Modules.



1 "nnnn" is the Software Revision Number for 68020 firmware.
2 "pppp" is the Software Revision Number for 8031 firmware.

Figure 104 SMM EPROM Locations

B

Pin-Outs for Cables and Connectors

Note This information is provided for reference and troubleshooting purposes only. Do not construct cables solely on the basis of information contained in this guide. Triconex is not responsible for problems that may be encountered if cables are so constructed.

EICM Pin-Outs and Cable Information 268

TCM Pin-Outs and Cable Information 279

I/O Bus Cable (for Interconnected Chassis) Information 286

EICM Pin-Outs and Cable Information

This section includes pin-out information for these EICM cables and connections:

- [TriStation PC to EICM Cable Pin-Outs on page 268](#)
- [EICM Serial Port Pin-Out and Signal Information on page 268](#)
- [EICM Modbus Network Pin-Out and Wiring Diagrams on page 272](#)
- [EICM Cables for RS-422 Modbus Connections on page 274](#)
- [EICM Printer Cable Pin-Outs on page 277](#)
- [EICM to Honeywell DHP Cable Pin-Outs on page 278](#)

TriStation PC to EICM Cable Pin-Outs

A TriStation 1131 PC can be connected by using an RS-232 cable with a 25-pin connector on the EICM (P2) end and a 25-pin or 9-pin connector on the PC (P1) end. The maximum length of an RS-232 cable is 50 feet (15 meters). You can extend the length of an RS-232 connection by using modems. Shield Ground must be connected to pin 1 on the PC end.

Table 110 TriStation PC (P1) to EICM (P2) Cable Pin-Outs

PC Female Connector P1 25 Pins	PC Female Connection P1 9 Pins	PC Signal	EICM Female Connector P2 25 Pins	EICM Signal
2	3	TXD	3	RTX
3	2	RDX	2	TXD
7	5	Signal Ground	7	Signal Ground
4	7	RTS	5	CTS
5	8	CTS	4	RTS
6	6	Not used	20	DTR
20	4	DTR	6	Not used
1		(Shield Ground)		

EICM Serial Port Pin-Out and Signal Information

This section describes pin-out and signal information for the ICM and EICM serial ports.

This section includes:

- [Models 4119 and 4119A Tricon EICM Serial Port Pin-Outs on page 269.](#)
- [RS-232 Signal Descriptions on page 270.](#)
- [RS-422 Signal Description on page 271.](#)

EICM Models 4119 and 4119A Pin-Outs

This table describes serial port pin-outs for EICM models 4119 and 4119A.

Table 111 Models 4119 and 4119A Tricon EICM Serial Port Pin-Outs

Pin	Signal	Direction	Designator	Interface
1	Shield (ground)			
2	Transmit Data	Output	TXD	RS-232
3	Receive Data	Input	RXD	RS-232
4	Request to Send	Output	RTS	RS-232
5	Clear to Send	Input	CTS	RS-232
6	Not used			
7	Signal Ground			
8	Data Carrier Detect	Input	DCD	RS-232
9	Not used			
10	Not used			
11	Not used			
12	Not used			
13	Not used			
14	Transmit Data, Inverted	Output	SD-B	RS-422
15	Transmit Data	Output	SD-A	RS-422
16	Not used			
17	Not used			
18	Not used			
19	Not used			
20	Data Terminal Ready	Output	DTR	RS-232
21	Receive Data, Inverted	Input	RD-B	RS-422
22	Receive Data	Input	RD-A	RS-422
23	Not used			
24	Not used			
25	+5 VDC through 1 K Ω			RS-422

EICM RS-232 Signals

When RS-232 signals are between +6 and +12 VDC they are spacing (on or 0); when they are between -6 and -12 VDC they are marking (off or 1). The maximum length of an RS-232 cable is 50 feet (15 meters). You can extend the length of RS-232 cables by using modems.

Table 112 RS-232 Signal Descriptions

Signal	Designator	Description
Clear to Send	CTS	When in HRDWR handshake mode, the ICM waits for CTS to go on before transmitting data. When not in HRDWR handshake mode, the ICM ignores CTS and transmits data as soon as it is available.
Request to Send	RTS	When in HRDWR handshake mode, the ICM set RTS on when it has data to send. When not in HRDWR handshake mode, the ICM turns RTS on unconditionally.
Data Carrier Detect	DCD	When in HRDWR handshake mode and if DCD is off, the ICM ignores RXD. When not in HRDWR handshake mode, the ICM always accepts data from RXD.
Transmit Data	TXD	Serial Transmit Data
Receive Data	RXD	Serial Receive Data

EICM RS-422 Signals

RS-422 signals are transmitted over twisted-pair wires. The polarity of the 2- to-6 volt differential between the two wires indicates whether the data is marking or spacing. In other words, if terminal A is negative with respect to terminal B, the line is marking. If terminal A is positive with respect to terminal B, the line is spacing. The maximum length of an RS-422 cable is dependent upon the type of cable you use. For example, using 24 awg twisted-pair wire, the maximum length is 4,000 feet (1,220 meters). You can extend the length of RS-422 cables by using modems.

This table describes the RS-422 signals as they are used by the Tricon controller and the EICM.

Table 113 RS-422 Signal Description

Signal	Designator	Description
Transmit Data	SD-A	In HRDWR handshake mode and when the ICM has data to send, it: 1. Enables the RS-422 SD-A/SD-B driver. 2. Waits five character intervals. 3. Sends the data. 4. Disables (tristates) the RS-422 driver. When not in HRDWR handshake mode, the ICM unconditionally enables the RS-422 SD-A/SD-B driver. To use this mode, the serial port must be: - A master or slave in a double twisted-pair, point-to-point network, — or — - A master in a double twisted-pair, multipoint network
Transmit Data, Inverted	SD-B	
Receive Data	RD-A	Serial Receive Data
Receive Data, Inverted	RD-B	
Signal Ground		Optionally connected to RD-A through a 1 K Ω resistor.
5 VDC through 1 K Ω		Optionally connected to RD-B. This resistor is internal to the ICM, whereas the resistor from ground to RD-A must be external.

EICM Modbus Network Pin-Out and Wiring Diagrams

This section shows pin-out and wiring diagrams for EICM modules used for Modbus communication.

These diagrams are included:

- EICM Modbus Connection Using RS-422 Single Twisted-Pair Cables on page 272
- EICM Modbus Slave Using RS-422 Double Twisted-Pair Cables on page 273
- EICM Modbus Master Using RS-422 Double Twisted-Pair Cables on page 274

EICM Modbus Connection Using RS-422 Single Twisted-Pair Cables

This figure shows pin-out and wiring information for a Tricon EICM RS-422 single twisted-pair Modbus network. Note: Hardware Handshake must be On.

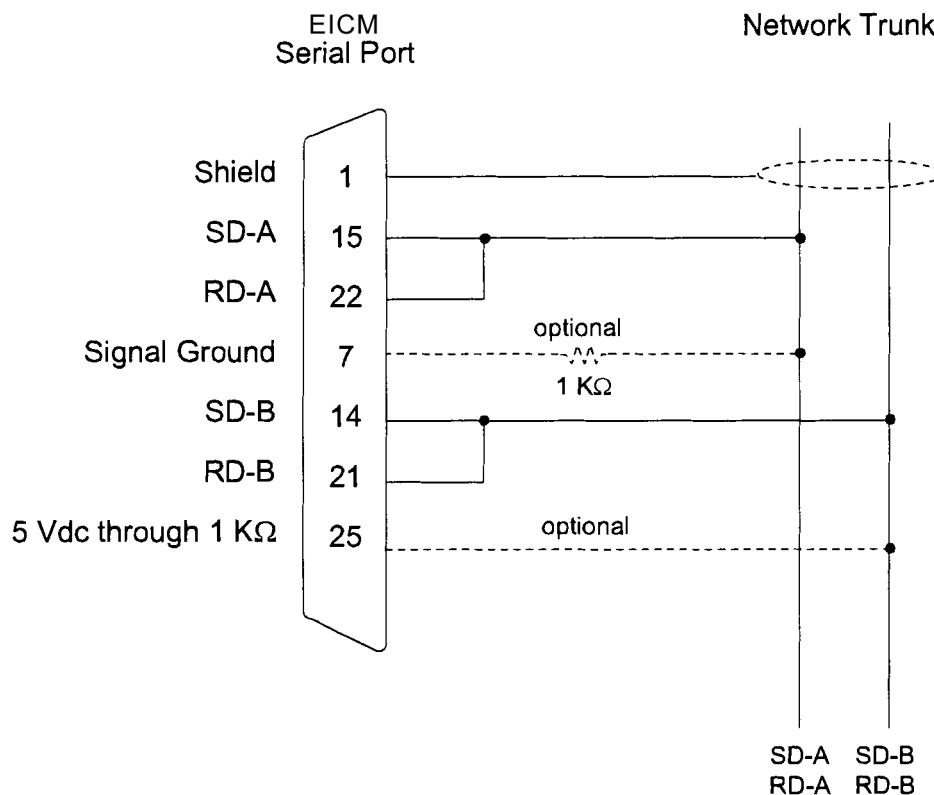


Figure 105 Tricon EICM Modbus Connection Using RS-422 Single Twisted-Pair Cables

EICM Modbus Slave Using RS-422 Double Twisted-Pair Cables

This figure shows pin-out and wiring information for a Tricon EICM Modbus slave using RS-422 double twisted-pair cables. If using a multipoint connection, HRDWR handshake must be On.

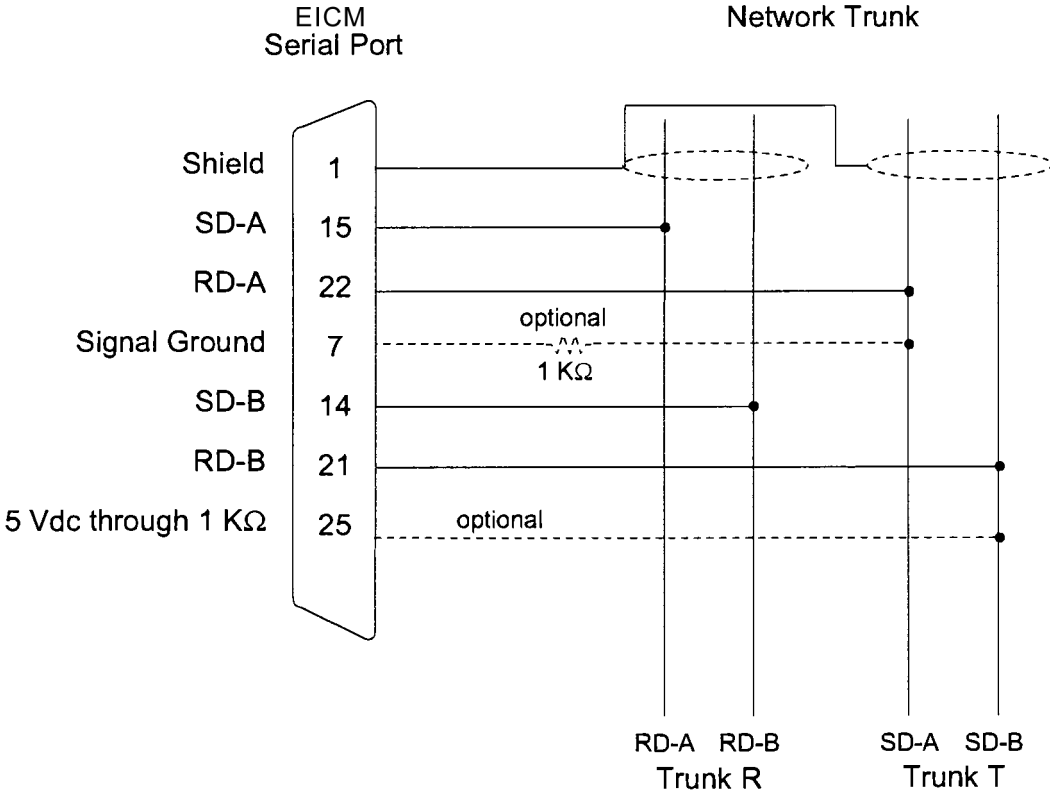


Figure 106 Tricon EICM Modbus Slave Using RS-422 Double Twisted-Pair Cables

EICM Modbus Master Using RS-422 Double Twisted-Pair Cables

This figure shows pin-out and wiring information for a Tricon EICM Modbus master using RS-422 double twisted-pair cables.

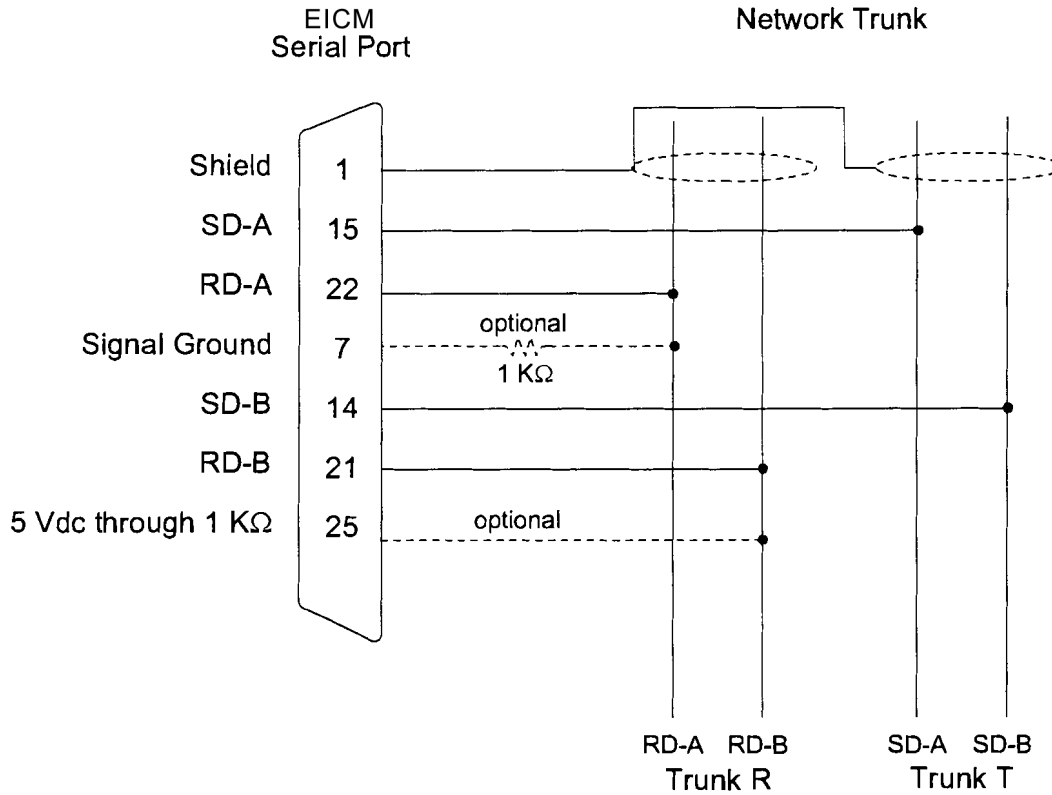


Figure 107 Tricon EICM Modbus Master Using RS-422 Double Twisted-Pair Cables

EICM Cables for RS-422 Modbus Connections

These guidelines should be observed when selecting the RS-422 cables for a Modbus network.

- Cable impedance should be ≥ 100 ohms.
- Each twisted pair should have its own shield.
- Double twisted-pair networks can house the pairs in a single sheath or in separate sheaths.
- Branch cables should be the same quality as the trunk cable, but of less rigid construction. For example, Belden 9182 cables for the trunk and Belden 9729 cables for the branches, which are both 150 ohm cables.
- Follow all applicable local codes.
- Terminate the trunk cable in the characteristic impedance of the cable.

EICM RS-422 Modbus Cable Termination

RS-422 trunk cable termination (point-to-point or multipoint) greater than 100 feet (30 meters) require termination at each end. Traditionally, you connect resistors to each end of the cable. This technique matches the cable impedance and prevents signal reflections which could cause data errors. However, this technique has three undesirable side effects.

- When no driver is active on the pair, the resistors pull the two wires together. Noise, even very low-level noise, can be appear to be data when the wires are in this state.
- When a driver is active on the pair but not sending data, the resistors cause 33 mA of DC current to flow in the cable. This is an excessive load on the driver.
- When a driver is transmitting data on the cable, the resistors lower the signal level and consequently lower the immunity to noise.

This figure shows a better technique for terminating the cable pair, which is to use an RC network and pull-up/pull-down resistors. Resistor values must match the characteristic impedance of the cable. This reduces power consumption and forces the pair to a valid data state when no driver is active.

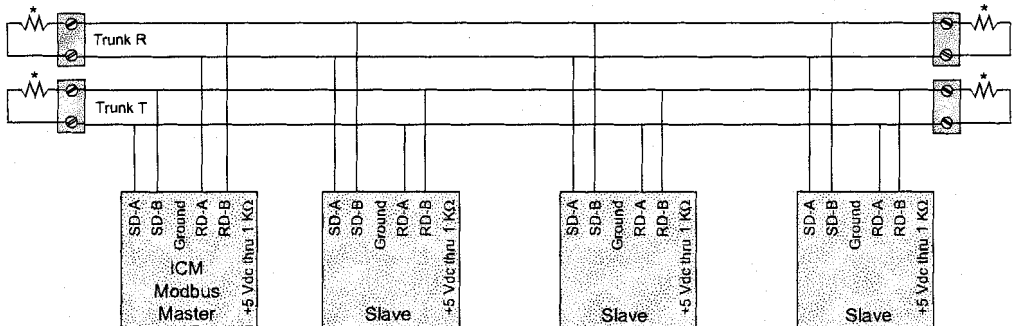


Figure 108 Traditional Network Termination

This figure shows the recommended network termination using a double-pair network. Resistor values must match the characteristic impedance of the cable. There is no need to provide pull-up/pull-down resistors at any of the slaves because the Modbus master ICM is configured without HRDWR handshake. This means its transmitter is always enabled.

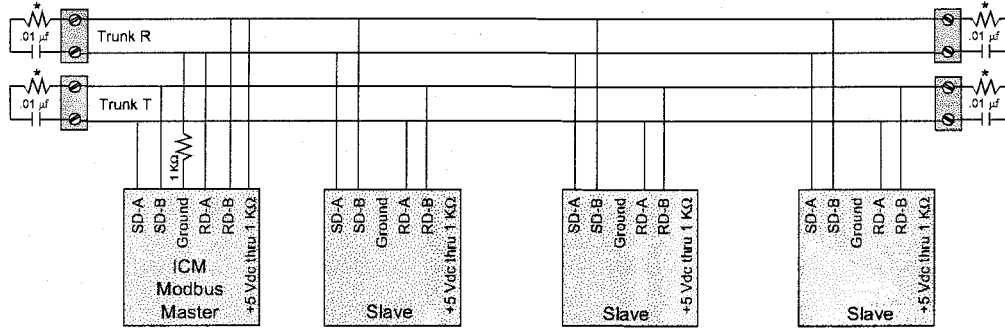


Figure 109 Triconex-Recommended Network Termination Using a Double-Pair Network

This figure shows the recommended network termination using a single-pair network. Resistor values must match the characteristic impedance of the cable. You should install pull-up/pull-down resistors at one node. You can install a second pair of resistors in another node for redundancy, but should never install more than two sets of resistors.

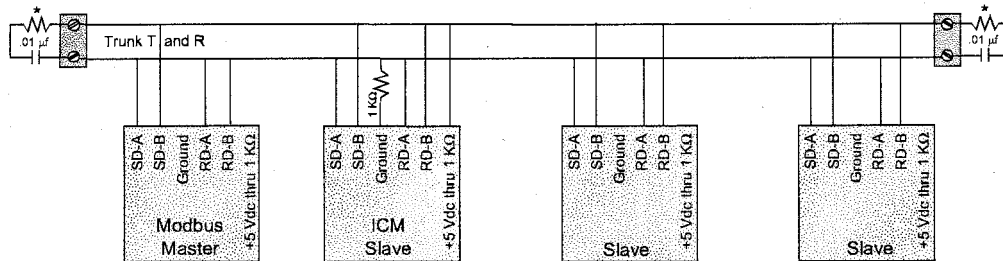


Figure 110 Triconex-Recommended Network Termination Using a Single-Pair Network

EICM Printer Cable Pin-Outs

The EICM module includes a parallel port which can be connected to a Centronics-compatible printer by using a standard PC printer cable. To guarantee proper connection, the printer cable must have a molded hood.

Table 114 EICM Printer Cable Pin-Outs

EICM Male Connector J2 25 Pins	Signal	Direction	Pins for Parallel Printer Connection
1	- Strobe	Output	1
2	+ Data Bit 0	Output	2
3	+ Data Bit 1	Output	3
4	+ Data Bit 2	Output	4
5	+ Data Bit 3	Output	5
6	+ Data Bit 4	Output	6
7	+ Data Bit 5	Output	7
8	+ Data Bit 6	Output	8
9	+ Data Bit 7	Output	9
10	- Acknowledge	Input	10
11	+ Busy	Input	11
12	+ P. End (out of paper)	Input	12
13	+ Select	Input	13
14	- Auto Feed	Output	14
15	- Error	Input	32
16	- Initialize	Output	31
17	- Select Input	Output	36
18-25	Ground		19-30, 33

EICM to Honeywell DHP Cable Pin-Outs

A Tricon EICM module can be connected to a Honeywell DHP by an RS-232 cable. The maximum length of an RS-232 cable is 50 feet (15 meters). You can extend the length of an RS-232 connection by using modems.

The cable part number is 4000041-0xx.

Table 115 EICM to Honeywell DHP Cable Pin-Outs

EICM Female Connector J2 25 Pins	Signal	DHP Female Connector J1 25 Pins	Signal
20	DTR	6	Not used
7	Signal Ground	7	Signal Ground
2	TXD	3	RXD
3	TXD	2	TXD
4 (must be shorted)	RTS	4 (must be shorted)	RTS
5 (must be shorted)	CST	5 (must be shorted)	CTS
6	Not used	20	DTR
1	Shield	1	Shield
8	DCD	8	DCD
25	NC	25	+5/+12 VDC

TCM Pin-Outs and Cable Information

This section includes pin-out and cable information for these TCM connectors and cables:

- TCM Copper Ethernet Connectors on page 279
- TCM Serial Connectors on page 279
- TCM Copper Ethernet Cables on page 282
- TCM Fiber-Optic Ethernet Cables on page 283
- TCM Serial Cables on page 284

TCM Copper Ethernet Connectors

This section includes pin-out information for TCM 10BaseT and 100BaseTX RJ-45 Ethernet connectors, which are on TCM models 4351, 4351A, 4351B, and 4353.

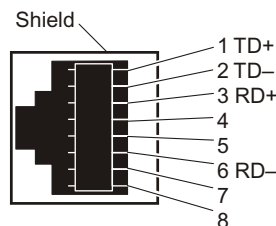


Table 116 TCM RJ-45 Ethernet Connector Pin-Outs

RJ-45 Pin	Signal	Direction	Function
1	TD+	Out	Transmit data +
2	TD-	Out	Transmit data -
3	RD+	In	Receive data +
4	TXCT1	Out	Transmit center tap 1
5	TXCT2	Out	Transmit center tap 2
6	RD-	In	Receive data -
7	RXCT1	In	Receive center tap 1
8	RXCT2	In	Receive center tap 2
Housing	Shield	—	Safety ground

TCM Serial Connectors

This section provides pin-out information for TCM serial connectors. The serial ports on the TCM can be configured in TriStation as RS-232 or RS-485.

This section includes:

- TCM RS-232 Pin-Outs on page 280
- TCM RS-232 Signal Descriptions on page 280
- TCM RS-485 Pin-Outs on page 281
- TCM RS-485 Signal Descriptions on page 281

TCM RS-232 Pin-Outs

This section includes pin-out information for RS-232 serial connections, which are typically used for Modbus or TriStation communication.

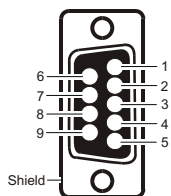


Table 117 TCM RS-232 Serial Connector Pin-Outs

DB-9 Pin	Signal	Direction	RS-232 Function
1	CD	In	Carrier detect
2	RXD	In	Receive data
3	TXD	Out	Transmit data
4	DTR	Out	Data terminal ready
5	GND	–	Isolated ground
6	DSR	–	Data set ready (not used)
7	RTS	Out	Request to send
8	CTS	In	Clear to send
9	RI	–	Ring indicator (not used)
Housing	Shield	–	Safety ground

TCM RS-232 Signal Descriptions

This table describes RS-232 signals. Spacing (on or 0) occurs when RS-232 signals are between +6 and +12 VDC; marking (off or 1) occurs when they are between –6 and –12 VDC. The maximum cable length is 50 feet (15 meters), but can be extended using modems.

Table 118 TCM RS-232 Signal Descriptions

Signal	Designator	Description
Clear to Send	CTS	Module ignores CTS and transmits data as soon as it is available
Request to Send	RTS	Module turns on RTS unconditionally
Data Carrier Detect	DCD	Module ignores DCD and always accepts data from RXD
Transmit Data	TXD	Module transmits serial data
Receive Data	RXD	Module receives serial data

TCM RS-485 Pin-Outs

This section includes pin-out information for RS-485 serial connections, which are typically used for Modbus or GPS communication.

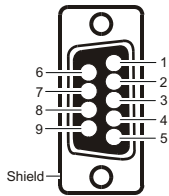


Table 119 TCM RS-485 Serial Connector Pin-Outs

DB-9 Pin	Signal	Direction	RS-485 Function
1	1PPS-	In	GPS 1PPS- (pulse per second signal)
2	RD-A	In	Receive data A -
3	SD-A	Out	Transmit data A -
4	DTR	Out	Data terminal ready
5	GND	-	Isolated ground
6	1PPS+	In	GPS 1PPS+ (pulse per second signal)
7	SD-B	Out	Transmit data B +
8	RD-B	In	Receive data B +
9	TERM+	-	1k Ω pull-up
Housing	Shield	-	Safety ground

TCM RS-485 Signal Descriptions

This table describes RS-485 signals, which are transmitted over a cable of twisted-pair-wires. The polarity of the 2-to-6-volt differential between the two wires indicates whether the data is marking or spacing. If terminal A is negative with respect to terminal B, the line is marking. If terminal A is positive with respect to terminal B, the line is spacing. The maximum cable length is dependent on the wire used. For example, using 24-AWG twisted-pair wire, the maximum length is 4,000 feet (1.2 kilometers), but can be extended using modems.

Table 120 TCM RS-485 Signal Descriptions

Signal	Designator	Description
Transmit Data	SD-A	Module transmits serial data
Transmit Data, Inverted	SD-B	
Receive Data	RD-A	Module receives serial data
Receive Data, Inverted	RD-B	
Signal Ground	GND	Signal ground
5 VDC through 1k Ω		Not used

TCM Copper Ethernet Cables

These cables can be used to connect the TCM to a TriStation PC or Ethernet hub.

Table 121 TCM Copper Ethernet Cables

Model	Description
1600044-020	10BaseT cross-over cable, 20 feet (6 meters), for direct connection from a TCM to a PC
1600045-020	10BaseT straight-through cable, 20 feet (6 meters), for connection from a TCM to an Ethernet hub

TCM Cross-Over Cable

Use a cross-over cable to directly connect an RJ-45 Ethernet connector on the TCM to the network adapter on a PC, for 10BaseT or 100BaseTX communication.

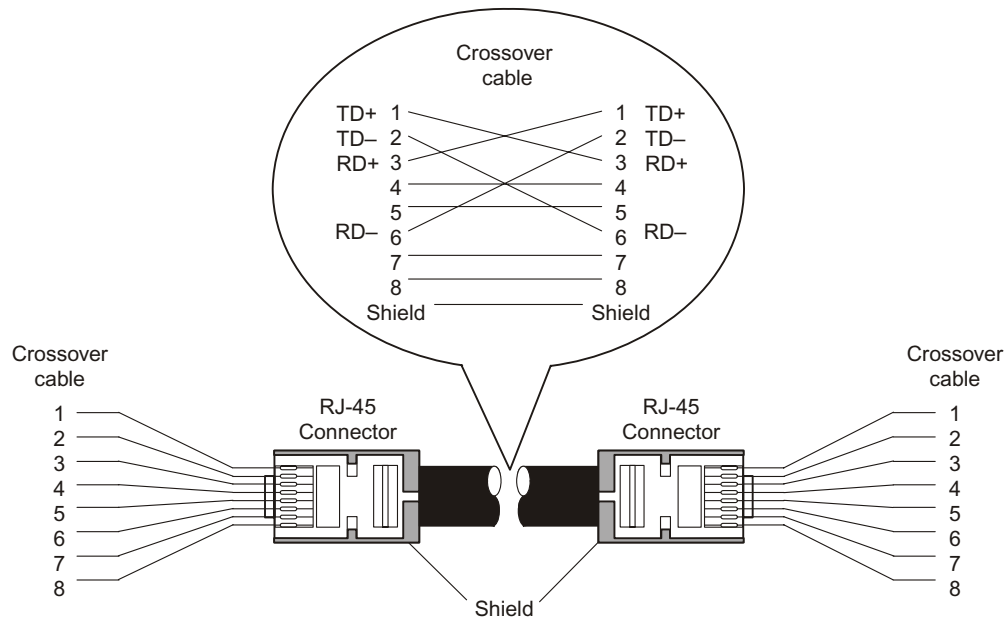


Figure 111 Cross-Over Copper Ethernet Cable with RJ-45 Connectors

TCM Straight-Through Cable

Use a straight-through cable to connect the RJ-45 Ethernet connector on the TCM to an Ethernet hub, or to connect a TriStation PC to an Ethernet hub, for 10BaseT or 100BaseTX communication.

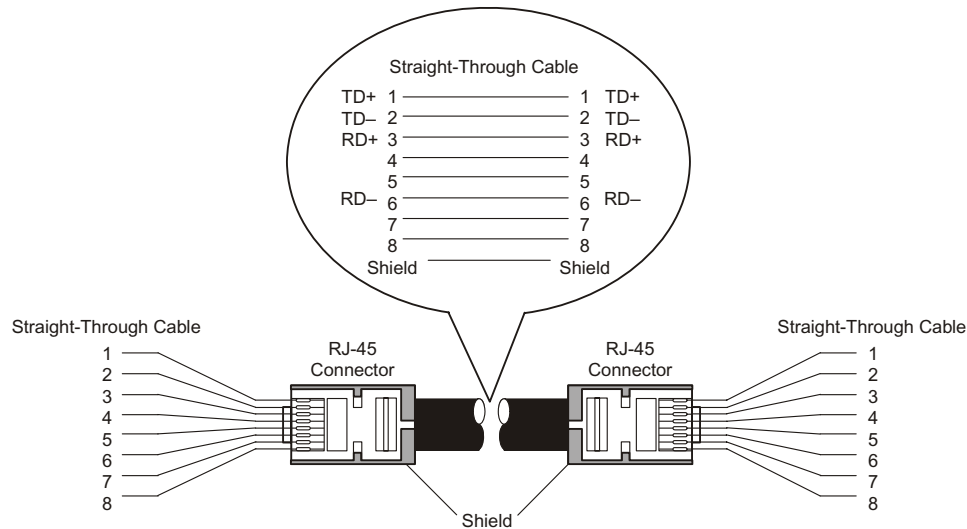


Figure 112 Straight-Through Copper Ethernet Cable with RJ-45 Connectors

TCM Fiber-Optic Ethernet Cables

If you are installing a TCM with fiber connectors (models 4352, 4352A, and 4354), you will need to provide your own fiber-optic cable(s). You cannot purchase a fiber-optic cable from Triconex. The fiber cable should be a multimode 62.5/125 μm cable which complies with the ANSI/TIA/EIA-568-B.3 standards and has a maximum length of 1.24 miles (2 kilometers).

TCM Serial Cables

This section describes serial cables which are generally used for Modbus or TriStation communication. Cable types include:

- [TCM RS-232 Serial Cable on page 284](#)
- [TCM RS-485 Serial Cables on page 285](#)

TCM RS-232 Serial Cable

This figure depicts an RS-232 serial cable, which is a standard null-modem cable used to link a serial connector on the TCM to a Modbus device or a TriStation PC.

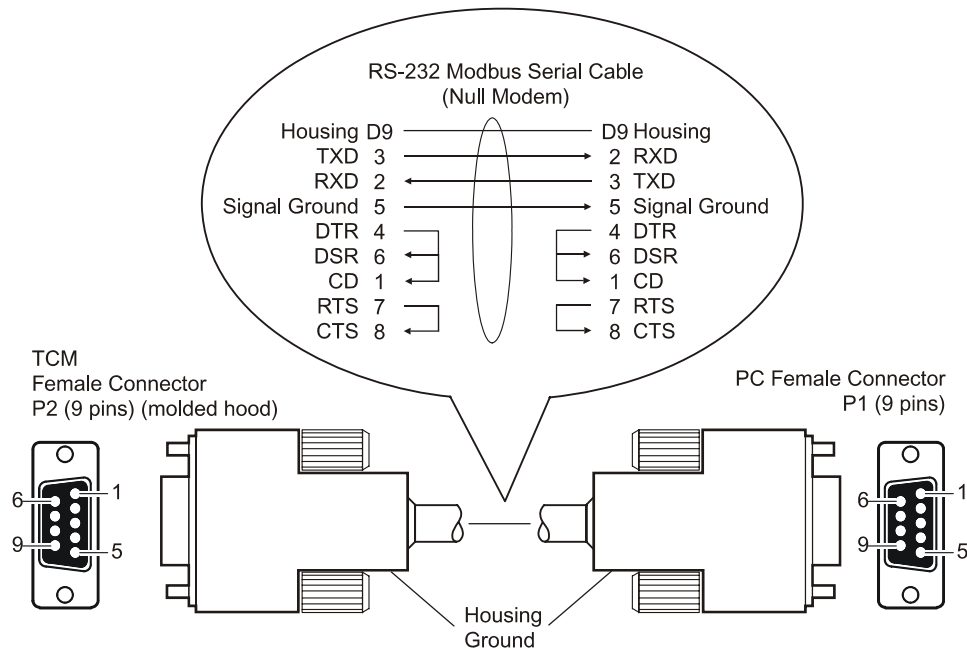


Figure 113 RS-232 Serial Cable with DB-9 Connectors

TCM RS-485 Serial Cables

RS-485 serial cables are typically used for point-to-point (direct) and multi-point (network) connections between a TCM and a Modbus master.

The TCM complies with the TIA/EIA-485 standard, which does not define a connector pin-out, but does define each differential twisted-pair wire as Wire A and Wire B. Some RS-485 suppliers rename these as Wire + and Wire -. This means you cannot always rely on the name to identify the polarity of the signal.

To determine the polarity of a signal in an RS-485 serial cable

- 1 For both the Triconex controller and DCS, ensure the send channel is on.
- 2 On the Triconex controller side, measure the signal ground to SDA and SDB.
The SDA will be less than 1 volt.
The SDB will be greater than 2.5 volts.
- 3 On the DCS side, measure the send channel.
If the channel is less than 1 volt, it is the A channel.
If the channel is greater than 2.5 volts, it is the B channel.
- 4 Use the following tables to determine whether the polarity is typical or reversed.
This table identifies a typical conversion with wires defined as A and B, or + and -.

Triconex		Other Suppliers
SDA = Send Data A	=	TX+ = Transmit Data, Positive Polarity
SDB = Send Data B	=	TX- = Transmit Data, Negative Polarity
RDA = Receive Data A	=	RX+ = Transmit Data, Positive Polarity
RDB = Receive Data B	=	RX- = Transmit Data, Negative Polarity

This table identifies a reverse polarity conversion.

Triconex		Other Suppliers
SDA = Send Data A	=	TX- = Transmit Data, Negative Polarity
SDB = Send Data B	=	TX+ = Transmit Data, Positive Polarity
RDA = Receive Data A	=	RX- = Transmit Data, Negative Polarity
RDB = Receive Data B	=	RX+ = Transmit Data, Positive Polarity

Ensure the RS-485 connection includes the following:

- A signal ground reference wire, which is mandatory due to opto-isolation on the TCM.
- Pull-up/pull-down resistors, which are highly advised.

If you have a noisy environment or poor Modbus-compliant devices, you may need stronger pull-up/pull-down resistors than what is provided by the TIA/EIA-485 standard. In RS-485 mode, you can enable or disable these resistors using Tristation.

Long distance RS-485 cables (up to 4000 feet) require termination at each end of the cable. Triconex recommends 120-ohm termination resistors. You can enable or disable these resistors using Tristation.

I/O Bus Cable (for Interconnected Chassis) Information

When a Tricon controller includes several chassis, the chassis must be connected with RS-485 I/O bus cables. For more information, see [Connecting Multiple Chassis](#) on page 181.

Table 122 I/O Bus Cable Pin-Outs

D Connector 9 Pins	Signal	D Connector 9 Pins	Comments
1	XMTR- (I/O)	1	Pins 1 and 2 are a twisted pair.
2	XMTR+ (I/O)	2	Pins 1 and 2 are a twisted pair.
3	RCVR- (I/O)	3	Pins 3 and 4 are a twisted pair.
4	RCVR+ (I/O)	4	Pins 3 and 4 are a twisted pair.
5	XMTR- (COMM)	5	Pins 5, 6, 7 and 8 are optional for I/O communication between Chassis 1 and Chassis 2 only.
6	XMTR+ (COMM)	6	
7	RCVR- (COMM)	7	
8	RCVR+ (COMM)	8	
9	Ground	9	

Warning Labels

This appendix provides a physical description of warning labels which must be prominently displayed on the cabinet door of any controller that provides less than an IP20 degree of protection as defined by IEC 60529. In other words, any system in which a person's finger could touch a termination panel.

Labels must meet the requirements of ANSI Z535, ISO 3864, and IEC 1310-1.

Labels are available from Triconex upon request.

General Hazard

This figure is an example of a general hazard label.

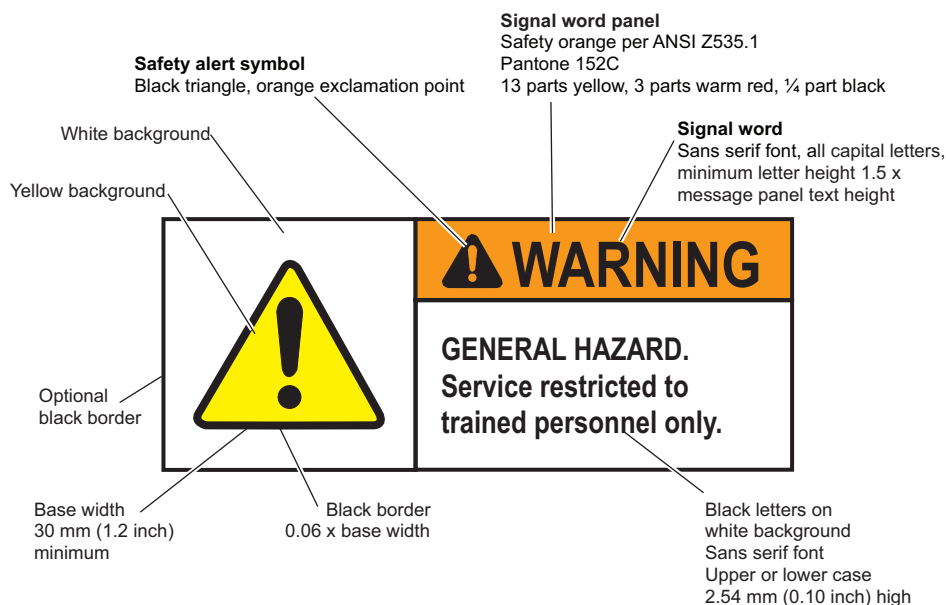


Figure 114 General Hazard Label

Hazardous Voltage

This figure is an example of a hazardous voltage label.

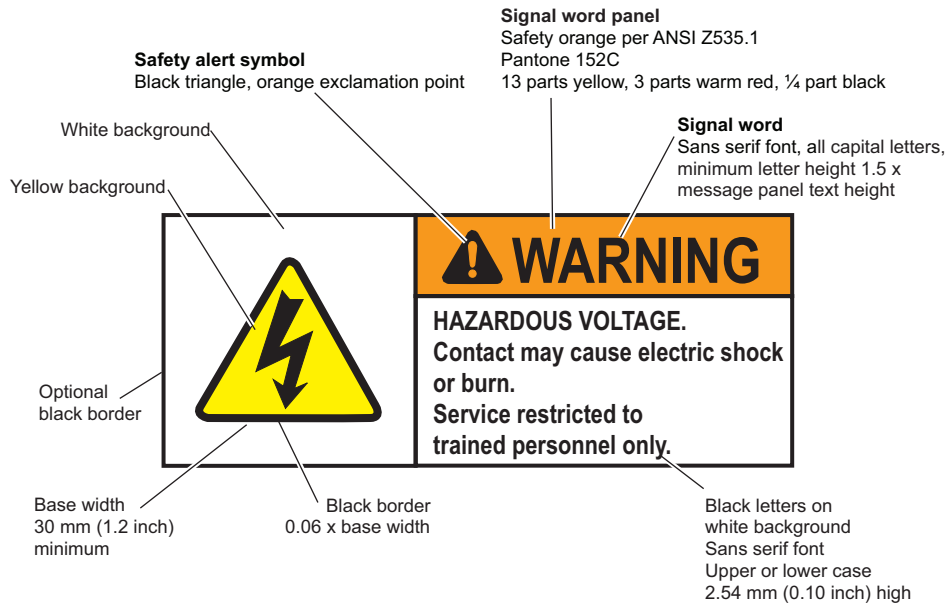


Figure 115 Hazardous Voltage Label

Hot Surface

This figure is an example of a hot surface label.

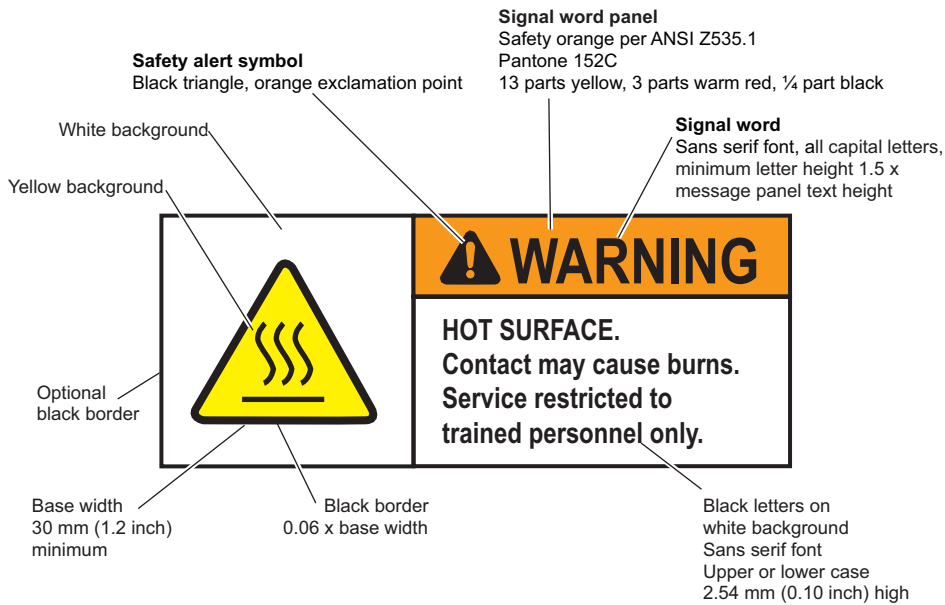


Figure 116 Hot Surface Label

D

Nonincendive Circuit Parameters

This appendix describes the parameters you should use for nonincendive communication circuits in the field. Parameters that apply to the various Tricon controller communication modules are shown in the figures in this appendix, which are extracted from Triconex Drawing 9110003-001, Rev. C.

	CLASS 1, DIV 2 HAZARDOUS LOCATION	CLASS 1, DIV 2 OR NON-HAZARDOUS	
EICM MODEL 4119	SERIAL PORT #1	(9) IN/OUT SIGNALS	ASSOCIATED APPARATUS (See Note)
	SERIAL PORT #2	(9) IN/OUT SIGNALS	
	SERIAL PORT #3	(9) IN/OUT SIGNALS	
	PARALLEL PORT #5	(17) IN/OUT SIGNALS	
ACM & NCM MODEL 4329 4609	CHANNEL A	(1) COAXIAL CABLE	ASSOCIATED APPARATUS (See Note)
	RS-232 (3 PORTS ON ACM)	(9) IN/OUT SIGNALS	
	CHANNEL B	(1) COAXIAL CABLE	
HIM MODEL 4509	NETWORK 1	(1) COAXIAL CABLE	ASSOCIATED APPARATUS (See Note)
	TRISTATION PORT	(9) IN/OUT SIGNALS	
	NETWORK 2	(1) COAXIAL CABLE	
SMM MODEL 4409	NETWORK 1	(1) COAXIAL CABLE	ASSOCIATED APPARATUS (See Note)
	RS-232	(9) IN/OUT SIGNALS	
	NETWORK 2	(1) COAXIAL CABLE	
MP MODELS 3006 3007	RS-232	(9) IN/OUT SIGNALS	ASSOCIATED APPARATUS (See Note)
MP MODEL 3008	NETWORK	(9) SHIELDED TWISTED PAIR IN/OUT SIGNALS	ASSOCIATED APPARATUS (See Note)
	SERIAL PORT	(9) SHIELDED IN/OUT SIGNALS	
	RS-232 DIAG READ	(5) IN/OUT SIGNALS	
TCM MODEL 4351 4352 4353 4354	CHANNEL A	(1) COAXIAL CABLE	ASSOCIATED APPARATUS (See Note)
	RS-232/485 4 PORTS	(9) IN/OUT SIGNALS	
	CHANNEL B	(1) COAXIAL CABLE	

Figure 117 Parameters for Nonincendive Communication Circuits

Note FMRC-approved apparatus. The voltage (V_{max}) and current (I_{max}) which the load device can receive must be equal to or greater than the maximum open circuit voltage (V_{oc}) and maximum short circuit current (I_{sc}) which can be delivered by the source device. In addition, the maximum capacitance (C_i) and inductance (L_i) of the load which is not prevented by circuit components from providing a stored energy charge to the field wiring (for example, a diode across a winding to clamp an inductive discharge) and the capacitance and inductance of the interconnecting wiring, must be equal to or less than the capacitance (C_a) or inductance (L_a) that can be driven by the source device.

	EICM MODEL: 4119		NCM & ACM MODELS: 4329, 4609		HIM MODEL: 4509		SMM MODEL: 4409	
	SERIAL PORT	PARALLEL PORT	CHANNELS A & B	RS-232	NETWORKS 1 & 2	TRISTATION PORT	CHANNELS A & B	RS-232
Voc/Vmax	10V/10V	5V/5V	3V/N.A.	10V/10V	1V/N.A.	10V/10V	5V/N.A.	10V/10V
Isc/Imax	30mA/30mA	100mA/100mA	250mA/N.A.	30mA/30mA	125mA/N.A.	30mA/30mA	66mA/N.A.	30mA/30mA
Ca/Ci	15uF/0	5,000uF/0	10,000uF/N.A.	15uF/0	10,000uF/N.A.	15uF/0	10,000uF/N.A.	15uF/0
La/Li	85mH/0	8mH/0	0.8mH/N.A.	85mH/0	5mH/N.A.	85mH/0	50uH/N.A.	85mH/0

(See Note 1)

(See Note 2)

(See Note 2)

(See Note 2)

	MP MODELS: 3006,3007	MP MODEL: 3008	TCM MODELS: 4351,4352,4353,4354		
	RS-232	NETWORK	SERIAL PORT & RS-232 DIAG READ	NETWORK	RS-232/485 PORTS
Voc/Vmax	10V/10V	1V/1V	10V/10V	1V/1V	10V/10V
Isc/Imax	30mA/30mA	1mA/1mA	30mA/30mA	1mA/1mA	30mA/30mA
Ca/Ci	15uF/0	40pf/40pf	15uF/0	40pf/40pf	15uF/0
La/Li	85mH/0	1.3mH/1.3mH	85mH/0	1.3mH/1.3mH	85mH/0

Figure 118 Parameters for Nonincendive Communication Circuits

Note 1 For more information on signal data, see the user's guide from the applicable manufacturer. For information on signal data for the EICM, HIM, and NCM, see the applicable Triconex guides.

Note 2 N.A. means not applicable. Connections provide output signals only.



Recommended Replacement Parts

This table contains recommended parts that can be used to replace existing Tricon parts, or customize a Tricon system.

Table 123 Recommended Replacement Parts

Part Description	Manufacturer Part No.	Manufacturer	Triconex Part No.	Triconex Models
Lithium battery, C-size, 3.6 VDC	1400010-001	Triconex	1400010-001	Main chassis
Lithium battery, AA-size packaged as C-size, 3.6 VDC	3000785-001	Triconex	3000785-001	Main chassis
15-amp time-delay fuse, 1/4 in x 1-1/4 in	326 015	Littlefuse	1410015-001	Earlier 24 VDC power supplies that have field-replaceable fuses
	MDA-15	Bussman		
	3W015	Bel Fuse		
5-amp time-delay fuse, 1/4 in x 1-1/4 in	326 005	Littlefuse	1410039-001	115 VAC/VDC power supplies
	MDA-5	Bussman		
	3S350	Bel Fuse		
2.5-amp time-delay fuse, 1/4 in x 1-1/4 in	326 02.5	Littlefuse	1410040-001	230 VAC power supplies
	MDA-2 1/2	Bussman		
	3SB2.5	Bel Fuse		
3-amp fast-acting fuse, 5 mm x 20 mm	235003	Littlefuse	1410003-001	Digital output termination panels
	GMA-3A	Bussman		
	5MF3	Bel Fuse		
2.5-amp fast-acting fuse, 5 mm x 20 mm	23502.5	Littlefuse	1410022-001	Digital output and relay output termination panels
	GMA-2.5A	Bussman		
	5MF 2.5	Bel Fuse		
2-amp fast-acting fuse, 5 mm x 20 mm	235002	Littlefuse	1410009-001	Relay output termination panels
	GMA-2A	Bussman		
	5MF2	Bel Fuse		

Table 123 Recommended Replacement Parts (continued)

Part Description	Manufacturer Part No.	Manufacturer	Triconex Part No.	Triconex Models
2-amp fuse, 1/4 in x 1-1/4 in	312002 3AG2	Littlefuse Bel Fuse	1410020-001	Bypass panel
1.25-amp fast-acting fuse, 5 mm x 20 mm	2351.25 GMA-1.25A 5MF1.25	Littlefuse Bussman Bel Fuse	1410023-001	Digital output termination panels
1-amp fast-acting fuse, 5 mm x 20 mm	235001 GMA-1A 5MF1	Littlefuse Bussman Bel Fuse	1410006-001	Digital output, relay and analog input termination panels
50 mA fast-acting fuse, 5 mm x 20 mm	216.050	Littlefuse	1410019-001	Analog input terminations
50 mA fuse	273.050	Littlefuse	1410037-001	3-wire analog input
500 mA fuse	273.500	Littlefuse	1410038-001	3-wire analog input
Lithium battery	1400080-001	Triconex	1400080-001	SMM
1.0-amp time-delay fuse, 5 mm x 20 mm	239001 GMC-1A 5TT1	Littlefuse Bussman Bel Fuse	1410011-001	Digital and analog input termination panels
IC Extractor	M125B002	OK	1580009-001	All modules
Fuse Extractor Tool	M45B001 34-015	Jensen Tools Ideal	1580000-001	Terminations
Load Resistor, 2200 ohm, 10 W, 10%	CP-10-2200-10 PW-10-2200-10 SQP-10-2200-10	Dale IRC, RCD RF	1100280-001	Supervised digital output termination panels
Load Resistor, 470 ohm, 10 W, 10%	CP-10-470-10 PW-10-470-10 SQP-10-470-10	Dale IRC, RCD RF	1100281-001	Supervised digital output termination panels
Load Resistor, 120 ohm, 10 W, 10%	CP-10-120-10 PW-10-120-10 SQP-10-120-10	Dale IRC, RCD RF	1100282-001	Supervised digital output termination panels

Table 123 Recommended Replacement Parts (continued)

Part Description	Manufacturer Part No.	Manufacturer	Triconex Part No.	Triconex Models
I-to-V Resistor, 250 ohm, 0.6 W, 0.01%	S102C 250 .010%	Vishay	1100375-001	V9 and later analog termination panels
	PF2260H 250 ohm .01%	Riedon		
	WAC250R00T	Wilbrecht Electronics Inc.		
I-to-V Resistor, 500 ohm, 0.6 W, 0.01%	S102C 500 .010%	Vishay	1100425-001	V9 and later analog termination panels
	PF2260H 500 ohm .01%	Riedon		
	WAC500R00T	Wilbrecht Electronics Inc.		
I-to-V Resistor, 250 ohm, 1/4 W, 0.05%	VMTB60 V4-250-5	Vishay	1100067-001	V6-V8 analog termination panels
	Type 135-250-5	Micro-Ohm		
	SM-15-250-5	Riedon		
	UPR5063ZT250-5	Phillips		
I-to-V Resistor, 500 ohm, 1/4 W, 0.05%	VMTB60 V4-500-5	Vishay	1100174-001	V6-V8 analog termination panels
	Type 135-250-5	Micro-Ohm		
	SM-15-500-5	Riedon		
	UPR5063ZT500-5	Phillips		
Cable assembly, Ethernet BNC, 20 feet (6 m)	1060-2	Inmac	1600010-006	ACM and NCM
Cable assembly, cable Ethernet BNC, 30 feet (9 m)	1060-3	Inmac	1600010-009	ACM and NCM
Feedthru terminator, Ethernet BNC	PE6008-50	Pasternack	n/a	ACM and NCM
Male terminator, Ethernet BNC	105000	Inmac	1600008-011	ACM and NCM
	PE6000-50	Pasternack		
BNC T- adapter F-M-F	1051	Inmac	1500097-001	ACM and NCM
	329518	Amp		
	3285	ITT Pomona		
	31-208	Amphenol		
Cable assembly, Ethernet shielded twisted-pair, RJ-45, 20 feet (6 m)	EVNSL60-0020	Black Box	1600045-020	TCM

Table 123 Recommended Replacement Parts (continued)

Part Description	Manufacturer Part No.	Manufacturer	Triconex Part No.	Triconex Models
Re-keying tool	2000236-001	Triconex	2000236-001	56-pin connectors on termination cables, panels, backplane and main chassis
Spring-loaded terminal, 16-position	18 73 34 6	Phoenix	1420045-016	All applicable V9 and later termination panels except basic, bypass, and interposing relay
Spring-loaded terminal, 12-position	18 73 30 4	Phoenix	1420045-012	All applicable V9 and later termination panels except basic, bypass, and interposing relay
Spring-loaded terminal, 8-position	18 73 26 5	Phoenix	1420045-008	All applicable V9 and later termination panels except basic, bypass, and interposing relay
ELCO connector gasket These gaskets must be replaced before the end of their 5-year life cycle.	3000793-001 (kit of 25 gaskets)	Triconex	3000793-001 (kit of 25 gaskets)	The male side of all ELCO connectors used in hazardous locations (those requiring nonincendive circuits)
Key for blank logical slot	2000508-001	Triconex	2000508-001	All chassis

Minimum Bend Radiuses of Cables

This table identifies the minimum bend radiuses of cables.

Table 124 Minimum Bend Radiuses of Cables

Triconex Cable Assembly Number	Minimum Bend Radius of Cable
4000002-006	4 in (10.16 cm)
4000004-0xx	1.75 in (4.445 cm)
4000006-0xx	2.125 in (5.3975 cm)
4000007-0xx	2.125 in (5.3975 cm)
4000008-0xx	2.125 in (5.3975 cm)
4000009-0xx	2.125 in (5.3975 cm)
4000010-00x	3 in (7.62 cm)
4000015-0xx	2.125 in (5.3975 cm)
4000016-0xx	2.125 in (5.3975 cm)
4000017-0xx	2.125 in (5.3975 cm)
4000027-006	2.5 in (6.35 cm)
4000028-006	1.75 in (4.445 cm)
4000029-0xx	5.5 in (13.97 cm)
4000030-025	1.75 in (4.445 cm)
4000041-0xx	2.125 in (5.3975 cm)
4000042-xxx	5.6 in (14.224 cm)
4000043-1xx	4.6 in (11.684 cm)
4000050-00x	3.25 in (8.255 cm)
4000052-006	2.5 in (6.35 cm)
4000054-x10	4.6 in (11.684 cm)
4000055-x10	5.6 in (14.224 cm)

Table 124 Minimum Bend Radiuses of Cables *(continued)*

Triconex Cable Assembly Number	Minimum Bend Radius of Cable
4000056-00x	3 in (7.62 cm)
4000058-x10	5.6 in (14.224 cm)
4000059-510	6.25 in (15.875 cm)
4000060-510	4.25 in (10.795 cm)
4000061-x10	3.5 in (8.89 cm)
4000062-x10	4.6 in (11.684 cm)
4000063-510	6.25 in (15.875 cm)
4000064-510	5.25 in (13.335 cm)
4000065-510	4.25 in (10.795 cm)
4000066-025	1.75 in (4.445 cm)
4000068-x10	5.6 in (14.224 cm)
4000069-x10	6.25 in (15.875 cm)
4000070-0x0	4.25 in (10.795 cm)
4000071-0x0	3.5 in (8.89 cm)
4000072-x10	4.6 in (11.684 cm)
4000073-x10	6.25 in (15.875 cm)
4000074-0x0	5.25 in (13.335 cm)
4000075-0x0	4.25 in (10.795 cm)
4000076-510	5 in (12.7 cm)
4000076-510	6.25 in (15.875 cm)
4000078-x10	5.6 in (14.224 cm)
4000079-510	6.25 in (15.875 cm)
4000085-x10	4.6 in (11.684 cm)
4000086-510	5.25 in (13.335 cm)
4000089-025	1.75 in (4.445 cm)
4000090-025	2.125 in (5.3975 cm)
4000091-0xx	2.125 in (5.3975 cm)
4000092-x10	5.6 in (14.224 cm)
4000093-x10	5.6 in (14.224 cm)
4000094-x10	5.6 in (14.224 cm)
4000096-x01	3.5 in (8.89 cm)
4000098-510	6.25 in (15.875 cm)

Table 124 Minimum Bend Radiuses of Cables *(continued)*

Triconex Cable Assembly Number	Minimum Bend Radius of Cable
4000100-310	5 in (12.7 cm)
4000101-310	4.5 in (11.43 cm)
4000102-x10	5 in (12.7 cm)
4000103-510	6.25 in (15.875 cm)
4000104-x10	4.6 in (11.684 cm)
4000107-x0x	3.5 in (8.89 cm)
4000109-x10	5.6 in (14.224 cm)
4000110-x10	4.6 in (11.684 cm)
4000111-x10	5.6 in (14.224 cm)
4000112-x10	5 in (12.7 cm)
4000113-x10	5 in (12.7 cm)
4000114-510	6 in (15.24 cm)
4000115-x10	5.6 in (14.224 cm)
4000116-510	5.5 in (13.97 cm)
4000117-110	5.6 in (14.224 cm)
4000118-510	5.5 in (13.97 cm)
4000120-510	6 in (15.24 cm)
4000121-010	5.5 in (13.97 cm)
4000122-x10	5.6 in (14.224 cm)
4000123-310	5.6 in (14.224 cm)
4000126-110	5.6 in (14.224 cm)
4000127-510	5.5 in (13.97 cm)
4000128-510	5.5 in (13.97 cm)
4000129-510	5.5 in (13.97 cm)
4000139-010	7.4 in (18.796 cm)
4000140-x10	6.6 in (16.764 cm)
4000141-x10	6.6 in (16.764 cm)
4000142-x10	8.1 in (20.574 cm)
4000143-x10	5.5 in (13.97 cm)
4000144-x10	6.6 in (16.764 cm)
4000147-510	7.4 in (18.796 cm)
4000150-510	7.4 in (18.796 cm)

Table 124 Minimum Bend Radiuses of Cables *(continued)*

Triconex Cable Assembly Number	Minimum Bend Radius of Cable
4000151-510	7.4 in (18.796 cm)
4000153-00x	3.6 in (9.144 cm)
4000154-00x	4.2 in (10.668 cm)
4000155-110	6.6 in (16.764 cm)
4000155-510	7.4 in (18.796 cm)
4000157-x10	8.1 in (20.574 cm)
4000161-002	3 in (7.62 cm)
4000163-xxx	6.25 in (15.875 cm)
4000164-xxx	6.25 in (15.875 cm)
4000165-xxx	5.6 in (14.224 cm)
4000166-xxx	5.6 in (14.224 cm)
4000172-3xx	5 in (12.7 cm)
4000173-3xx	4 in (10.16 cm)
4000174-3xx	4 in (10.16 cm)
4000182-5xx	6.25 in (15.875 cm)
4000183-5xx	5 in (12.7 cm)
4000184-5xx	5.5 in (13.97 cm)
4000185-3xx	5 in (12.7 cm)
4000186-3xx	5 in (12.7 cm)
4100002-001	3.5 in (8.89 cm)
4100005-xx0	2 in (5.08 cm)

alias

A five-digit number that the Tricon controller uses in place of a variable name when communicating with an external device. The alias is a convention of Modbus, an industry-standard protocol adopted by Triconex for use with its communication modules. Each alias contains a Modbus message type and the address of the variable in the Tricon controller.

ATEX

Stands for “AtmosphÈres Explosibles” and refers to the European Union Directive 94/9/EC, which is one of a number of new approach directives developed by the European Union and covers all equipment and protective systems intended for use in potentially explosive atmospheres.

availability

The probability that the controller is operational at some instant of time.

bin

An address range of aliased variables in the Tricon controller, based on Class and Type combinations. For example, all Read Only Input Discrete variables are grouped into Bin 2, and all Read/Write Memory Integer variables are grouped into Bin 12.

board

See *module*.

card

See *module*.

CE Mark

A type of certification by the European Union which ensures the electro-magnetic compatibility of the Tricon controller with other pieces of electrical/electronic equipment.

chassis

A metal frame which houses Tricon controller modules and can be mounted inside a standard 20 inch-deep NEMA cabinet. Also called a rack.

communication modules

Modules that enable the Tricon controller to communicate with other computers using serial and Ethernet communication protocols.

CSA

The acronym for Canadian Standards Association, a not-for-profit membership organization which develops standards and tests in areas ranging from nuclear power, health care, occupational health and safety, housing and construction materials to the electrical, electronic

and telecommunications fields. CSA certification of a product generates consumer confidence in many countries.

configuration

The arrangement of the programmable electronics within a Tricon controller and the combination of programmable and non-programmable equipment within the installation.

control system

A system that governs the operation of plant, machinery or other equipment by producing appropriate instructions in response to input signals.

coverage

The probability that a particular class of fault is successfully detected before a system failure occurs.

DDE

Dynamic Data Exchange (DDE) is an interprocess communication mechanism provided by Microsoft Windows. Applications running under Windows can use DDE to send and receive data and instructions to and from each other.

debug

The act of locating and correcting faults: 1) one of the normal operations in software development such as editing, compiling, debugging, loading, and verifying; or 2) the identification and isolation of a faulty physical component, including its replacement or repair to return the PLC to operational status.

design fault

A defect in the engineering or manufacturing of a process control system.

dual module

A type of digital output module which is optimized for safety-critical applications where low cost is more important than maximum availability. A dual module is equipped with one parallel or series signal path and applies the 2-out-of-3 voting process individually to each switch. While quadruplicated output circuitry provides multiple redundancy for all critical signal paths, dual circuitry provides just enough redundancy to ensure safe operation.

environment

Refers to the stimuli at an interface (or interfaces) of the system.

error

Occurs when a system resource assumes an undesired state. Such a state is then contrary to the specification of the resource or the expectation (requirement) of the user.

erroneous state

An internal state which, in the absence of actions for fault tolerance, could lead to a failure by a sequence of valid transitions.

event

A state change of a discrete aliased variable which has been designated for event logging. An event is said to occur if such a variable *changes from* the normal state. If the variable later *changes back* to the normal state, another event is said to have occurred.

event logger

An application that logs, displays and/or prints critical events in real time, based on state changes of discrete variables in the control program. Proper use of an event logger warns users about dangerous conditions and printouts of events can help identify the sequence of events that led to a trip.

event variable

A discrete memory variable or discrete input point that has been assigned to an SOE block.

external device

A device (PC, server, printer or other device) PC that communicates with the Tricon controller over a network.

fail-safe

Describes the characteristic of a device or system to always assume a safe, predictable state, even when one or more of its internal elements has failed.

failure

Occurs when a system resource perceives that a service resource ceases to deliver the expected services. The fault-tolerant Tricon controller masks most failures. (See *fault*.)

failure rate

Describes the rate at which failures occur over time. Usually expressed in failures per million hours. The inverse of failure rate is MTTF.

fault

A fault is detected when either a failure of the resource occurs, or an error is observed within the resource. The cause of the failure or error is said to be a fault.

fault avoidance

The result of conservative design techniques utilizing high-reliability components, system burn-in, and careful design. The goal of fault avoidance is to reduce the possibility of a failure by designing a device with performance margins so large that the probability of a detrimental failure is negligible.

fault masking

Any means of removing failed elements from influencing system operation while enabling properly operating redundant elements to continue the control process.

fault tolerance

The ability to identify and compensate for failed control system elements and allow repair while continuing an assigned task without process interruption. Fault tolerance is achieved by incorporating redundancy and fault masking.

FSR

The acronym for full scale range. Specifies an operating range for input or output signals. For example, if 0-5V is the “range,” then 5V is the “full scale.”

HART

Highway Addressable Remote Transducer protocol is a bi-directional industrial field communication protocol used to communicate between intelligent field instruments and host systems over 4–20 mA instrumentation wiring.

hazardous location

Any location that contains, or has the potential to contain, an explosive or flammable atmosphere.

host

See external host.

hot-spare module

A unique feature of the Tricon controller which allows you to install a second identical I/O module which becomes active if the other module fails.

input poll time

The time required by the Tricon controller to collect input data from the controlled process. Input polling is asynchronous and overlaps control program execution.

I/A Series DCS

The acronym for Foxboro’s Industrial Automation (I/ A) Series Distributed Control System. The Tricon controller’s Advanced Communication Module (ACM) acts an interface between the Tricon controller and the IA DCS.

IEEE

The Institute of Electrical and Electronics Engineers (IEEE) is a professional society for engineers.

ISO

The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies (ISO member bodies) that promulgates standards affecting international commerce and communications.

intermittent fault

A fault or error that is only occasionally present due to unstable hardware or varying software states.

LED

The acronym for light-emitting diode. One of the color-coded signal lights on each Tricon controller circuit board that indicates the board’s status. Every Tricon controller component includes at least the Pass, FAIL, and Active LEDs.

logical slot

In a Tricon controller chassis, a logical slot is a repository for a primary module, a hot spare module, and their associated field termination component.

Markov model

A generalized modeling technique which can be used to represent a system with an arbitrary number of modules, failure events, and repair events. A Markov model can be mathematically solved to produce a resultant probability.

module

An active field-replaceable unit consisting of an electronic circuit assembly housed in a metal spine. Also called *board* or *card*.

MS-DOS

Microsoft Disk Operating System (MS-DOS) is the operating system used by most IBM-compatible PCs. All Triconex-provided applications and utilities run on MS-DOS.

MTBF

The acronym for mean time between failure. The expected average time between failures, including the time taken to repair the system. Usually expressed in hours.

MTTF

The acronym for mean time to failure. The expected average time to a system failure in a population of identical systems. Usually expressed in hours.

MTTR

The acronym for mean time to repair. The expected time to repair a failed system or sub-system. Usually expressed in hours.

node

Any of the machines on a network – in this document, node usually means Tricon controller.

node number

The physical address of a node.

nonincendive

Not capable of igniting a flammable gas or vapor under normal operating conditions.

non-triplicated module

An I/O module with a single set of field-interface circuitry for communication with all three Main Processor Modules. Non-triplicated modules provide a cost-effective alternative to the use of TMR modules for non-critical applications.

open network

A network to which an external host can be connected.

output poll time

The time required by the Tricon controller to implement the outputs generated by the control program in response to inputs from the controlled process.

Peer-to-Peer

A Triconex protocol that allow multiple Triconex controllers on a proprietary network to exchange small amounts of process and safety information.

permanent fault

A failure, fault or error in the system that is continuous and stable.

physical slot

In a Tricon controller chassis, a physical slot is a repository for either a primary module, a hot spare module, or a termination panel. The Tricon controller's system software uses physical slot numbers to access individual modules within a rack, and to reference the slot positions of "system variables" which describe the status of modules and their points.

program

The basic programming unit in a project. A set of instructions, commands, and other directions. In TriStation MSW, programs can be written in Ladder Diagram language. In TriStation 1131, programs can be written in Function Block Diagram, Ladder Diagram, Structured Text, and an optional language, Cause and Effect Matrix language.

programmable logic controller

1. A "black box" device which accepts analog and/or digital input signals, acts upon them in a well-defined way, and produces appropriate output signals as a result.
2. The Tricon controller.

proprietary network

A network of Tricon controller chassis only or mixed Tricon and Trident controller chassis only.

protocol

A set of rules describing the format used for data exchange between two entities.

quad output circuit

A unique feature of the Tricon controller which provides fault-tolerant outputs. Each Tricon controller output is composed of four identical switching elements in a "quad" arrangement.

rack

See *chassis*.

reliability

The probability that no failure of the system has occurred in a given period of time.

scan time

The period of the Tricon controller's cycle of required control functions. The scan time is composed of three elements:

- Input poll time (asynchronous with control program execution)
- Time required to execute the control program
- Output poll time

single module

A type of digital input module which is optimized for safety-critical applications where low cost is more important than maximum availability. On a single module, only those portions of the signal path which are required to ensure safe operation are triplicated. Special self-test circuitry detects all stuck-On and stuck-Off fault conditions in less than half a second.

system

Consists of a set of components which interact under the control of a design.

TCP/IP

Transmission Control Protocol/Internet Protocol (TCP/IP) are protocols for the Transport and Network layers of the OSI network model. TCP/IP provides reliable, sequenced data delivery.

transient fault

A fault or error resulting from a temporary environmental condition.

TMR

The acronym for Triple Modular Redundant architecture, which allows the Tricon controller to achieve fault tolerance. The controller is triplicated; each of the three identical sub-systems is called a channel. Each channel independently executes the control program in parallel with the other channels.

Tricon

A state-of-the-art programmable logic and process controller that provides a high level of fault tolerance.

trip

A safety-related shutdown of the controlled process, or a portion of the controlled process.

TriStation 1131

TriStation 1131 is Windows-based software for writing and downloading control programs and for performing maintenance and diagnostics on Tricon controllers.

TriStation MSW

TriStation MSW is DOS-based software for writing and downloading control programs and for performing maintenance and diagnostics on Tricon controllers.

TriStation protocol

A master/slave protocol used by a TriStation for communication with the Tricon controller. The TriStation protocol supports a maximum of 10 Tricons, but each master can communicate with only one slave at a time.

TSAA

Tricon System Access Application (TSAA) protocol is a master-slave protocol in which the master (an external host) communicates with one or more slaves (Tricons or Tridents) over an open network. TSAA supports a maximum of 10 Tricons.

TÜV Rheinland

TÜV is the acronym for Technischer Überwachungs-Verein in German, which translates to Technical Supervisory Association. In Germany, TÜV Rheinland is an authorized technical inspection agency for a wide variety of products, processes, installations, plants and equipment. In addition, the agency is authorized to carry out statutory inspections and acceptance tests by more than 25 other countries.

UCN

The Universal Control Network (UCN) is one of three principal networks of Honeywell's TDC-3000 Distributed Control System (DCS). The Tricon controller provides the Safety Manager Module (SMM) solely for communication with the UCN.

UDP/IP

User Datagram Protocol/Internet Protocol (UDP/IP) are protocols for the Transport and Network layers of the OSI network model. UDP/IP provides best-effort datagram delivery.

voting

A mechanism whereby each channel of a TMR controller compares and corrects the data in each channel using a two-out-of-three majority voting scheme.

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