TRICONEX

Tricon Version 9-10 Systems

Communication Guide
for Tricon v9-v10 Systems

Assembly No. 9700088-008

IPS
INVENSYS PROCESS SYSTEMS

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Contents

Preface

This guide describes communication features available with Tricon version 9 to Tricon version 10 and later systems, including how to install and configure communication modules.

In this guide, *Triconex controllers* refers to Tricon and Trident controllers.

Summary of Sections

- Chapter 1, Introduction – Describes the types of communication available with a Triconex controller and the capabilities of its communication modules.

- Chapter 2, Communication Hardware – Discusses the hardware used to enable Triconex controllers for communication with each other and with external devices.

- Chapter 3, TriStation Communication – Explains how to connect a TriStation PC to a Triconex controller and specify write access to points.

- Chapter 4, Client/Server Communication – Explains how to configure and use client/server communication, including OPC Server and DDE Server client.

- Chapter 5, Peer-to-Peer Communication – Explains how to set up controllers for communication in a Peer-to-Peer network.

- Chapter 6, Modbus Communication – Explains how to set up a controller for communication as a Modbus master, slave, or both.

- Chapter 7, Related Communication Features – Describes the time synchronization and printing features of a Tricon controller.

- Appendix A, TCM Capabilities – Describes TCM operation and physical communication interfaces.

- Appendix B, NCM and NCMG Capabilities – Describes NCM operation and physical communication interfaces.

- Appendix C, EICM Capabilities – Describes EICM operation and physical communication interfaces.

- Appendix D, TSAA Protocol – Provides a programmer's reference for TSAA, a Triconex protocol used for client/server applications.

- Appendix E, Modbus Protocol – Provides detailed information about the Modbus protocol that can be used by Triconex network and serial ports.

- Appendix F, Tricon System Aliases – Describes the system aliases available with the Tricon controller.

- Appendix G, TCM Model 4351/4352 Configuration – Explains how to configure the older model 4351 or 4352 Tricon Communication Module.

- Glossary – Provides definitions of terms used in this guide.

Related Documentation

- *Enhanced Diagnostic Monitor User Guide, v2.2*
- *Planning and Installation Guide for Tricon v9–v10 Systems*
- *TriStation 1131 Developer's Guide, v4.5*
- *Safety Considerations Guide for Tricon v9–v10 Systems*
- *SOE Recorder User's Guide*

Product and Training Information

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

Web Site

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

Technical Support

Customers in the U.S. and Canada can obtain technical support from the IPS Global Client Support (GCS) center at the numbers below. International customers should contact their regional support center.

Requests for support are prioritized as follows:

- Emergency requests are given the highest priority
- Requests from participants in the System Watch Agreement (SWA) and customers with purchase order or charge card authorization are given next priority
- All other requests are handled on a time-available basis

If you require emergency or immediate response and are not an SWA participant, you may incur a charge. Please have a purchase order or credit card available for billing.

Telephone

Toll-free number   866-746-6477, or
Toll number   508-549-2424 (outside U.S.)

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Toll number   508-549-4999

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http://support.ips.invensys.com (registration required)

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We Welcome Your Comments

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Introduction

Overview

Tricon controllers can communicate with other Triconex controllers and with external devices through these communication modules:

- Tricon Communication Module (TCM)
- Advanced Communication Module (ACM)
- Enhanced Intelligent Communication Module (EICM)
- Network Communication Module (NCM)
- Network Communication Module with GPS Interface (NCMG)

For guidelines on using Triconex communication protocols in safety-critical applications, see the *Safety Considerations Guide for Tricon v9–v10 Systems*.

TriStation Communication

The TriStation protocol enables communication between a TriStation PC and a Triconex controller. A TriStation PC can be connected to a Triconex controller through an Ethernet port on the ACM, NCM, or TCM, or through a serial port on the EICM or TCM.

TriStation 1131 Developer's Workbench is used to develop and monitor applications which run in a Triconex controller. The TriStation 1131 software is compliant with Part 3 of the IEC 61131 International Standard for Programmable Controllers.

For more information about using the TriStation software, see the *TriStation 1131 Developer's Guide, v4.5*.

Client/Server Communication

The TSAA protocol allows client/server communication between a Triconex controller and a PC. OPC Server and DDE Server use TSAA protocol to exchange data with Triconex controllers. TSAA protocol can also be used to write custom programs for accessing Triconex points.

OPC Server

OPC is a standard set of non-proprietary interfaces used to develop client/server programs. OPC Server is a client/server application, which allows OPC clients to read and write to Triconex program variables.

The external OPC server is installed on a PC connected to the controller, and is available from Triconex or Matrikon. For more information, see External OPC Server on page 49.

TCM models 4353 and 4354 have an embedded OPC server, which makes an external PC for the server unnecessary. For more information, see TCM with Embedded OPC Server on page 55.

Triconex DDE Server

DDE Server is a client/server application that allows DDE clients to read and write to Triconex program variables. Using DDE Server, any Windows application that supports DDE protocol, such as Microsoft Excel, can access Triconex variables. For more information, see DDE Server for Triconex on page 38.

Peer-to-Peer Communication

The Triconex proprietary Peer-to-Peer protocol allows multiple Triconex controllers in a closed network to exchange safety-critical data. The controllers exchange data by using Send and Receive function blocks in their TriStation applications. The controllers can synchronize their time with the master node (the one with the lowest node number) or with an external device, such as a DCS. For the TCM, Peer-to-Peer communication can use DLC or UDP/IP protocols.

Modbus Communication

Modbus is an industry-standard master/slave protocol that is traditionally used for energy management, transfer line control, pipeline monitoring, and other industrial processes. A Tricon controller with an EICM or TCM can operate as a Modbus master or slave. A DCS typically acts as the master while the Triconex controller acts as a slave. The master can also be an operator workstation or other device that is programmed to support Modbus devices. The ability to be a master or slave is available on each port.

The Tricon controller includes serial ports on the EICM or TCM that enable communication with Modbus devices. The serial ports on the EICM or TCM can be configured for use as Modbus masters or slaves. The NET 1 or NET 2 port on TCM models 4351A, 4351B, 4352A, and 4352B can be configured for use as a Modbus master or slave for communication over TCP. The NET 1 port on TCM models 4353 or 4354 can be configured for use as a Modbus master or slave for communication over TCP.

Triconex Time Synchronization

The Time Synchronization protocol allows networks of Triconex controllers to be synchronized with each other, and optionally, with external devices.

Triconex controllers on a network are typically synchronized with the master node (the controller with the lowest node number). If desired, the master node can accept time adjustments from an external device, such as a Foxboro DCS or an OPC client, so that the external device time prevails for all Triconex controllers on the network. Triconex Time Synchronization can be used with external devices that use TSAA or Modbus protocol.

If networked controllers are collecting event data for system maintenance and shutdown analysis, Triconex Time Synchronization must be used to ensure accurate time-stamping of events.

For the TCM, Time Synchronization can use the SNTP, DLC, or UDP/IP protocols. For controllers using NCMs for Triconex Time Synchronization, communication is limited to the

link layer (DLC) protocol. For controllers using TCM, link layer or UDP/IP communication are available to allow greater networking capability.

Trimble GPS Time Synchronization

A Tricon controller with an NCMG or TCM can receive time adjustments from a Global Positioning System (GPS) by using the Trimble Acutime Gold GPS smart antenna. The antenna must be connected to an RS-232 port on the NCMG or TCM for communication using the Trimble Standard Interface Protocol.

If a controller includes an NCMG or TCM, it can act as a master node in a network of Triconex controllers and can accept GPS time adjustments to synchronize all Triconex controllers on the network with GPS time.

Centronics Interface for Printing

A Tricon controller can send brief ASCII text messages to a printer that is connected to a parallel port on the EICM. These messages are typically used for alarms, status, and maintenance. You must use a printer which is compatible with the Centronics interface on the EICM parallel port.

Network Printing

A Tricon controller can send brief ASCII text messages to a printer by means of a print server connected to an Ethernet port on the TCM. These messages are typically used for alarms, status, and maintenance. The printing devices you can use with a Tricon controller include an HP JetDirect-compatible print server and a networked printer through a router or hub.

Module Capabilities and Usage

This table lists the types of communication that can be done using ports on the Tricon communication modules.

Table 1   Capabilities of Tricon Communication Modules

Type of Communication	ACM	EICM	NCM, NCMG	TCM
Modbus Master or Slave (RTU or ASCII)	—[1]	4 serial ports	—	4 serial ports
Modbus Master or Slave (TCP)	—	—	—	NET 1, NET 2[2]
Peer-to-Peer (DLC) Communication	—	—	NET 1	NET 1
Peer-to-Peer (UDP/IP) Communication	—	—	—	NET 1, NET 2[2]
Printing using a Parallel Port	—	1 parallel port	—	—
Printing using an Ethernet Port	—	—	—	NET 1, NET 2[2]
Triconex Time Synchronization via DLC	NET 2	—	NET 1	NET 1
Triconex Time Synchronization via UDP/IP	—	—	—	NET 1, NET 2[2]
SNTP Triconex Time Synchronization	—	—	—	NET 1, NET 2
Time Synchronization (Trimble GPS)	—	—	1 port (NCMG)	Port 1 (serial)
TriStation via a Serial Port	—	1 port only (Port 1 to Port 4)	—	Port 4 (serial)
TriStation via an Ethernet Port	NET 2	—	NET 2	NET 1, NET 2
TSAA Client/Server Communication	NET 2	—	NET 2	NET 1, NET 2[2]
TSAA Client/Server Communication with IP Multicast (UDP/IP)[3]	—	—	—	NET 1, NET 2[4]
OPC via an Embedded OPC Server	—	—	—	NET 2 (models 4353 and 4354)

1. — means this communication type is not available with this module.
2. NET2 supports this communication type only on models 4351A, 4351B, 4352A, and 4352B.
3. Supported only on models 4351B, 4352B, 4353, and 4354.
4. NET2 supports this communication type only on models 4351B and 4352B.

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Communication Hardware

Overview

This chapter describes Triconex products and other devices that must be purchased to enable a Triconex controller for communication. Typical configurations include redundant modules, cables, and workstations, but can include other devices.

Triconex supplies some communication cables, but does not supply PCs, hubs, switches, media converters, or printers. You must purchase these devices from manufacturers such as Black Box Network Services and Hewlett-Packard.

If the system requires an Ethernet hub, switch, or managed switch, it should operate at 10 or 100 megabits per second, or be auto-negotiable for either speed. Most hubs do not require configuration and do not have IP addresses. If you are using a managed switch, follow the manufacturer's instructions for installation and configuration. If you need assistance with selecting communication hardware, please contact your network administrator or Information Technology department.

Triconex Products

This section describes the communication products available from Triconex.

Serial Cables and Adapter

Triconex serial cables are used to connect a serial port on the EICM or TCM to the TriStation PC.

The standard length for serial cables is 20 feet (6 meters), but you can order other lengths if necessary. The xx in the part number indicates that you can specify another cable length.

For connections to Modbus masters or slaves, use a cable based on the requirements of the Modbus device.

Accessory	Part Number
Serial cable with two 9-pin connectors	1600080-0xx[1]
Serial cable with one 25-pin connector and one 9-pin connector	4000016-0xx
DB-25-pin to DB-9-pin adapter	1420102-001

1. xx indicates the cable can be ordered in various cable lengths.

Network Hardware Accessory Kit

The Network Hardware Accessory Kit (model 7600-3) can be used for these connections:

- ACM or NCM Ethernet connection to TriStation PC.
- NCM Peer-to-Peer connection.
- Media or protocol converter connected to a faster Ethernet network.

NET 2 ports on communication modules other than the TCM must use 10Base2 coaxial cables, but these cables can be connected to media converters which allow the Tricon to communicate with other Ethernet media. For more information, see Connecting Ethernet Devices on page 11.

The accessory kit includes:

Accessory	Model Number
One 3Com network interface card (model 3C503). (Not required with Peer-to-Peer ports.)	7600-3
One 10Base2 coaxial cable (Can be ordered separately as 1600010-006.)	
Two BNC T-connectors	
Two 50-ohm terminators with straps	

Chassis and Module Selection

A Tricon controller must have a Main Chassis and can have up to 14 Expansion or RXM Chassis.

These rules apply to the selection of communication modules for a Tricon controller:

- A TriStation PC must be connected to an ACM, NCM, EICM, or TCM, which means that one of these modules must be included in each Tricon configuration.
- Each Tricon controller includes one logical slot for ACM, EICM, or NCM modules, which can include a module in the left and right position.
- Each Tricon controller includes two logical slots for the TCM, each of which can include a module in the left and right position, for a total of four modules.
- The COM slot can be configured for a TCM, NCM, or EICM only.
- You cannot install an NCM and a TCM in the same Tricon system.
- You cannot install an EICM and a TCM in the same Tricon system.
- You cannot install model 4351A, 4351B, 4352A,4352B, 4353, or 4354 TCMs in the same system with model 4351 or 4352 TCMs, even if they are installed in different chassis.
- All types of communication modules must be housed in the Main Chassis or in Chassis 2.
- If communication modules are housed in Chassis 2, this chassis must be connected directly to the Main Chassis using I/O Comm Cables (model 9001) rather than standard I/O Bus Cables.
- Chassis 2 can be an I/O Expansion Chassis or a Primary RXM Chassis.

For detailed guidelines on chassis configuration and power limitations, see the *Planning and Installation Guide for Tricon v9–v10 Systems*.

Connecting Ethernet Devices

NET 2 Ethernet ports on the ACM and NCM have BNC connectors that require 10Base2 coaxial cables, limiting data transmission speed to 10 megabits per second. For this type of connection, Triconex provides a Network Hardware Accessory Kit which includes a 10Base2 coaxial cable, BNC T-connectors, and 50-ohm terminators for unused connectors.
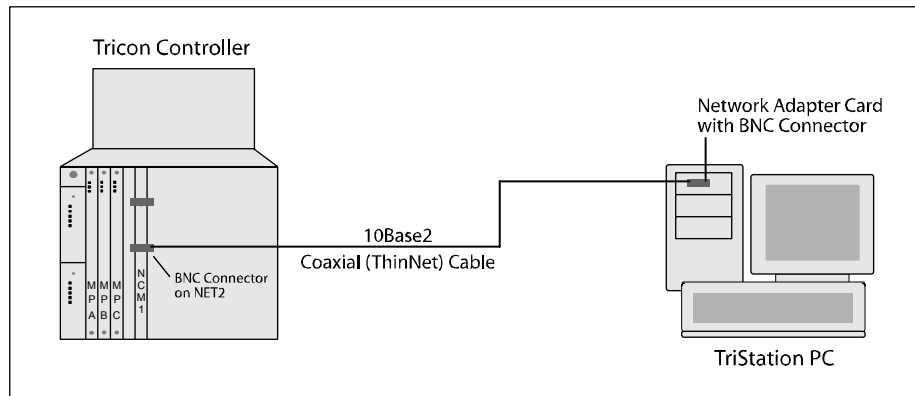
Figure 1   Ethernet Connection Between Tricon with NCM or ACM and TriStation PC

You must use or terminate the BNC connectors on all ACM or NCM NET 2 ports in the Tricon controller. To terminate an unused BNC connector, you can attach a T-connector with 50-ohm terminators on each end to produce a 25-ohm parallel resistance. If necessary, ask your network administrator about other termination methods.

Depending on which model you have, NET 1 or NET 2 Ethernet ports on the TCM have RJ-45 or fiber MT-RJ Ethernet connectors that can be connected via a hub or router on the Ethernet network to the TriStation PC.
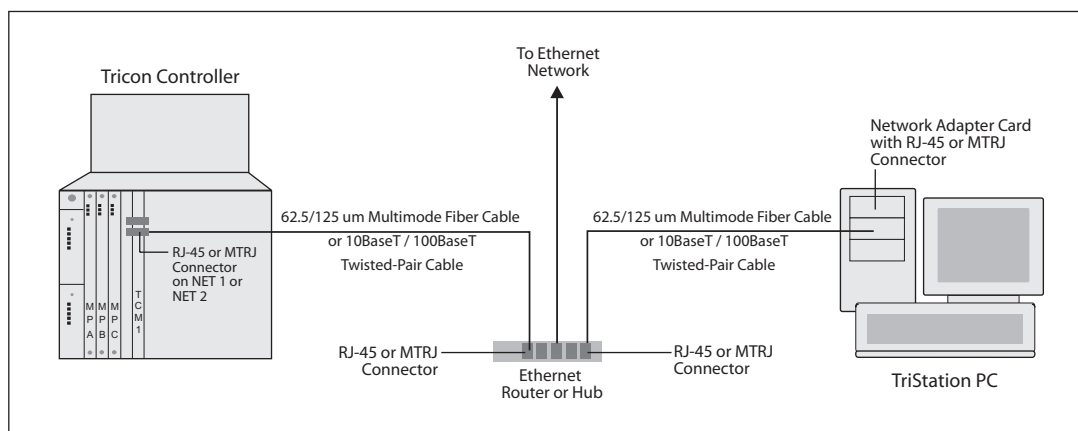
Figure 2   Ethernet Connection Between Tricon with TCM and TriStation PC

Triconex does not supply Ethernet cables or hubs; you must purchase them from a third party. Examples of dependable manufacturers are Black Box Network Services and Hewlett-Packard.

Converting from 10Base2 to Faster Media

If an ACM or NCM needs to communicate with a 10BaseT, 100BaseTX, or faster Ethernet device, you can connect it to a media converter which is connected to faster devices or a faster network.

Procedure

1 To each end of a 10Base2 cable, attach a BNC T-connector and a terminator.

2 Attach one of the T-connectors to a BNC connector on a communication module NET 2 port.

3 Attach the other T-connector to a BNC connector on the media converter.

4 Attach one end of the twisted-pair cable to an RJ-45 connector on the media converter.

5 Attach the other end of the twisted-pair cable to an RJ-45 connector on a compatible Ethernet device.
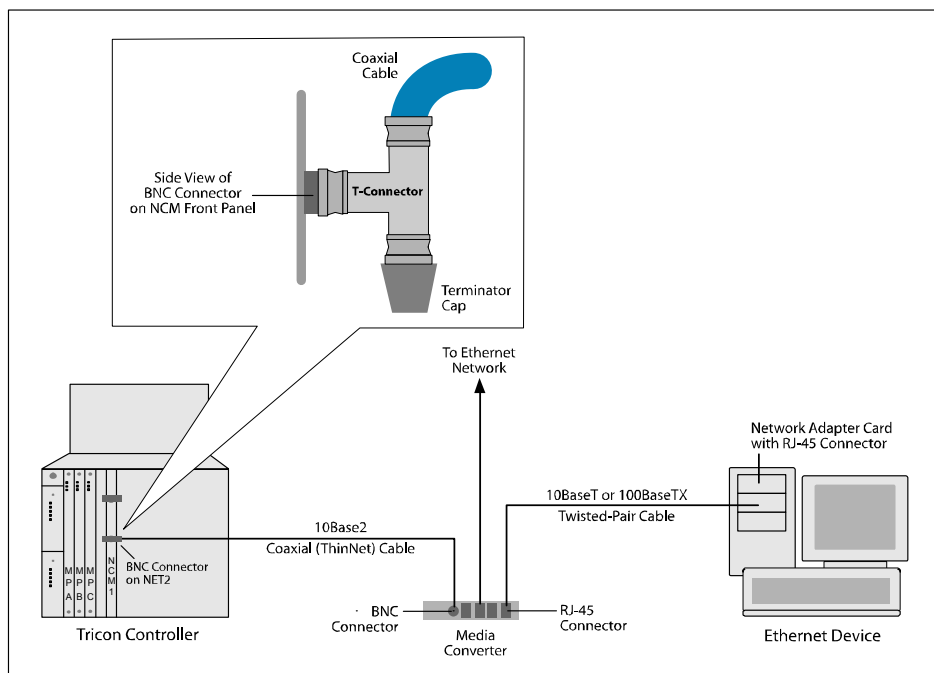
Figure 3   Using a Media Converter for Ethernet Connections

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

Redundant Devices

To ensure continuous operation of a Triconex system if a hardware failure occurs, you can create a redundant configuration. Redundant devices can include modules, workstations, cables, hubs, media converters, printers, and power sources.

A redundant device operates in parallel with a primary device so that, if the primary device fails, the redundant device is easily or automatically placed into service. A typical configuration includes two NCM or TCM modules with redundant cables connected to one port on each module. The redundant modules protect against internal faults, and the redundant cables protect against cable breakage. To protect against network failures, you can connect a primary workstation to one network and a redundant workstation to another network, as shown in this figure.
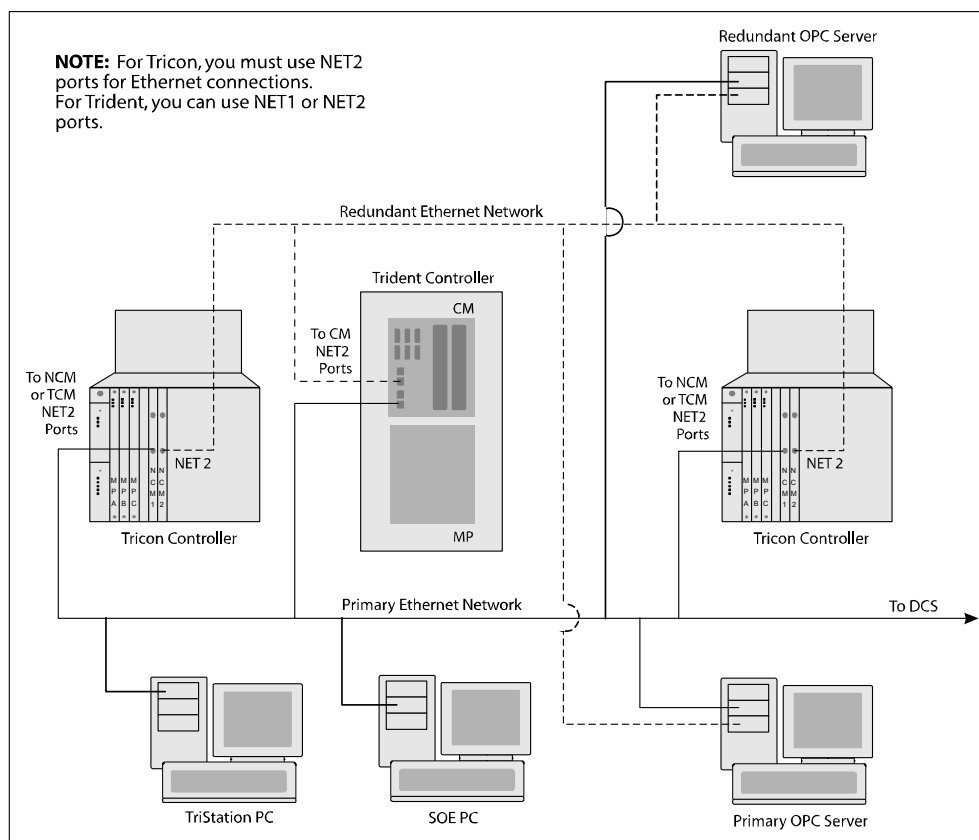
Figure 4   Sample Redundant Device Configuration

PC Redundancy for TriStation and SOE Recorder

For TriStation and SOE Recorder, you can maintain redundant PCs and place them into service manually if the primary workstations fail. An efficient practice is to install the necessary programs on the PCs in advance. For TriStation, you should install the TriStation 1131 software and store a backup copy of the project on the redundant workstation. For SOE, you should install and configure the SOE Recorder software on the redundant workstation.

Testing for Hardware Failures

A redundancy scheme is effective only if the primary and redundant devices are connected and operational. Routing the redundant cables over different paths through the facility reduces the possibility of cable damage. To test for hardware failures, you must use the TR_PEER_STATUS and TR_PORT_STATUS function blocks in the TriStation application.

These Triconex communication products provide another layer of redundancy testing:

- The Peer-to-Peer and Time Synchronization protocols transmit messages over both the primary and redundant networks at all times, discarding duplicate messages when both networks are operational.

- The OPC Server and DDE Server programs communicate with the Triconex controller over the primary network and switch to the redundant network if the primary device fails.

If you are using Modbus protocol or a customized TSAA application, you must develop the additional layer of redundancy testing on your own.

Printing

The Tricon controller supports two types of printing, depending on which communication module is installed:

- The EICM supports Centronics-compatible printing through port 5.

- The TCM supports printing to network-attached printers through NET 1 or NET 2 on models 4351A, 4351B, 4352A, and 4352B; and NET1 on models 4353 and 4354.

The Tricon TCM also supports JetDirect-compatible print servers connected to Centronics-compatible printers. The print server must be specified for the JetDirect print protocol and speeds of 10 or 100 megabits per second.

Triconex has tested and can recommend the following Hewlett-Packard print servers:

- HP JetDirect Ex Plus

- HP JetDirect 500X Series, model J3265A

This figure depicts a typical configuration that includes a print server.
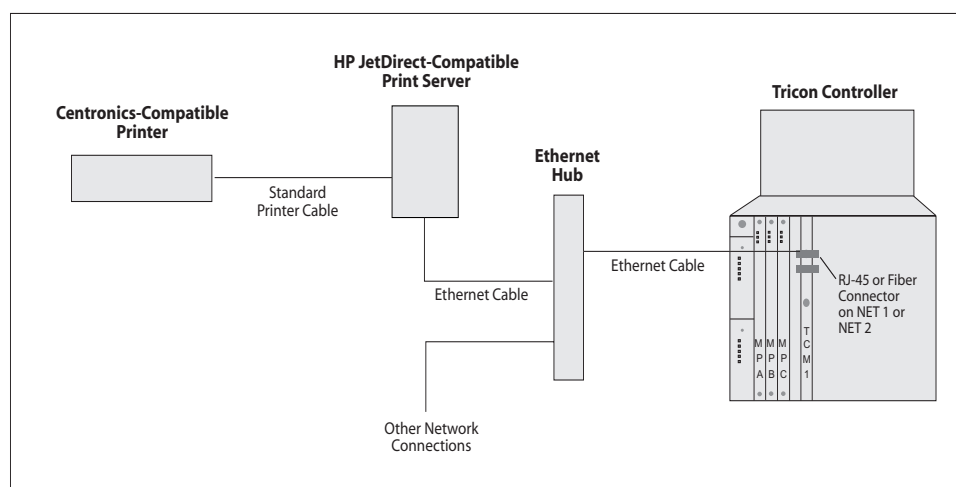
Figure 5   Tricon TCM Connection to Printer via Hub and Print Server

For more information, see .

3

TriStation Communication

Overview

This chapter describes the tasks required to connect a TriStation PC to a Tricon controller. TriStation 1131 must be used to program and operate the controller, and to establish the controller address on an Ethernet network. TriStation can also be used to monitor applications that are running on Tricon controllers. The TCM supports three concurrent TriStation connections.

Connection Tasks

1   Set up a PC with the required hardware and communication protocols. This includes installing a network adapter card and TCP/IP protocol if you plan to connect the TriStation PC to an Ethernet port on an ACM, NCM, or TCM module.

2   Install the TriStation software on a PC using the setup program provided by Triconex.

3   Physically connect the TriStation PC via the following means:

   • To a serial port on the EICM or TCM.

   • To the NET 2 Ethernet port on the ACM or NCM.

   • To the NET 1 or NET 2 Ethernet port on the TCM.

   If using Ethernet, you can connect the PC via a router or hub to an Ethernet port, or to a media converter that is connected to the Ethernet port. A router or hub is not required if you do not need to connect any additional devices besides the TCM and the PC.

   • To connect the TriStation PC to the Tricon controller with a TCM Model 4351, 4351A, 4351B, or 4353 via Ethernet, you must install a network adapter card with an RJ-45 connector in the PC and use a twisted-pair cable. You also need to use a router or hub between the Tricon and the PC.

   • To connect the TriStation PC to the Tricon controller with a TCM Model 4352, 4352A, 4352B, or 4354 via Ethernet, you must install a network adapter card with an MT-RJ fiber connector in the PC and use a multimode fiber cable. You also need to use a router or hub between the Tricon and the PC.

   • To directly connect the TriStation PC to the Tricon controller with an ACM or NCM, you must install a network adapter card with a BNC connector in the PC and use a 10Base2 coaxial cable.

     If the network adapter card does not have a BNC connector, you must use an appropriate cable and a media converter. You can buy communication cables from Triconex or from other manufacturers. You must buy media converters from other manufacturers.

4   Set the node number of the controller using the rotary switches on the ACM or NCM, if you are using one of these modules. The physical node number must match the node number that you set in the TriStation project.

   Note   The TCM uses the node number set on the MP Front Panel. You need to physically set the switches to the desired node number on the MP.

5   After the physical connection tasks are completed, you must logically configure the connection in the TriStation project. This includes specifying which port the communication cable is connected to and the address of the Tricon controller.

After completing the physical and logical connection tasks, you can download, run, and monitor the TriStation application.

The sections in this chapter include instructions for all of the hardware-related tasks. For procedures explaining how to configure connections using TriStation, see the *TriStation 1131 Developer's Guide, v4.5.*

Communication Cables and Accessories

The TriStation PC can be connected to an ACM, NCM, or TCM Ethernet port, or to an EICM or TCM serial port. These communication cables and accessories are available from Triconex. For more information, see Triconex Products on page 8.

> ⚠ **WARNING**   In hazardous indoor locations, apparatus used with Triconex communication modules must be FM certified for Class I, Division II.

Accessory	Part/Model	Description
Serial Cable	4000015-0xx	Used for an EICM connection to a TriStation PC.
	4000016-0xx	Used for a TCM connection to a TriStation PC.
25-pin to 9-pin adapter	1420102-001	Needed for an EICM connection if the PC has a DB-9-pin connector.
Network Hardware Accessory Kit (10Base2)	7600-3	Used for an ACM or NCM Ethernet connection to a TriStation PC. Includes NIC card, 10Base2 cable, BNC T-connectors, and terminators.

Notes

- Triconex does not supply Ethernet cables or hubs; you must purchase them from a third party. Examples of dependable manufacturers are Black Box Network Services and Hewlett-Packard.

- If you are installing a TCM with fiber connectors (model 4352, 4352A, 4352B, or 4354), you will need to provide your own fiber-optic cable(s). You cannot purchase fiber-optic cables from Triconex. The fiber cable should be a multimode 62.5/125 um cable, have a maximum length of 1.24 miles (2 kilometers), and comply with the ANSI/TIA/EIA-568-B.3 standards.

Network Connection to TriStation

This section explains how to make a network connection between a ACM, NCM, or TCM communication module and a TriStation PC. This can be a direct connection from the communication module to the PC, or a connection through a router, hub, or media converter. A router or hub is not required if you do not need to connect any additional devices besides the TCM and the PC. You cannot use both an NCM and TCM module in a Tricon controller.

To set up the connection, you must install a network interface card and TCP/IP protocol on the PC, set the node number of the controller, connect the PC to a network port on the communication module, and configure the connection in the TriStation 1131 project. This section includes procedures for each of these tasks.

CAUTION The node setting (on the ACM or NCM module or the 3008 MP Front Panel) must match the node number specified in the TriStation project. See the *Planning and Installation Guide for Tricon v9–v10 Systems* for instructions on changing the MP node setting.

Topics include:

- Installing a NIC Card in a TriStation PC on page 21
- Using ACM Switches to Set the Node Number on page 21
- Using NCM Switches to Set the Node Number on page 24
- Changing the Node Number on page 26
- Directly Connecting an ACM or NCM Network Port to a TriStation PC on page 27
- Connecting a TCM Network Port to a TriStation PC Using a Router or Hub on page 28
- Connecting a Tricon Network Port Using a Media Converter on page 29

Note If you are connecting the TCM or EICM to the TriStation PC via serial port, see Serial Connection to TriStation on page 31.

Installing a NIC Card in a TriStation PC

This procedure explains how to install a network interface card (NIC) in a TriStation 1131 PC to be connected to a Tricon ACM, NCM, or TCM.

Procedure

1 Install the network interface card by following the manufacturer's instructions. *Do not change the factory default settings on the NIC card.*

2 To connect a TCM to the TriStation PC, do one of the following:

- If the network interface card has an RJ-45 connector, you can connect it to the NET 1 or NET 2 port on the TCM (model 4351, 4351A, 4351B, or 4353) via a router or hub using a patch cable.

- If the network interface card has a MT-RJ (fiber) connector, you can connect it to the NET 1 or NET 2 port on the TCM (model 4352, 4352A, 4352B, or 4354) via a router or hub using a patch cable.

- If the network interface card does not have the appropriate connector for your TCM model, connect the network interface card to a media converter that is connected to the NET 1 or NET 2 port.

  Note See Appendix A, TCM Capabilities for more information about the differences between TCM models 4351, 4351A, 4351B, or 4353 (copper) and models 4352, 4352A, 4352B, or 4354 (fiber).

3 To connect an ACM or NCM to the TriStation PC, do one of the following:

- If the network interface card has a BNC connector, you can connect it directly to the NET 2 port.

- If the network interface card does not have a BNC connector, connect the network interface card to a media converter that is connected to the NET 2 port.

4 Run the diagnostics provided with the network interface card according to the manufacturer's instructions.

Using ACM Switches to Set the Node Number

This procedure explains how to set the node number of a Tricon controller by using rotary switches on an ACM. The node number uniquely identifies a controller on a network and is typically determined during network planning. The node number must be physically set on the ACM module during installation and must match the node setting on the MP front panel and the configuration setting in the TriStation project.

The default (factory-configured) setting is for node number 1, which is the top switch set to 0 (zero) and the bottom switch set to 1.

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

Procedure

1   If needed, remove the module from the chassis. This figure shows the default node setting, which is 1.
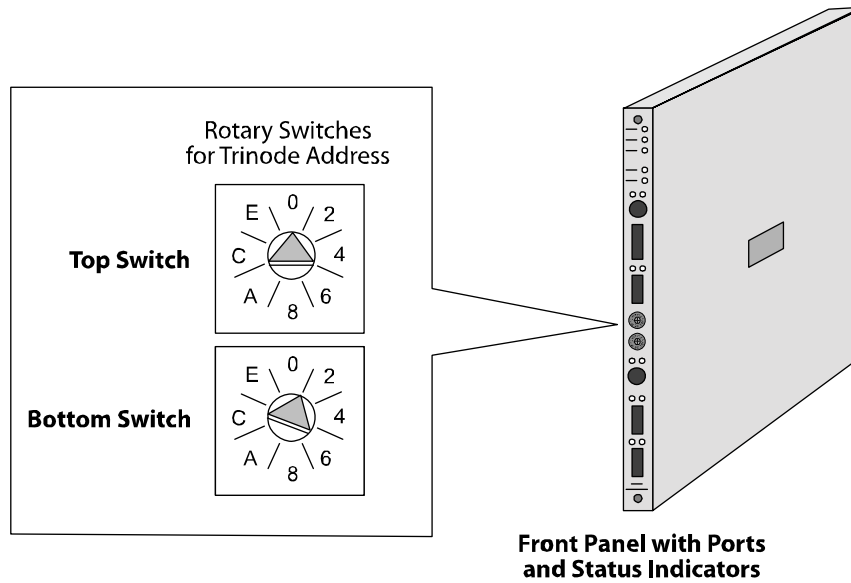
Figure 6   Setting the Node Number on the ACM Front Panel

2   Set the switches to identify the node number, which can be 1 to 31.

If a Tricon controller includes two ACMs, you must set the switches on both modules to the same node number.

This table identifies the switch settings for nodes 1 to 31.

Node Number	Top Switch	Bottom Switch	Node Number	Top Switch	Bottom Switch
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			

3 Set the top switch and the bottom switch on the front panel of the ACM to the hexadecimal values you selected.

Using NCM Switches to Set the Node Number

This procedure explains how to set the node number of a Tricon controller by using rotary switches on an NCM. The node number uniquely identifies a controller on a network and is typically determined during network planning. The node number must be physically set on the NCM during installation and must match the node setting on the MP front panel and the configuration setting in the TriStation project.

The default (factory-configured) setting is for node number 1, which is switch 1 set to 1 and switch 2 set to zero.

Note Older NCMs have eight rotary switches, using hexadecimal notation. Newer NCMs have only two switches, using the numbers 0 – 15.

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

Procedure

1 If needed, remove the module from the chassis. This figure shows the default (factory-configured) node setting, which is 1.

Rotary switches on top of NCM, set to 1 in hexadecimal notation.
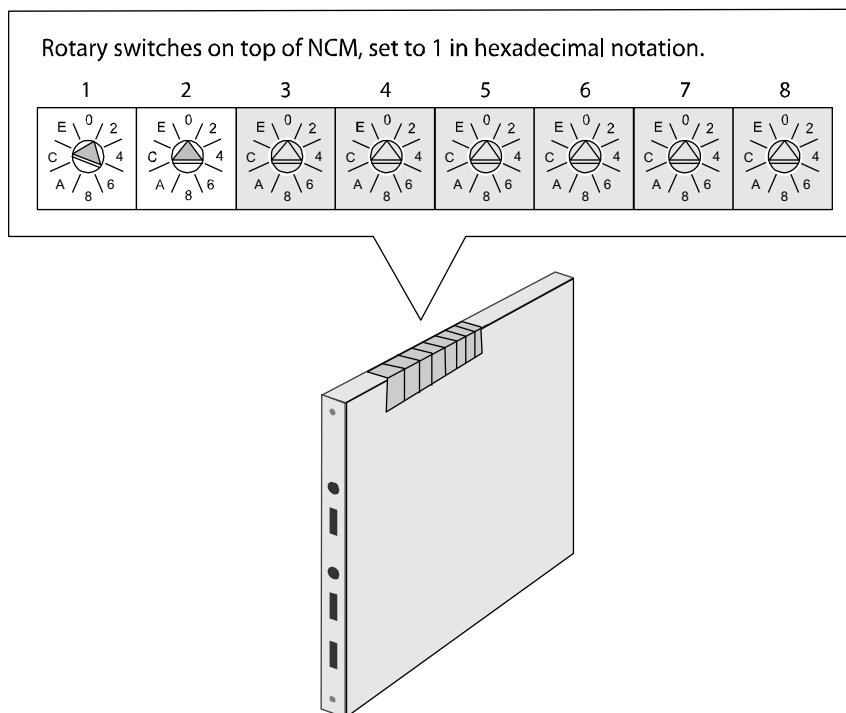
Figure 7 Setting the Node Number on the NCM Top Panel (Older Version)

2 Set the switches to identify the node number, which can be 1 to 31.

If a Tricon controller includes two NCMs, you must set the switches on both modules to the same node number.

This table identifies the switch settings for nodes 1 to 31.

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

1. If you have an older NCM (with eight switches), use the hexadecimal value (A, B, C, and so on). If you have a newer NCM (with two switches), use the numerical value (10, 11, 12, and so on).

3 Set switches 1 and 2 on the top of the NCM to the values you selected.

4 If you have an older NCM, verify that switches 3 through 8 are set to zero because they are unused.

Changing the Node Number

These procedures explain how to change the node number of an ACM, NCM, or TCM after the TriStation application has been downloaded.

Typically a node number is changed only during unplanned expansion or reconfiguration of an existing Ethernet network. **Changing the node number requires a shutdown of the controlled process and another Download All.**

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

Procedure

1   Prepare for a complete shutdown.

2   Remove all three MPs and all ACMs, NCMs, or TCMs from their respective slots.

3   Change the node number switches on the MP modules.

4   Wait for approximately 60 seconds, and then re-install the MPs.

5   Change the node number switches on the ACMs, NCMs, or TCMs.

6   Re-install the ACMs, NCMs, or TCMs.

7   In TriStation, go to the TriStation Communication screen. Specify the node name, node number, and IP address.

8   Wait for the Pass indicators on the MPs and on the ACMs, NCMs, or TCMs to illuminate.

9   In TriStation, on the Commands menu, click Download All.

Directly Connecting an ACM or NCM Network Port to a TriStation PC

This procedure explains how to directly connect an ACM or NCM to a TriStation PC if the network interface card in the PC has a BNC connector.

The connection requires a 10Base2 coaxial cable. Triconex provides an accessory kit that includes a 10Base2 coaxial cable, BNC T-connectors, and 50-ohm terminators for unused connectors (see page 8).

Procedure

1 To each end of a 10Base2 cable, attach a BNC T-connector and a terminator.

2 Attach one of the T-connectors to a BNC connector on NET 2 of the communication module. An NCM is used as an example in the following figure.

3 Attach the other T-connector to the BNC connector on the network interface card in the TriStation PC.

4 Terminate the BNC connectors on all communication modules that are installed in the Tricon controller.

5 To terminate an unused BNC connector, you can attach a T-connector with 50-ohm terminators on each end to produce a 25-ohm parallel resistance. Ask your network administrator for information about other termination methods.
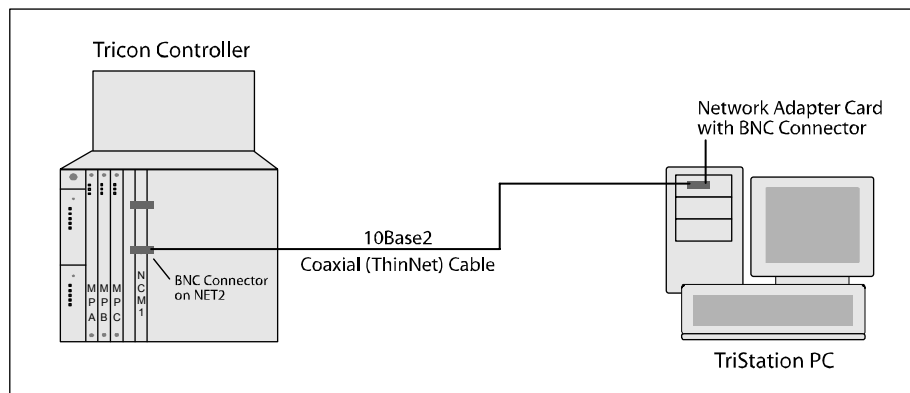
Figure 8   Directly Connecting an ACM or NCM to a TriStation PC

Connecting a TCM Network Port to a TriStation PC Using a Router or Hub

This procedure explains how to connect a TCM to a TriStation PC if the network interface card in the PC has an RJ-45 connector or a MT-RJ fiber connector. You must use an Ethernet router or hub between the Tricon and the TriStation PC.

The RJ-45 connection requires twisted-pair straight-through cables. The fiber connection requires 62.5/125 um multimode fiber cables. See Triconex Products on page 8 and Fiber-Optic Cables on page 12 for more information about the required cables.

Procedure

1   Attach one end of the first cable to the NET 1 or NET 2 port on the TCM.

2   Attach the other end of the first cable to the connector on the Ethernet router or hub.

3   Attach one end of the second cable to the connector on the network interface card in the TriStation PC.

4   Attach the other end of the second cable to the connector on the router or hub.
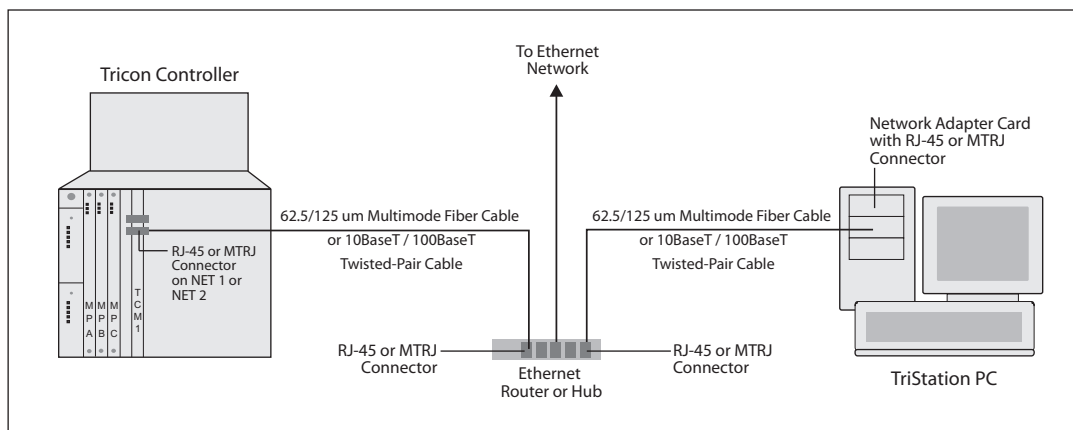
Figure 9   Connecting a TCM (Copper or Fiber) to a TriStation PC Using a Router or Hub

Notes

- If the correct cable is connected to the TCM and the TCM is installed in a powered Tricon chassis, the green LED indicator turns on. If the LED indicator is not on, there is a problem with the physical cable connection.

- If the network ports on model 4352, 4352A, 4352B, or 4354 TCMs do not resume after a power restart, you may have an interface problem with the router or hub. Triconex recommends that you momentarily disconnect both ends of the fiber cable from the TCM and the router or hub, and then reconnect to allow the fiber network to resume proper communication.

Connecting a Tricon Network Port Using a Media Converter

This procedure explains how to connect an ACM, NCM, or TCM to a TriStation PC if the network interface card in the PC requires a media converter because it does not have the appropriate connector.

- The connection to an ACM or NCM requires a 10Base2 cable, a media converter, and another appropriate cable, such as a twisted-pair cable.

- The connection to a TCM (model 4352, 4352A, 4352B, or 4354 - fiber) requires a 62.5/125 um multimode fiber cable, a media converter, and another appropriate cable, such as a twisted-pair cable.

Procedure for Connecting an ACM or NCM

1   To each end of a 10Base2 cable, attach a BNC T-connector and a terminator.

2   Attach one of the T-connectors to a BNC connector on the NET 2 port.

3   Attach the other T-connector to a BNC connector on the media converter.

For the TriStation PC, you can use a 10BaseT or 100BaseTX twisted-pair cable for faster communication.

4   Attach one end of the twisted-pair cable to an RJ-45 connector on the network interface card in the TriStation 1131 PC.

5   Attach the other end of the twisted-pair cable to an RJ-45 connector on the media converter.
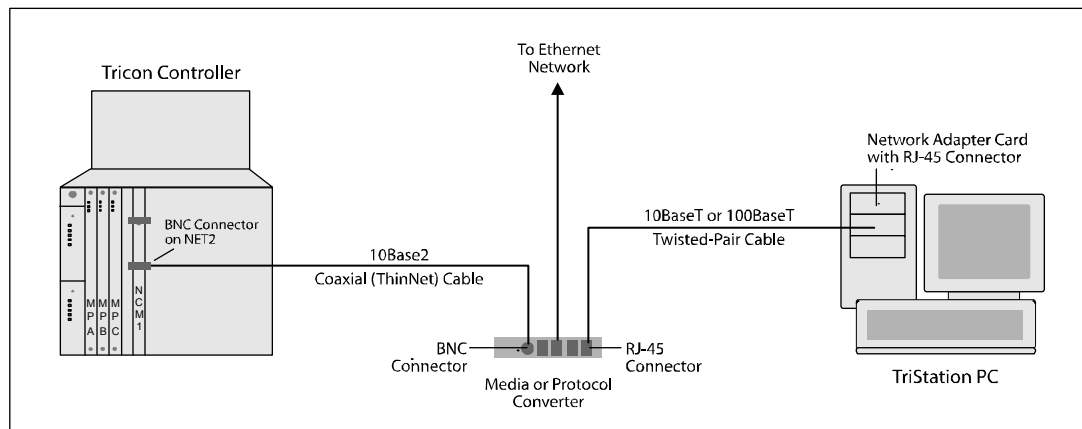
Figure 10   Connecting an ACM or NCM to the TriStation PC Using a Media Converter

Procedure for Connecting a TCM (Model 4352, 4352A, 4352B, or 4354 - Fiber)

1 Attach one end of the fiber cable to the NET 1 or NET 2 port on the TCM.

2 Connect one end of the twisted-pair cable to the RJ-45 connector on the network interface card in the TriStation PC.

3 Attach the other end of the twisted-pair cable to an RJ-45 connector on the media converter.

4 Attach the other end of the fiber cable to a MT-RJ fiber connector on the media converter.
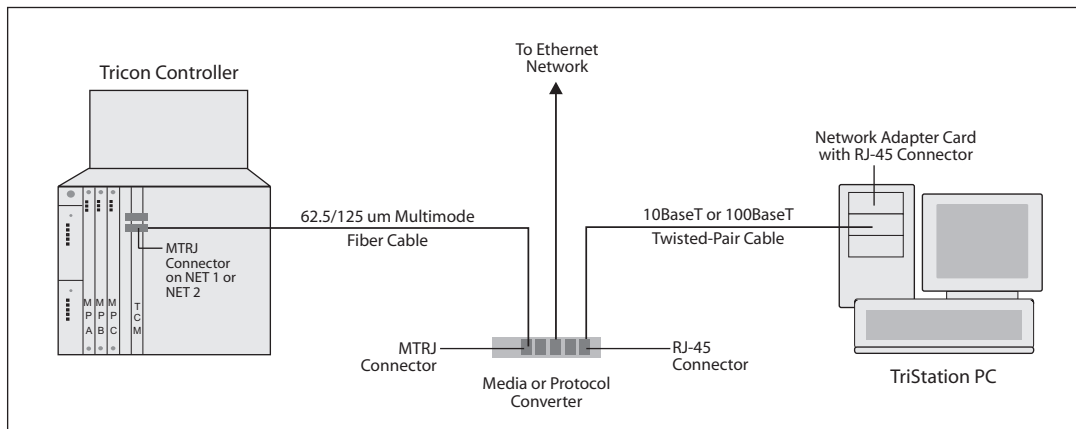
Figure 11   Connecting a TCM (Model 4352, 4352A, 4352B, or 4354 - Fiber) to the TriStation PC Using a Media Converter

Notes

• If the correct cable is connected to the TCM and the TCM is installed in a powered Tricon chassis, the green LED indicator turns on. If the LED indicator is not on, there is a problem with the physical cable connection.

• If the network ports on model 4352, 4352A, 4352B, or 4354 TCMs do not resume after a power restart, you may have an interface problem with the media converter. Triconex recommends that you momentarily disconnect both ends of the fiber cable from the TCM and the media converter, and then reconnect to allow the fiber network to resume proper communication.

Serial Connection to TriStation

This section explains how to make a direct (point-to-point) serial connection between a Tricon EICM or TCM and a TriStation PC. You cannot use both an EICM and TCM module in the same Tricon system.

By default, both the EICM and the TCM use port 4 for the TriStation connection. Triconex strongly recommends you use the default setting. If port 4 on the EICM fails, port 1, 2, or 3 can be used by changing settings on the module switch block. If port 4 on the TCM fails, you can connect to TriStation using the NET 1 or NET 2 port.

Topics include:

- Connecting a Tricon Serial Port to a TriStation PC on page 31
- Changing the TriStation Port Used with EICM on page 32

Connecting a Tricon Serial Port to a TriStation PC

This procedure explains how to connect an EICM or TCM serial port to a TriStation PC.

Triconex provides a serial cable that has a 9-pin connector on each end. If the COM port on the PC has a 25-pin connector, you can use a Triconex 25-pin to 9-pin adapter. If you need other parts, you can purchase them from another manufacturer.

Procedure

1   Connect one end of the serial cable to a serial port on the EICM or TCM. This is typically port 4.

2   Connect the other end of the serial cable to a COM port on the TriStation PC. The COM port is typically numbered COM1, COM2, COM3, or COM4.
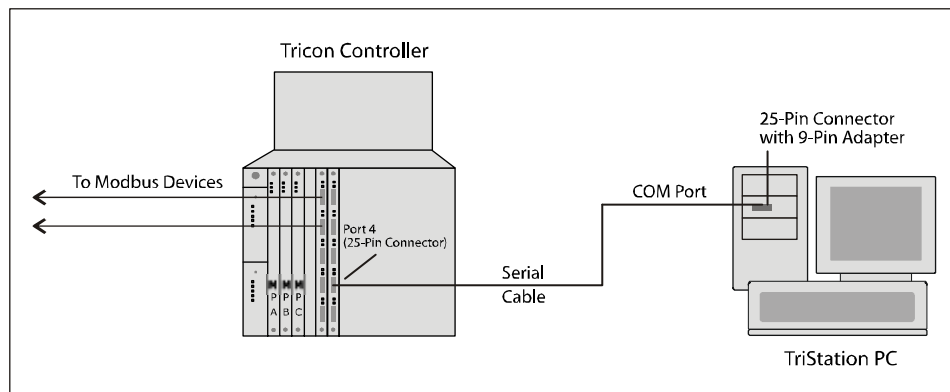
Figure 12   Connecting a Tricon Serial Port to the TriStation PC

Changing the TriStation Port Used with EICM

This procedure explains how to change the port used for the EICM to TriStation serial connection, which should only be done if there is a hardware failure on port 4. If port 4 fails, you can use port 1, 2, or 3 by setting switches on the EICM.

By default, all the switches are set to Off. This means that the default setup is for a TriStation connection to port 4 using a RS-232 interface.

In addition to changing the TriStation port, you can set the interface for the port. The default setting for ports 1 through 4 is for RS-232. To use RS-422 (point-to-point) or RS-485 (multi-point), the switch must be turned On.

Procedure

1 Remove the EICM from its slot in the Tricon chassis.

   Figure 13 shows the default settings for port 4.

2 Use Figure 14 to set the switches for the TriStation port. Switches 7 and 8 determine the port used for the TriStation connection.

   Switches 1, 2, 3, and 4 specify the RS interface for the port. If the switch is Off, the port uses RS-232; if On, the port uses RS-422 (point-to-point) or RS-485 (multi-point).

3 Replace the EICM in its slot. You can now connect the serial cable from the EICM port to the TriStation PC.
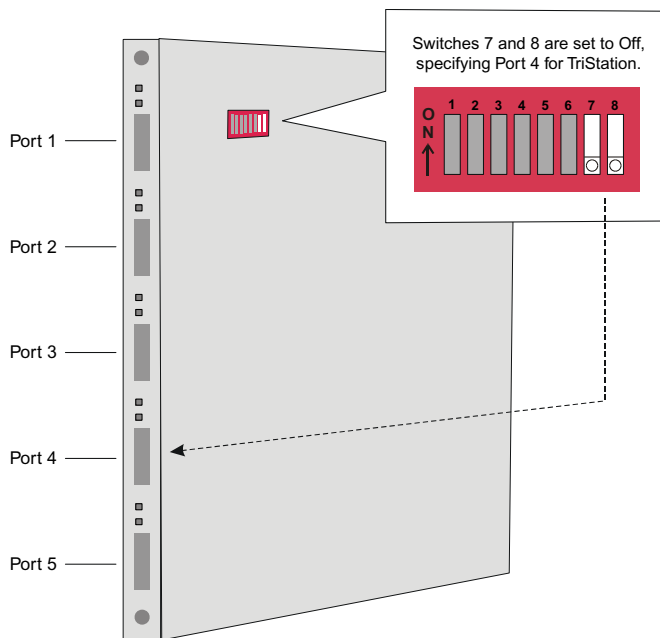
Figure 13   EICM Switch Block Set to Use Port 4 for TriStation Serial Connection

TriStation on Port 1
Switch 7 is off.
Switch 8 is on.

TriStation on Port 2
Switch 7 is on.
Switch 8 is off.

TriStation on Port 3
Switch 7 is on.
Switch 8 is on.

TriStation on Port 4
Switch 7 is off.
Switch 8 is off.
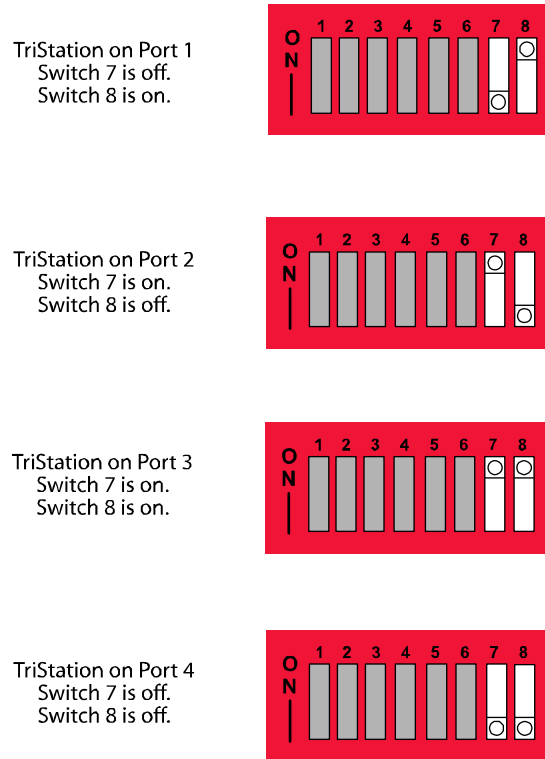
Figure 14   Using Switches to Change the Port Selection for EICM Serial Connection to TriStation

Controlling Access to the TCM

The model 4351A, 4351B, 4352A, 4352B, 4353, and 4354 Tricon Communication Modules (TCMs) give you the ability to control who can access TCM resources through the module's network ports, and the level of access each user has.

What Are TCM Resources?

A *resource* is any service or information provided by the TCM through the supported communications protocols. Examples of these resources include:

- Access to the controller via TriStation (ability to perform a Download Change or Download All)
- Access to Tricon diagnostic information via Diagnostic Monitor
- Access to information provided in applications such as SOE Recorder or DDE Server that use the TSAA protocol
- Access to applications that use the TSAA protocol

How Is Access Controlled?

Access is controlled via client IP addresses. You can control access for a single IP address (one client), or for a group of IP addresses (a group of clients).

If you want to group clients into a single access list entry, they must be physically separated in a sub-network, and a *subnet mask* must be used to group them in the access list. A subnet mask of 255.255.255.255 restricts an access list entry so that it applies only to the specific IP address identified in the entry. A subnet mask of 255.255.255.0 applies an access list entry to *any* client on the same subnet as the IP address identified in the entry. Other subnet masks may also be used, depending on your network structure.

For example, if you want two clients with IP addresses of 192.168.1.134 and 192.168.1.65 to share the same access permissions, and there are no other clients on the same subnet, you can group them in the access list by setting the IP address for a single entry as 192.168.1.x and the subnet mask to 255.255.255.0.

For each IP address or group of IP addresses, you can set the access level, the protocols the client can use to access the TCM, and the network ports the client can use to access the TCM.

For more detailed information, including procedures explaining how to control access to TCM resources, see the *TriStation 1131 Developer's Guide, v4.5.*

4

Client/Server Communication

Overview

Client/server communication with Triconex controllers can be done by using the DDE Server and OPC Server applications, which use the Triconex System Access Application (TSAA) protocol. For most process control networks, using DDE Server or OPC Server is the best solution.

TSAA protocol can also be used to write custom applications for accessing Triconex data, such as these:

- Control (read/write) applications for operators that need read access to Triconex status and write access to Triconex data.

- Monitor (read-only) applications such as a sequential events recorder or a status display that collects and records Triconex data.

CAUTION

Retrieving data on every scan may not be possible in some system configurations, especially those that use the following:

- TCM with TSAA multicast, which does not support broadcasts faster than every 250 milliseconds.
- OPC DA, which does not support broadcasts faster than every 250 milliseconds.
- OPC A&E, which provides data upon alarm generation.

For detailed protocol information, see Appendix D, TSAA Protocol.
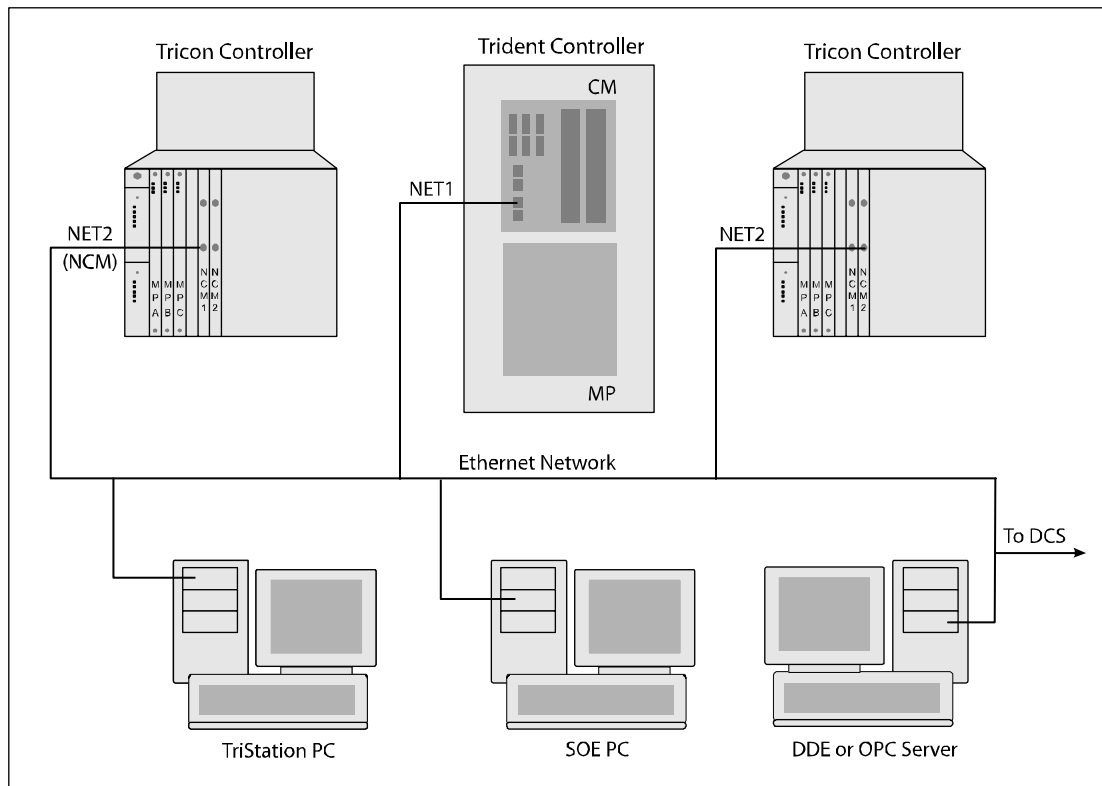
Figure 15   Sample Tricon System Configuration

Applications that use TSAA to exchange information with a Triconex controller require a Tricon ACM, NCM, or TCM. You can install a maximum of two ACM and four NCM modules or four TCM modules in a controller. You can physically connect one Ethernet port on each ACM or NCM to an Ethernet network; you can connect one or more Ethernet ports for each TCM. Through one Ethernet port, the controller can communicate with multiple devices on a network, such as a TriStation PC, a print server, and a client PC.

The Ethernet port on the ACM and NCM is called NET 2 and it operates at 10 megabits per second. If you connect the ACM or NCM to a network that is faster than 10 megabits per second, you must use a media converter with appropriate cables.

Ethernet ports on the TCM are called NET 1 and NET 2. The NET 1 and NET 2 ports can operate at 10 or 100 megabits per second, except for TCM model 4353 which supports only 100 megabits per second connections. The data transmission rate of the device or network you connect determines which port and cabling you must use. Most Ethernet devices and networks operate at 100 megabits per second, so connecting one to a Tricon controller with a TCM usually means you must use Fast Ethernet (100BaseTX) cabling.

Each Ethernet port must be configured in the TriStation project, which means you must specify the mode, access privilege, port type and speed, IP address, and time synchronization properties. Part of physically connecting an ACM, NCM, or TCM port to a network is to set the IP address of the port. The most convenient methods is to use the Triconex default address or a Reverse ARP server. Other ways are discussed in this chapter.

A Tricon controller with a TCM installed on an Ethernet network can communicate with devices on other networks if you specify the IP address of the default gateway or other routes in the TriStation project. Specifying the default gateway is often sufficient, but you can specify multiple other routes if necessary.

Another task is to specify whether external devices are to have access to the application running on the Triconex controller. There are many levels of access, including allowing general write access while protecting specific points from write access through configuration settings. For more information, see Tricon Write Access on page 91.

DDE Server for Triconex

This section explains how to use the Triconex DDE Server software to communicate between Triconex controllers and DDE clients on an Ethernet network. Triconex DDE Server is a Windows application that enables DDE-compliant clients to request data and, if allowed, to change data in a Triconex application. A client can request data about input and output variables, memory variables, and system attributes.

Client applications use DDE protocol to communicate with a DDE server. Any Windows application that supports DDE protocol—such as Microsoft Excel—can use Triconex DDE Server. Triconex DDE Server communicates with one or more Triconex controllers through the TSAA (Triconex System Access Application) protocol. To return data to clients, the DDE Server uses DDE protocol.

The DDE Server PC must be connected to an Ethernet port on a Triconex controller. For Tricon controllers, the NCM, ACM, or TCM can be used. For Trident controllers, the CM can be used.

To enable communication between the DDE Server and Triconex controller, you must use TriStation to configure an Ethernet port and the protocols on the Communication Module. For procedures explaining how to do this, see the *TriStation 1131 Developer's Guide, v4.5.*

This figure depicts the communication protocols used with Triconex DDE Server.
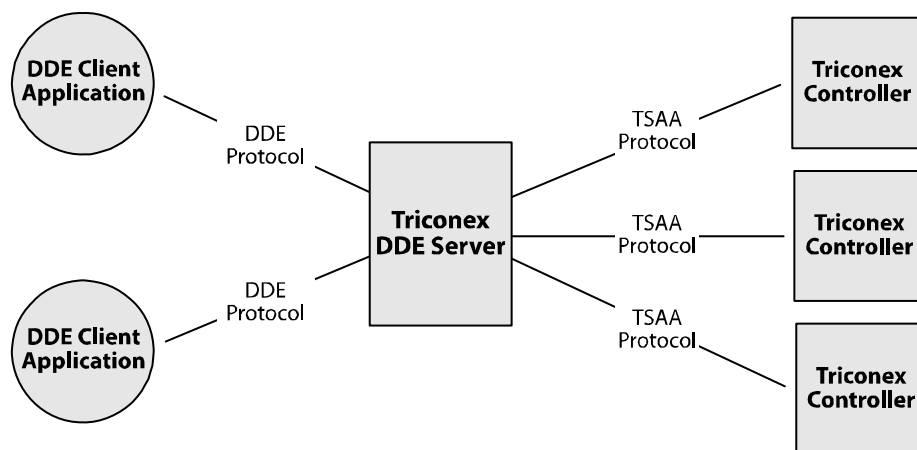
Figure 16   Triconex DDE Server Protocols

Topics include:

- DDE Server Menu Commands on page 48

Triconex DDE Server System Requirements

The following are the minimum system requirements for a PC running Triconex DDE Server:

- Microsoft Windows NT version 4.0 (Service Pack 5), Windows 2000 or XP
- Pentium™ III
- 128 MB RAM
- CD-ROM drive
- 125 MB free space on the hard drive
- Network interface card (also referred to as network adapter card)
- DLC protocol installed

Installing DLC on Windows XP

Installing the DLC protocol on a Windows XP workstation is a three-step process.

Note   If you have already installed the DLC protocol on your workstation, you can configure it to start automatically each time you start your workstation by changing a registry value. Go to HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Services\Dlc, and then change the Start value to 1.

Step 1: Downloading the DLC Protocol Installation Program

1. Open your Internet browser, and enter the following URL in the address field: http://www.microsoft.com/downloads/

2. In the Search for a Download section, perform a search for "DLC Protocol" and then go to the download page for the DLC protocol for Windows XP.

3. Follow the instructions on the download page to start the download process.

4. When prompted, save the dlc.exe file to your local drive.

5. When the download is complete, double-click the self-extracting dlc.exe file to unzip the five DLC protocol files.

   Save the files to a location on your local drive that will be easy to remember (for example, C:\DLC).

Step 2: Modifying the .INF File

1. Go to the location where you saved the DLC protocol files in step 4 of the previous section.

2. Right-click on NetDLC.inf, and select Open with from the shortcut menu that appears. Then select Notepad from the Open with dialog box and click OK. The .inf file opens in Notepad.

3 Scroll down until you see the following section:

```
;----------------------------------------------------------------------
; DLC Service Definitions and Settings
;----------------------------------------------------------------------
[DLC_Service_Inst]
DisplayName      = %DLC_Desc%
ServiceType      = 1 ;SERVICE_KERNEL_DRIVER
StartType        = 3 ;SERVICE_MANUAL_START
ErrorControl     = 1 ;SERVICE_ERROR_NORMAL
ServiceBinary    = %12%\dlc.sys
AddReg           = AddReg_Service_Inst
Description      = %DLC_Desc%

[AddReg_Service_Inst]
HKR,"Parameters",,%FLG_ADDREG_KEYONLY%,
```

4 Change the value for StartType from 3 to 1. This ensures that the DLC protocol will start automatically each time you start your workstation.

5 Save the file and then exit Notepad.

Step 3: Configuring the DLC Protocol Network Connection

1 Go to the location where you saved the DLC protocol files in Step 1.

2 Double-click install.cmd to start the installation script.

3 On the Start menu, click Control Panel, and then double-click Network Connections.

4 Right-click the network connection where you want to install the protocol, then click Properties.

5 On the General tab, click Install.

6 In the Select Network Component Type dialog box, click Protocol, and then click Add.

7 Click the DLC Protocol, and then click OK.

8 Once installation is complete, you can close the Network Connections dialog box.

Installing the Triconex DDE Server

The setup program provided by Triconex installs the Triconex DDE Server on a Windows 2000/XP or NT PC.

To install DDE Server, you must be logged on to Windows as an Administrator or you must have the privileges of an Administrator.

Installing on Windows 2000 or XP

1 If a previous version is installed, uninstall it.

2 Close all open applications.

3 Insert the Triconex DDE Server CD in the CD-ROM drive.

4 Browse the CD contents to locate the Windows2000 folder.

5 Double-click setup.exe to start the installation.

6 Follow the InstallShield Wizard instructions.

Note   The Triconex DDE Server requires the DLC protocol, which is not included in Windows XP. For an explanation of how to install the DLC protocol, see Installing DLC on Windows XP on page 39.

Installing on Windows NT

1   If a previous version is installed, uninstall it.

2   Close all open applications.

3   Browse the CD contents to locate the WindowsNT folder.

4   Double-click setup.exe to start the installation.

5   Follow the InstallShield Wizard instructions.

- If the installation is successful, a message advises you to click Finish. You are finished with the installation procedure.

- If the installation requires Factory Suite 2000 components, a message appears and the DDE Server setup is closed. Continue to step 6 in this procedure.

6   Go to the FS2000 folder (under the WindowsNT folder) and double-click SETUP.bat.

You may see a warning about the Windows service pack installed on your PC. Click OK to continue installing the Factory Suite 2000 components.

7   Follow the installation instructions. You may also be asked if you want to install Adobe Acrobat 3.0, which is an older version of the product. Click Cancel to not install this version, and then click OK.

8   Go back to the WindowsNT folder and double-click the setup.exe program to restart the DDE Server installation.

9   Click Finish to complete the installation. You may be required to reboot your PC.

Configuring the DDE Server Application

When you configure the DDE Server application, you specify communication properties used by a Triconex controller (also called a *host* or *node*) to communicate with DDE clients. These properties allow DDE clients to identify which controller to communicate with and what communication protocol to use.

If you plan to use a redundant DDE network, you need to use DDE Server PCs and install redundant communication modules in the controller. For more information, see Configuration Requirements for Redundancy on page 45.

You can also modify or delete the configuration of a Triconex controller. Before modifying a configuration, make sure it is not being used by a DDE client. If you delete a configuration, the associated controller can no longer be accessed by a DDE client.

To allow a DDE client to change the values of Triconex variables, you must enable write access by setting controls in the TriStation application.

Specifying the Triconex Host Configuration

This procedure explains how to specify host information for the Triconex controller, which must be done before a DDE client can access data from the controller.

Procedure

1   From the Start menu, select Programs, then Triconex, then Triconex DDE Server. The DDE Server main window appears.

2   From the File menu, click Configure. The Configuring Host Information screen appears.

3   Do one of the following:

- Select an existing node and click Modify.

- Click Add to add a host.

The Host Name Configuration screen appears.
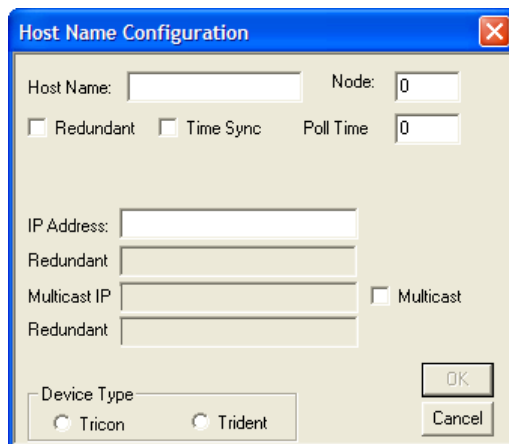
4   Specify the following properties:

Property	Action
Host Name	Enter the user-defined name for the controller.
	This name must be unique for each controller. (It is used by the DDE client application to request data from the controller.)
	The default names are TRINODE01 (for node 1) through TRINODE31 (for node 31).
Node Number	Enter the Triconex node number.
	This number must be unique for each controller. It also must match the physical switch settings on the MP Front Panel, the ACM or NCM (if installed), and the node number specified in the TriStation project. The default values are 1 to 31.

Property	Action
Redundant	Identifies whether there are redundant paths to the controller. Select this check box if the physical configuration is redundant. This means that two network interface cards must be connected to network ports on two communication modules.
	• For Tricon, the NET 2 port on two ACMs or two NCMs.
	Note: The redundant paths can be configured through the NET 1 and NET 2 ports on one TCM.
	• For Trident, the NET 1 or NET 2 port on two CM modules
	The default is *not* redundant.
	For more information, see Configuration Requirements for Redundancy on page 45.
Time Sync	Identifies whether a Triconex node (host) is to be synchronized with the clock on the DDE Server PC. If there is more than one Triconex controller in a network, select the master node for synchronization with the DDE Server PC clock. The master node can then synchronize the time of the other Triconex controllers.
	For time-critical applications, Triconex does not recommend selecting the Time Sync property because PCs are not generally a reliable source for time synchronization.
	The default is *not* synchronized.
Poll Time	Identifies how often the Triconex controller refreshes the data stored as aliases. The polling interval must be greater than the scan time of the controller. For more information on aliases, see Appendix F, Tricon System Aliases.
	The default is 1,000 milliseconds (one second).
Use 802.2	Select this check box if the 802.2 protocol is used to communicate with the DDE client. If you configure a node to use the 802.2 protocol, you must also configure the server properties. For more information, see Configuring Server Properties for the 802.2 Protocol on page 44.
	These configuration rules apply to the 802.2 protocol:
	• For Tricon v7.x and v8.x nodes, you must use the 802.2 protocol.
	• For Tricon v9.x or 10.x nodes with ACMs or NCMs, you can use either the 802.2 protocol or the TCP/IP protocol.
	• For v10 nodes with TCMs, you cannot use the 802.2 protocol. You must use the TCP/IP protocol.
	The default is cleared—meaning the TCP/IP protocol is used.
First Adapter	Enter the number of the first network adapter (interface) card in the primary PC. Available only if the Use 802.2 check box is selected.
	You can have multiple Ethernet adapters in your DDE PC. One is typical; two are needed for redundancy.
	The first adapter number is usually zero (0).

Property	Action
2nd Adapter	Enter the number of the second network adapter (interface) card in the redundant PC. Available only if the Use 802.2 and Redundant check boxes are selected.
	The second adapter number is usually one (1).
IP Address	Enter the IP address of the primary communication module in the Triconex controller. You must specify this property if the Use 802.2 check box is cleared.
Redundant (IP Address)	Enter the IP address of the redundant communication module in the Triconex controller. You cannot specify a redundant IP address if the Use 802.2 check box is selected.
Device Type	Select whether the host is a Tricon or a Trident controller.

Configuring Server Properties for the 802.2 Protocol

This procedure explains how to configure the server properties, which must be specified if the Use 802.2 property is specified for any of the hosts (controllers).

Note   TCMs are not compatible with the 802.2 protocol.

Procedure

1   On the Host Name Configuration screen, click Server. The Configuring Host Information screen appears.

2   Specify the following properties:

Property	Action
Server Poll Rate (MS)	Enter the rate in milliseconds at which DDE Server updates clients such as Microsoft Excel or Wonderware InTouch applications. Must be greater than 20 milliseconds and less than 1,000 milliseconds.
LLC Buffer Size	Enter the size of the buffer (in bytes).
	This depends on the number of Triconex controllers using the 802.2 protocol. For each host using the 802.2 protocol, a minimum of 50,000 bytes for each host must be specified. For example, if three hosts use the 802.2 protocol, the buffer must be set to 150,000 bytes.
	The default is 100,000.
LLC SAP (Server Access Point)	Enter the address for the DDE Server on the PC. This must be a unique address. The default is 4.

Testing a TCP/IP Connection

This procedure explains how to determine if the network connection is valid, which can be done after configuring the Triconex hosts. You might want to test the IP addresses of the network adapter card in the client PC, and the Triconex communication module(s).

Procedure

1 On any PC connected to the network, from the Start menu, click the MS-DOS Command Prompt.

2 Type the word *ping* followed by the IP address to be tested. For example, for an IP address of 206.32.216.43, enter this:

```
ping 206.32.216.43
```

3 If the network connection is made, the reply includes the IP address followed by byte and time information. If the connection is not okay, the reply is Request Timed Out.

Configuration Requirements for Redundancy

For Tricon controllers, a redundant network can be configured using either the TCP/IP protocol or the 802.2 protocol. Typically, hardware setup is done before software configuration. The following hardware is required:

- For Tricon, two NCMs, two ACMs, or two TCMs in one or more Tricon controllers.

- For the DDE client PC, two network adapter cards.

Configuring Redundancy With TCP/IP Protocol

This procedure explains how to configure network redundancy when using TCP/IP protocol, which can be used with Tricon version 9 and later controllers that are using TriStation 1131.

The configuration procedure involves setting IP addresses. If the network topology permits, use the Triconex default addresses. If not, get the IP addresses from your network administrator. If the DDE Server PC is not on the same subnet as the Triconex controller, you must specify the destination address during Ethernet port configuration.

Procedure

1 Install two network adapter cards and the TCP/IP protocol, if not already installed, on the DDE Server PC.

2 On the DDE Server PC, use Windows NT/2000 procedures to set the IP addresses of the network adapter cards. A sample IP address is:

206.32.216.x (where x = 1 to 254)

3 Connect the network adapter cards on the DDE Server PC to Ethernet ports on the primary and redundant Triconex communication modules.

4 In TriStation, set the IP addresses for the primary and redundant communication modules.

A sample IP address is 206.32.64.y where y is the node number. The node number is set with physical switches on the NCM, ACM or MP front panel (for TCM).

5 From the DDE server application, configure each Triconex node with a host name. You must use the same IP address for the node configuration in DDE Server that is used in TriStation.

Configuring Redundancy With the 802.2 Protocol

This procedure explains how to configure network redundancy when using the 802.2 protocol, which can be used with Tricon version 7 and later controllers. The 802.2 protocol is only available for Tricon controllers.

Note   TCMs are not compatible with the 802.2 protocol.

Procedure

   1   Install two network adapter cards and the DLC protocol (see page 39) on each network card on your DDE PC.

   2   Connect the first network adapter card in the DDE Server PC to the left NCM or ACM.

   3   Connect the second network adapter card to the right NCM or ACM.

   4   In the DDE Server application, select the Redundant and Use 802.2 check boxes (see page 41). When these properties are selected, it is not necessary to configure IP addresses.

   5   Set the First Adapter property to 0 (zero) and the 2nd Adapter property to 1 (one).

Requesting Data with a DDE Client Application

When you use a DDE client application to request data, you identify the DDE Server application to use, the Triconex controller to be accessed, and the data to be accessed. This information is referred to as the *DDE address*. Each DDE client application uses a three-part DDE address format, but might use slightly different syntax.

The DDE address format is as follows:

   Application + Topic + Item

DDE Address	Description
Application	Identifies the Triconex DDE Server application name, which is TR1DDE.
Topic	Identifies the node name for a Triconex controller as configured in the DDE Server application. The default node names for controllers 1-31 are TRINODE01 through TRINODE31.
	For more information on defining nodes, see Specifying the Triconex Host Configuration on page 42.
Item	Identifies the alias number for the requested Triconex variable. You can identify one or more items.
	For more information on aliases, see the *TriStation 1131 Developer's Guide, v4.5*.

Save the address you have specified in the DDE client application and start the DDE Server application. Both the client and server applications must be running concurrently to request or exchange data. The DDE server sends the request to the Triconex controller, then returns the data to the DDE client application.

As an example, the following address could be entered in a blank cell of a Microsoft Excel worksheet to request the value for alias 40001 in TRINODE02:

=TR1DDE|TRINODE02!'40001'

Although you can run only one DDE Server application at a time, you can run as many DDE client applications as allowed by the virtual memory available on your PC.

Requesting Network Status

To find out whether the network ports on a Triconex controller are receiving data, enter either of the following commands in any client application using the following format.

=tr1dde|TRINODE01!STATUS   Reads network status

=tr1dde|TRINODE01!RSTATUS   Reads redundant network status

For details on syntax for the DDE address, see the user's manual for the client application you are using.

Monitoring Responses from the Controller

The Triconex DDE Server allows you to monitor responses from the Triconex controller which can include alert entries as well as log entries that indicate a successful response. The entries are logged in the order in which they occur. To view the most current entries, scroll to the bottom of the list. If you select the Stats command on the Dump menu, older entries might appear at the bottom of the list, as shown in this screen.
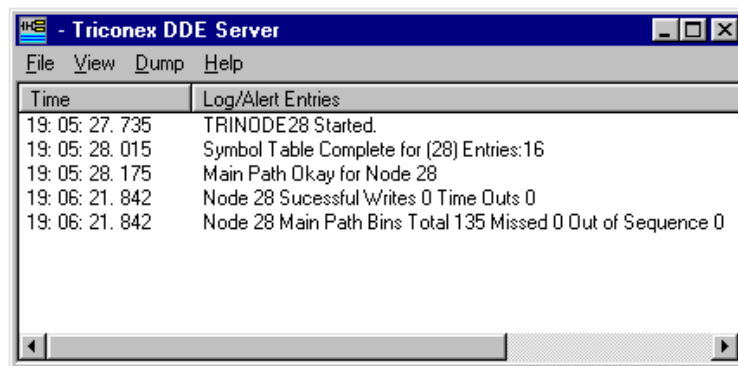
Changing View Options

To keep the DDE Server main window on top of all other windows, select the Always on Top command on the View menu. A check mark next to the command means it is selected.

DDE Server Menu Commands

The DDE Server menus include these commands:

Command	Menu	Description
Configure...	File	Opens the Configure Host Information screen and allows you to configure up to 31 controllers for use with the DDE Server application.
Exit	File	Closes the DDE Server application.
Always on Top	View	Keeps the DDE Server main window on top of other windows.
Stats	Dump	Displays statistics for all Triconex controllers.
Triconex DDE Server Help	Help	Opens the online Help for the DDE Server application.
About Triconex DDE Server	Help	Displays the current version number of the DDE Server application and registered owner information.

External OPC Server

The external OPC server is a Windows application which allows OPC clients to have read and write access to Triconex program variables. OPC is a standard set of non-proprietary interfaces used to develop client/server applications.

The OPC server PC must be connected to an Ethernet port on a Triconex controller, as described in this table.

To enable communication between the External OPC Server and the Triconex controller, you must use TriStation to configure an Ethernet port and the protocols on the Communication Module. For procedures explaining how to do this, see the *TriStation 1131 Developer's Guide, v4.5*.

If you are using a	Connect the External OPC Server to
Tricon ACM or NCM	NET 2
Tricon TCM model 4351A, 4351B, 4352A, or 4352B	NET 1 or NET 2
Tricon TCM model 4353 or 4354	NET 1

The OPC server is configured by exporting an XML configuration file from a TriStation project and opening that file in the OPC server software. After the OPC server is configured, the OPC client can ask the OPC server to get data from a Triconex controller.

This figure depicts the communication protocols used with the external OPC server.
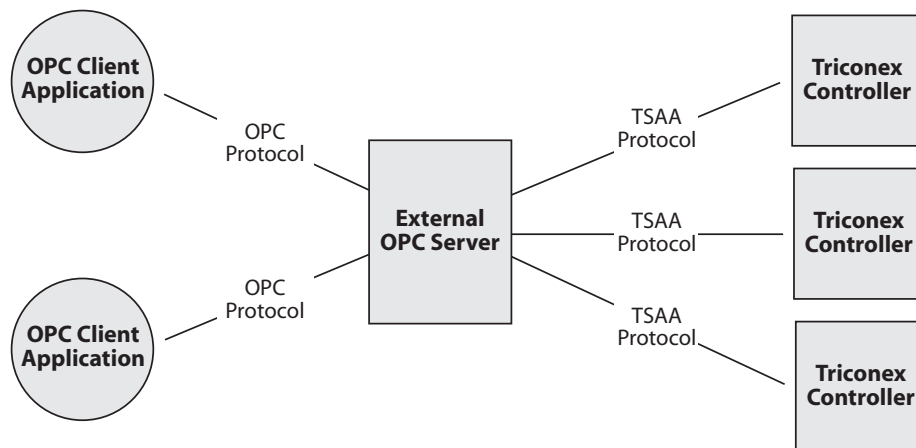
Figure 17   Communication Protocols Used with the External OPC Server

You can include TriStation configurations for multiple networked controllers in one XML file by using the same file name when exporting each configuration. The information from each TriStation configuration is appended to the file.

In the OPC server, you can edit the properties of aliases, tagnames, and other aspects of the configuration. If you change the name of the configuration or alias, a new entry is created in the XML configuration file. If you change properties related to the entry, but do not change the configuration or alias name, those properties are changed for the entry.

The external OPC server is available from Triconex and Matrikon. For more information on the external OPC server and OPC client applications, see the Matrikon OPC Web site at www.matrikonopc.com.

Configuring the External OPC Server

This procedure explains how to configure the OPC Server with alias information from a TriStation project. With TriStation 1131 version 3.1 and later, alias information can be exported to an XML file and then imported to the OPC Server. To use OPC Server with TriStation versions earlier than v3.1, alias information must be manually entered to the OPC Server.

Exporting the Configuration File From TriStation

1   In TriStation, assign all aliases to be accessed by OPC Server.

2   To allow an OPC client to change the values of Triconex variables, enable write access in the TriStation application.

3   From TriStation, complete the application and download it to the controller.

4   Export the XML configuration file by exporting the tagnames (points).

   Select the file type as Matrikon OPC XML Data Files (*.XML). Name the file using the XML extension, using a maximum of eight characters. If you include multiple configurations, use the same file name each time you use the export command.

Configuring OPC Server

1   If not already done, install OPC Server and start it. Refer to the installation instructions provided by Matrikon for detailed installation information.

   When OPC Server is loaded, a gray Triconex icon appears on the status bar.

2   Open the XML configuration file by right-clicking the Triconex icon from the status bar and selecting Configure.

   The OPC Server for Triconex PLCs window appears.

3   From the File menu, select Open, then select the XML file you exported from TriStation.

   As the file loads, statistics are displayed. When finished, you can display Server Configuration and Alias Configuration information.

4   Select a node from the Current Configuration pane to view Server Configuration information.

   This following screen shows the Server Configuration information. You can make changes to these properties by entering the changes and clicking Apply.
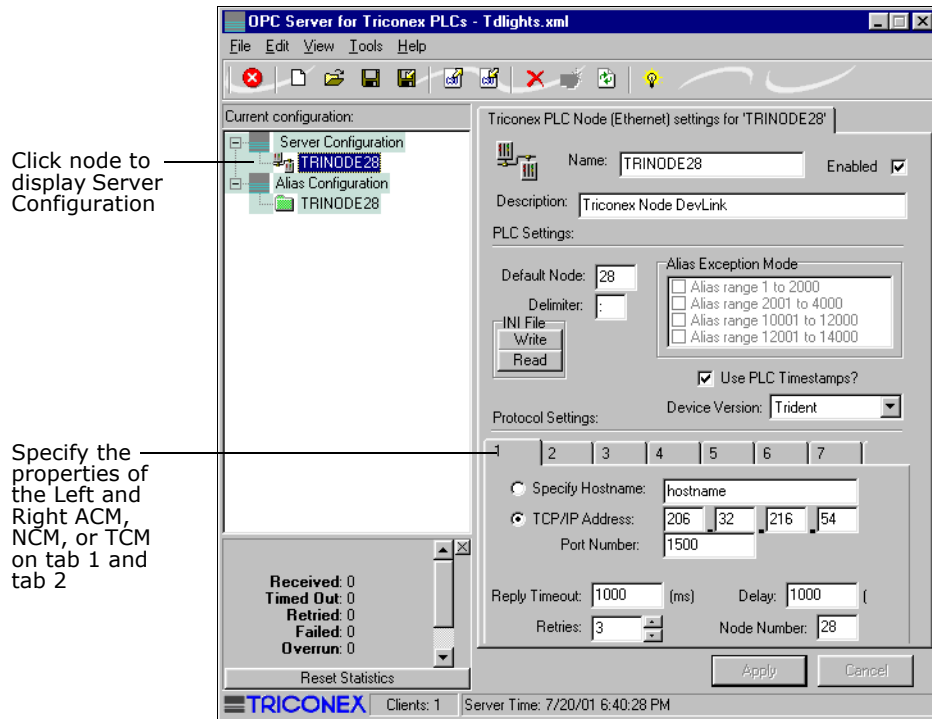
5 Under Protocol Settings, specify the TCP/IP address and other Triconex communication module properties on tab 1.

If the controller includes two communication modules, specify the properties of the left module and the right module on tabs 1 and 2.

Do not use tabs 3 through 7.

6 Select a node under Alias Configuration in the Current Configuration pane to view alias information. To make changes to an alias, double-click the alias row. The Edit Alias dialog box appears, as shown in this following figure.

The Name column displays tagnames

The Item Path column displays the node, bin, and memory offset

Click node to display Alias Configuration

Double-click alias row to edit an alias
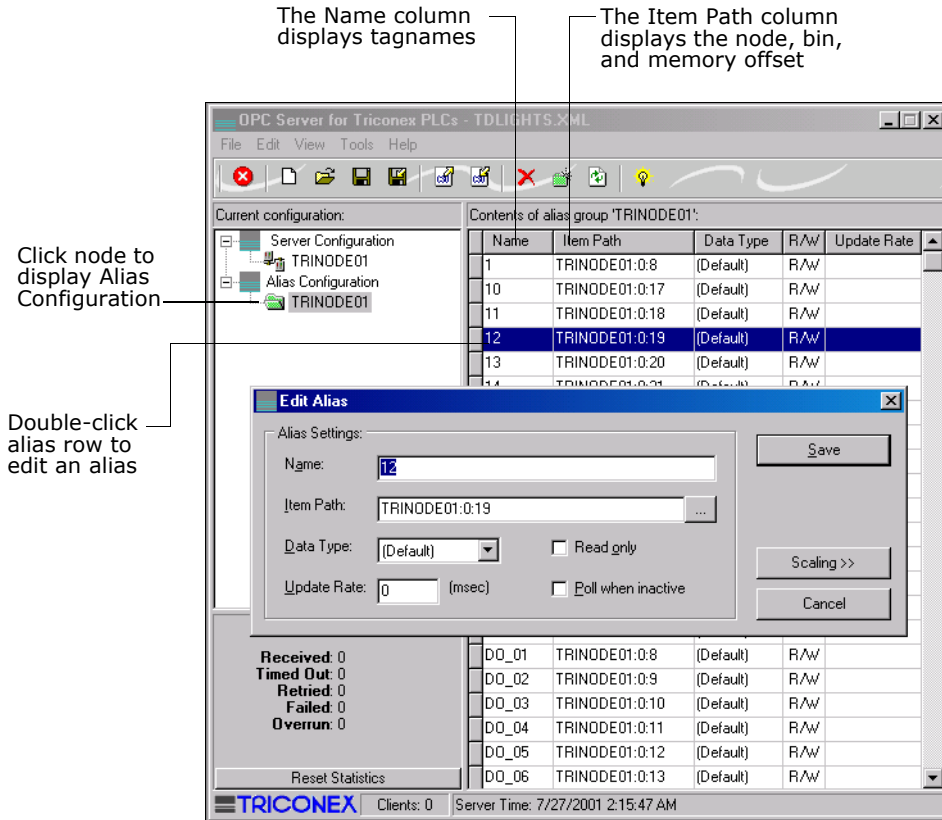
7 Repeat steps 8 through 11 for each node configuration included in the XML file.

8 If you made changes to any of the configurations and want to keep them, save the configuration file.

Configuring the OPC Client

1 To use the OPC Server to get data from a Triconex controller, install an OPC client application. (Matrikon sells OPC client applications.)

2 In the OPC client application, you can specify the tagnames or aliases of the data to be accessed.

A sample tagname is DO_02, as shown in the preceding screen.

The location of the data is described as node: bin: offset in the Item Path column for the Alias Configuration.

Redundant Configuration

OPC Server can be configured for dual redundancy by using two OPC Server PCs. Each PC must include two Ethernet interface cards, which must be connected to one Triconex communication module on the primary network and one Triconex communication module on the redundant network. You must specify the properties of the redundant Triconex communication modules in the OPC Server Configuration dialog box (see page 50).

See Redundant Devices on page 13 for a sample redundant configuration including OPC Server.

Adjusting System Time

An OPC client can use the Device Clock tagname to read or write the system time of a Triconex controller. The Device Clock tagname is derived from Triconex status information in the OPC Server Configuration. For more information, see Time Synchronization on page 94. See also the documentation for the OPC client software.

Before you can use the Device Clock tagname to adjust the system time of a Triconex controller, you must configure the TriStation project to allow write access by external devices on an open network. See the *TriStation 1131 Developer's Guide, v4.5* for more information.

Other OPC Products

For users of OPC Server, two additional OPC products are available from Triconex and Matrikon: the OPC Data Manager and the OPC Redundancy Broker.

OPC Data Manager

The OPC Data Manager (ODM) is an application that transfers data from one OPC server to another. ODM is useful for sharing data between two or more control systems, such as a Triconex controller and a DCS. Traditional OPC-enabled systems share data by implementing one application as an OPC client, and another as an OPC server. If two applications are servers instead of clients, they cannot exchange data. ODM solves this problem by acting as a *double-headed* or *thin* OPC client to both servers. It requests data from one OPC server and immediately sends it to the other OPC server.

ODM includes these features:

- Support for both COM and DCOM architectures
- Support for DDE and OPC message protocols
- Operation as a Windows service or a normal application
- Real-time data monitoring
- Extensive error tracking and management

For more information, see the *MatrikonOPC Data Manager User's Manual* or the Matrikon OPC Web site at www.matrikonopc.com.

OPC Redundancy Broker

The OPC Redundancy Broker (ORB) is a messaging application designed for systems that must use redundant devices to ensure high reliability. ORB constantly monitors the primary OPC server and redirects communication to the standby OPC server when a failure is detected. ORB can integrate with any OPC compliant client/server configuration and can be retrofitted to existing configurations.

ORB includes these features:

- Intuitive configuration and monitoring features
- Choice of hot, cold, or warm fail-over for each OPC server
- Automatic fail-over notification by e-mail, fax, log file, or pager
- Extensive error tracking and diagnostic capabilities

For more information, see the *MatrikonOPC Redundancy Broker User's Manual* or the Matrikon OPC Web site at www.matrikonopc.com.

TCM with Embedded OPC Server

OPC is a standard set of non-proprietary interfaces used to develop client/server programs. OPC Server is a client/server application, which allows OPC clients to read and write to Triconex program variables.

TCM models 4353 and 4354 have an embedded OPC server, which makes an external PC for the server unnecessary. (However, a PC for the client is still required.) The OPC protocol is supported only on the NET 2 port of the TCM, as shown in this figure.
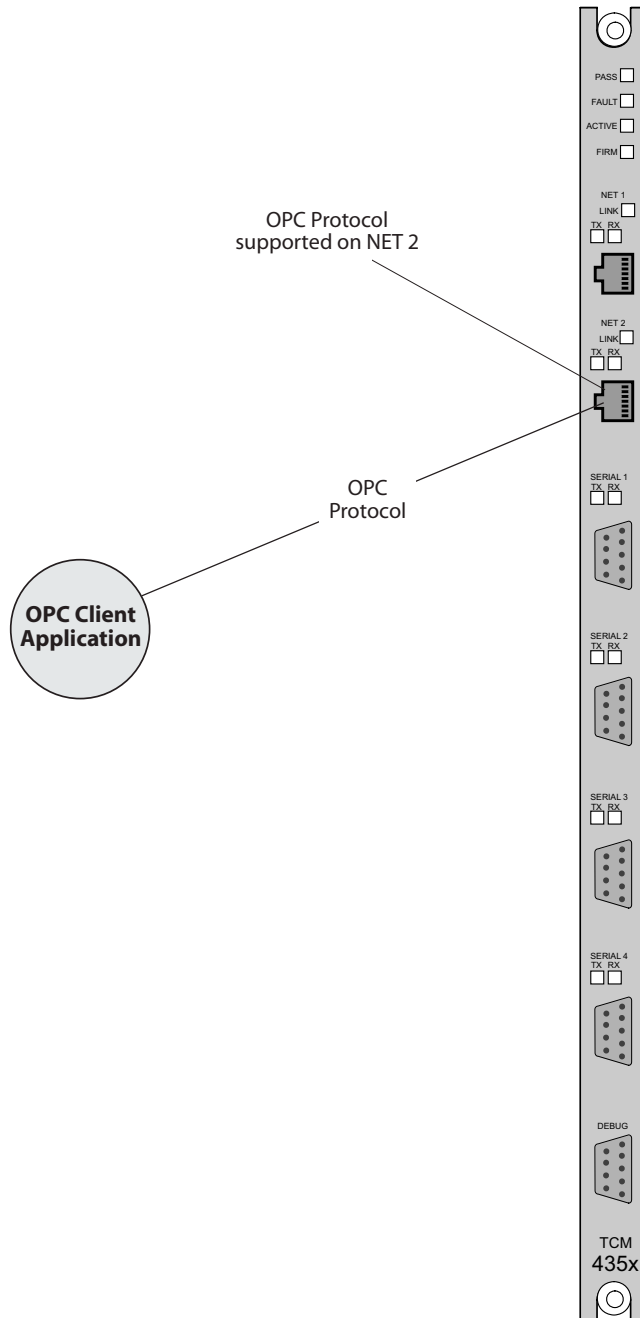
Figure 18   TCM with Embedded OPC Server

OPC Data Access

The embedded OPC Server on the TCM supports the Data Access v2.05 standard (DA), which is used to move real-time data from PLCs, DCSs, and other control devices to HMIs and other display clients. You can use an OPC client to view real-time Tricon bin data such as aliased tag names and system variables. For more information, see Tricon System Variables on page 57.

The embedded OPC DA on the TCM has these limitations:

- 10 OPC clients total (DA and A&E) can subscribe to OPC data
- 100 groups total
- 2000 points per group
- 20,000 points total

OPC Alarms and Events

The embedded OPC Server on the TCM supports the OPC Alarms and Events v1.10 standard (A&E), which provides alarm and event notification on demand; including process alarms, operator actions, informational messages, and tracking/auditing messages.

The embedded OPC A&E on the TCM has these limitations:

- All events are reported as Simple Events
- 20 subscriptions total
- Burst of 16,000 events in one second
- Sustained rate of 1,000 events per second

Connecting an OPC Client to the TCM with Embedded OPC Server

There are numerous OPC clients that you can use to connect to the TCM with Embedded OPC Server. For instructions on connecting your client, refer to the client user documentation.

To connect, most OPC clients require only the IP address of the server, which you configure using TriStation 1131. Some OPC clients may require the server name, or the server name and the CLSID.

Default server name:
Triconex.OPCEvtAndDAServer.1

CLSID:
{1BAAC831-0472-4605-8669-4721FB2D5AE9}

Notes

- If you have just performed a Download All or Download Changes, you may have to wait up to six minutes, for the symbol table to download, before you can connect an OPC client to the TCM with Embedded OPC Server.

- It is possible for corrupt data from an OPC client to cause the TCM with Embedded OPC Server to fail. If this happens, the TCM will automatically restart; however, all connections to the TCM will be lost for approximately one to two minutes while the TCM is restarting.

- If a connected OPC client abnormally shuts down—such as the PC stops responding or the OPC Client process is stopped using Task Manager—the TCM with Embedded OPC Server will take approximately three to five minutes to recognize that the connection has been lost. During this time, you cannot connect another OPC client if the maximum of 10 clients had been connected.

- Sequence of Events (SOE) data is not extracted when there is no OPC client connected to the OPC A&E Server on the TCM. When a client connects to the OPC A&E Server on the TCM, the collected events are extracted to the client. The events are not retained in the TCM once they are extracted.

Configuring the TCM with Embedded OPC Server

You configure OPC Alarms and Events by using TriStation 1131. For more information, see the *TriStation 1131 Developer's Guide, v4.5*.

There is no configuration of OPC Data Access.

Tricon System Variables

This section describes the Tricon system variables that you can view using an OPC client connected to the TCM with Embedded OPC Server.

Table 2   Single Discrete System Variables

Name	Description	Type
MPMAINT	MP faulted - Main Chassis Alarm indicator ON	BOOL
MPBAD	Two MPs faulted - Tricon in simplex mode	BOOL
MPARITH	Arithmetic error during scan	BOOL
MPDIVZERO	Integer or real divided by zero	BOOL
MPOVRFLOW	Floating-point overflow	BOOL
MPUDRFLOW	Floating-point underflow	BOOL
MPINEXACT	Floating-point inexact result	BOOL
MPBADPARAM	Parameter out of range	BOOL
POWERUP	The first scan after power up	BOOL
FIRSTSCAN	First scan	BOOL
MPAPASS	MP A Pass indicator	BOOL
MPAFAIL	MP A Fault indicator	BOOL
MPAACTIVE	MP A Active indicator	BOOL

Table 2 Single Discrete System Variables *(continued)*

Name	Description	Type
MPAMAINT1	MP A MAINT1 indicator	BOOL
MPBPASS	MP B Pass indicator	BOOL
MPBFAIL	MP B Fault indicator	BOOL
MPBACTIVE	MP B Active indicator	BOOL
MPBMAINT1	MP B MAINT1 indicator	BOOL
MPCPASS	MP C Pass indicator	BOOL
MPCFAIL	MP C Fault indicator	BOOL
MPCACTIVE	MP C Active indicator	BOOL
MPCMAINT1	MP C MAINT1 indicator	BOOL
IOMAINT	One Comm Bus leg or one MP not functioning	BOOL
IOBAD	I/O module running in simplex mode	BOOL
GATEENABLED	Remote writes to aliased variables in Tricon enabled	BOOL
MASTERCLOCK	The system owns the master clock	BOOL
NET1L	NET 1 on left NCM or TCM is operational	BOOL
NET2L	NET 2 on left NCM or TCM is operational	BOOL
NET1R	NET 1 on right NCM or TCM is operational	BOOL
NET2R	NET 2 on right NCM or TCM is operational	BOOL
COLDSTART	The first scan after initializing retentive variables	BOOL
DISABLEDISALLOWED	Variable True (ON) indicates that disabling tagnames is not allowed	BOOL

Table 3 Array Discrete System Variables

Name	Main Array BOOLs	Sub Array BOOLs	Description
NODEOK	Node 1-32	—	Communication with node is OK
NODEREDUNDANT	Node 1-32	—	Redundant communication exists with node
RKV1L	Chassis 1-15	—	Upper power supply fault
RKV2L	Chassis 1-15	—	Lower power supply fault
RKMNT	Chassis 1-15	—	Maintenance required
RKBAD	Chassis 1-15	—	Active board with fault
RDYXX	Chassis 1-15	—	Printer ready
OVFLXX	Chassis 1-15	—	Printer overflow
RKALARM	Chassis 1-15	—	Chassis alarm

Table 3   Array Discrete System Variables *(continued)*

Name	Main Array BOOLs	Sub Array BOOLs	Description
RKBRDMNT	Chassis 1-15	—	Board maintenance required
RACKSTATUS	Chassis 1-15		Chassis/Slot Statuses:
		Slot 1-16	PASS: Board installed not faulted
		Slot 1-16	FAIL: Board faulted
		Slot 1-16	ACTIVE: Board is active
		Slot 1-16	BAD: Board is bad
		Slot 1-16	INSTALLED: Board is installed
BRDIOBAD	Chassis 1-15	Slot 1-16	The I/O module has failures on two legs
SLOTONLINE	Chassis 1-15	Slot 1-16	The external host is online with this communication module
SLOTSTBRDY	Chassis 1-15	Slot 1-16	The standby module is ready to take over in the case of a failure

Table 4   Integer System Variables

Name	Description	Type
RELSECONDS	The relative seconds since January 1, 1970	INT
YEAR	Current year	INT
MONTH	Current month	INT
DAY	Current day	INT
HOUR	Current hour	INT
MINUTE	Current minute	INT
SECOND	Current second	INT
MILLISEC	Current millisecond	INT
WEEKDAY	Current day of the week (0 = Sunday to 6 = Saturday)	INT
KEYSW	Main chassis keyswitch position	INT
SCANTIME	Requested scan time (ms)	INT
SCANREAL	Measured scan time (ms) for latest scan	INT
SCANSURPLUS	Surplus scan time (averaged over last 100 scans)	INT
SCANOVERRUNS	Number of overruns (averaged over last 100 scans)	INT
RUNSTATE	Control program mode	INT
MPBADPARMCODE	Out-of-range parameter error code	INT
CPVERSIONMINOR	Minor version number of control program	INT
CPVERSIONMAJOR	Major version number of control program	INT

Table 4 **Integer System Variables** *(continued)*

Name	Description	Type
PROGRAMNAME	Control program name	INT
IOPOLLTIME	I/O Poll time	INT
BINXMTTIME	Bin transmit time in milliseconds	INT
PTSDISABLED	Number of disabled points	INT
MINNODE	Smallest node number on P2P network	INT
MAXNODE	Largest node number on P2P network	INT
LOCALSECONDSBIAS	Offset from UTC (seconds)	INT
BINSEQNUMBER	Bin sequence number	INT

Redundant Configuration

The embedded OPC server can be configured for dual redundancy by using two TCMs with embedded OPC servers. One of the TCMs must be on the primary network and the other TCM must be on the redundant network. You must specify the properties of the redundant TCM using TriStation 1131 software. For more information, see the *TriStation 1131 Developer's Guide, v4.5*.

See Redundant Devices on page 13 for a sample redundant configuration including OPC Server.

Adjusting System Time

An OPC client can use the Device Clock tagname to read or write the system time of a Triconex controller. The Device Clock tagname is derived from Triconex status information in the OPC Server Configuration. For more information, see Time Synchronization on page 94. See also the documentation for the OPC client software.

Before you can use the Device Clock tagname to adjust the system time of a Triconex controller, you must configure the TriStation project to allow write access by external devices on an open network. See the *TriStation 1131 Developer's Guide, v4.5* for more information.

Other OPC Products

For users of OPC Server, two additional OPC products are available from Triconex and Matrikon: the OPC Data Manager and the OPC Redundancy Broker.

OPC Data Manager

The OPC Data Manager (ODM) is an application that transfers data from one OPC server to another. ODM is useful for sharing data between two or more control systems, such as a Triconex controller and a DCS. Traditional OPC-enabled systems share data by implementing one application as an OPC client, and another as an OPC server. If two applications are servers instead of clients, they cannot exchange data. ODM solves this problem by acting as a *double-*

headed or *thin* OPC client to both servers. It requests data from one OPC server and immediately sends it to the other OPC server.

ODM includes these features:

- Support for both COM and DCOM architectures
- Support for DDE and OPC message protocols
- Operation as a Windows service or a normal application
- Real-time data monitoring
- Extensive error tracking and management

For more information, see the *MatrikonOPC Data Manager User's Manual* or the Matrikon OPC Web site at www.matrikonopc.com.

OPC Redundancy Broker

The OPC Redundancy Broker (ORB) is a messaging application designed for systems that must use redundant devices to ensure high reliability. ORB constantly monitors the primary OPC server and redirects communication to the standby OPC server when a failure is detected. ORB can integrate with any OPC compliant client/server configuration and can be retrofitted to existing configurations.

ORB includes these features:

- Intuitive configuration and monitoring features
- Choice of hot, cold, or warm fail-over for each OPC server
- Automatic fail-over notification by e-mail, fax, log file, or pager
- Extensive error tracking and diagnostic capabilities

For more information, see the *MatrikonOPC Redundancy Broker User's Manual* or the Matrikon OPC Web site at www.matrikonopc.com.

5

Peer-to-Peer Communication

Overview

Triconex Peer-to-Peer protocol is designed to allow multiple Tricon and Trident controllers in a closed network to exchange safety-critical data. (If you plan to implement a complex Peer-to-Peer network, please contact the IPS Global Client Support (GCS) center.)

To enable Peer-to-Peer communication, you must connect each controller to an Ethernet network by using a NET 1 (Ethernet) port on the NCM or TCM models 4353 and 4354, or a NET 1 or NET 2 port on TCM models 4351A, 4351B, 4352A, or 4352B. The controllers exchange data by using Send and Receive function blocks in their TriStation applications.
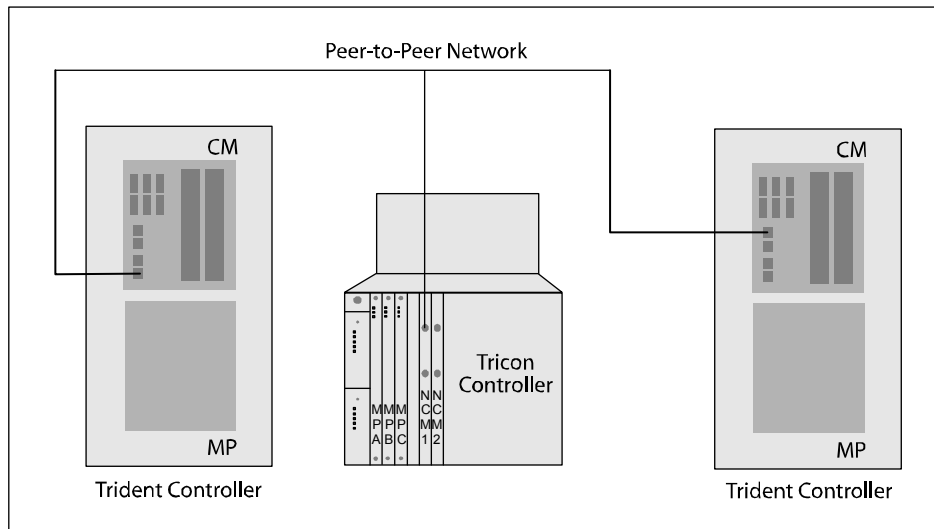
Figure 19   Simple Triconex Peer-to-Peer Network Configuration

To configure a TriStation application for Peer-to-Peer communication, you must:

- Configure the physical port connection for Peer-to-Peer mode
- Allocate memory for Send and Receive function blocks
- Add Send and Receive function blocks to the TriStation application
- Observe restrictions on data transmission speed

In addition, Triconex recommends that you calculate the data transfer time to determine whether the control algorithms will operate correctly.

For procedures explaining how to estimate memory for Peer-to-Peer data transfer time, configure Peer-to-Peer ports, and allocate Peer-to-Peer memory, see the *TriStation 1131 Developer's Guide, v4.5*.

A TriStation application must use a specific Send function block to send data to a matching Receive function block in another TriStation application. Each Send function block has a parameter that identifies the Receive function block to which it sends data. Each Receive function block has a parameter that identifies the Send function block from which it receives data.

The Send and Receive function blocks can transfer data with BOOL, DINT, or REAL data types. Some function blocks transfer 20 data values, and others transfer 32 data values. For detailed

information about the available Send and Receive function blocks, see the *TriStation 1131 Libraries Reference*.

Peer-to-Peer communication speed for Tricon controllers is 10 megabits per second with an NCM installed, and 10 or 100 megabits per second with a TCM installed; however, the TCM model 4354 supports only 100 megabits per second connections. Trident controllers communication speed is 10 or 100 megabits per second. If your network includes a Tricon with a TCM and a Trident, you can run the entire network at 100 megabits per second.

If your network includes a Tricon with an NCM and a Trident, you can run the entire network at 10 megabits per second, or you can use a hub that converts messages from 10 to 100 megabits per second when they are transferred from the Tricon to the Trident. In this scenario, Triconex suggests using the NET 1 port on both Tricon and Trident communication modules, because 10 megabits per second is the only speed available on NET 1. With this setup, NET 2 is available for faster communication with external devices on an Ethernet network. For more information, see Restrictions on Data Transmission Speed on page 68.

For monitoring Peer-to-Peer data exchange, TriStation provides function blocks and system aliases to track network communication paths and verify whether the Ethernet ports are receiving data from other controllers.

The sample programs described in this chapter are available as part of the TriStation 1131 installation. These programs show how to send data at high speed and under controlled conditions, and how to measure the maximum data transfer time.

Note   If your network includes a Trident with a CM installed, you can perform time synchronization over the Peer-to-Peer network using the NET 1 or NET 2 port. If your network includes a Tricon with a TCM installed, you can perform time synchronization over the Peer-to-Peer network using the NET 1 or NET 2 port on TCM models 4351A, 4351B, 4352A, and 4352B, or the NET 1 port on TCM models 4353 and 4354. See Time Synchronization on page 94 for more information.

Using Send and Receive Function Blocks

A TriStation application must use a specific Send function block to send data of a certain type to a matching Receive function block in another TriStation application. Each Send function block has a parameter that identifies the Receive function block to which it sends data. Each Receive function block has a parameter that identifies the Send function block from which it receives data.

Send and Receive Function Blocks

The Send and Receive function blocks that you can include in a TriStation application have data types of BOOL, DINT, and REAL. The following function blocks are available:

Send Function Blocks	Receive Function Blocks
TR_USEND_BOOL	TR_URCV_BOOL
TR_USEND_DINT	TR_URCV_DINT
TR_USEND_REAL	TR_URCV_REAL
TR_USEND_BOOL_32	TR_URCV_BOOL_32
TR_USEND_DINT_32	TR_URCV_DINT_32
TR_USEND_REAL_32	TR_URCV_REAL_32

The _32 ending means that the function block can send 32 data values. Function block names that do not include the _32 ending can send 20 data values.

All Send function blocks—and all Receive function blocks—have the same parameters, except for the data transfer parameters which are BOOL, DINT, or REAL. For detailed descriptions, see the *TriStation 1131 Libraries Reference*.

Sample Send and Receive Pair

This figure depicts a sample pair of Send and Receive function blocks. A Send function block in one TriStation application is sending input values from the field over a Peer-to-Peer network to a matching Receive function block in another TriStation application. The Recvid and Sendid parameters are used to cross-reference the Send and Receive function blocks. The Recvnode and Sendnode parameters are used to cross-reference the sending and receiving nodes (TriStation applications).

For more information, see .
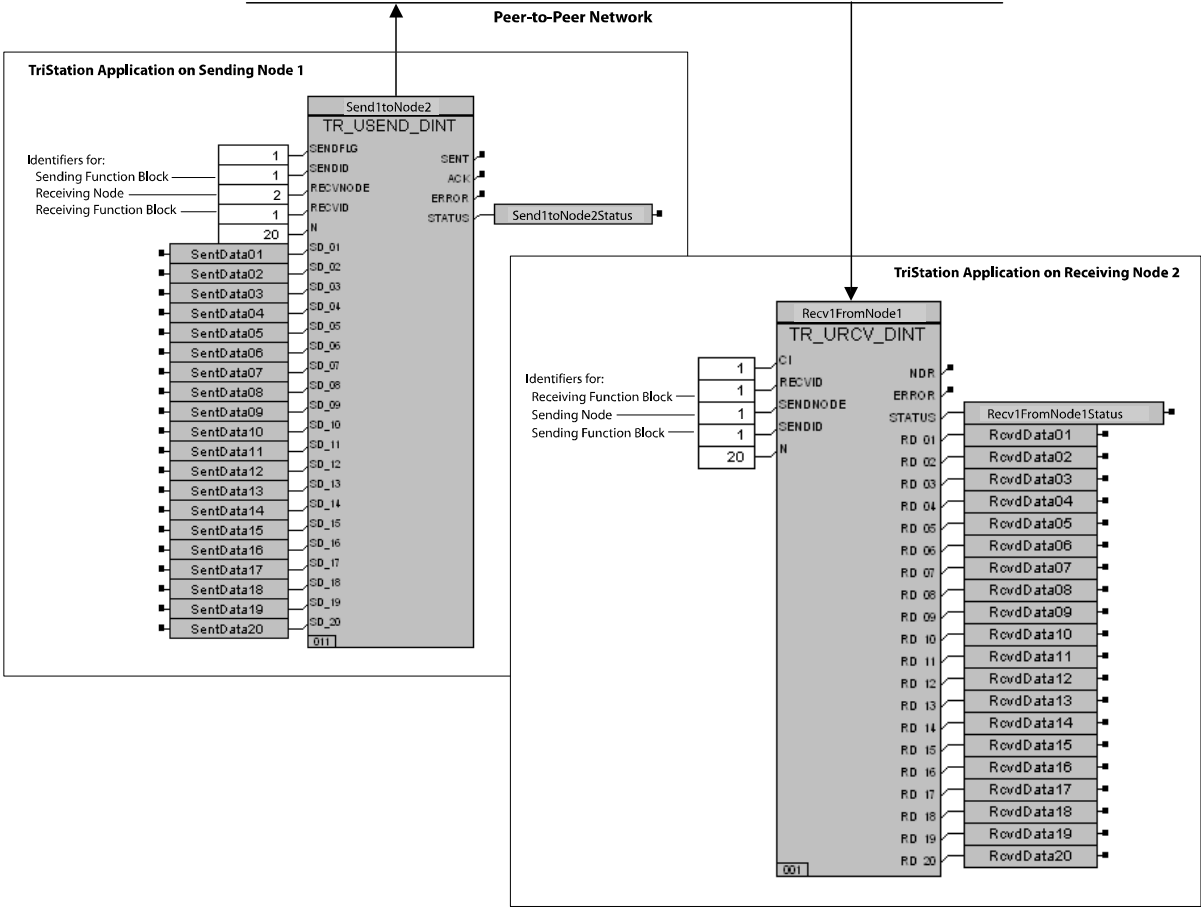
Figure 20   Sample Pair of Send and Receive Function Blocks in a Peer-to-Peer Application

Restrictions on Data Transmission Speed

Tricon controllers with an NCM installed perform Peer-to-Peer communication at 10 megabits per second. Trident controllers with a CM installed and Tricon controllers with a TCM installed can perform Peer-to-Peer communication at 10 or 100 megabits per second; however, the TCM model 4354 supports only 100 megabits per second connections.

Peer-to-Peer communication can be performed across the entire network at 100 megabits per second if your network satisfies one of the following conditions:

- includes only Tricon controllers with TCMs installed.
- includes only Trident controllers.
- includes only Tricon controllers with TCMs installed AND Trident controllers.

If your network includes a Tricon with an NCM and a Trident controller, you must choose either of the following solutions.

Solution	Description
Run the entire network at 10 megabits	Data exchange among Triconex controllers can be effectively done at a rate of 10 megabits per second. Triconex suggests using the NET 1 port on both Trident and Tricon communication modules, because 10 megabits per second is the only speed available on the NCM NET 1 port. With this setup, NET 2 is available for faster communication with external devices on an Ethernet network.
Convert messages from 10 to 100 megabits	The data rate can be converted when messages are transferred from a Tricon controller with an NCM to a Trident controller. A typical method is to connect the Tricon and Trident controllers to a hub which can convert from 10 to 100 megabits.

Monitoring Peer-to-Peer Communication

TriStation provides function blocks for monitoring the status of Peer-to-Peer communication paths (routes between NCM or TCM modules on the network) and the status of NET 1 ports on the NCM or TCM. For detailed information, see the *TriStation 1131 Libraries Reference*.

Status of Communication Paths

For controllers with NCM modules installed, the Peer-to-Peer network can communicate over one or two paths, depending on whether each controller contains one or two NCM modules. If there are two paths (two NCM modules), then both are used simultaneously to exchange Peer-to-Peer data.

For controllers with TCM modules installed, the Peer-to-Peer network can communicate over one, two, three, or four paths, depending on the number of TCM modules installed. If there are four paths (four TCM modules), then all are used simultaneously to exchange Peer-to-Peer data.

The failure of one path does not affect Peer-to-Peer communication. To monitor the paths, use the TR_PEER_STATUS function block in the TriStation application. Path status is updated every 30 seconds.
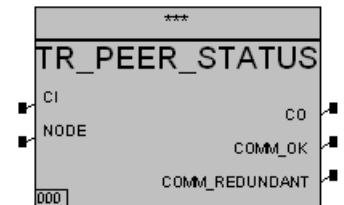
Status of NET 1 Ports

You can determine whether the NET 1 ports on an NCM or TCM are receiving Peer-to-Peer data by using the TR_PORT_STATUS function block in the TriStation application.

This figure depicts the FBD representation of a TR_PORT_STATUS function block.
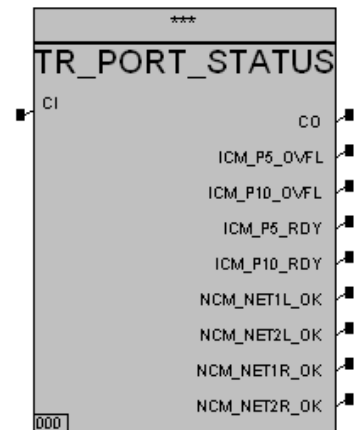
Examples of Peer-to-Peer Applications

Triconex Peer-to-Peer function blocks are designed to transfer limited amounts of data between two applications. Therefore you should use these function blocks sparingly in your applications.

Ideally, you should control the execution of each SEND function block in such a way that each SEND is initiated only when the acknowledgment for the last SEND is received and new data is available for sending. You can do this through effective use of the SENDFLG parameter in the SEND function block and the STATUS output of the SEND function block, as shown in Examples 3 and 4.

The examples described below can be found in the Expeer.pt2 project included as part of the TriStation 1131 installation.

Example 1: Fast Send to One Triconex Node

This example shows how to send data as fast as possible from node #2 to node #3. Scan time in both controllers is set to 100 milliseconds.

The example uses the following project elements:

- PEER_EX1_SEND_FBD (for sending node #2)
- PEER_EX1_RCV_FBD (for receiving node #3)

Example 2: Sending Data Every Second to One Node

This example shows how to send data every second from node #2 to node #3. Scan time in both controllers is set to 100 milliseconds.

The example uses the following project elements:

- PEER_EX2_SEND_FBD (for sending node #2)
- PEER_EX2_RCV_FBD (for receiving node #3)

Example 3: Controlled Use of SEND/RECEIVE Function Blocks

This example shows how to use SEND/RECEIVE function blocks correctly, in a controlled way, so that a limited amount of important data can be transferred between two applications when new data is ready to be sent.

This example uses the following project elements:

- PEER_EX3_SEND_FBD (for sending node #2)
- PEER_EX3_RCV_FBD (for receiving node #3)

Example 4: Using SEND/RECEIVE Function Blocks for Safety-Critical Data

This example shows how to use SEND/RECEIVE function blocks for transferring a limited amount of safety-critical data between the two applications as fast as possible. It also shows how to measure the actual maximum time for transferring data from the sending node to the receiving node.

Because this is safety-critical data, each controller must use two NCMs or TCMs and two Peer-to-Peer networks. However, this is for availability reasons only, and is not necessary if you have already included in your safety logic that a loss of communications will cause a shutdown of the process under safety control.

Sending Node #1 Parameters:

- Scan time (SS) = 150 milliseconds

- Number of aliased variables in bytes = 2000

- Time to transfer alias data over the communication bus in milliseconds (TS) = (2000/20000) * 1000 = 100 milliseconds

- The sending controller has only one SEND function block in the application, meeting the requirement to have five or fewer SEND function blocks. The sendflag is on in the SEND function block so that, as soon as the last SEND is acknowledged by the receiving controller, the sending controller initiates another SEND.

Receiving Node #3 Parameters:

- Scan time (SR) = 200 milliseconds

- Number of aliased variables in bytes = 5000

- Time to transfer aliased data over the communication bus in milliseconds (TR) = (5000/20000) * 1000 = 250 milliseconds

- Process tolerance time = 4 seconds

- Estimated data transfer time = 2 * 150 + 2 * 250 = 800 milliseconds.

If the sending controller does not receive acknowledgment from the receiving controller in one second, it automatically retries the last TR_USEND message. Because of network collisions, communication bus loading, etc., the sending controller occasionally has to retry once to get the message to the receiving node. This is why the general rule for data transfer time is one to two seconds, even though the estimated time is 800 milliseconds.

The receiving node has a network to measure the actual time so you can validate the assumed two-second maximum transfer time. Since the process-tolerance time of the receiving node is four seconds, the maximum time-out limit is set to two seconds (half the process-tolerance time). The receiving node should receive at least one data transfer within the maximum time-out limit. Using this criteria meets the basic requirement for using peer-to-peer communication to transfer safety-critical data.

This example packs 32 BOOL values into a DWORD and sends the DWORD and a diagnostic variable to a receiving node as fast as possible by setting the sendflag parameter to 1 all the time. The diagnostic variable is incremented every time a new SEND is initiated. The receiving node checks the diagnostic variable to verify that it has changed from the previous value received. The receiving node also determines whether it has received at least one data transfer within the process-tolerance time. If not, the application takes appropriate action, such as using the last data received or using default data to make safety-critical decisions.

This example uses the following project elements:

- PEER_EX4_SEND_FBD (for sending Node #1)
- PEER_EX4_RCV_FBD (for receiving Node #3)

6

Modbus Communication

Overview

Modbus is an industry-standard master/slave communication protocol that is traditionally used for energy management, transfer line control, pipeline monitoring, and other industrial processes.

Before the CM or MP can communicate with Modbus devices, you must use TriStation to configure a Modbus port. For procedures explaining how to configure Modbus serial ports or Modbus TCP ports, see the *TriStation 1131 Developer's Guide, v4.5.*

A Tricon controller with a TCM can operate as a Modbus master or slave; a controller with an EICM can operate as a Modbus master, slave, or both. A DCS typically acts as the master, while the Tricon acts as a slave. The master can also be an operator workstation or other device that is programmed to support Modbus devices.

The Tricon controller has serial ports on the EICM or TCM that provide options for communication with a Modbus devices. Each serial port can operate in a point-to-point configuration with a single Modbus device, or in a multi-point configuration with several Modbus devices connected to a serial link. For an example, see Configuration Options on page 76. The TCM also supports Modbus over TCP through the NET 1 or NET 2 Ethernet port on models 4351A, 4351B, 4352A, and 4352B, and the NET 1 port on models 4353 and 4354.

Note   If you have just performed a Download All or Download Changes in a system that contains TCM model 4353 or 4354 (TCM with Embedded OPC Server), you may have to wait up to six minutes, for the symbol table to download, before you can connect a Modbus device to the system.

Each serial port on the EICM or TCM can be configured as a master or slave. Serial ports on the EICM can also be configured as a combination master/slave. The Ethernet ports on the TCM can be configured as a master or slave, with up to 32 Modbus masters or slaves per Tricon system.

A Triconserial port can act as a master, slave, or combination master/slave with these physical features:

- Point-to-point or multi-point network topology
- RS-232, RS-422, or RS-485 communication interface
- 2-wire (half duplex) or 4-wire (full duplex) cables
- Hardware handshake with or without signal delays

   Note   Signal delays are not available on TCMs.

For an EICM or TCM port configured as a master, the associated TriStation application can use Modbus Read and Write function blocks to communicate with slave devices, including other Triconex controllers. Programs in external Modbus master devices can directly access point values in a Triconex controller if the points have aliases and if write access controls are correctly applied.

A TriStation application normally uses alphanumeric names to identify Triconex points (program variables). Numeric identifiers called aliases must also be used to make the point values accessible to external Modbus devices. An alias has five digits that define its data type and hardware address in the controller.

Function blocks allow you to monitor the communication status of each EICM and TCM serial port. The status information includes the number and kinds of messages received and sent and milliseconds since the last message was received.

The sample programs described in this chapter are included as part of the TriStation installation. These programs show how to use the Modbus Read and Write function blocks for transmitting aliased data, how to set time-out and retry values for Modbus communication, and how to control the flow of data from slave to master. For detailed information, see Appendix E, Modbus Protocol

Physical Features

When connecting a Tricon EICM or TCM serial port to one or more Modbus devices, you can select from these physical features.

Feature	Option	Use for
Network Topology	Point-to-point	Connection to one Modbus device
	Multi-point	Connection to multiple Modbus devices. One master with up to 32 slaves.
Communication Interface	RS-232	Maximum speed across distances up to 50 ft (15 m)
	RS-422	Distances up to 4,000 ft (1,220 m), point-to-point only
	RS-485	Distances up to 4,000 ft (1,220 m)
Cable Type	2-wire	Half-duplex data transmission
	4-wire	Full-duplex data transmission
Hardware Handshake	None	See Hardware Handshake Rules on page 79
	Hardware	

Configuration Options

A Tricon TCM or EICMserial port can operate in a point-to-point connection with a single Modbus device, or in a multi-point serial link with several Modbus devices.

Point-to-Point Connection

This figure shows a point-to-point connection, which is a direct connection between devices.
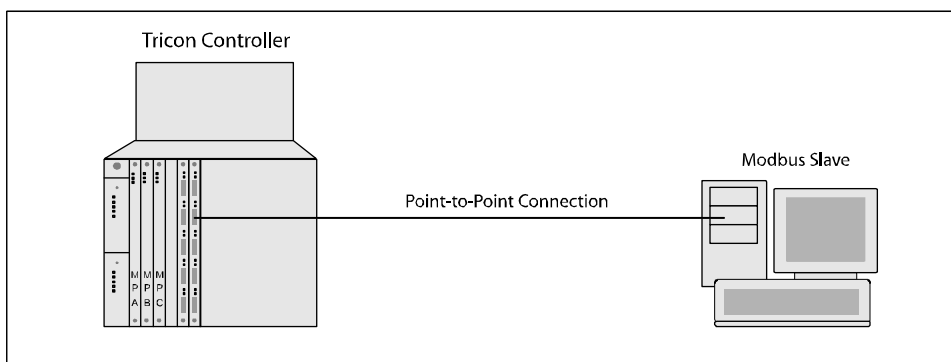
Figure 21   Modbus Point-to-Point Connection

Multi-Point Connection

This figure shows a multi-point connection, which allows connections between several devices.
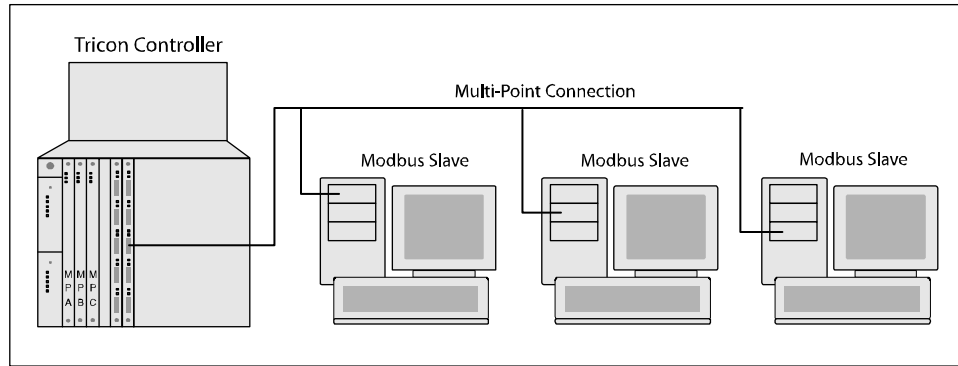
Figure 22   Modbus Multi-Point Connection

Physical Media Rules

These rules apply to the communication interfaces and cables you can use with TCM or EICM serial ports:

- RS-232 can be used only for point-to-point connections across distances up to 50 feet (15 meters). At higher baud rates, the maximum recommended distance is reduced.

- RS-422 can be used only for point-to-point connections across distances up to 4,000 feet (1,220 meters)

- RS-485 can be used:

  — for point-to-point connections or multi-point serial links

  — with 2-wire or 4-wire cables

  — across distances up to 4,000 feet (1,220 meters) on a multi-point serial link

  — for one master with up to 32 slaves

Multi-Point Connection Considerations

This section includes considerations for using RS-422 multi-point connections, which are also referred to as RS-485 with more than two connections. Also included is information on how the wires are identified and used.

You should ensure that the connection includes the following:

- Mandatory pull-up/pull-down resistors
- A signal ground reference wire (optional, but highly advised)

The RS-422 and RS-485 standards do not define a connector pin-out, but do define each differential twisted-pair wire as Wire A and Wire B. Some RS-422 and 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:

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

Hardware Handshake Rules

Hardware handshake refers to signals transmitted back and forth between two stations to coordinate the timing of data transmission. These rules apply to the use of hardware handshake with Modbus devices:

- Generally, hardware handshake can be used with the RS-232 or RS-485 communication interface.

- With a 2-wire cable, you must use hardware handshake.

- For a point-to-point configuration, you should use hardware handshake only if the connected Modbus device requires it.

- For a multi-point configuration that uses 4-wire cables, typically the slaves use hardware handshake but the master does not.

Valid Modbus Configurations

A valid configuration of Modbus devices must use one of these combinations of physical features.

Valid Configuration	Network Topology	Communication Interface	Physical Media	Hardware Handshake
Combination 1	Point-to-Point	RS-232	Not applicable	Optional
Combination 2	Point-to-Point	RS-485	2-wire	Required
Combination 3	Point-to-Point	RS-485	4-wire	Optional
Combination 4	Multi-Point	RS-485	2-wire	Required
Combination 5	Multi-Point	RS-485	4-wire	Optional

Setting EICM Switches for Serial Ports

This procedure explains how to specify the communication interface for each port, which determines whether the port uses RS-232 or RS-422/RS-485. This procedure should be performed before installing an EICM in the Tricon chassis. The factory default setting is all switches Off.

Procedure

1   Remove the EICM module, if needed.

Figure 23 depicts the EICM module and switch block.

2   Set switches as needed.

- To use RS-232, the switch must be set to Off.

- To use RS-422 or RS-485, the switch must be set to On.

3   Replace the EICM in its slot.

Switches 1 and 2 are set to On, specifying Ports 1 and 2 for RS-422 or RS-485.

Switches 3 and 4 are set to Off, specifying Ports 3 and 4 for RS-232.

Port 1

Port 2

Port 3

Port 4

Port 5
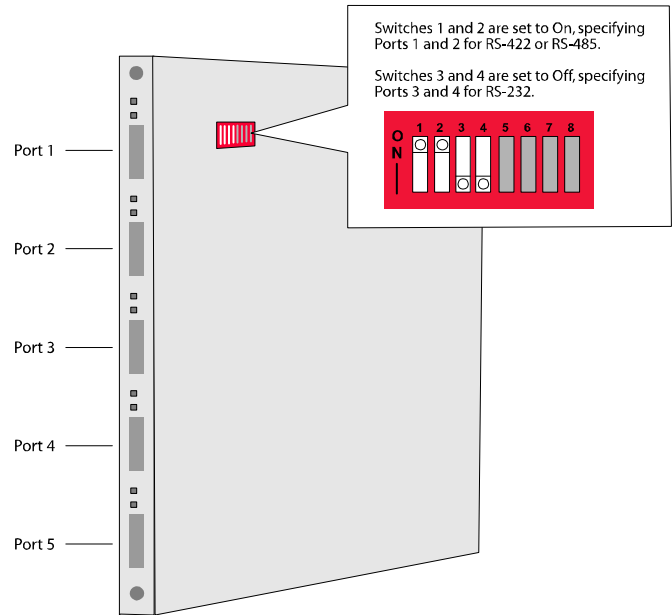
Figure 23   Using EICM Switches to Configure Port Communication Interfaces

Setting Signal Delays for Hardware Handshake (EICM Only)

For Modbus devices that use hardware handshake, setting CTS and RTS signals can delay the timing of data transmissions, a method for ensuring that devices are ready to receive data.

The RTS (Request to Send) signal opens and closes the data transmission channel. The RTS pre-delay setting specifies the number of milliseconds to wait before the data is transmitted.

The CTS (Clear to Send) signal indicates the transmitting station that it is ready to receive data. The CTS Pre-delay setting specifies the number of milliseconds to keep the channel open after data is transmitted. The following is a sample timing figure.

```
    40001              40004
    ┌────────┐         ┌────────┐
    │  RTS   │         │  CTS   │
    │Post-delay│       │Pre-delay│
    │←──────→│         │←──────→│
────┘        └─────────┘        └─────  RTS

         ┌────────┐
─────────┘        └──────────────────  Data
```
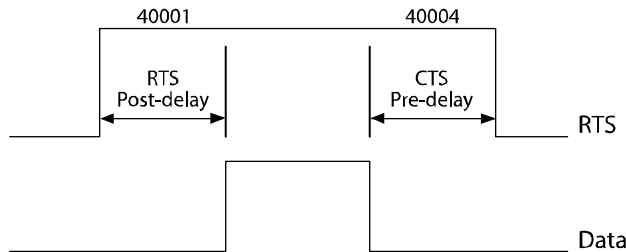
Figure 24   Sample Signal Timing Delays for Modbus Communication

Setting Signal Delays on a Tricon EICM

Signal delays are set by using the MBWRITE function blocks in a program.

Procedure

1   Set the Handshake property to Hardware on the Tricon EICM Setup screen.

2   Add an MBWRITE function block for each type of delay (CTS and RTS) you want to specify.

3   Specify these parameters in the function block.

Parameter	Action
Alias	For CTS, enter 40001. For RTS, enter 40004.
Port	Enter the EICM port number.
Station	Enter the slave station address.
D01	Enter the delay in milliseconds; 0 to 10,000.

Programming for Triconex Masters

If you configure a serial port on a Triconex controller as a Modbus master, the TriStation application can use Modbus Read and Write function blocks to communicate with slave devices, including other Triconex controllers.

The following Read and Write function blocks are available.

- MBREAD_BOOL
- MBREAD_DINT
- MBREAD_REAL
- MBREAD_REAL_TRD

- MBWRITE_BOOL
- MBWRITE_DINT
- MBWRITE_REAL
- MBWRITE_REAL_TRD

Read and Write function blocks of types BOOL and DINT can transmit 32 data values. Read and Write function blocks of type REAL can transmit 25 data values.

Triconex controllers use BOOL, 32-bit DINT (double integer) and 32-bit REAL numbers, whereas traditional Modbus protocol supports only Booleans and 16-bit integers. For this reason, TriStation includes function blocks which convert REAL values to integers and integers to REAL values. The sections beginning on page 83 provide guidelines for use of these function blocks.

For detailed information on function blocks, see the *TriStation 1131 Libraries Reference*. For examples, see Sample Modbus Programs on page 88.

Processing of Modbus Function Blocks

During each scan, a Triconex controller initiates up to five Modbus read or write operations for each Modbus master port. Each Modbus master port is limited to 10 outstanding requests for a Modbus operation. A Modbus operation might require up to six scans to complete. When a Modbus operation is completed, the controller initiates the next pending request for a Modbus operation.

For example, with a single Modbus master port and a TriStation application that uses 12 MBREAD function blocks and no MBWRITE or MBCTRL function blocks, the controller initiates the first five Modbus reads during the first scan. During the second scan, the controller initiates the sixth through tenth Modbus reads. When a Modbus read is completed, the controller initiates the 11th Modbus read. When the next Modbus read is completed, the controller initiates the 12th Modbus read. As each Modbus read is completed, the controller initiates the next pending request for a Modbus read.

For more information, see Appendix E, Modbus Protocol.

Function Blocks for Communicating with Non-Triconex Slaves

These function blocks can be used when a Triconex master interfaces with a non-Triconex slave device.

Data Type in Slave	Function Block in Triconex Master	Application Notes
Boolean	MBWRITE_BOOL MBREAD_BOOL	• Values are True (1) and False (0).
Integer	MBREAD_DINT MBWRITE_DINT	• Although the DINT data type uses signed 32-bit integers, only the least significant 16 bits are transferred. • Values should be limited to the range of zero through 32,767.
Real	MBREAD_REAL_TRD MBWRITE_REAL_TRD	• REAL values are read from the slave as two 16-bit consecutive aliases and concatenated to form a 32-bit REAL value (see Example 2). • 32-bit REAL values to be written to the slave are first split into two 16-bit values which are written to two consecutive aliases (see Example 1).
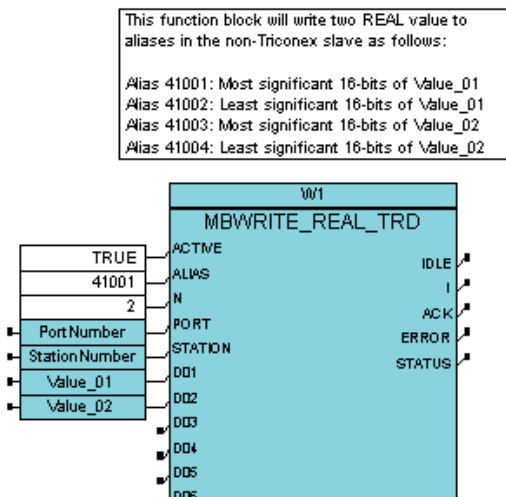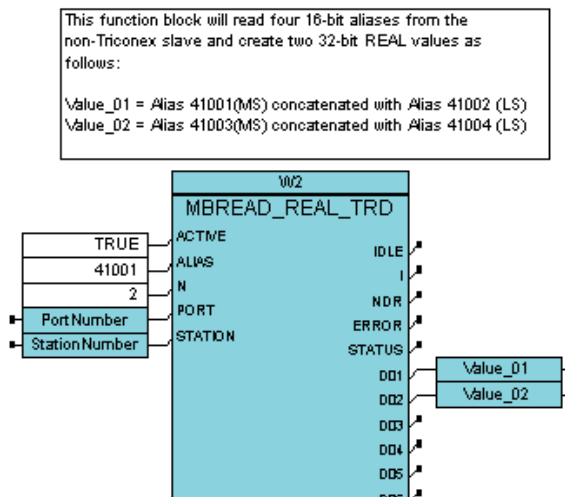
Figure 25   Modbus Function Block Examples – Communicating with Non-Triconex Slaves

Function Blocks for Communicating with Trident Slaves

These function blocks can be used when a Triconex master communicates with a Trident slave.

Data Type in Slave	Function Block in Triconex Master	Application Notes
BOOL	MBWRITE_BOOL MBREAD_BOOL	• Values are True (1) and False (0).
DINT	MBREAD_DINT MBWRITE_DINT	• Although the DINT data type uses signed 32-bit integers, only the least significant 16 bits are transferred. • Values should be limited to the range of zero through 32,767.
REAL	MBREAD_REAL_TRD MBWRITE_REAL_TRD	• Each REAL aliased variable in the Trident slave must have scaling disabled in the Min/Max screen.

Function Blocks for Communicating with Tricon Slaves

These function blocks can be used when a Triconex master communicates with a Tricon slave.

Data Type in Slave	Function Block in Triconex Master	Application Notes
BOOL	MBWRITE_BOOL MBREAD_BOOL	• Values are True (1) and False (0).
DINT	MBREAD_DINT MBWRITE_DINT	• Although the DINT data type uses signed 32-bit integers, only the least significant 16 bits are transferred. • Values should be limited to the range of zero through 32,767.
REAL	MBREAD_REAL MBWRITE_REAL	• The SPECIAL parameter on each of these function blocks should be set to False.

Sample Modbus Read Function Block

This figure shows a sample Modbus Read function block in a TriStation application that includes programming for Serial Port 1 (as indicated by the Port parameter). The function block is reading values from Slave Station 2 (as indicated by the Station parameter) through Serial Port 1 and storing the values in local variables.
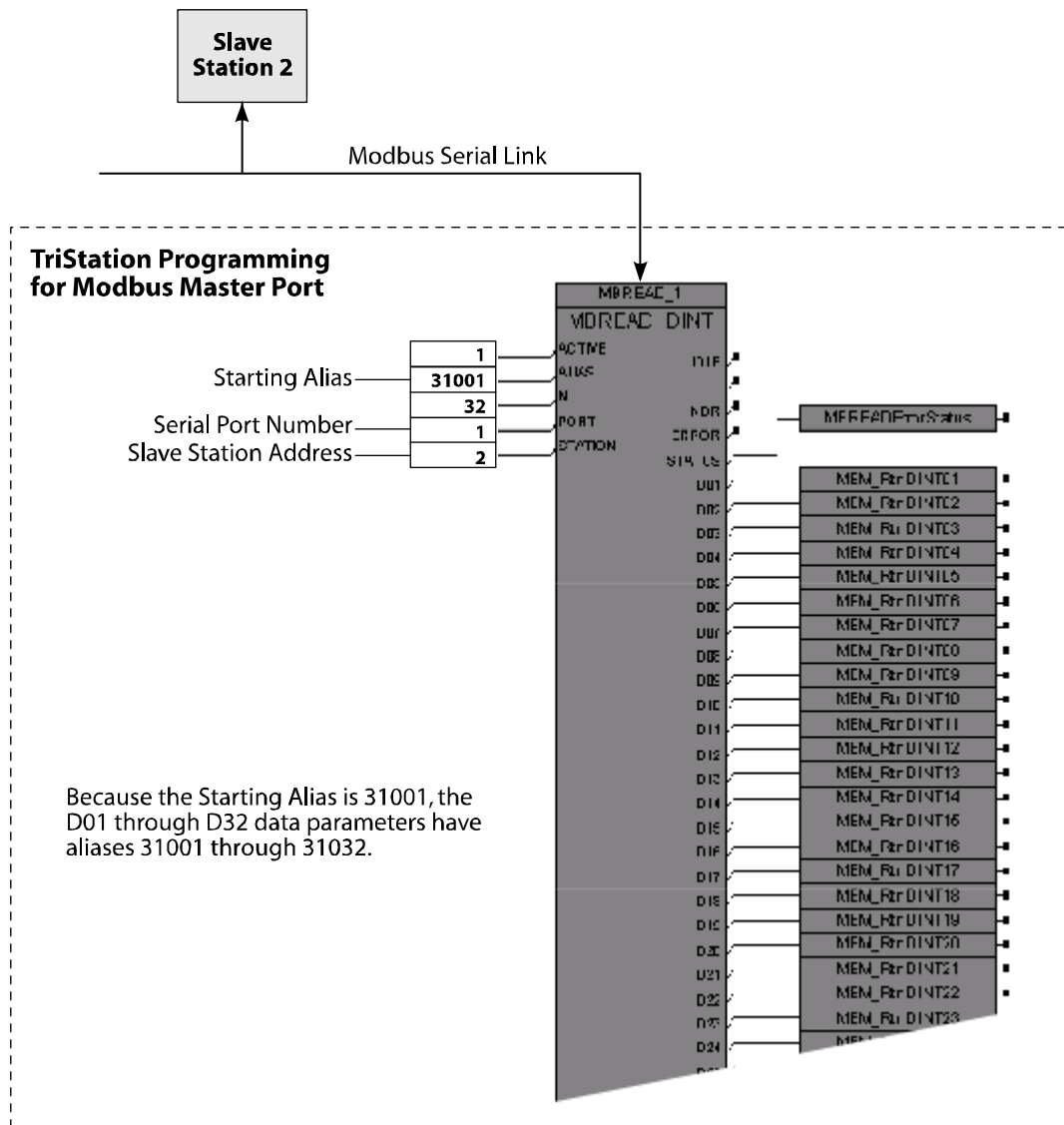
Figure 26   Sample TriStation Modbus Read Function Block

Sample Modbus Write Function Block

This figure shows a sample Modbus Write function block in a TriStation application that includes programming for Serial Port 1 (as indicated by the Port parameter). The function block is writing values to Slave Station 2 (as indicated by the Station parameter) through Serial Port 1.
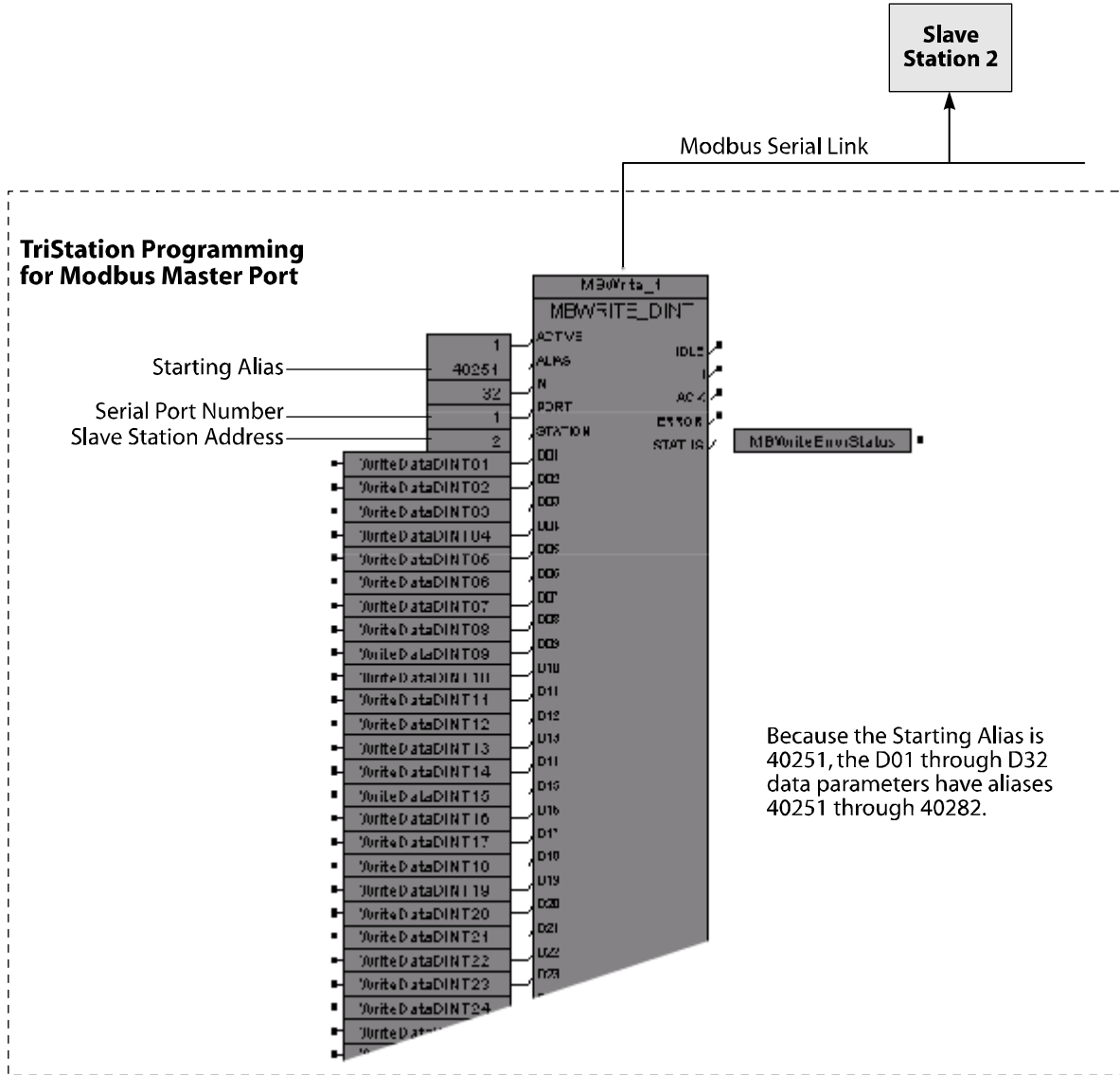
Figure 27   Sample TriStation Modbus Write Function Block

Programming for Triconex Slaves

If you configure a serial port on the Tricon controller as a Modbus slave, aliases must be assigned to tagnames that will be accessed by the external Modbus master.

Triconex controllers support BOOL, 32-bit DINT (double integer) and 32-bit REAL numbers, whereas traditional Modbus protocol supports only Booleans and 16-bit integers. This means that DINT and REAL values from a Triconex controller are transmitted as follows:

- For DINT tagnames in a Triconex slave, the Triconex controller transfers only the least significant 16 bits.

- For REAL tagnames in a Tricon slave, you specify whether to use a special alias, which maps a 32-bit REAL number to two 16-bit REAL integers, or to scale the REAL number to a 16-bit integer.

For procedures and explanations on these topics, see the *TriStation 1131 Developer's Guide, v4.5*:

- Assigning Alias Numbers to Tagnames
- How Tricon Transmits REAL Values With Special Alias Numbers
- Tricon Special Alias Numbers
- How REAL Numbers are Scaled to Integers
- Scaling REAL Values to Integers

Sample Modbus Programs

Sample Modbus projects are included on the TriStation CD. These programs show how to use the Modbus Read and Write function blocks for transmitting aliased data, how to set time-out and retry values for Modbus communication, and how to control the flow of data from slave to master.

Reading and Writing DINT Data

These programs show how to read and write N values of type DINT from Port P, Station S, starting at specified aliases.

- MB_EX1_READ_DINT_FBD
- MB_EX4_WRITE_DINT_FBD

Reading and Writing REAL Data

These programs show how to read and write N values of type REAL from Port P, Station S, starting at specified aliases.

- MB_EX2_READ_REAL_FBD
- MB_EX5_WRITE_REAL

Reading and Writing BOOL Data

These programs show how to read and write N values of type BOOL from Port P, Station S, starting at specified aliases.

- MB_EX3_READ_BOOL_FBD
- MB_EX6_WRITE_BOOL

Setting Time-Out and Retry Values

The MB_EX7_CONTROL program shows how to use the MBCTRL function block to set time-out and retry values for the communications initiated by a Modbus master port.

Controlling the Flow of Data

The MB_EX8_FLOW_CONTROL program shows how to control the flow of data from a Modbus slave to a Modbus master.

Counting Values and Verifying Outputs

These programs count the number of errors, reads and writes, time-outs, and other values; and verify the consistency of outputs.

- MB_READ_TEST
- MB_WRITE_TEST

7

Related Communication Features

Overview

This chapter describes the time synchronization and printing features that can be used with Triconex controllers.

Time Synchronization protocol allows networks of Tricon and Trident controllers to be synchronized with each other, and optionally, with external devices. In addition, a Tricon controller with an NCMG or TCM module can receive time adjustments from the Global Positioning System (GPS) by using the Trimble Acutime 2000 Synchronization Kit.

A Tricon controller can send brief ASCII text messages to a printer that is connected to a parallel port on an EICM. The printer must be compatible with the Centronics interface provided by the EICM parallel port.

Network printing protocol allows a Triconcontroller to print messages by means of a print server connected to an Ethernet port on the TCM. The print server must be compatible with the JetDirect network printing protocol, and the printer must be compatible with the print server. An Ethernet hub might also be needed.

For both types of printing, a TriStation application must include print function blocks to send messages to a printer.

Tricon Write Access

Write access for external devices can be allowed or restricted for memory and output points by using keyswitch settings, configuration settings, and program logic in a TriStation application. External devices cannot write to input points but can read input, memory, and output points if allowed. For procedures on allowing and restricting access, see the *TriStation 1131 Developer's Guide, v4.5.*

The following types of read and write access are possible:

- Input, output, and memory points can be read by any external device that can communicate with a Tricon controller.

- Write access to input points is not allowed from any external device.

- Write access to an output or memory point is allowed or restricted based on the system, communication, application, and point settings.

This table describes write access to Tricon points from external devices.

Property or Feature	Description
Tricon keyswitch	A system setting that determines write access to output and memory points unless overruled by the GATENB function block in the application. • Restricts write access when set to the Run position. • Allows write access when set to the Remote or Program position.
GATENB	A Tricon function block that programmatically allows write access to a specified range of aliased memory points when the keyswitch is in the Run position.
GATDIS	A Tricon function block that programmatically restricts remote write access for all ranges of aliased memory points that were previously enabled by GATENB.
Disable Remote Changes to Outputs	A system setting on the Operating Parameters screen that determines write access to output points. When selected, external devices cannot write to output points, no matter what other settings are made.
Port Write Enabled	A Tricon TCM setting that determines whether TriStation, TSAA, or Modbus have write access to the selected port. The default value is cleared, meaning the port is read-only. This property is available only on TCM models 4351A and 4352A. Use the Access List for TCM models 4351B, 4352B, 4353, and 4354.
TCM Access List	An optional Tricon TCM feature that gives you the ability to control which clients can access TCM resources, the protocols they can use, and the level of access each client has.

Property or Feature	Description
Privilege	A Tricon ACM and NCM module setting that determines whether network devices using DDE, OPC, or TSAA communication have write access to output points and read/write aliased memory points. • For Tricon ACM, the default it Read. • For Tricon NCM, the default is Read/Write. • The Tricon TCM, EICM, HIM, and SMM modules do not have this property.
Prohibit Writes	A Tricon SMM module setting that determines whether Honeywell devices have write access to output points and read/write aliased memory points. The default is cleared, which means write access is allowed.
Point Assignment	A tagname setting that determines whether the output and memory point is assigned a Read or Read/Write alias number. • For output points, all alias numbers are Read/Write. • For memory points, alias numbers can be Read or Read/Write.

Tagnames and Aliases

This section describes *tagnames*, which is the word commonly used when referring to input points (sensors) and output points (final elements). In TriStation 1131, tagnames are references to physical tagnames (labels) on the connected field devices or to memory points which are locations in the controller memory. In IEC terminology, tagnames are called *global variables*.

For Modbus or DDE communication, tagnames must be assigned an alias number that allows read or read/write access. An alias number is a five-digit identifier which defines the data type and location of a point in the controller memory. See Sample Modbus Programs on page 88.

For Peer-to-Peer, OPC, or TSAA applications, tagnames can be accessed by the tagname.

For more information about tagnames and aliases, see the *TriStation 1131 Developer's Guide, v4.5*.

Protocol or Application	Access by Tagname	Access by Alias
Modbus Master		✓
Modbus Slave		✓
Peer-to-Peer (Triconex)	✓	
OPC Server, OPC Data Manager, and OPC Redundancy Broker	✓	✓
DDE Server		✓
User-Written TSAA Application	✓	✓

System Aliases for Tricon Status

TriStation includes predefined system aliases which external devices can read to obtain Tricon status information. The system aliases provide information about the Tricon chassis, slots, Main Processors, communication modules, and system performance. For more information, see Appendix F, Tricon System Aliases.

Time Synchronization

If you have multiple Triconex controllers on an Ethernet network, you can synchronize their time with:

- The master node (the controller with the lowest node number)
- An external device, such as an OPC client, that writes time values to a TriStation application
- A Global Positioning System (GPS)
- A combination of the master node and an external device or a GPS
- An SNTP server over NET 1 or NET 2 (with TCM only)

These sections provide more information about these strategies and instructions for setting the Triconex controller clock. For instructions on configuring Triconex communication modules for time synchronization, see the *TriStation 1131 Developer's Guide, v4.5*.

Master Node in a Network

In a network of Triconex controllers, the master node determines the time for all controllers that are synchronized with it.

The master node is the controller with the lowest node number. For example, in a network of five controllers which have node numbers 1, 2, 3, 4, and 5, node 1 is the master node. If node 1 goes down, node 2 becomes the master node. When node 1 comes back online, it again becomes the master node.

In a typical Triconex network, the controllers are synchronized with the master node within plus or minus 25 milliseconds. When a controller is synchronized with the master node, it rejects time adjustment attempts from all other sources.

You must use Ethernet ports on ACM, NCM, or TCM modules to synchronize Tricon controllers in a network with the master node. For instructions, see the *TriStation 1131 Developer's Guide, v4.5*. If you plan to synchronize ACM modules with the master node, contact the IPS Global Client Support (GCS) center for assistance.

CAUTION   In a network of Triconex controllers, all controllers with low node numbers should be configured for time synchronization. If a Triconex controller becomes the master node but is not configured for time synchronization, none of the controllers in the network can be synchronized.

Master Node in a Peer-to-Peer Network

In a Peer-to-Peer network of Triconex controllers, the master node determines the time for all controllers that are synchronized with it. Node status is broadcast every 10 seconds; a node is considered active if a status message has been received from the node within the last 30 seconds.

Up to 31 nodes can be present in a Peer-to-Peer network. The master node is the controller with the lowest node number. For example, in a network of five controllers which have node numbers 1, 2, 3, 4, and 5, node 1 is the master node. If node 1 goes down, node 2 becomes the master node. When node 1 comes back online, it again becomes the master node.

In a typical Triconex Peer-to-Peer network, the controllers are synchronized with the master node within plus or minus 25 milliseconds. Time synchronization in a Peer-to-Peer network is performed via the UDP/IP protocol (NET 1 or NET 2 on TCM models 4351A, 4351B, 4352A, and 4352B, or NET 1 on TCM models 4353 and 4354) or the DLC protocol (NET 1 only) on the TCM.

GPS time synchronization can also be used in a Peer-to-Peer network, so that all controllers on the network are synchronized with a master node that is synchronized with a GPS.

You can use the NET 1 or NET 2 ports on TCM models 4351A, 4351B, 4352A, and 4352B, or the NET 1 port on TCM models 4353 and 4354 to synchronize Tricon controllers in a Peer-to-Peer network. For instructions, see the *TriStation 1131 Developer's Guide, v4.5.*

Time Adjustments from External Devices

A Triconex controller can receive time adjustments from external devices such as a DCS or an OPC client. When the OPC Server application is used, the OPC client can adjust the Triconex clock using the Device Clock tagname, which is derived from Triconex system status information in the OPC Server Configuration. For more information, see the user's manual for the OPC client application you are using.

The Foxboro DCS is the only external device that can send time adjustments to the Tricon controller through the ACM. This is done through the NET 2 port on the ACM with external DDE server. For instructions, see the *ACM User's Guide.*

On the TCM, time adjustments are done through the UDP/IP protocol (NET 1 or NET 2 on models 4351A, 4351B, 4352A, and 4352B, or NET 1 on models 4353 and 4354) or DLC protocol (NET 1 only). On the NCM, time adjustments are done through NET 1.

Another way for an external device to adjust the Triconex controller clock is to write aliased data to the TIMESET or TIMEADJ function blocks in the TriStation application. This can be done though an Ethernet port or a serial port. If you need assistance with the specialized programming that is required, please contact the IPS Global Client Support (GCS) center.

To allow an external device to adjust the Triconex clock, you must configure an ACM, NCM, or TCM for time synchronization, and you must configure the TriStation application to allow write access. For instructions, see Tricon Write Access on page 91 and the *TriStation 1131 Developer's Guide, v4.5*

GPS Time Adjustments

A Tricon controller with a TCM or NCMG (for GPS Interface) can receive time adjustments from the Global Positioning System (GPS) by using the Trimble Acutime Gold GPS smart antenna. This antenna is available from Triconex or Trimble.

To use the antenna, you must connect it to a serial port on the TCM or NCMG for communication. In the TriStation project, you must configure the TCM or NCMG for GPS time synchronization. For instructions on installing the Acutime Gold GPS smart antenna, see TAN #043, "Connecting the Trimble Acutime Gold GPS Smart Antenna to Tricon Controllers" on the IPS Global Client Support Web Site at support.ips.invensys.com. For additional information about the Acutime Gold GPS smart antenna, go to www.trimble.com.

When a TCM or NCMG is connected to an Acutime Gold GPS smart antenna, the Tricon clock is adjusted to within 5 milliseconds of the GPS time. Since the GPS time uses the universal GMT time zone, time adjustments in the Tricon only use the minutes, seconds, and milliseconds portion of the GPS time, and assume that the local time zone is correctly indicating the current Tricon time. Local time zones vary by one-hour or half-hour increments. For example, if the current Tricon time is 14:25 and the GPS time received is 17:58, Tricon time is adjusted to 14:28. Therefore, in order to assure correct times when using GPS time adjustment, it is essential that the Tricon clock be set to within 10 minutes of the correct local time. For instructions, see Setting the Controller Clock on page 98.

Redundant Configuration

The GPS feature can be used in a redundant configuration which requires two TCM or NCMG modules and two Acutime Gold GPS smart antennas. Typically, the left (primary) TCM or NCMG adjusts the time. The right (redundant) TCM or NCMG begins to adjust the time if the left TCM or NCMG detects a problem with its antenna or if communication with the left module fails.

Several types of faults can cause the Tricon to switch control to the redundant TCM or NCMG module. For example, each TCM or NCMG module requests an event timestamp from the Acutime Gold GPS smart antenna every 10 seconds. If the event is not received within 5 seconds, the Tricon assumes there is a failure in the TCM, NCMG or the antenna and switches control to the redundant TCM or NCMG module. For more information, see the *Trimble Acutime Gold GPS Smart Antenna User Guide*, and TAN #043, "Connecting the Trimble Acutime Gold GPS Smart Antenna to Tricon Controllers" on the IPS Global Client Support Web Site at support.ips.invensys.com.
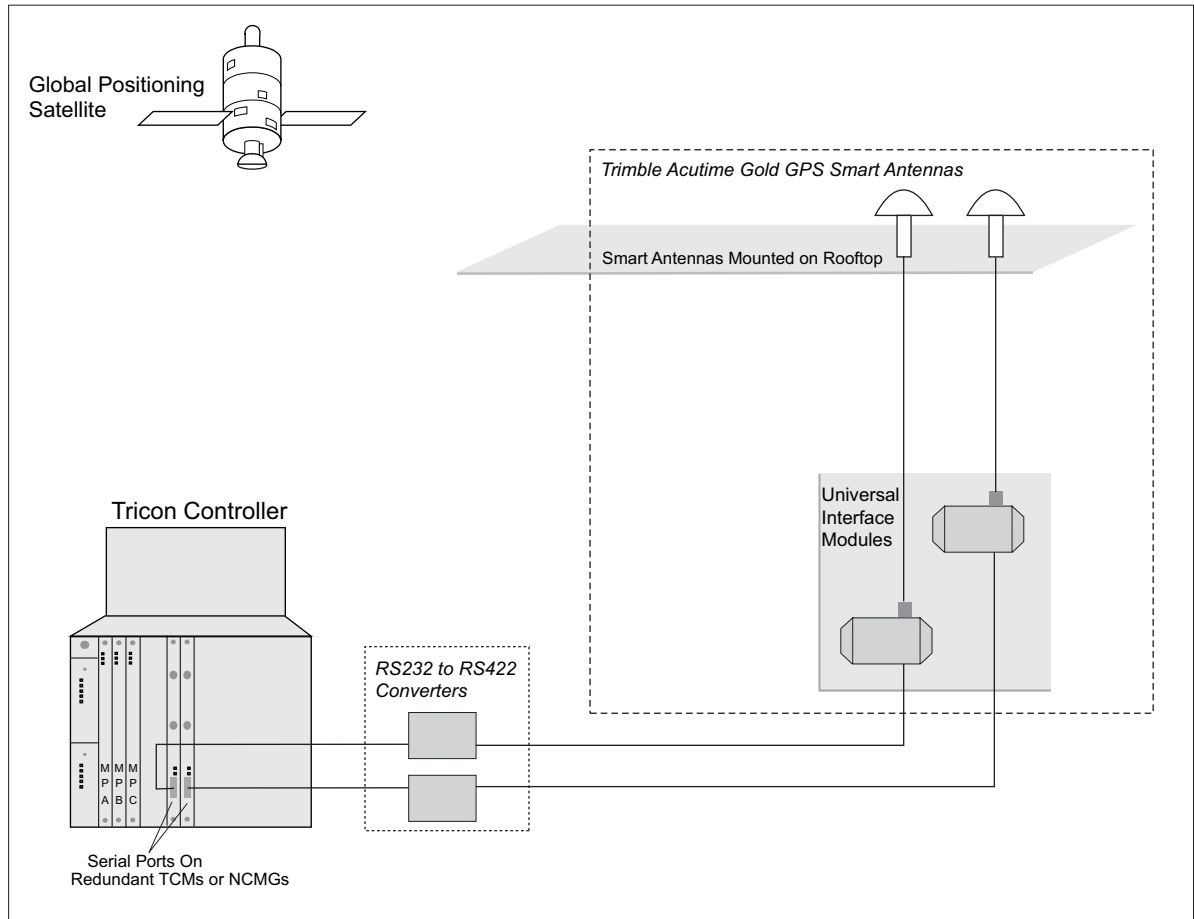
Figure 28   TCM/NCMG GPS Configuration Using Trimble Acutime Gold GPS Smart Antenna

Combination Schemes

In a typical configuration, Triconex controllers on a network are synchronized with the master node. In addition, the master node can accept time adjustments from an external device so that the external time prevails for all controllers on the network. Examples of external time sources are an OPC client and a GPS.

Guidelines for Networks

These guidelines apply to Triconex controllers in a network whose time is synchronized with an external device:

- Every controller to be synchronized must have its Ethernet port configured for time synchronization, including the master node.

- If a controller is synchronized with the master node, it rejects time adjustment attempts from all other sources.

- In a redundant network of Triconex controllers that each have two NCM or TCM modules installed, you can implement redundant time synchronization by selecting the time synchronization property for both NCM or TCM modules in TriStation.

CAUTION
In a network of Triconex controllers, all controllers with low node numbers should be configured for time synchronization. If a controller becomes the master node but is not configured, none of the controllers can be synchronized.

Setting the Controller Clock

This procedure explains how to set the Triconex controller clock to the correct local time, which is important if you are using time synchronization strategy. When an application is downloaded and run, the controller automatically sets the clock to the PC time. You can reset the clock at any time while the application is running, without having to download again. The need for accuracy depends on the application.

Procedure

1   On the TriStation PC, right-click the time icon in the message bar or open the Date/Time dialog box from the Control Panel.

2   Ensure the PC is set to the correct local time.

3   In TriStation, open the TriStation project that is running in the controller.

4   On the Configuration tree, double-click the Controller Panel.

5   On the Commands menu, click Connect, and then click Set Calendar Clock.

6   Click Yes when asked whether to set the calendar clock to the current configuration.

   If the node is currently synched to a master node, the set time will be rejected.

The Triconex clock is now set to the TriStation PC time, that is, to the correct local time.

Use the System Overview window in the Enhanced Diagnostic Monitor to verify the time adjustment.

Using a Tricon TCM to Synchronize Time

Time synchronization can be enabled using the following protocols:

- GPS
- SNTP
- Triconex Time Synchronization via DLC (NET 1 only) or UDP/IP (NET 1 or NET 2 on models 4351A, 4351B, 4352A, and 4352B, or NET 1 on models 4353 and 4354) on a Peer-to-Peer network

In a redundant network of Triconex controllers that each have two TCMs installed, you can implement redundant time synchronization by configuring time synchronization for both TCM modules (both left and right slots). Time synchronization can be enabled only for a single logical slot.

If the TCM is installed in the COM slot, you configure time synchronization only for the left slot (there is no redundancy when installed in the COM slot).

For procedures explaining how to configure Triconex communication modules for time synchronization, see the TriStation 1131 Developer's Guide, v4.5.

Printing from a Tricon Controller

A Tricon controller can print brief ASCII text messages if a communication port is connected to a printer and the TriStation application includes standard print function blocks.

Print messages are typically used for alarms, status, and maintenance. A sample alarm message might include the name of an analog input point, its time stamp and value, and a statement that the value is out of range. If the Triconex system includes numerous controllers or is connected to a DCS, alarms are typically displayed on an operator workstation.

To print from a Tricon controller with a TCM, you must connect a TCM Ethernet port to a print server that is connected to a printer, configure these devices in the TriStation project, and use print function blocks in the TriStation application. For TriStation procedures, see the *TriStation 1131 Developer's Guide, v4.5.*

To print from a Tricon controller with an EICM, you must connect an EICM parallel port to a Centronics-compatible printer, configure the port in the TriStation project, and use print function blocks in the TriStation application. For TriStation procedures, see the *TriStation 1131 Developer's Guide, v4.5.*

Topics include:

- Effect of Printing on Scan Time on page 100
- Devices for Tricon Printing on page 101
- Installing Printer Devices on page 101
- Connecting a Tricon EICM Port to a Printer on page 102
- Connecting a TCM to Printing Devices on page 103
- Connecting a TCM to Printing Devices Using a Hub on page 103
- About Function Blocks for Printing on page 105

Effect of Printing on Scan Time

Each time a message is printed, the print function blocks in the TriStation application are executed and the scan time increases. Typically, the print function blocks are subject to conditional execution, which means they are not executed every scan. When you set the scan time in TriStation, make sure it includes the execution time for all conditional statements in the application.

If the scan time is not long enough, the execution of all conditional statements (when the conditions are True) could result in scan-time overruns. You can minimize this problem by limiting the amount of printer output. An alternative is to use a PC event logger such as the Triconex SOE Recorder. For more information, see the *SOE Recorder User's Guide.*

Devices for Tricon Printing

The devices required to print from a Tricon depend on the module you are connecting to the printer.

Printing with an EICM

You must use a Centronics-compatible printer with a Tricon controller with an EICM installed. The printer can be connected using a standard PC printer cable. The maximum cable length is 15 to 20 feet (5 to 6 meters), depending on the quality of the cable. For pin-out information, see the *Planning and Installation Guide for Tricon v9–v10 Systems*.

Printing with a TCM

At a minimum, the printing devices you can use with a Tricon controller with a TCM installed are an HP JetDirect-compatible print server and a line printer for ASCII text. You can also use a router or a hub.

Print Server and Cables

A print server that is connected to a Tricon TCM must use the HP JetDirect print protocol and operate at speeds of 10 or 100 megabits per second. Standard communication cables are suitable for this connection.

You can purchase communication cables from other manufacturers. You must purchase print servers elsewhere because Triconex does not supply them. Black-box cables and Hewlett-Packard print servers are examples of dependable network printing devices.

Triconex has tested these Hewlett-Packard print servers and can recommend them.

- HP JetDirect Ex Plus
- HP JetDirect 500X Series, model J3265A

Printers

You must select a printer that is compatible with your print server. The TCM prints ASCII text only, which does not include formatting or graphics, so a Centronics-compatible printer is adequate. Laser printers are also suitable.

Installing Printer Devices

Most printers and print servers require configuration with an install program on a workstation or other device. For each device, follow the instructions provided by the manufacturer, and run the diagnostic routine if one is included with the package.

To print from a Triconex controller, the printer driver that comes with the printer package is not needed. The TriStation project must identify the EICM parallel port to which the printer cable is connected, or, if using a TCM, the target printer, and the print server, using the TCM Setup dialog box, as explained in the following sections.

Connecting a Tricon EICM Port to a Printer

This procedure explains how to set up a Centronics-compatible printer and connect it directly to a Tricon EICM parallel port.

You can use a standard PC printer cable with a maximum cable length of 5 to 6 meters (15 to 20 feet), depending on the quality of the cable

Procedure

1 If the printer package has an installation program, copy the program to the TriStation PC.

2 Follow the instructions, and run the diagnostic routine, if available.

You do not need the printer driver that may have come with the package.

3 Connect one end of the cable to the printer, and connect the other end to port 5 or 10 on the EICM. (Other EICM ports cannot be used for printing.)
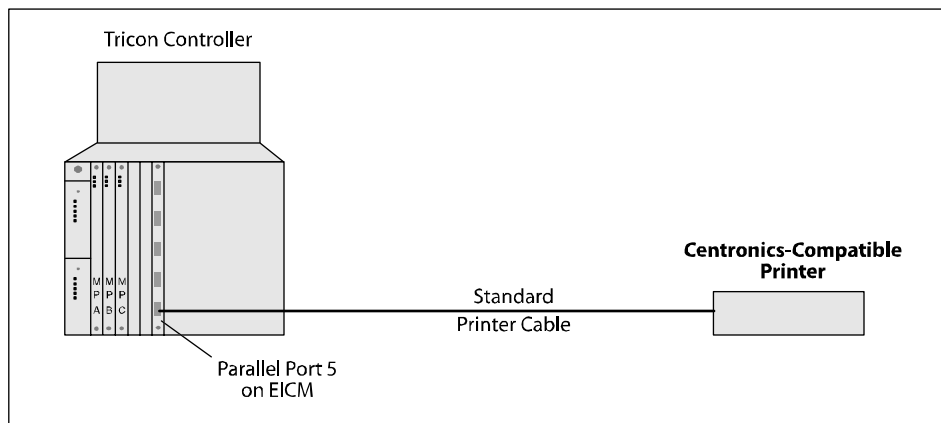
4 Go to the next section to configure the EICM port for printing.

Before the EICM can communicate with printing devices, you must use TriStation to configure the EICM parallel port. For procedures explaining how to do this, see the *TriStation 1131 Developer's Guide, v4.5*.

Connecting a TCM to Printing Devices

This procedure explains how to directly connect a TCM to an HP JetDirect-compatible print server and printer.

You can use standard communication cables for these connections.

Procedure

1   If the print server and printer packages have installation programs, install them on the TriStation PC.

2   Follow the instructions, and run the diagnostic routines if available.

    You do not need the printer drivers that came with the packages.

3   Record the IP address of the print server. You will need the IP address when configuring the TCM printer.

4   Connect the printer to the print server, and connect the print server to a TCM Ethernet port (NET 1 or NET 2 on models 4351A, 4351B, 4352A, and 4352B, or NET 1 on models 4353 and 4354).

Before the TCM can communicate with printing devices, you must use TriStation to configure the TCM Ethernet port. For procedures explaining how to do this, see the *TriStation 1131 Developer's Guide, v4.5.*
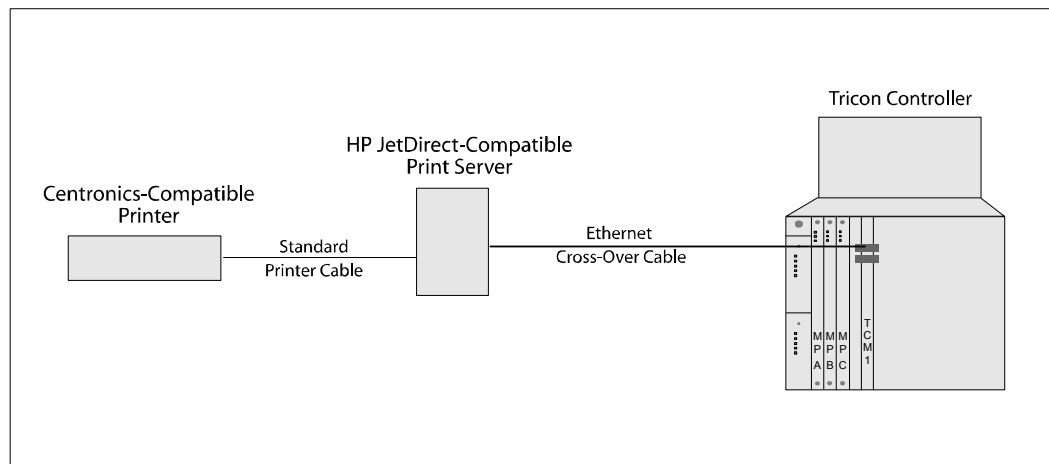
Figure 29   Connecting a Tricon TCM to a Printer and Print Server

Connecting a TCM to Printing Devices Using a Hub

This procedure explains how to connect a TCM to an HP JetDirect-compatible print server and printer by using a hub. You can use standard communication cables for these connections.

You do not need to install the printer drivers that may have come with the print server and printer packages.

Procedure

1 If the print server and printer packages have installation programs, install them on the TriStation PC.

2 Follow the instructions that came with the packages, and run the diagnostic routines, if available.

3 Record the IP address of the print server. You will need the IP address when configuring the TCM printer.

Connect the printer to the print server, and connect the print server to a hub. Connect the hub to a TCM Ethernet port (NET 1 or NET 2 on models 4351A, 4351B, 4352A, and 4352B, or NET 1 on models 4353 and 4354).

Before the TCM can communicate with printing devices, you must use TriStation to configure the TCM Ethernet port. For procedures explaining how to do this, see the *TriStation 1131 Developer's Guide, v4.5*.
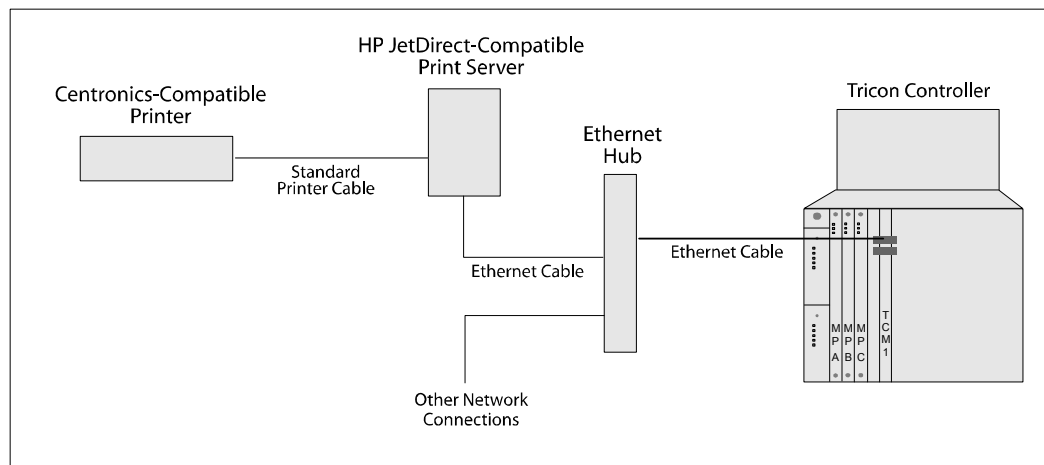
Figure 30 Connecting the Tricon TCM to a Printer Server and Printer Using a Hub

About Function Blocks for Printing

A TriStation application must use print function blocks to send messages to a printer.

Each print function block has a PRINTER parameter which specifies the port number where the printer cable is connected. For a Tricon EICM or TCM port, the PRINTER parameter must be 5 for a left EICM or TCM port, or 10 for a right EICM or TCM port. (Other EICM or TCM ports cannot be used for printing.)

Each time a message is printed, the print function blocks in the TriStation application are executed and the scan time increases

This table lists the print function blocks in the TriconLibrary.

Print Function Block	Purpose
PRINT_BOOL	Prints a three-character field containing either Off or On.
PRINT_CDT	Prints the current date and time.
PRINT_CRLF	Prints a new line (carriage return and line feed).
PRINT_CTOD	Prints the current time of day.
PRINT_DINT	Prints a DINT value.
PRINT_REAL	Prints a REAL value.
PRINT_STRING	Prints a string of text.
PRINTR_FLUSH	Clears the print buffer.

A

TCM Capabilities

TCM Operation

The TCM (Tricon Communication Module) is an optional module for the Tricon controller which supports multiple message protocols and physical media types. Ports on the TCM can communicate with TriStation, other Tricon or Trident controllers, Ethernet devices, and Modbus master and slave devices.

The Tricon controller supports two slots of TCMs, which means there can be a maximum of four TCMs in a system. The TCMs operate independently. Each TCM can be connected to a separate network, or they can be used in a redundant configuration.

This table describes TCM model and Tricon system version compatibility.

Table 5   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

Message Handling

This figure depicts how message handling works. The TCM ports communicate with the three MP modules by means of the Comm Bus.

A message received by a TCM port is passed to all three MP modules over the Comm Bus. The TriBus votes on the message before sending it to the MP modules for processing, and sends the response back to the Comm Bus after processing is complete. The Comm Bus then forwards the response to the TCM port.

Figure 31   TCM Message Handling

The TCM and MP modules handle message types as follows.

TriStation, Peer-to-Peer, and Time Synchronization Messages

1   Receives the message and transmits it to the MP modules over the Comm Bus.

2   Votes the message request with other MP modules over TriBus.

3   Receives the message from the Comm Bus, processes the message and transmits a response.

Modbus and TSAA Read Queries

1   Receives the read query.

2   Gets the requested alias from the Comm Bus voted data pool.

3   Transmits the response.

Modbus and TSAA Write Commands

1   Receives the write request and transmits it to the MP modules over the Comm Bus.

2   Votes the write request with the other MP modules over TriBus.

3   Receives the message from the Comm Bus, processes the message, and transmits a write confirmation response.

Typical Message Response Time

Because most messages (excluding Modbus and TSAA read queries) require TriBus voting, typical message response times require three or more scans to complete.

Physical Description

There are two types of TCMs:

- *Copper (models 4351, 4351A, 4351B, and 4353)*
- *Fiber (models 4352, 4352A, 4352B, and 4354)*

The Copper TCM uses RJ-45 network ports; the Fiber TCM uses multi-mode fiber-optic network ports.

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

The TCM includes these ports:

- Four RS-232/RS-485 serial ports, each of which are TriStation-configurable for Modbus master or slave, Trimble GPS, and TriStation

- Two 10/100 Mbps RJ-45 Ethernet ports (model 4351, 4351A, 4351B), or one 10/100 Mbps and one 100 Mbps RJ-45 Ethernet ports (model 4353), or two 100 Mbps fiber-optic MT-RJ Ethernet ports (model 4352, 4352A, 4352B, 4354)

- One RS-232 debug port (for Triconex use only)

The TCM front panel also includes status and communication indicators.

- For information about the communication indicators, see TCM Communication Indicators on page 114.

- For information about the other indicators, see the *Planning and Installation Guide for Tricon v9–v10 Systems*.
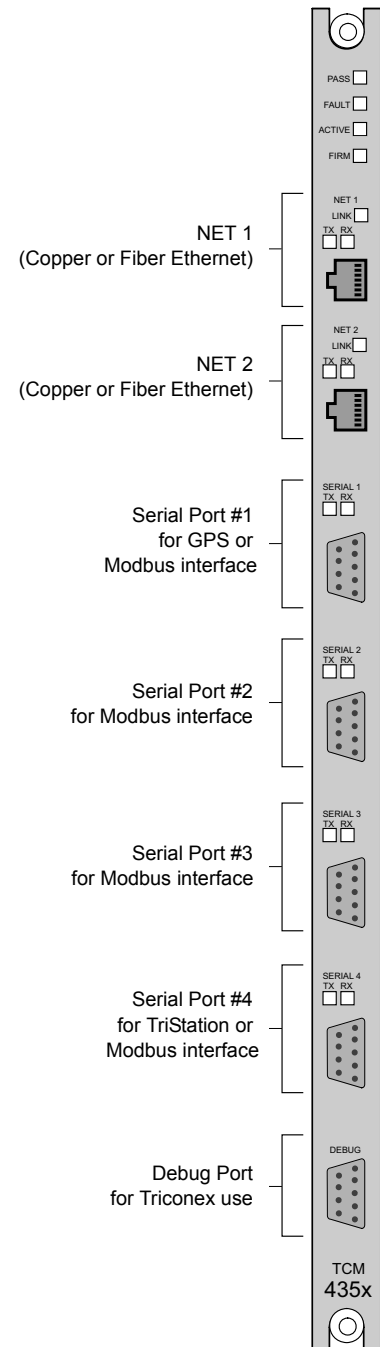
Figure 32   TCM Front Panel

TCM Ports

Serial Ports

A TCM provides four optically isolated RS-232/RS-485 serial ports which are TriStation-configurable for point-to-point or multi-point serial connections. Transmission rates up to 115.2 kilobits per second per port can be selected. When the port is in RS-485 mode, there is software configurable termination for the port; see Setting Signal Delays for Hardware Handshake (EICM Only) on page 80.

Specifications

Feature	Description
Serial (Modbus) ports	4 optically-isolated RS-232/RS-485 ports, configurable from TriStation. The termination for RS-485 ports can be configured from TriStation.
Connector	DB-9-pin PE standard, shielded, located on front panel
RS-232 maximum cable length	50 ft (15 m)
RS-485 maximum cable length	100 (30 m) to 4,000 ft (1.2 km), depending on baud rate
Supported transmission rates (bps)	115200, 57600, 38400, 19200, 9600, 4800, 2400, 1200.
Protocols supported	• Modbus Master or Slave, ASCII and RTU modes, optional parity, 1 stop bit • Trimble GPS • Serial TriStation
Galvanic isolation	500 VDC
Status indicator: Module status	Pass, Fault, Active
Status indicator: Port activity	TX (Transmit) — 1 per port RX (Receive) — 1 per port

Network Ports

A TCM provides two Ethernet ports with either RJ-45 sockets for connection to twisted-pair cable, or fiber-optic MT-RJ sockets. Models 4351, 4351A, 4351B, and the NET 1 port on 4353 support connections at 10 or 100 megabits per second. Models 4352, 4352A, 4352B, the NET 2 port on 4353, and 4354 support connections at 100 megabits per second.

Specifications

Feature	Description
Network ports	2, 10/100BaseT Ethernet ports, RJ-45 connectors (models 4351, 4351A, 4351B, and 4353; however, the NET 2 port on 4353 only supports 100 Mbps)
	2, fiber-optic mode Ethernet ports, MT-RJ connectors with 62.5/125 um fiber cables (models 4352, 4352A, 4352B, and 4354)
Communication speed	Copper Ethernet ports: 10/100 Mbps (the NET 2 port on model 4353 only supports 100 Mbps connections)
	Fiber Ethernet ports: 100 Mbps
10/100BaseTX connector	RJ-45 standard, shielded, located on front panel
10/100BaseTX maximum cable length	100 m using category 5 shielded twisted-pair cable
Application protocols[1]	• Network-connected TCP/IP printer
	• Simple Network Time Protocol (SNTP)
	• Triconex Time Synchronization (UDP/IP)
	• Triconex Time Synchronization (DLC)
	• GPS
	• Modbus
	• Triconex Peer-to-Peer (UDP/IP)
	• Triconex Peer-to-Peer (DLC)
	• TriStation
	• Embedded OPC Server (models 4353 and 4354)
	• TSAA with IP Multicast (UDP/IP)
Network protocols[1]	TCP/IP, SNTP, ICMP, UDP/IP
Maximum Peer-to-Peer Nodes[2]	31
Galvanic isolation	500 VDC
Status indicator: Module status	Pass, Fault, Active
Status indicator: Port activity	TX (Transmit) — 1 per port
	RX (Receive) — 1 per port

1. For more information, see Protocols Supported by TCM Ports on page 115.
2. Contact Triconex for application guidelines and potential performance limitations.

Debug Port

The TCM includes one RS-232 serial port at the bottom of the module. This port is intended for Triconex use as a Debug port. For more information, contact the IPS Global Client Support (GCS) center.

Specifications

Parameter	Description
Type	RS-232 C
Connector	DB9
Baud rate	9600
Protocol	ASCII
	8-bit
	1 stop bit
	No parity
Galvanic Isolation	500 VDC

TCM Communication Indicators

The TCM communication indicators identify the type of communication occurring on the Tricon controller. The TX light indicates the TCM is transmitting a message and the RX light indicates the TCM is receiving a message.

This symbol (—) means the indicator is not important for this condition.

Serial 1-4	NET 1		NET 2		Description
RX/TX	Link	RX/TX	Link	RX/TX	
Green blinking	—	—	—	—	Normal response. TCM is communicating with the attached Modbus master/slave device.
—	Green steady	Green blinking	—	—	TCM is communicating 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 cause 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

Protocols Supported by TCM Ports

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

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	—
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.

For summary information about the protocols, see Chapter 1, Introduction.

B

NCM and NCMG Capabilities

NCM Operation

The Network Communication Module (NCM) and Network Communication Module GPS (NCMG) are optional modules for the Tricon controller that can communicate with other Triconex controllers, with external devices on Ethernet networks, and with a Global Positioning System (GPS). The NCM and NCMG support several Triconex protocols and applications and client/server applications from other manufacturers.

The NCM provides two BNC connectors as ports with these capabilities:

- NET 1 supports Peer-to-Peer protocol for safety networks comprised of Triconex controllers only.

- NET 2 supports open communication with external devices on an Ethernet network. These devices can include PCs which are running Triconex applications such as TriStation, SOE Recorder, OPC Server, and DDE Server, or user-written applications.

The NCMG also provides an RS-232 serial port which can be connected to the Trimble Acutime 2000 Synchronization Kit for GPS time synchronization.

The Tricon controller supports two NCM modules or NCMG modules in one logical slot, or one of these modules in the COM slot. If two modules are in one slot, they function independently, not as hot spares. Each module can be connected to a separate network, or both can be used in a redundant configuration. For more information, see Redundant Devices on page 13.

The NCM and NCMG are compatible with the Ethernet (IEEE 802.3) communication interface and operate at communication speeds up to 10 megabits per second. The modules connect with external host devices by means of 10Base2 coaxial cabling 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 or fiber-optic) cabling.

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

Note   Throughout this section, the name NCM represents both the NCM and the NCMG modules.

Message Processing

Figure 33 depicts how NCM ports communicate with all three MP modules by means of the Comm Bus.

A message received by a NCM port is passed to all three MP modules over the Comm Bus. The TriBus votes on the message before sending it to the MP modules for processing, and returns the response to the Comm Bus after processing is complete. The Comm Bus then forwards the response to the NCM port.
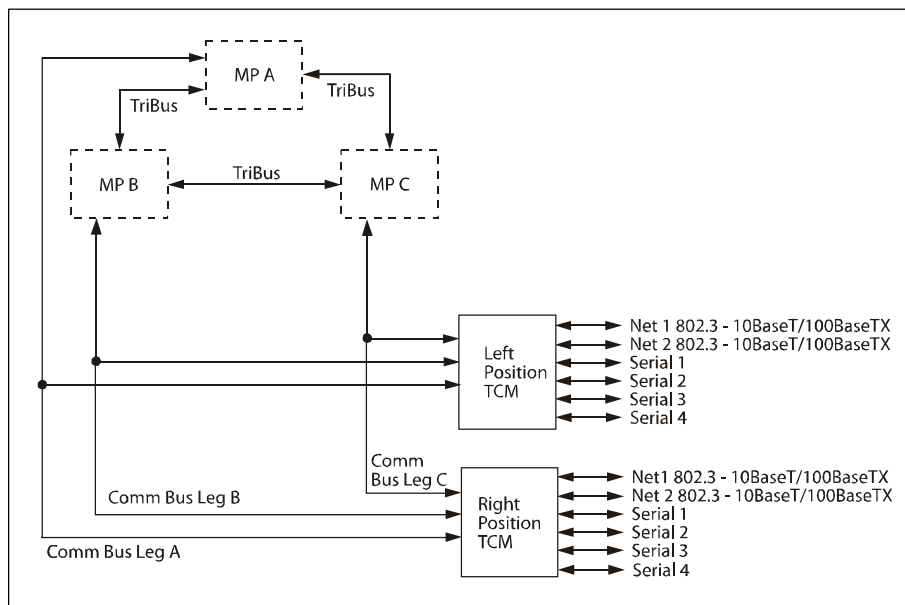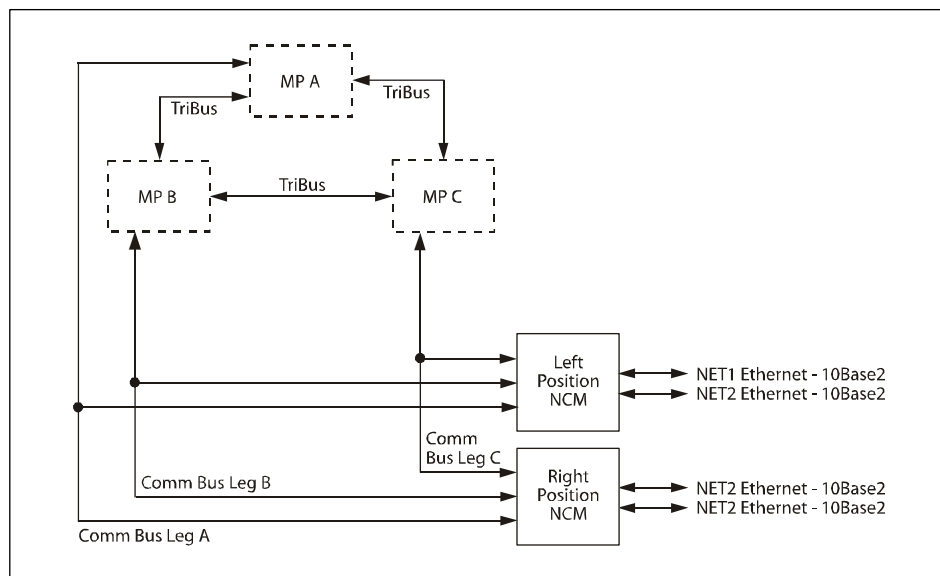
Figure 33   NCM Communication with MPs

The NCM processes messages as described in these sections.

TriStation, Peer-to-Peer, and Time Synchronization Messages

1 Receives the message and transmits it to the MP modules over the Comm Bus.

2 Votes the message request with other MP modules over TriBus.

3 Receives the message from the Comm Bus, processes the message, and transmits a response.

TSAA Read Queries

1 Receives the read query.

2 Gets the requested alias from the Comm Bus voted data pool.

3 Transmits the response.

TSAA Write Commands

1 Receives the write request, transmits it to the MP modules over the Comm Bus.

2 Votes the write request with the other MP modules over TriBus.

3 Receives the message from the Comm Bus, processes the message, and transmits a write confirmation response.

Typical Message Response Time

Because most messages (except TSAA read queries) require TriBus voting, typical message response times require three or more scans to complete. For more information, contact the IPS Global Client Support (GCS) center.

Physical Description

An NCM includes two Ethernet ports which operate at 10 megabits per second. An NCMG also includes an RS-232 serial port for communication with a GPS interface.
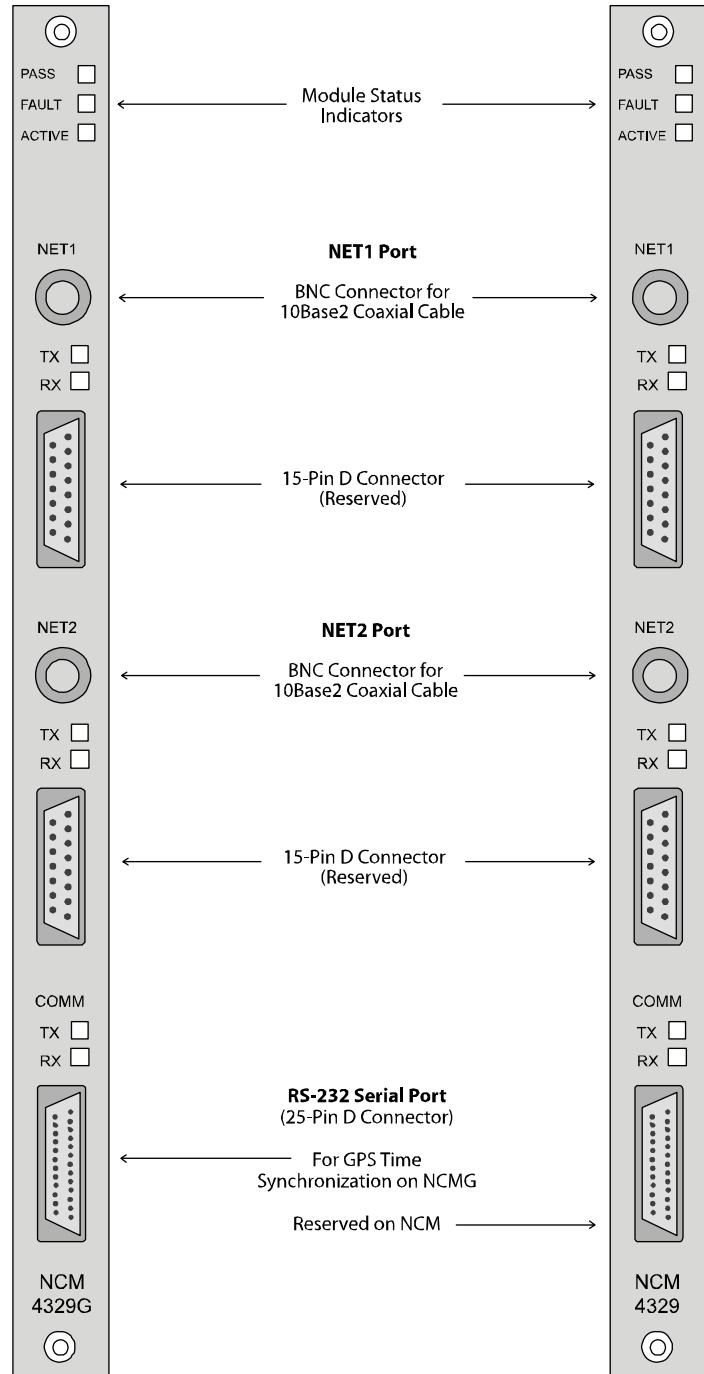
Figure 34 NCM and NCMG Front Panels

Specifications

These specifications apply to both the NCM and NCMG, except for the serial port which is functional on the NCMG only.

Feature	Specification
Ethernet ports	Two BNC connectors that require 10Base2 coaxial cables
External transceiver ports	Reserved
Serial port	One RS-232 connector for GPS time synchronization Maximum cable length is 15 m (50 ft)
Galvanic isolation	500 VDC (applies to Ethernet and serial ports)
Protocols supported	See Protocols Supported on page 122.
Maximum Peer-to-Peer Nodes[1]	31
Communication speed	10 megabits per second
Status indicators	
Module status	Pass, Fault, Active
Port activity	TX (Transmit) — 1 per port RX (Receive) — 1 per port
Logic power	< 20 W

1. Contact Triconex for application guidelines and potential performance limitations.

Communication Indicators

The NCM and NCMG have yellow TX (transmit) and RX (receive) indicators for the NET 1 and NET 2 Ethernet ports and for the COMM serial port. TX blinks each time an NCM port transmits a message and RX blinks each time an NCM port receives a message from an external device. If a TX indicator stops blinking, the NCM module or the controller could have a problem. If an RX indicator stops blinking, the external device could have a problem.

NET 1 RX/TX	NET 2 RX/TX	COMM RX/TX	Description
Yellow blinking	Yellow blinking	—[1]	Normal response. The Ethernet port is communicating with an Ethernet device or TriStation.
—	—	Yellow blinking	Normal response. The COMM serial port is communicating with the Trimble Acutime 2000 Synchronization Kit.

1. This symbol (—) means the indicator is not important for this condition.

Protocols Supported

Ports on the NCM and NCMG support these protocols.

Supported Protocols	NET 1 Ethernet (NCM and NCMG)	NET 2 Ethernet (NCM and NCMG)	COMM Serial (NCMG Only)
TriStation		✓	
TSAA Client/Server		✓	
Peer-to-Peer	✓		
Triconex Time Synchronization	✓		
Trimble GPS Time Synchronization			✓

For summary information about the protocols, see Chapter 1, Introduction.

C

EICM Capabilities

EICM Operation

The Enhanced Intelligent Communication Module (EICM) enables communication with these devices:

- Modbus masters and slaves
- Other Triconex controllers
- TriStation PC
- Centronics-compatible printers

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

A Tricon controller supports up to two EICM modules which must reside in one logical slot. This arrangement provides a total of eight serial ports and two printer ports. The hot-spare feature is not available for the EICM. However, you can connect redundant devices to ports on two EICM modules in the same logical slot. For more information, see Redundant Devices on page 13.

Each EICM supports an aggregate data rate of 57.6 kilobits per second, that is, the total data rate for all four ports must be less than or equal to 57.6 kilobits per second. Each EICM port provides 500 VDC isolation between the external signals and Tricon logic ground.

Any standard Modbus device can communicate with the Tricon controller by means of the EICM, provided that aliases are assigned to the program variables.

Message Processing

This figure depicts EICM modules communicating with the Main Processors by means of the triplicated Comm Bus. The Comm Bus has three channels (one for each MP) which are connected to each EICM module.
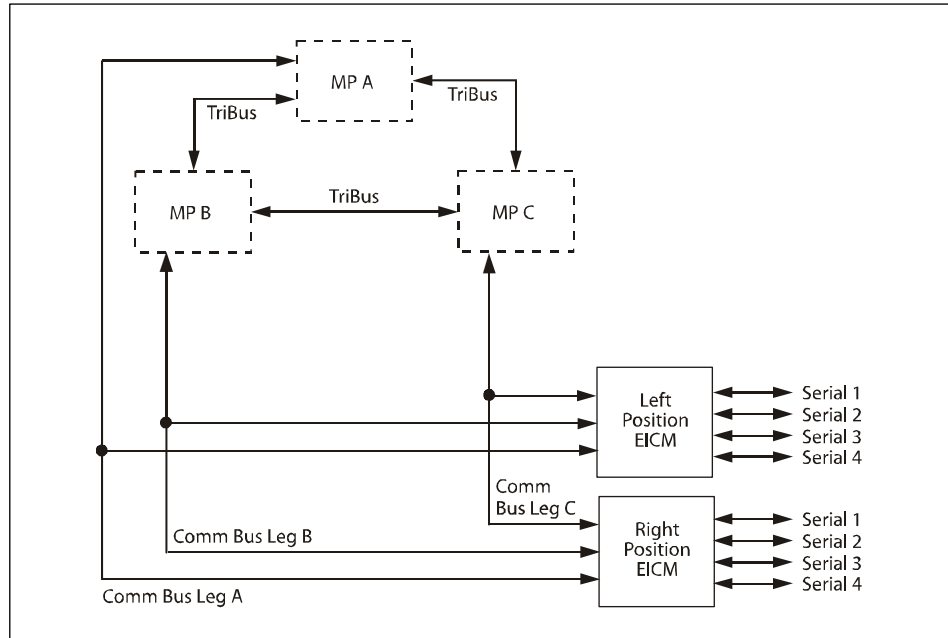
Figure 35   EICM Communication with MPs

A message received by an EICM port is passed to all three MPs over the Comm Bus. The TriBus votes on the message before sending it to the MP modules for processing, and returns the response to the Comm Bus after processing is complete. The Comm Bus then forwards the response to the EICM port. The EICM processes messages as described in the following sections.

TriStation Messages

1   Receives the message and transmits it to the MP modules over the Comm Bus.

2   Votes the message request with other MP modules over TriBus.

3   Receives the message from the Comm Bus, processes the message and transmits a response.

Modbus Read Queries

1   Receives the read query.

2   Gets the requested alias from the Comm Bus voted data pool.

3   Transmits the response.

Modbus Write Commands

1 Receives the write request, transmits it to the MP modules over the Comm Bus.

2 Votes the write request with the other MP modules over TriBus.

3 Receives the message from the Comm Bus, processes the message and transmits a write confirmation response.

Typical Message Response Time

Because all messages except Modbus read queries require Tribus voting, typical message response times require three or more scans to complete.

For more information, see Determining Message Response Time on page 167 or contact the IPS Global Client Support (GCS) center.

Physical Description

Each EICM includes four serial ports and one parallel port with indicators that blink when data is being transmitted and received.
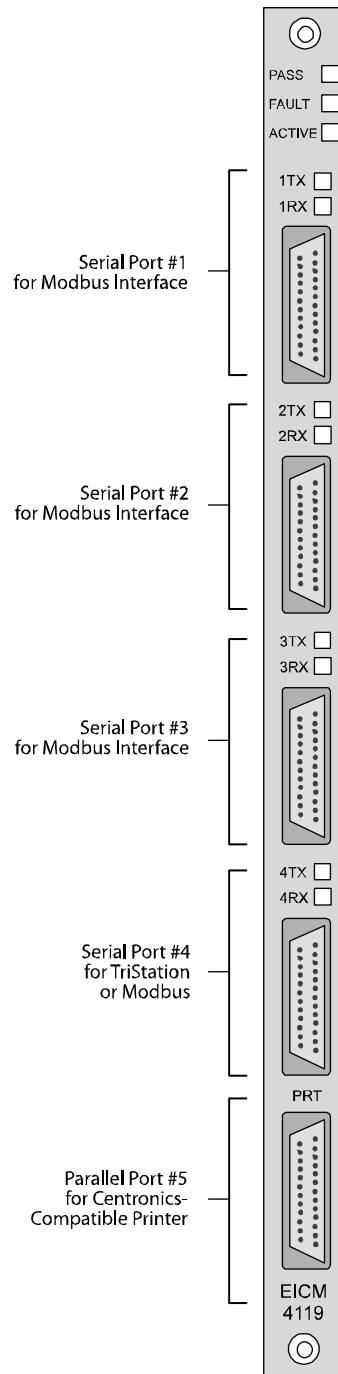
Figure 36   EICM Front Panel

Serial Port Specifications

An EICM has four serial ports which can be connected to Modbus master or slave devices in point-to-point or multi-point configurations. Each serial port provides a DB-25-pin male connector. For each port, you must set a switch on the side of the EICM module to specify whether the communication interface uses RS-232, or RS-422/RS-485. For instructions, see Setting EICM Switches for Serial Ports on page 79.

Feature	Specification
Physical features	RS-232, RS-422 or RS-485 communication interface
	Other options are configurable from TriStation.
Connectors	Male DB-25-pin, DTE standard, shielded
RS-232 maximum cable length	50 ft (15 m)
RS-422/RS-485 maximum cable length	4,520 ft (1.2 km)
Data transmission rates	19200, 9600, 4800, 2400, or 1200 kilobits per second
Protocols	Master, slave, or master/slave
	RTU or ASCII mode
Galvanic isolation	500 VDC
Logic power	< 10 W

Parallel Port Specifications

An EICM module has one parallel port which can be connected to a Centronics-compatible printer. The port is galvanically isolated to 500 VDC and provides a female 25-pin D series connector for use with a standard printing cable. The maximum cable length is 15 to 20 feet (5 to 6 meters), depending on the quality of the cable.

Port Numbers and Connections

For configuration in TriStation, EICM ports in a left and right logical slot have these port numbers and can be connected to these devices. Ports 4 and 9 are the defaults for TriStation connection, although Ports 1 through 3 and Ports 6 through 8 can also be used for TriStation.

Left Slot	Right Slot	Type of Port	Connection
01	06		
02	07		
03	08	Serial	Modbus Device or TriStation
04	09		
05	10	Parallel	Centronics-compatible parallel printer

EICM Communication Indicators

The EICM has a yellow TX and RX indicator for each serial port. TX blinks each time an EICM port transmits a message and RX blinks each time an EICM port receives a message from an external Modbus device or TriStation. If a TX indicator stops blinking, the EICM module or the controller could have a problem. If an RX indicator stops blinking, the external Modbus device or TriStation could have a problem.

Serial 1 RX/TX	Serial 2 RX/TX	Serial 3 RX/TX	Serial 4 RX/TX	Description
Yellow blinking	Yellow blinking	Yellow blinking	Yellow blinking	Normal response. EICM is communicating with a Modbus device or TriStation.

Protocols Supported

EICM ports can use these protocols.

Protocol	Serial Ports	Printer Ports
TriStation	✓	
Modbus Slave	✓	
Modbus Master	✓	
Modbus Master/Slave	✓	
Parallel Printing		✓

For summary information about the protocols, see Chapter 1, Introduction

D

TSAA Protocol

Overview

Triconex System Access Application (TSAA) protocol is a messaging protocol which provides message formats used in application programs that read and write data to Triconex controllers. TSAA is based on a client/server model which allows a client to request information from an external device using a server application.

These Tricon communication modules can be used with TSAA communication:

- Advanced Communication Module (ACM)
- Network Communication Module (NCM)
- Tricon Communication Module (TCM)

You can use TSAA to develop these types of applications:

- *Control (Read/Write) Applications*, such as an operator interface station, that require access to the status of the Triconex controller and the ability to write data to the controller.
- *Monitor (Read-Only) Applications*, such as SOE Recorder, that receive data from the controller.

Byte Ordering in Messages

This section describes the byte ordering used in message fields.

Little-Endian Order

In little-endian ordering, the data is ordered from right to left with the least significant bits or bytes to the right.

Bit Ordering for Bit Fields

Bit 31	. . .	Bit 3	Bit 2	Bit 1	Bit 0

Byte Ordering for 16-Bit Variables

Byte 1	Byte 0

Byte Ordering for 32-Bit Variables

Byte 3	Byte 2	Byte 1	Byte 0

Big-Endian Order

In big-endian ordering, the data is ordered from the left to right with the least significant bits or bytes to the left.

Bit Ordering for Bit Fields

Bit 0	Bit 1	Bit 2	Bit 3	. . .	Bit 31

Byte Ordering for 16-Bit Variables

Byte 0	Byte 1

Byte Ordering for 32-Bit Variables

Byte 0	Byte1	Byte 2	Byte 3

Symbol Table Information

The symbol table includes information about TriStation 1131 variables, Modbus alias numbers, bin numbers, and offset. This information is required when data is read or written to the controller. The symbol table is downloaded to the controller with the TriStation 1131 application.

Symbol table information for Tricon control programs can be retrieved by exporting the information from TriStation 1131. For more information, see the Export Points command in the *TriStation 1131 Developer's Guide, v4.5*.

TSAA Messages

A TSAA message is a request made by a client, or a response made by the Triconex controller. This section describes the format of TSAA messages and the available types of messages. In this section, the words *frame* and *message* mean the same thing—a unit of data that is transmitted through a network.

> **CAUTION**
>
> - UDP protocol is the only supported protocol.
> - The Tricon NCM uses UDP port 1500 for all TSAA communication. Using any other port may cause problems.

Message Format

Each TSAA message uses a format which includes these fields:

- A frame header which identifies the message
- A data area which contains the frame message
- A 32-bit Cyclic Redundancy Check (CRC)

Frame Header	Data Area	CRC
8 bytes	variable length	4 bytes

Note Unless otherwise specified, fields in messages are unsigned.

Frame Header

The frame header in a TSAA message includes these fields.

Type	nodeNumber	seqNum	version	flag	id	length
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	2 bytes

Type

The Type field in the frame header identifies the message type. These types of TSAA messages are available.

Type	Message Type	Description	Request from Client	Triconex Controller Response
1	TRICON_DATA	Returns data in response to a type 2 message.		✓
2	TRICON_DATA_REQ	Requests data from the TriStation application.	✓	
3	WRITE_TRICON_DATA	Requests the controller to write to memory and output variables in the TriStation application.	✓	
4	WRITE_TRICON_DATA_RSP	Responds to a request to write to memory and output variables by a type 3 message.		✓
5	READ_TRICON_CLOCK	Requests the current time on the controller clock.	✓	
6	READ_TRICON_CLOCK_RSP	Returns the current time on the controller clock in response to a type 5 message.		✓
7	SET_TRICON_CLOCK	Requests setting of the controller clock.	✓	
8	SET_TRICON_CLOCK_RSP	Responds to a request to set the clock made by a type 7 message.		✓
9	ADJUST_TRICON_CLOCK	Requests controller to adjust clock forward or backward.	✓	
10	ADJUST_TRICON_CLOCK_RSP	Responds to a request to adjust the clock made by a type 9 message.		✓
11	READ_TRICON_DATA	Requests data (memory, input, or output variables) to be read from the TriStation application.	✓	
12	READ_TRICON_RSP	Returns variable data in response to a type 11 message.		✓
13	TRICON_SOE_REQ	Requests SOE (sequence of events) data from the controller.	✓	
14	TRICON_SOE_RSP	Returns SOE data in response to a type 13 message.		✓
15	TRICON_CPSTATUS_REQ	Requests the TriStation application name and version number.	✓	

Type	Message Type	Description	Request from Client	Triconex Controller Response
16	TRICON_CPSTATUS_RSP	Returns program information in response to a type 15 message.		✓
17	TRICON_SOE_DATAAVAIL	Sends a message to the client when SOE data is available. The message is sent when SOE data is put into an empty SOE block and every 10 seconds while there is data available in any block.		✓

nodeNumber

The nodeNumber field identifies the destination node number for the message, which is the node number for the Triconex controller.

seqNum

The seqNum field identifies the number of the message in a multiple-message response. This field can help determine if there are missing messages.

version

The version field identifies the version number of the protocol used by the sender. For a Tricon system, the number must be 0.

flag

The flag field is a bit field that indicates the position of the frame in a multi-frame message, or that the message is a single frame.

Flag	Frame Position
0x00	mid-frame of a multi-frame message
0x01	first frame of a multi-frame message
0x01	last frame of a multi-frame message
0x03	single frame message

id

The id field assigns a number to a request and associated response. If a client makes periodic requests of the same message type and wants to associate them with the responses, this field can be used to assign an identifier. The request and response use the same identifier.

length

The length field identifies the length of the frame excluding the CRC32 field.

TRICON_DATA (Type 1)

A TRICON_DATA message replies to a request for data made by a TRICON_DATA_REQ (type 2) message. If the client sends a data request at least once every two minutes, the controller continues sending data responses at the interval specified by the request.

CAUTION If more than one client sends a TRICON_DATA_REQ to a controller, the controller response changes to a UDP broadcast which is sent to all the clients. If the client connects on a port other than 1500, broadcast data may be lost when a second client sends a data request.

This message includes these fields.

Frame_Hdr	Data_Hdr	Bin (1) Header	Bin (2) Header...	CRC
8 bytes (big-endian)	4 bytes (big-endian)	varies (big-endian)	varies (big-endian)	4 bytes (little-endian)

Data_Hdr

The Data_Hdr field includes these fields.

numberOfBlocks	rfu
2 bytes (big-endian)	2 bytes (reserved)

numberOfBlocks

The numberOfBlocks field identifies the number of blocks in the data portion of the message.

Bin Headers

A TRICON_DATA (Type 1) message can have multiple bin headers followed by bin data. Each bin header includes these fields.

bin	rfu	totalLength	offset	length	Data
1 byte (big-endian)	1 byte (reserved)	2 bytes (big-endian)	2 bytes (big-endian)	2 bytes (big-endian)	varies (byte — big-endian, bit — little-endian)

bin

The bin field identifies which bin holds the message data, using a numeric value to represent the variable type and data type. This table identifies Tricon bin information.

Bin	Data Type	Variable Type	Message Type	Tricon Range	Bin Size
0	BOOL	Output	Read/Write	00001 - 02000	2048
1	BOOL	Memory	Read/Write	02001 - 04000	2016
2	BOOL	Input	Read	10001 - 12000	4096
3	BOOL	Memory	Read	12001 - 14000	2016
4	DINT	Input	Read	30001 - 31000	1024
5	DINT	Memory	Read	31001 - 32000	1000
6	REAL	Input	Read	32001 - 32120	120
7	REAL	Memory	Read	33001 - 34000	1000
8	BOOL	System status	Read	14001 - 19999	5999
9	DINT	System status	Read	39631 - 39999	369
10	DINT	Output	Read/Write	40001 - 40250	512
11	DINT	Memory	Read/Write	40251 - 41000	750
12	REAL	Memory	Read/Write	41001 - 42000	1000
13	Not applicable (Number of bins)				

totalLength

The totalLength field indicates the length of the bin.

offset

The offset field identifies the starting position of the requested data in the bin.

- For discrete data types, the offset is the number of bits.
- For integer and real data types, the offset is the number of 32-bit words.

length

The length field contains the length of the data returned in the message.

TRICON_DATA_REQ (Type 2)

A TRICON_DATA_REQ message requests one or more bins of data from a Triconex controller. The controller responds with a TRICON_DATA (type 1) message. If the client sends a data request at least once every two minutes, the controller continues sending data responses at the interval specified by the request.

The data request message is designed for applications that require all of the data in one or more bins. After the request is sent, the controller continuously sends data responses to the client at specified intervals. The client cannot stop the controller from sending data, but the controller will stop sending data if a data request is not received again within two minutes.

If you use TCP protocol (or UDP protocol with connect and disconnect functions), you must leave the connection open for a minimum of two minutes after sending this request. If the application requires specifying the range of data, use READ_TRICON_DATA (type 11).

This message includes these fields.

Frame_Hdr	Data_Req_Hdr	CRC
8 bytes (big-endian)	4 bytes (big-endian)	4 bytes (little-endian)

Data_Req_Hdr

The Data_Req_Hdr field contains these fields.

binsRequested	reqTime
2 bytes (big-endian)	2 bytes[1] (big-endian)

1. If the requested time is less than 65,535 seconds (0xFFFF), these two bytes reflect the requested time; otherwise, only the last two bytes of the requested time exist—the preceding bytes get truncated.

binsRequested

The binsRequested field is a binary mask that identifies which bins of data the Triconex controller should send.

If the request includes an invalid bin number, the response is a bin header with no data.

Binary Mask	Description
0x1fff	Masks all bins
0x0001	Masks discrete output

Binary Mask	Description
0x0002	Masks read/write discrete memory
0x0004	Masks discrete input
0x0008	Masks read-only discrete memory
0x0010	Masks analog input
0x0020	Masks read-only integer memory
0x0040	Masks real input
0x0080	Masks read-only real memory
0x0100	Masks discrete system status
0x0200	Masks integer system status
0x0400	Masks analog output
0x0800	Masks read/write integer memory
0x1000	Masks read/write real memory

reqTime

The reqTime field indicates the time in milliseconds between broadcasts of the requested bins. For example, a value of 1,000 causes a Triconex controller to broadcast the data once per second. A value of zero (0) causes the controller to broadcast the data each time the ACM, NCM, or TCM is updated.

On TCM models 4351B, 4352B, 4353, and 4354, the TSAA protocol uses IP Multicasting to limit the broadcasts on a network. On these modules, the TSAA server has an IP Multicast address and a data rate that are configured using TriStation. The TSAA server broadcasts the bin data at the configured data rate to the IP Multicast group and the reqTime is ignored.

WRITE_TRICON_DATA (Type 3)

A WRITE_TRICON_DATA message requests the Triconex controller to write data to output and memory variables in the TriStation application. These conditions must be met for the controller to accept this request:

- The variables must be defined as read/write.

- The keyswitch must be in the Program or Remote position.

- The TriStation configuration setting (Disable Remote Changes to Outputs) which was downloaded to the controller must allow remote changes. (This setting only affects changes to discrete outputs and analog outputs.)

- The TriStation configuration for the ACM, NCM, or TCM must be configured as read/write.

If the controller cannot write the data, it sends a reject response code. For more information, see Response Codes on page 163.

This message includes these fields.

Frame_Hdr	Write_Hdr	Write_Data	. . .	Write_Data	CRC
8 bytes (big-endian)	4 bytes (big-endian)	varies		varies	4 bytes (little-endian)

Write_Hdr

The Write_Hdr contains these fields.

numberOfBlocks	rfu
2 bytes (big-endian)	2 bytes (reserved)

numberOfBlocks

The numberOfBlocks field indicates the number of write data blocks for the message type.

Write_Data

The Write_Data field includes these fields.

binNumber	rfu	offset	numberOfValues	Values
1 byte (big-endian)	3 bytes	2 bytes (big-endian)	2 bytes (big-endian)	varies (little-endian)

binNumber

The binNumber field indicates the number of the bin to be changed.

offset

The offset field identifies the starting position of the requested data in the bin.

- For discrete data types, the offset is the number of bits.
- For integer and real data types, the offset is the number of 32-bit words.

numberOfValues

The numberOfValues field indicates the number of variables to be written starting at the specified offset.

Values

The Values field contains the values for the variables to be changed. Discrete variables require one byte each for the new value (0 or 1).

WRITE_TRICON_DATA_RSP (Type 4)

A WRITE_TRICON_DATA_RSP message replies with a success or failure code to a request to write data sent by a WRITE_TRICON_DATA (type 3) message.

This message includes these fields.

Frame_Hdr	responseCode	subReason	rfu	CRC
8 bytes (big-endian)	1 byte (big-endian)	1 byte (big-endian)	2 bytes	4 bytes (little-endian)

responseCode

The responseCode field indicates the success or failure of the request. A value of zero (0) indicates the request was successfully completed.

For more information, see Response Codes on page 163.

subReason

The subReason field contains additional information about the failure of the request.

READ_TRICON_CLOCK (Type 5)

A READ_TRICON_CLOCK message requests the current time on the Triconex controller. The controller responds with READ_TRICON_CLOCK_RSP (type 6) which sends the current time to the client.

There are no fields specific to this message.

Frame_Hdr	CRC
8 bytes (big-endian)	4 bytes (little-endian)

READ_TRICON_CLOCK_RSP (Type 6)

A READ_TRICON_CLOCK_RSP message sends the current controller time to the client in response to a READ_TRICON_CLOCK (type 5) request.

This message includes these fields.

Frame_Hdr	Read_Clock_Resp	CRC
8 bytes (big-endian)	12 bytes (big-endian)	4 bytes (little-endian)

Read_Clock_Rsp

The Read_Clock_Rsp field includes these fields.

responseCode	subReason	rfu	relSec	milliSec	rfu2
1 byte (big-endian)	1 byte (big-endian)	2 bytes (reserved)	4 bytes (big-endian)	2 bytes (big-endian)	2 bytes (big-endian)

ResponseCode

The responseCode field indicates the success or failure of the request. A value of zero (0) indicates the request was successfully completed.

For more information, see Response Codes on page 163.

subReason

The subReason field contains additional information about the failure of the request.

relSec

The relSec field indicates the current Triconex system time expressed in relative seconds. For Tricon, relative seconds are seconds past 00:00 January 1, 1970 based on local time.

milliSec

The milliSec field indicates the millisecond portion of the Triconex system time.

SET_TRICON_CLOCK (Type 7)

A SET_TRICON_CLOCK message requests the time to be set on the Triconex controller. The controller responds with a SET_TRICON_CLOCK_RSP (type 8) message.

This message includes these fields.

Frame_Hdr	Set_Clock	CRC
8 bytes (big-endian)	8 bytes (big-endian)	4 bytes (little-endian)

Set_Clock

The Set_Clock field includes these fields.

relSec	milliSec	rfu
4 bytes (big-endian)	2 bytes (big-endian)	2 bytes reserved

relSec

The relSec field contains the controller system time expressed in relative seconds. For Tricon, relative seconds are seconds past 00:00 January 1, 1970 based on local time.

milliSec

The milliSec field contains the millisecond portion of the system time.

SET_TRICON_CLOCK_RSP (Type 8)

A SET_TRICON_CLOCK_RSP message replies with a success or failure code to a SET_TRICON_CLOCK (type 7) message.

This message includes these fields.

Frame_Hdr	Set_Clock_Rsp	CRC
8 bytes (big-endian)	4 bytes (big-endian)	4 bytes (little-endian)

Set_Clock_Rsp

The Set_Clock_Rsp field contains these fields.

responseCode	subReason	rfu
1 byte (big-endian)	1 byte (big-endian)	2 bytes

responseCode

The responseCode field indicates the success or failure of the request. A value of zero (0) indicates the request was successfully completed.

For more information, see Response Codes on page 163.

subReason

The subReason field contains additional information about the failure of the request.

ADJUST_TRICON_CLOCK (Type 9)

An ADJUST_TRICON_CLOCK message requests the time to be adjusted on the Triconex controller either forward or backward. The controller responds with an ADJUST_TRICON_CLOCK_RSP (type 10) message.

This message includes these fields.

Frame_Hdr	Adjust_Clock	CRC
8 bytes (big-endian)	8 bytes (big-endian)	4 bytes (little-endian)

Adjust_Clock

The Adjust_Clock field includes these fields.

AdjustSeconds	AdjustMilliseconds
4 bytes signed (big-endian)	4 bytes signed (big-endian)

AdjustSeconds

The AdjustSeconds field contains the number of seconds to adjust the controller clock either forward or backward.

AdjustMilliseconds

The AdjustMilliseconds field contains the number of milliseconds to adjust the controller clock either forward or backward.

ADJUST_TRICON_CLOCK_RSP (Type 10)

An ADJUST_TRICON_CLOCK_RSP message replies with a success or failure code to an ADJUST_TRICON_CLOCK (type 9) message.

This message includes these fields.

Frame_Hdr	Adjust_Clock_Rsp	CRC
8 bytes (big-endian)	4 bytes (big-endian)	4 bytes (little-endian)

Adjust_Clock_Rsp

The Adjust_Clock_Rsp field contains these fields.

responseCode	subReason	adjustSeconds[1]
1 byte (big-endian)	1 byte (big-endian)	2 bytes (big-endian)

1. If the requested time is less than 65,535 seconds (0xFFFF), these two bytes reflect the requested time; otherwise, only the last two bytes of the requested time exist—the preceding bytes get truncated.

responseCode

The responseCode field indicates the success or failure of the request. A value of zero (0) indicates the request was successfully completed.

For more information, see Response Codes on page 163.

subReason

The subReason field contains additional information about the failure of the request.

READ_TRICON_DATA (Type 11)

A READ_TRICON_DATA message requests variable data from the Triconex controller. The controller responds with the requested data using one or more READ_TRICON_RSP (type 12) messages depending on the amount of data requested.

This message includes these fields.

Frame_Hdr	Read_Hdr	Read_Data	CRC
8 bytes (big-endian)	4 bytes (big-endian)	8 bytes (big-endian)	4 bytes (little-endian)

Read_Hdr

The Read_Hdr field includes these fields.

numberOfBlocks	rfu
2 bytes (big-endian)	2 bytes

numberOfBlocks

The numberOfBlocks field indicates the number of Read_Data blocks for this message.

Read_Data

The Read_Data field includes these fields.

binNumber	rfu	offset	numberOfValues
1 byte (big-endian)	3 bytes	2 bytes (big-endian)	2 bytes (big-endian)

binNumber

The binNumber field contains the number of the bin to be read.

offset

The offset field identifies the starting position of the requested data in the bin.

- For discrete data types, the offset is the number of bits.
- For integer and real data types, the offset is the number of 32-bit words.

If the numberOfValues field is zero (0), this field is ignored.

numberOfValues

The numberOfValues field contains the number of variables to be read from the bin. If the number is zero (0), all of the data in the bin is returned.

READ_TRICON_RSP (Type 12)

A READ_TRICON_RSP message responds to a request to read data on the controller made by a READ_TRICON_DATA (type 11) message. The controller sends one or more of these messages depending on the amount of data requested.

This message includes these fields.

Frame_Hdr	Read_Rsp_Hdr	Read_Data_Rsp	Data	...	CRC
8 bytes (big-endian)	4 bytes (big-endian)	12 bytes (big-endian)	varies (byte—big-endian, bit—little-endian)		4 bytes (little-endian)

Read_Rsp_Hdr

The Read_Rsp_Hdr field includes these fields.

responseCode	subReason	numberOfBlocks
1 byte (big-endian)	1 byte (big-endian)	2 bytes (big-endian)

responseCode

The responseCode field indicates the success or failure of the request. A value of zero (0) indicates the request was successfully completed.

For more information, see Response Codes on page 163.

subReason

The subReason field contains additional information about the failure of the request.

numberOfBlocks

The numberOfBlocks field indicates the number of Read_Data_Rsp blocks in the message.

Read_Data_Rsp

The Read_Data_Rsp field includes these fields.

binNumber	rfu	offset	relSec	milliSec	numberOfValues
1 byte (big-endian)	1 byte	2 bytes (big-endian)	4 bytes (big-endian)	2 bytes (big-endian)	2 bytes (big-endian)

binNumber

The binNumber field contains the number of the bin to be read.

offset

The offset field contains the number of variables from the beginning of the bin.

- For discrete data types, the offset is the number of bits.
- For integer and real data types, the offset is the number of 32-bit words.

relSec and milliSec

The relSec field contains the controller time stamp for bin data expressed in relative seconds. The milliSec field contains the millisecond portion of the controller time stamp. For Tricon, relative seconds are seconds past 00:00 January 1, 1970 based on local time.

numberOfValues

The numberOfValues field indicates the number of variables that are read starting at the specified offset.

Data

The Data field contains data from the bin.

For more information about Trident data, see Symbol Table Information on page 133.

TRICON_SOE_REQ (Type 13)

A TRICON_SOE_REQ message requests the Triconex controller to send event data collected in an SOE block. The controller responds with a TRICON_SOE_RSP (type 14) message.

This message includes these fields.

Frame_Hdr	Soe_Req	CRC
8 bytes (big-endian)	16 bytes (big-endian)	4 bytes (little-endian)

Soe_Req

The Soe_Req field includes these fields.

soeNumber	firstFlag	ackFlag	rfu1	getIndex	rfu2	wrapCount	generation
1 byte (big-endian)	1 byte (big-endian)	1 byte (big-endian)	1 byte	2 bytes (big-endian)	2 bytes	4 bytes (big-endian)	4 bytes (big-endian)

soeNumber

The soeNumber field contains the SOE block number which can be 1 to 16. (SOE blocks are configured in TriStation.)

firstFlag

The firstFlag field indicates whether this is the first data request for this SOE block. This value should be set to one (1) for the first request. For all subsequent requests, it should be set it to zero (0).

ackFlag

The ackFlag field indicates whether the last TRICON_SOE_RSP message was received correctly. If the message was received correctly, set the field to one (1). If not, set it to zero (0).

getIndex

The getIndex field is a pointer into the SOE data block that indicates the start of the data being requested.

wrapCount

The wrapCount field indicates the number of times the buffer has been filled since the last time the TriStation application issued an SOECLR command for this block.

generation

The generation field indicates the number of times the TriStation application has issued the SOECLR command.

TRICON_SOE_RSP (Type 14)

A TRICON_SOE_RSP message responds to a TRICON_SOE_REQ (type 13) request by sending data from the SOE block.

The values for the getIndex, wrapCount, and generation fields may not match the numbers requested because their values change depending on how frequently you request data and whether events are occurring.

This message includes these fields.

Frame_Hdr	Soe_Rsp	Time Stamp Entry	Data Entry	. . .	CRC
8 bytes (big-endian)	16 bytes (big-endian)	8 bytes (little-endian)	8 bytes (big-endian)		4 bytes (little-endian)

Soe_Rsp

The Soe_Rsp field includes these fields.

soe Number	response Code	sub Reason	rfu	next Index	numberOf Entries	wrap Count	generation
1 byte (big-endian)	1 byte (big-endian)	1 byte (big-endian)	1 byte	2 bytes (big-endian)	2 bytes (big-endian)	4 bytes (big-endian)	4 bytes (big-endian)

soeNumber

The soeNumber field indicates the number of the SOE block.

responseCode

The responseCode field indicates the success or failure of the request. A value of zero (0) indicates the request was successfully completed.

For more information, see Response Codes on page 163.

subReason

The subReason field identifies the subcode for the request, which is used for debugging problems.

nextIndex

The nextIndex field is a pointer into the SOE data block that indicates the start of the data being requested.

numberOfEntries

The numberOfEntries field indicates the number of entries in the response. There are two types of entry: time stamp and event data. For more information, see entry (SOE Data) on page 153 and TRICON_CPSTATUS_REQ (Type 15) on page 154.

wrapCount

The wrapCount field indicates the number of times the buffer has been filled since the last time the TriStation application issued an SOECLR command for this block.

generation

The generation field indicates the number of times the TriStation application has issued the SOECLR command.

entry (SOE Time Stamp)

The entry field for an SOE time stamp entry includes these fields.

seconds	milli seconds	Date	Hour	Minutes	year	month	rfu	reason	soe Number	type
6 bits (big-endian)	10 bits (big-endian)	5 bits (big-endian)	5 bits (big-endian)	6 bits (big-endian)	12 bits (big-endian)	4 bits (big-endian)	4 bits (big-endian)	4 bits (big-endian)	5 bits (big-endian)	3 bits (big-endian)

seconds

The seconds field contains the seconds part of the time stamp, which can be from 0 to 59.

milliseconds

The milliseconds field contains the millisecond portion of the time stamp.

Date

The Date field contains the date portion of the time stamp.

Hour

The Hour field contains the hour portion of the time stamp.

Minutes

The Minutes field contains the minutes portion of the time stamp.

year

The year field contains the year portion of the time stamp.

month

The month field contains the month portion of the time stamp.

reason

The reason field indicates the reason a time stamp entry was made. The reasons are described in this table.

Value	Reason
1	SOESTRT command processed.
2	SOESTOP command processed or buffer full for First Out block.
3	SOECLR command processed.
4	Event has been detected. It can be collected from the Entry field of the TRICON_SOE_RSP message.

soeNumber

The soeNumber field identifies the SOE block number.

type

The type field indicates whether the entry is an SOE time stamp or an SOE data entry.

- If 1, the entry is a time stamp.
- If 2, the entry is a data entry.

entry (SOE Data)

The entry field for an SOE data entry includes these fields.

soeNumber	Type	rfu	offset	value
5 bits (big-endian)	3 bits (big-endian)	8 bits	2 bytes (little-endian)	4 bytes (little-endian)

soeNumber

The soeNumber field identifies the SOE block number.

Type

The type field indicates whether the entry is an SOE time stamp or an SOE data entry.

- If 1, the entry is a time stamp.
- If 2, the entry is a data entry.

offset

The offset field contains the number of variables from the beginning of the bin.

- For discrete data types, the offset is the number of bits.
- For integer and real data types, the offset is the number of 32-bit words.

value

The value field contains the value of the aliased variable. If On, it is 0x00000001; if Off, it is 0x00000000.

TRICON_CPSTATUS_REQ (Type 15)

A TRICON_CPSTATUS_REQ message requests the TriStation application name and version number from the Triconex controller. This message does not require any data. The controller responds with a TRICON_CPSTATUS_RSP (type 16) message.

There are no fields specific to this message.

Frame_Hdr	CRC
8 bytes (big-endian)	4 bytes (little-endian)

TRICON_CPSTATUS_RSP (Type 16)

A TRICON_CPSTATUS_RSP message replies to the request for TriStation application name and version number made by a TRICON_CPSTATUS_REQ (type 15) message.

This message includes these fields.

Frame_Hdr	CPStatus_Rsp	CP_STAT	SYSTEM_VARS_STRUCT	CRC
8 bytes (big-endian)	4 bytes (big-endian)	struct length ended on a 4-byte boundary	struct length ended on a 4-byte boundary	4 bytes (little-endian)

CPStatus_Rsp

The CPStatus_Rsp field includes these fields:

responseCode	subReason	rfu
1 byte (big-endian)	1 byte (big-endian)	2 bytes (reserved)

responseCode

The responseCode field indicates the success or failure of the request. A value of zero (0) indicates the request was successfully completed.

For more information, see Response Codes on page 163.

subReason

The subReason field contains additional information about the failure of the request, which is used for debugging problems.

CP_STAT

The CP_STAT field is defined in the following:

```
#define VNAME_LENGTH 10 /* Length of Control Program Name */
#define NUMBER_SOE 16 /* The number of SOE blocks */

typedef struct cpStatStruct {
   BYTEloadInProgress;
   BYTEmodInProgress;
   BYTEcpLoadState;
   BYTEcpSingleScan;
   BYTEcpValid;
   BYTEcpKeySwitch;/* tricon run/stop/program/remote switch */
   BYTEcpRunState;
   BYTEtsxSubVersion;/* Sub version of tsx */
   /* pointers must start on an double byte bountry for the WIZ */
   /* Tribus control sizes and pointers */
   char*startOfInternals;
   char*startOfMY;
   char*startOfUS;
   char*startOfDS;
   char*firstCPPage;
   char*lastCPPage;
   WORDsizeOfMY;
   WORDsizeOfUS;
   WORDsizeOfDS;
   WORDsizeOfMYdfA;
   WORDsizeOfMYdfB;
   WORDsizeOfMYdfC;
   WORDsizeOfInternals;/* size in Words */
   WORDconfig_size;
   WORDcpScanTime;
   WORDactualScanTime;
   shortavgTimeAvail;
   WORDtsxVersion;/* PROM version number of TSX*/
         /* If high order bit is on, this is
         an enhance MP */
   DWORDcpVersion;
   DWORDcpDwnLdTime;/* Last down load time        */
   charprogramName[VNAME_LENGTH];/* 10 Bytes long currently   */
   WORDtsxVendorCode;/* PROM vendor code number    */
   WORDptsDisabled;/* Count of points disabled */
   BYTEalarmStatus;/* Set to one if there is alarm on */
   BYTEnumberSoes;/* Number of SOEs */
   BYTEsoeState[NUMBER_SOE];/* State of soe */
         /* end on the 4-byte boundry */
} CP_STAT;
```

cpVersion

The cpVersion field identifies the control program version.

cpDwnLdTime

The cpDwnLdTime field identifies the time that the control program was last downloaded.

programName[]

The programName[] field contains the name of the control program RLL file.

numberSoes

The numbrSoes field identifies the number of SOE blocks that have been defined.

soeState[]

The soeState[] field identifies the state of each of the sixteen possible SOE blocks.

The states include:

0   Block is not defined or block is not started.

1   Block is collecting.

2   Block is stopped or cleared.

3   Block is full.

SYSTEM_VARS_STRUCT

The SYSTEM_VARS_STRUCT field is defined in the following:

```
typedef struct SYSTEM_VARS_STRUCT {
   BYTEfiller_1[4];
   unsigned short key_stop_disabled: 1;
   unsigned short set_outputs_disabled: 1;
   unsigned short master_clock: 1;
   unsigned short password_enabled: 1;
   unsigned short disable_disallowed: 1; /* Disallow any disables */
   unsigned short filler_2: 3;
   unsigned short filler_3: 8;  /* fill out to WORD */
   BYTEnodeNumber;/* Node number for tricon */
   BYTEfiller_4;
   BYTErackType[NUM_CHASSIS];/* 1-byte per rack show type    */
   WORDvalidBoards[NUM_CHASSIS];/* 1 bit per board slot */
   BYTEpassword[10];/* Control program password */
   BYTEuser[20];/* User name of downloader */
   WORD filler_5;/* Round to four byte boundry */
} SYSTEM_VARS_STRUCT;
```

TRICON_SOE_DATAAVAIL (Type 17)

A TRICON_SOE_DATAAVAIL message sends a message to the client when SOE data is available. The message is sent when SOE data is put into an empty SOE block and every 10 seconds while there is data available in any block. This is a broadcast message.

This message includes these fields.

Frame_Hdr	rfu1	SoeDataAvail	rfu2	Entry	Entry	. . .	CRC
8 bytes (big-endian)	1 byte	16 bytes (big-endian)	19 bytes	16 bytes (big-endian)	16 bytes (big-endian)		4 bytes (little-endian)

SoeDataAvail

The SoeDataAvail field contains these fields.

blk1	blk2	blk3	blk4	blk5	blk6	blk7	blk8	blk9	blk10	blk11	blk12	blk13	blk14	blk15	blk16
1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)	1 B (BE)

blk=SOE block

B=byte

BE=big endian

blk1-blk16

The blk1 through blk16 fields identify the state of each of the sixteen possible SOE blocks.

The states include:

    0   Block is not defined or block is not started, block is stopped or cleared.

    1   Block is collecting.

Entry

The Entry field contains these fields.

putIndex	firstIndex	bufferSize	state	rfu	wrapCount	generation
2 bytes (big-endian)	2 bytes (big-endian)	2 bytes (big-endian)	1 byte (big-endian)	1 byte	4 bytes (big-endian)	4 bytes (big-endian)

putIndex

The putIndex field contains a pointer to the last data available in the SOE data block.

firstIndex

The firstIndex field contains a pointer to the beginning of the available data in the SOE data block.

bufferSize

The size field contains the number of entries in the block. The block size is specified in TriStation.

state

The state field contains a number representing the status of the SOE block. The states are:

0   SOE block is not defined or block is not started

1   SOE is collecting data

2   SOE data collection is stopped

3   SOE block is full

wrapCount

The wrapCount field contains the number of times the buffer has been filled since the last time the TriStation application issued an SOECLR command for this block.

generation

The generation field contains the number of times the SOE block has been created. It is incremented each time the SOE_CLEAR command is issued.

Performance Considerations

This section describes factors affecting the performance of TSAA communication, which is measured in terms of the Triconex controller's response to a client's read and write requests.

These actions occur with TSAA messages:

- Read requests are directly processed by the communication module. The communication module returns data from bins which mirror the bins stored on the MPs. This data is updated by the MPs via the Communication Bus at the end of each scan, during the period referred to as the scan surplus.

- Write requests pass through the communication module and are processed by the MPs TSX operating system. If the data items are aliased read/write variables and remote access is enabled, the MPs update data in its bins and communicate the updates to the application running on the controller and to the communication module. The communication module then responds with a success or failure message to the client.

This figure shows the path of read and write messages.
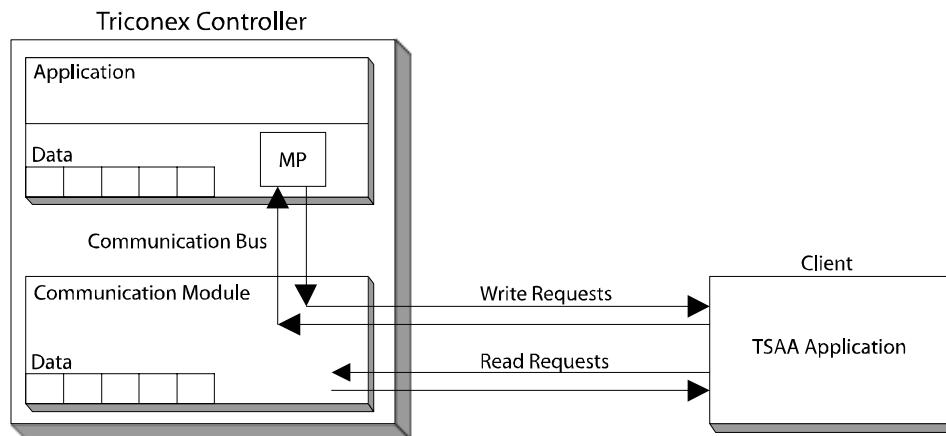
Figure 37   Message Flow Between Triconex Controller and Client

CAUTION

- TSAA applications must request data from the controller every 10 seconds or less to prevent the TR_PORT_STATUS function block from indicating a bad port status.

- Retrieving data on every scan may not be possible in some system configurations, especially those that use a TCM with TSAA multicast, which does not support broadcasts faster than every 250 milliseconds.

Performance Factors

Factors which affect performance include: communication bus speed, the amount of aliased data and scan time, and network speed and loading. Read requests are typically processed in 10 to 50 milliseconds because the communication module responds with data from its bins, without communicating with the MPs. Write requests depend on scan time because the request must be communicated to and from the MPs.

Communication Bus Speed

The communication bus speed determines the speed at which data is communicated between the MPs and communication modules. If the amount of aliased data updated by the MPs is too large for a single scan, it may take several scans to update the aliased data stored in the communication modules.

Controller Version	Speed/Bytes Per Second
Tricon v9.0—v9.5	20,000
Tricon v9.6 and later	100,000

Amount of Aliased Data and Scan Time

The amount of aliased data and scan time can affect the data communication timing because the MPs send updated data to the communication modules after each scan. If the amount of aliased data is large and the scan time is small, it may require several scans to update all the bins in the communication module.

The number of bytes of aliased data is calculated as follows:

- Each group of eight or fewer contiguous BOOL data equals one byte.
- Each DINT or REAL data equals four bytes.

Use this formula to determine whether the data can be updated in a single scan:

Bytes of aliased data must be ≤ *bus speed factor* times *scan time*

This table includes examples.

Controller Version	Communication Bus Factor	Scan Time (in ms)	Data can be Updated in a Single Scan if bytes of aliased data are
Tricon v9.0—v9.5	20	100	≤ 2000
Tricon v9.6 and later	100	150	≤ 15000

Network Speed and Loading

Network communication speeds are 10 to 100 megabits-per-second, which means that data transfer between the communication module and client is not usually affected by the physical network.

A 10-megabit-per-second Ethernet network with fewer than 15 nodes (less than 20 percent loading) should not experience throughput problems. (Network loading is the portion of the total network capacity that is currently being used.)

Performance Data

The performance data in this section indicates the type of performance you can anticipate. Actual performance will vary depending on the number of nodes on the network, the message size, and the client hardware and software.

The network used for testing included the following two nodes: a Tricon controller with two chassis, and a 486 PC (33 MHz) for ACM and NCM or a Pentium 4 PC (1.4 GHz) for TCM. The scan time for the Tricon system was 100 milliseconds. The PC used UDP/IP protocols and a sample application program.

Connection Performance

The connection was immediately followed by a disconnect. This operation was repeated 2,000 times in a tight loop. The time was measured by reading the PC clock before and after the loop. The time required for ACM and NCM to perform a connect followed by a disconnect was 28 milliseconds for UDP. For TCM, the time required perform a connect followed by a disconnect was 26 milliseconds for UDP.

Read Performance

Read performance was measured by using READ_TRICON_DATA (message type 11) and READ_TRICON_RSP (message type 12). In the test, a connection was opened, the PC clock was read, and the read request was executed in a tight loop 2,000 times followed by a PC clock read and a disconnect. The requests were for bin 12 (8 values) and bin 7 (130 values) with 4 bytes per value.

This table identifies an average read response time which includes the client request processing, network transmission time, and communication module processing. The average read time does not include the time to make the initial connection time between the client PC and Triconex controller.

Controller/ Communication Module	Number of Bytes	Average Read Time
Tricon ACM or NCM	502	19 milliseconds
Tricon TCM	502	1 milliseconds

Write Performance

Write performance was measured using WRITE_TRICON_DATA (message type 3) and WRITE_TRICON_DATA_RSP (message type 4). In this test, a connection was opened, the PC clock was read, and a write request and response was executed in a tight loop 200 times followed by a PC clock read and a disconnect. The requests were for bin 12 (8 values) and bin 10 (30 values) with 4 bytes per value.

This table identifies an average write response time which includes the client request processing, network transmission time, communication bus time, and MP response processing. The average write time does not include the time to make the initial connection time between the client PC and Triconex controller.

Controller/ Communication Module	Number of Bytes	Average Write Time
Tricon ACM or NCM	120	232 milliseconds
Tricon TCM	120	145 milliseconds

Response Codes

Every response sent by a Triconex controller in reply to an external device includes a code which indicates the result of the request. A response code of zero (0) indicates the message was successful. Other codes indicate specific errors.

Code	Description
0	Request was successful.
1	No buffer available to process the request. Retry the request.
2	Bin number specified in the request was not in the range from 0 to12.
3	The Triconex communication module is busy processing previous requests and cannot accept another request. This can happen if more than four WRITE_TRICON_DATA requests are outstanding at one time.
4	No MP is running.
5	TSX has rejected the request. The subReason field contains the specific reason.
6	Request to TSX timed out.
7	Invalid response from TX.
8	Message was too big.
9	Offset or numberOfValues in the request was invalid.
10	No control program (TriStation application).
11	Read-only port.
236	Bad SOE number.
237	Invalid SOE type.
238	Invalid SOE state.

E

Modbus Protocol

Overview

This appendix provides detailed information about Modbus protocol, which is a communication protocol used with serial ports to transmit data between a Modbus master and slave. Modbus protocol includes functions which define the message format for the query and response.

Query-Response Sessions

Modbus communication is a query-response session, in which the Modbus master initiates a query and a Modbus slave responds. In Modbus communication, a serial link transmits data in both directions, but in only one direction at a time.

A query-response session consists of these actions:

- The master sends a query to a slave.

- The master starts a fail-safe timer while it waits for the slave response. Typical slave response time is in hundreds of milliseconds.

- The slave returns a response to the master.

- The master waits until it has received the response from the slave before sending another query.

- If there is a slave response timeout, the master will retry the query. The number of retries and the timeout interval is configured by the MBCTRL function block.

Message Response Time

This section explains how to estimate the message response time, which is the total time for preparing, transmitting, receiving, and processing a Modbus query. Function blocks that are the least and most affected by scan time increases are also identified in this section.

Topics include:

-
-

Determining Message Response Time

This table explains how to estimate the number of milliseconds required for the message response time on a Triconex controller acting as a Modbus slave.

Modbus Operation	Equation or Constraints
Prepare Query (master)	Varies depending on the specific Modbus function (message) and any other program processing
Transmit Query (master)	(1000 ÷ Baud Rate) x Bits per Characters x Number of Characters

Receive and Process Query	Tricon EICM or TCM slave:
	    Writes: 3 x Scan Time
	    Reads: 10 milliseconds
	Trident MP slave:
	    Writes: 3 x Scan Time
	    Reads: 2 x Scan Time
	Trident CM slave:
	    Writes: 3 x Scan Time
	    Reads: 10 milliseconds

Transmit Response (slave) (in milliseconds)	(1000 ÷ Baud Rate) x Bits per Characters x Number of Characters
Process Response (master) (in milliseconds)	Depends on customer-provided equipment performance.
Time-Out and Retry Values	Varies depending on settings for the MBCTRL function block, which determines the time-out and retry values which can increase the message time. Message Response Time = the sum of all the results.

Modbus Functions and Scan Time

Modbus performance degrades slightly as the scan time of the controller increases.

When the controller acts as a slave, the functions most affected by scan time increases are:

- Force Single Coil (Function Code 05) on page 179
- Preset Single Register (Function Code 06) on page 180
- Force Multiple Coils (Function Code 15) on page 183
- Preset Multiple Registers (Function Code 16) on page 184

The functions least affected by scan time increases are:

- Read Coil Status Function (Function 01) on page 175
- Read Input Status (Function 02) on page 176
- Read Holding Registers (Function Code 03) on page 177
- Read Input Registers (Function Code 04) on page 178

Modbus Messages

This section describes the Modbus messages (query and response functions) supported by Triconex communication modules. The serial ports on Triconex communication modules support several Modbus message formats and functions (queries and responses).

Topics include:

Communication Modes

A Modbus serial link must use either the RTU or ASCII mode of communication. If both modes are available, you should choose RTU because it is more efficient and robust than ASCII. Each serial port can use a different communication mode, assuming that each port is connected to a separate Modbus master or slave device. If you configure a port for combination Modbus master and slave operation, you must use RTU mode.

RTU Mode

In RTU mode, data is sent in 8-bit binary characters. Gaps between characters cannot exceed three character times (the time it takes to send a character). RTU mode uses a 16-bit cyclic redundancy check (CRC) to detect transmission errors.

ASCII Mode

In ASCII mode, data is transmitted in pairs of ASCII characters. The first character is the ASCII representation of the most significant 4 bits of the corresponding RTU character. The second character is the ASCII representation of the least significant 4 bits of the corresponding RTU character. For example, the RTU character 01001111_2 ($4F_{16}$) is sent as the two ASCII characters 4 and F (34_{16} and 46_{16}). Each ASCII message has a colon at the beginning and a carriage return and line feed at the end. Gaps between characters in an ASCII message are not significant.

Function Names and Aliases

The starting address field of a Modbus message ranges from zero to one less than the number of coils or registers available.

A serial port of a Trident or Tricon communication module maps the Modbus starting address field to an alias by adding a constant determined by the function code, as shown in this table.

Function Name	Code	Coil or Register	Constant
Read Coil Status	01	Coil	1
Read Input Status	02	Coil	10001
Read Holding Registers	03	Register	40001
Read Input Registers	04	Register	30001
Force Single Coil	05	Coil	1
Preset Single Register	06	Register	40001
Read Exception Status	07	Coil	n/a
Loop Back Diagnostic Test	08	Register	n/a
Force Multiple Coils	15	Coil	1
Preset Multiple Registers	16	Register	40001

Modbus Message Formats

For each Modbus function, the message formats for RTU and ASCII modes are shown below.

RTU Mode

Bytes							
1	2	3	4	5	6	7	8
Station Address	Function Code	Data		Data		CRC	

ASCII Mode

Bytes																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		Function Code		Data				Data				LRC		CR	LF
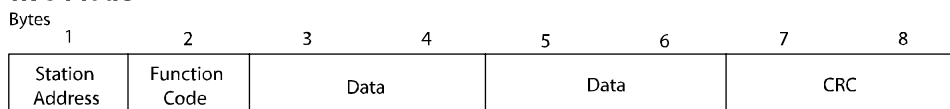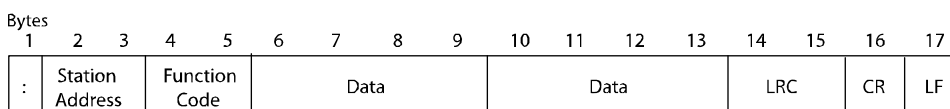
Figure 38   Modbus Message Formats for RTU and ASCII Modes

Message Header Field (ASCII Only)

The Message Header in ASCII mode is a colon (:) and is required. There is no message header in RTU mode.

Station Address Field

The Station Address field identifies the station to which a query is directed or the station that is sending a response. In RTU mode, the station address has one character (eight bits). In ASCII mode, the station address has two characters.

The range for station addresses is 1 through 247. Each station connected to a Modbus serial link must have a unique address. Station address 0 (zero) is the broadcast address and addresses all slaves. When a slave receives a query with the broadcast address, the slave processes the query but does not send a response.

Function Code Field

The Function Code field identifies the operation to be performed (the query), or the operation that was performed (the response). If the most significant bit of the function code in a response is 1, the response is an exception response. For more information, see Transmission Errors on page 185.

Data Fields

The Data fields contain information that is specific to the query or response. The length of the data varies, depending on the function code.

Checksum Field (CRC or LRC)

The Checksum field is a 16-bit word which is a CRC in RTU mode or an LRC in ASCII mode. The error check is performed by both the transmitting and the receiving units to detect transmission errors. For more information about error checking, see Transmission Errors on page 185. The following sections describe the error check calculations that are performed for CRC and LRC.

CRC Error Check — RTU Mode

During a CRC error check, the CRC-16 polynomial is used to compute a checksum for the entire message. The CRC-16 polynomial is:

$$x^{16} + x^{15} + x^2 + 1$$

The CRC is computed across the station address, the function code, and the data and appended to the end of the message.

LRC Error Check — ASCII Mode

The LRC checksum is an 8-bit binary number represented and transmitted as two ASCII hexadecimal characters. The checksum is produced in this manner:

- The hex characters that comprise the content of a message are converted to binary notation. The colon, carriage return, and line feed are ignored.

- The binary characters are summed without wrap-around carry.

- The resulting sum is negated.

This table shows how to calculate the LRC for the sample message shown in Sample Query and Response Messages on page 173.

Message Content				Checksum Calculation	
Address	0	2		0000	0010
Function Code	0	1		0000	0001
Starting Address (H.O.)	0	0		0000	0000
Starting Address (L.O.)	1	3		0001	0011
Quantity of Points (H.O.)	0	0		0000	0000
Quantity of Points (L.O.)	2	5	+	0010	0101
				0011	1011
One's-Complement:				1100	0100
Add 1:			+	0000	0001
Two's-Complement:				1100	0101
Error Check				C	5

CR Field and LF Field (ASCII Only)

The CR field contains an ASCII carriage return and the LF field contains an ASCII line feed.

Sample Query and Response Messages

This table shows the content of a sample query and response in RTU and ASCII modes. The query is a Read Input Status (Function 02) requesting 37 (25_{16}) points starting at point 20 (13_{16} + 1). The response packs the 37 points into five 8-bit bytes, and clears the three high-order bits of the last byte.

Query Message	RTU		ASCII	
Header	None		:	
Station Address	0000	0010	0	2
Function Code	0000	0001	0	1
Starting Address (High Order)	0000	0000	0	0
Starting Address (Low Order)	0001	0011	1	3
Number of Points (High Order)	0000	0000	0	0
Number of Points (Low Order)	0010	0101	2	5
Error Check	0000	1100	C	5
	0010	0111		
Trailer	None		CR	LF

Response Message	RTU		ASCII	
Header	None		:	
Station Address	0000	0010	0	2
Function Code	0000	0001	0	1
Byte Count	0000	0101	0	5
Data Byte 1	<u>1</u>100[1]	110<u>1</u>[2]	C	D
Data Byte 2	0110	1011	6	B
Data Byte 3	1011	0010	B	2
Data Byte 4	0000	1110	0	E
Data Byte 5	0001	1011	1	B
Error Check	0000	0100	E	5
	1111	1111		
Trailer	None		CR	LF

1. The underscored digit indicates that Coil #27 is in the On state.
2. The underscored digit indicates that Coil #20 is in the On state.

Modbus Message Lengths

The length of a Modbus message depends on the function being used and whether the message is a query or a response.

This table shows the Modbus query message lengths per function:

Function Code	Query	Number of RTU Characters	Number of ASCII Characters
01	Read Coil Status	8	17
02	Read Input Status	8	17
03	Read Holding Registers	8	17
04	Read Input Registers	8	17
05	Force Single Coil	8	17
06	Preset Single Register	8	17
15	Force Multiple Coils	9 + (1 per 8 coils)	19 + (2 per 8 coils)
16	Preset Multiple Registers	9 + (2 per register)	19 + (4 per register)

This table shows the Modbus response message lengths per function:

Function Code	Response	Number of RTU Characters	Number of ASCII Characters
01	Read Coil Status	5 + (1 per 8 coils)	11 + (2 per 8 coils)
02	Read Input Status	5 + (1 per 8 coils)	11 + (2 per 8 coils)
03	Read Holding Registers	5 + (2 per register)	11 + (4 per register)
04	Read Input Register	5 + (2 per register)	11 + (4 per register)
05	Force Single Coil	8	17
06	Preset Single Register	8	17
15	Force Multiple Coils	8	17
16	Preset Multiple Registers	8	17

Modbus Functions

This section includes details on Modbus functions.

Functions include:

Read Coil Status Function (Function 01)

Query Format

The Read Coil Status query requests the On/Off status of a group of logic coils from a station. You can request the status of as many as 2,000 coils with each query, but some Modbus devices have lower limits. The coils are numbered starting at 0; for example, coil 0 is alias 1, coil 1 is alias 2, and so forth.

The Read Coil Status query is also known as the Read Output Status query.

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0001	Starting Address		Number of Coils		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	1	Starting Address				Number of Coils				LRC		CR	LF

Response Format

The Read Coil Status response data is packed with one bit for each coil, where 1=On, and 0=Off. The low-order bit of the first RTU character contains the status of the first coil. For coil quantities that are not even multiples of eight, the last RTU character is zero-filled at the high-order end.

RTU Mode

Bytes

1	2	3	4		n	n+1	n+2
Station Address	0000 0001	Data Length	Data		Data	CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8		n	n+1	n+2	n+3	n+4
:	Station Address	0	1	Data Length	Data				Data	LRC		CR	LF

Read Input Status (Function 02)

Query Format

The Read Input Status function operates in the same manner as Read Coil Status (Function Code 01), except that the status of digital inputs is obtained. Inputs are also numbered starting at 0. For example, input status 0 is alias 10001, input status 1 is alias 10002, and so forth. You can request the status of as many as 2,000 coils with each query, but some Modbus devices have lower limits.

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0010	Starting Address		Number of Input Points		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address	0	2	Starting Addresses					Number of Input Points				LRC		CR	LF

Response Format

RTU Mode

Bytes

1	2	3	4		n	n+1	n+2
Station Address	0000 0010	Data Length	Data		Data	CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8		n	n+1	n+2	n+3	n+4
:	Station Address	0	2	Data Length	Data				Data	LRC		CR	LF

Read Holding Registers (Function Code 03)

Query Format

The Read Holding Registers query requests the binary content of holding registers from a station. You can request the status of as many as 125 registers with each query, but some Modbus devices have lower limits. The registers are numbered beginning with 0. For example, register 0 is alias 40001, register 1 is alias 40002, and so forth.

The Read Holding Registers query is also known as the Read Output Registers query.

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0011	Starting Address		Number of Registers		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	3	Starting Address				Number of Registers				LRC		CR	LF

Response Format

The Read Holding Registers response data consists of two bytes for each register queried, with the binary content right-justified. The leftmost character includes the high-order bits, and the rightmost character includes the low-order bits.

RTU Mode

Bytes

1	2	3	4	n	n+1	n+2
Station Address	0000 0011	Data Length	Data	Data	CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	n	n+1	n+2	n+3	n+4
:	Station Address		0	3	Data Length		Data	Data	LRC		CR	LF

Read Input Registers (Function Code 04)

Query Format

The Read Input Registers function operates in the same manner as the Read Holding Registers query (Function Code 03), except that it obtains the status of input registers. You can request the status of as many as 125 registers with each query, but some Modbus devices have lower limits. The registers are numbered beginning with 0. For example, register 0 is alias 30001, register 1 is alias 30002, and so forth.

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0100	Starting Address		Number of Registers		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	4	Starting Address				Number of Registers				LRC		CR	LF

Response Format

RTU Mode

Bytes

1	2	3	4		n	n+1	n+2
Station Address	0000 0100	Data Length	Data		Data	CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8		n	n+1	n+2	n+3	n+4
:	Station Address		0	4	Data Length		Data		Data	LRC		CR	LF

Force Single Coil (Function Code 05)

Query Format

The Force Single Coil function turns a single coil On or Off, depending on its current state. Because the slave is actively scanning, it can also alter the state of the coil (unless the coil is disabled). Coils are numbered beginning with 0; for example, coil 0 is alias 1, coil 1 is alias 2, and so forth.

A coil value of 65,280 ($FF00_{16}$) turns the coil On, and a coil value of zero (0000_{16}) turns the coil Off. All other values are illegal and do not affect the coil. If the query contains legal values, the slave responds after the coil state has been altered.

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0101	Address to Modify		Coil Value		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	5	Address to Modify				Coil Value				LRC		CR	LF

Response Format

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0101	Address Modified		Coil Value		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	5	Address Modified				Coil Value				LRC		CR	LF

Preset Single Register (Function Code 06)

The Preset Single Register function modifies the content of one holding register. Because the slave is actively scanning, it can also alter the register's content. Register values are 16 bits. Holding registers are numbered starting at 0; for example, register 0 is alias 40001, register 1 is alias 40002.

Query Format

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0101	Address to Modify		Register Value		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	5	Address to Modify				Register Value				LRC		CR	LF

Response Format

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 0110	Address to Modify		Register Value		CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	6	Address to Modify				Register Value				LRC		CR	LF

Read Exception Status (Function Code 07)

Query Format

The Read Exception Status function returns the status of eight coils from the slave application running in the controller. Which coils and what they represent depends on the slave. When a serial port, configured as a slave, responds to this query, it sends the status of the first eight coils (aliases 00001 through 00008) defined in the application. Coils are numbered from 0; for example, coil 0 is alias 1, coil 1 is alias 2, and so forth. The status of each coil is packed in the data field, one bit for each coil (1=On, 0=Off). You can program these coils to hold any type of information; for example, machine on or off, heads retracted, safeties satisfied, and receipt-in-process error conditions.

Note   A TCM serial port configured as a Modbus master cannot use the Read Exception Status function.

RTU Mode

Bytes

1	2	3	4
Station Address	0000 0111	CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9
:	Station Address		0	7	LRC		CR	LF

Response Format

RTU Mode

Bytes

1	2	3	4	5
Station Address	0000 0111	Coil Data	CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11
:	Station Address		0	7	Coil Data		LRC		CR	LF

Loop-Back Diagnostic Test (Function 08)

Query Format

The Loop-Back Diagnostics Test query tests the communications link between the Modbus master and slave. This query does not affect point values in the slave. When the serial port acting as a slave receives this query, it re-transmits the query as the response.

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 1000	Data				CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	8	Data								LRC		CR	LF

Response Format

RTU Mode

Bytes

1	2	3	4	5	6	7	8
Station Address	0000 1000	Data				CRC	

ASCII Mode

Bytes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
:	Station Address		0	8	Data								LRC		CR	LF

Note   A EICM or TCM serial port configured as a Modbus Master cannot use the Loop-Back Diagnostic Test function.

Force Multiple Coils (Function Code 15)

Query Format

The Force Multiple Coils query sets each coil in a consecutive block of coils to the specified state (On or Off) regardless of whether the coils are enabled or disabled. Because the slave is actively scanning, it can also alter the state of a coil (unless it is disabled). Coils are numbered from 0; for example, coil 0 is alias 1, coil 1 is alias 2, and so forth. The status of each coil is packed in the data field, one bit for each coil (1=On, 0=Off).

A single Force Multiple Coils query can set a maximum of 128 coils. The query-response time required by some Modbus masters might require a much smaller quantity.

RTU Mode

Bytes

1	2	3 4	5 6	7	8		n	n+1 n+2
Station Address	0000 1111	Starting Address	Quantity	Byte Count	Coil Data		Coil Data	CRC

ASCII Mode

Bytes

1	2 3	4	5	6 7 8 9	10 11 12 13	14 15	16 17		n	n+1 n+2	n+3 n+4
:	Station Address	0	F	Starting Address	Quantity	Byte Count	Coil Data		Coil Data	LRC	CR LF

Response Format

RTU Mode

Bytes

1	2	3 4	5 6	7	8		n	n+1 n+2
Station Address	0000 1111	Starting Address	Quantity	Byte Count	Coil Data		Coil Data	CRC

ASCII Mode

Bytes

1	2 3	4	5	6 7 8 9	10 11 12 13	14 15	16 17		n	n+1 n+2	n+3 n+4
:	Station Address	0	F	Starting Address	Quantity	Byte Count	Coil Data		Coil Data	LRC	CR LF

Preset Multiple Registers (Function Code 16)

Query Format

The Preset Multiple Registers query can change the contents of a maximum of 60 consecutive holding registers, however, some Modbus devices have lower limits. Because the slave is actively scanning, it can also alter the state of the registers (unless they are disabled). The values are provided in binary code up to the maximum valid register value of the controller (16-bit for Trident). Unused high-order bits must be set to zero. The registers are numbered beginning with 0; for example, register 0 is alias 40001, register 1 is alias 40002, and so forth.

RTU Mode

Bytes

1	2	3 4	5 6	7	8	n	n+1 n+2
Station Address	0001 0000	Starting Address	Quantity	Byte Count	Register Data	Register Data	CRC

ASCII Mode

Bytes

1	2 3	4	5	6 7 8 9 10 11 12 13	14 15	16 17	n	n+1 n+2	n+3 n+4
:	Station Address	1	0	Starting Address · Quantity	Byte Count	Register Data	Register Data	LRC	CR LF

Response Format

RTU Mode

Bytes

1	2	3 4	5 6	7 8
Station Address	0001 0000	Starting Address	Quantity	CRC

ASCII Mode

Bytes

1	2 3	4	5	6 7 8 9	10 11 12 13	14 15	16	17
:	Station Address	1	0	Starting Address	Quantity	LRC	CR	LF

Transmission Errors and Exception Conditions

During Modbus communication, transmission errors and exception conditions can occur. Transmission errors do not cause exception conditions and are not acknowledged by Modbus slaves. Programming and operation errors do cause exception conditions which elicit exception responses from slaves.

Topics include:

- Transmission Errors on page 185
- Exception Conditions on page 185
- Exception Responses on page 186

Transmission Errors

The most frequent cause of transmission errors is noise. Noise sources include improperly installed or broken connectors, damaged cables, electrical equipment such as generators and elevators, and lightning. Transmission errors can be detected through the use of character framing, parity checking, and redundancy checking.

When a slave detects a transmission error, it does not act on or respond to the message. The master assumes a communications error has occurred if there is no response within a specified time, usually three seconds.

Parity checking helps detect single-bit transmission errors. However, if there are two errors within a single character, parity checking cannot detect a change. For example, if 1100 0100 is distorted to 1111 0100, the number of 1 bits in the data is still odd.

Modbus protocol provides several levels of error checking in order to assure the accuracy of data transmission. To detect multiple bit errors, the system uses cyclic redundancy check (CRC) for RTU mode, or longitudinal redundancy check (LRC) for ASCII mode. For more information, see Checksum Field (CRC or LRC) on page 171.

Exception Conditions

If a master detects an exception in a response to a query or does not receive a response, it takes appropriate actions, which usually includes re-transmitting the query. This table lists exception conditions that are returned by the slave if a programming or operation error causes a master to send an incorrect query.

Exception Condition	Description
Query Message CRC or LRC Error	The slave does not respond, because the error could be in the station address. The master uses its response fail-safe timer to recover.
Query Function Code Error	The slave sends an Illegal Function (01) response code when it detects an error in the function code field.
Query Address Error	The slave sends an Illegal Data Address (02) response code when it detects an error in the starting address field.

Exception Condition	Description
Query Data Error	The slave sends an Illegal Data Value (03) response code when it detects an error in the data field.
Main Processors Not Communicating	This exception applies only to serial ports configured as slaves.
	If the slave port receives a query requiring a data exchange and it cannot communicate with the Main Processors, it sends a Busy, Reject Message (06) response code and turns off the Active indicator on the communication module.
Remote Write Disabled	The slave port sends a Busy, Reject Message (06) response code if a master sends one of these queries and the slave port is not enabled for remote (external) writes: • Force Single Coil (Function Code 05) • Preset Single Register (Function Code 06) • Force Multiple Coils (Function Code 15) • Preset Multiple Registers (Function Code 16)

Exception Responses

When a slave detects an exception condition, it sends a response message to the master consisting of the slave's station address, function code, error code, and error-check fields. To indicate that the message is an exception response, the slave sets the high-order bit of the function code to 1. The example shows an exception response to a Preset Multiple Registers query.

Sample Query

RTU Mode

Bytes

1	2	3 4	5 6	7	8	n	n+1 n+2
Station Address	0001 0000	Starting Address	Quantity	Byte Count	Register Data	Register Data	CRC

ASCII Mode

Bytes

1	2 3	4	5	6 7 8 9	10 11 12 13	14 15	16 17	n	n+1 n+2	n+3	n+4
:	Station Address	1	0	Starting Address	Quantity	Byte Count	Register Data	Register Data	LRC	CR	LF

Sample Exception Response

RTU Mode

Bytes

1	2	3 4	5 6
Station Address	1001 0000	Exception Code	CRC

ASCII Mode

Bytes

1	2 3	4	5	6 7 8 9	10 11	12	13
:	Station Address	9	0	Exception Code	LRC	CR	LF

Exception Response Codes

This table lists exception response codes which are sent by the slave after an invalid query.

Code	Name	Description
01	Illegal Function	The requested function is not in the slave's repertoire.
02	Illegal Data Address	The alias in the query does not exist in the slave.
03	Illegal Data Value	The value is not in the range allowed for the alias.
04	Failure in Associated Device	The slave failed to respond to a message or an error that occurred in the controller. When a master receives this response code, it must issue a supervisory alert.
05	Acknowledge	A slave port does not send this exception response code.
06	Busy, Rejected Message	The query was received without error, but the slave cannot comply.
07	Negative Acknowledge	A slave port does not send this exception response code.
08	Memory Parity Error	A slave port does not send this exception response code.

F

Tricon System Aliases

Overview of Tricon Aliases and Variables

System aliases are used in the place of system variables to access data in a Tricon controller from a Modbus master or another external computer. System aliases provide the same information to external hosts that system variables provide to TriStation 1131 applications.

There are three general classes of variables and aliases used by a Tricon system: input/output (I/O), memory, and system.

- I/O aliases are automatically assigned by the Tricon when a user installs or moves a module in a chassis.
- Memory aliases must be assigned by the programmer according to the convention shown in this section.
- System aliases are predefined by Triconex and cannot be changed.

Alias numbers consist of five digits according to this convention.

Digit 1 (Modbus data type)	Digits 2 to 5
0 = Read/write discrete (coil)	Address of variable
1 = Read-only discrete (input coil)	
3 = Read-only register (input register)	
4 = Read/write register (holding register)	

Tricon Modbus Alias Ranges

This table lists the Modbus alias ranges for Tricon. An asterisk (*) means Modbus SOE data can be retrieved through the EICM or TCM.

Class	Point Type	Message Type	Alias Range	Auto-Assigned	User-Assigned	Pre-Defined
Input	Discrete	Read-only	10001-12000	✓		
Input	Integer	Read-only	30001-31000	✓		
Input	Real	Read-only	32001-32120	✓		
Output	Discrete	Read/write	00001-02000	✓		
Output	Integer	Read/write	40001-40250	✓		
Memory	Discrete	Read/write	02001-04000		✓	
Memory	Discrete	Read-only	12001-14000		✓	
Memory	Integer	Read-only	31001-32000		✓	
System	Integer *	Read-only	38001-38999	✓		
Memory	Integer	Read/write	40251-41000		✓	
System	Integer *	Read/write	48001-48002	✓		
Memory	Real	Read-only	33001-34000		✓	
Memory	Real	Read/write	41001-42000		✓	

Class	Point Type	Message Type	Alias Range	Auto-Assigned	User-Assigned	Pre-Defined
System	Discrete	Read-only	14001-19999			✓
System	Integer	Read-only	39001-39999			✓
Memory	Integer	Read-only	38000-39630	✓		
Memory	Discrete	Read-only	18001-19999	✓		

System Variables Naming Convention

System variables are named according to this convention (applicable only for those systems using TriStation MSW).

Characters 1 and 2	Characters 3 and 4	Characters 5 and 6	Character 8
$S	Chassis number	Physical slot number	A = Active indicator B = Load/fuse indicator F = Fault indicator I = Installed P = Pass indicator

To determine a system variable name, first determine the logical slot number, then look up its physical slot number in the appropriate chassis type as shown here. For example, the system variable name for the Pass Indicator in Chassis 1, Slot 4 is $S0104P.

For all slots except the MP, RXM and COM slots, one logical slot number corresponds to two physical slot numbers. The physical slot number is used to determine the system variable name for that slot.

High-Density Logical and Physical Slot Numbers

This table identifies the logical and physical slot numbers for the high-density chassis.

Main Chassis and RXM		Expansion	
Logical Slot	Physical Slot	Logical Slot	Physical Slot
Comm or Blank	4	1	1, 2
2	5, 6	2	3, 4
3	7, 8	3	5, 6
4	9, 10	4	7, 8
5	11, 12	5	9, 10
6	13, 14	6	11, 12
7	15, 16	7	13, 14
		8	15, 16

Low-Density Logical and Physical Slot Numbers

This table identifies the logical and physical slot numbers for the low-density chassis.

Main Chassis and RXM		Expansion	
Logical Slot	Physical Slot	Logical Slot	Physical Slot
1	5,6	1	3, 4
2	7, 8	2	5, 6
3	9, 10	3	7, 8
4	11, 12	4	9, 10
		5	11, 12

Main Processor Status Aliases

This table lists the system aliases for the MP status.

Variable	Alias	Description
$MPMain	14001	Main Processor fault - Main Chassis alarm ON
$MPBad	14002	2 EMPs faulted - Tricon in simplex mode
$ArithE	14003	Arithmetic error during scan
$DivBy0	14004	Integer or real divided by zero
$OvrFlw	14005	Floating-point overflow
$UdrFlw	14006	Floating-point underflow
$BadPrm	14008	Parameter out of range
$PwrUp	14009	All EMPs reset - first scan after power-up
$FrstSc	14010	First scan after power-up or halt
EMP-A pass	14011	Pass indicator of Main Processor A
EMP-A fault	14012	Fault indicator of Main Processor A
EMP-A active	14013	Active indicator of Main Processor A
EMP-A maint2	14014	Maintenance 2 on Main Processor A
EMP-A maint1	14015	Maintenance 1 on Main Processor A
EMP-B pass	14017	Pass indicator of Main Processor A
EMP-B fault	14018	Fault indicator of Main Processor B
EMP-B active	14019	Active indicator of Main Processor B
EMP-B maint2	14020	Maintenance 2 on Main Processor B
EMP-B maint1	14021	Maintenance 1 on Main Processor B

EMP-C pass	14023	Pass indicator of Main Processor C
EMP-C fault	14024	Fault indicator of Main Processor C
EMP-C active	14025	Active indicator of Main Processor C
EMP-C maint2	14026	Maintenance 2 on Main Processor C
EMP-C maint1	14027	Maintenance 1 on Main Processor C
$IOMain	14029	1 Comm bus leg or 1 MP not functioning
$IOBad	14030	I/O module is running in simplex mode
$WRTENB	14031	Writes from external devices are enabled.

EICM Status Aliases

This table lists the aliases for the EICM module status.

Variable	Alias	Description
$rdy05	14229	Printer ready Port 05
$rdy10	14234	Printer ready Port 10
$ovfl05	14245	Printer overflow Port 05
$ovfl10	14250	Printer overflow Port 10

Chassis Upper Power Supply Fault Aliases

This table lists the aliases that identify whether there is a chassis upper power supply fault.

Variable	Alias	Description
$R01V1L	14162	Chassis 1 Upper Power Supply Fault
$R02V1L	14163	Chassis 2 Upper Power Supply Fault
$R03V1L	14164	Chassis 3 Upper Power Supply Fault
$R04V1L	14165	Chassis 4 Upper Power Supply Fault
$R05V1L	14166	Chassis 5 Upper Power Supply Fault
$R06V1L	14167	Chassis 6 Upper Power Supply Fault
$R07V1L	14168	Chassis 7 Upper Power Supply Fault
$R08V1L	14169	Chassis 8 Upper Power Supply Fault
$R09V1L	14170	Chassis 9 Upper Power Supply Fault
$R10V1L	14171	Chassis 10 Upper Power Supply Fault
$R11V1L	14172	Chassis 11 Upper Power Supply Fault

Variable	Alias	Description
$R12V1L	14173	Chassis 12 Upper Power Supply Fault
$R13V1L	14174	Chassis 13 Upper Power Supply Fault
$R14V1L	14175	Chassis 14 Upper Power Supply Fault
$R15V1L	14176	Chassis 15 Upper Power Supply Fault

Chassis Lower Power Supply Fault Status

This table lists the aliases that identify whether there is a chassis lower power supply fault.

Variable	Alias	Description
$R01V2L	14178	Chassis 1 Lower Power Supply Fault
$R02V2L	14179	Chassis 2 Lower Power Supply Fault
$R03V2L	14180	Chassis 3 Lower Power Supply Fault
$R04V2L	14181	Chassis 4 Lower Power Supply Fault
$R05V2L	14182	Chassis 5 Lower Power Supply Fault
$R06V2L	14183	Chassis 6 Lower Power Supply Fault
$R07V2L	14184	Chassis 7 Lower Power Supply Fault
$R08V2L	14185	Chassis 8 Lower Power Supply Fault
$R09V2L	14186	Chassis 9 Lower Power Supply Fault
$R10V2L	14187	Chassis 10 Lower Power Supply Fault
$R11V2L	14188	Chassis 11 Lower Power Supply Fault
$R12V2L	14189	Chassis 12 Lower Power Supply Fault
$R13V2L	14190	Chassis 13 Lower Power Supply Fault
$R14V2L	14191	Chassis 14 Lower Power Supply Fault
$R15V2L	14192	Chassis 15 Lower Power Supply Fault

Chassis Requires Maintenance Aliases

This table lists the aliases that identify whether the chassis requires maintenance.

Variable	Alias	Description
$R01Mnt	14194	Chassis 1 Requires Maintenance
$R02Mnt	14195	Chassis 2 Requires Maintenance
$R03Mnt	14196	Chassis 3 Requires Maintenance
$R04Mnt	14197	Chassis 4 Requires Maintenance
$R05Mnt	14198	Chassis 5 Requires Maintenance
$R06Mnt	14199	Chassis 6 Requires Maintenance
$R07Mnt	14200	Chassis 7 Requires Maintenance
$R08Mnt	14201	Chassis 8 Requires Maintenance
$R09Mnt	14202	Chassis 9 Requires Maintenance
$R10Mnt	14203	Chassis 10 Requires Maintenance
$R11Mnt	14204	Chassis 11 Requires Maintenance
$R12Mnt	14205	Chassis 12 Requires Maintenance
$R13Mnt	14206	Chassis 13 Requires Maintenance
$R14Mnt	14207	Chassis 14 Requires Maintenance
$R15Mnt	14208	Chassis 15 Requires Maintenance

Chassis Has Active Board with Fault Aliases

This table lists the aliases that identify whether the chassis has an active board with a fault.

Variable	Alias	Description
$R01Bad	14210	Chassis 1 Has Active Board with Fault
$R02Bad	14211	Chassis 2 Has Active Board with Fault
$R03Bad	14212	Chassis 3 Has Active Board with Fault
$R04Bad	14213	Chassis 4 Has Active Board with Fault
$R05Bad	14214	Chassis 5 Has Active Board with Fault
$R06Bad	14215	Chassis 6 Has Active Board with Fault
$R07Bad	14216	Chassis 7 Has Active Board with Fault
$R08Bad	14217	Chassis 8 Has Active Board with Fault
$R09Bad	14218	Chassis 9 Has Active Board with Fault
$R10Bad	14219	Chassis 10 Has Active Board with Fault
$R11Bad	14220	Chassis 11 Has Active Board with Fault
$R12Bad	14221	Chassis 12 Has Active Board with Fault
$R13Bad	14222	Chassis 13 Has Active Board with Fault
$R14Bad	14223	Chassis 14 Has Active Board with Fault
$R15Bad	14224	Chassis 15 Has Active Board with Fault

Slot Status

These tables list the aliases that identify the slot status.

Chassis 1 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 1.

Variable	Alias	Description
$S0104P	14420	Chassis 1 Slot 4 Pass Indicator
$S0105P	14421	Chassis 1 Slot 5 Pass Indicator
$S0106P	14422	Chassis 1 Slot 6 Pass Indicator
$S0107P	14423	Chassis 1 Slot 7 Pass Indicator
$S0108P	14424	Chassis 1 Slot 8 Pass Indicator

Chassis 1 Fault Indicator Aliases

This table lists the aliases that identify the Fault indicators for chassis 1.

Variable	Alias	Description
$S0104F	14436	Chassis 1 Slot 4 Fault Indicator
$S0105F	14437	Chassis 1 Slot 5 Fault Indicator
$S0106F	14438	Chassis 1 Slot 6 Fault Indicator
$S0107F	14439	Chassis 1 Slot 7 Fault Indicator
$S0108F	14440	Chassis 1 Slot 8 Fault Indicator
$S0109F	14441	Chassis 1 Slot 9 Fault Indicator
$S0110F	14442	Chassis 1 Slot 10 Fault Indicator
$S0111F	14443	Chassis 1 Slot 11 Fault Indicator
$S0112F	14444	Chassis 1 Slot 12 Fault Indicator
$S0113F	14445	Chassis 1 Slot 13 Fault Indicator
$S0114F	14446	Chassis 1 Slot 14 Fault Indicator
$S0115F	14447	Chassis 1 Slot 15 Fault Indicator
$S0116F	14448	Chassis 1 Slot 16 Fault Indicator

Chassis 1 Active Indicator Aliases

This table lists the aliases that identify the Active indicators for chassis 1.

Variable	Alias	Description
$S0104A	14452	Chassis 1 Slot 4 Active Indicator
$S0105A	14453	Chassis 1 Slot 5 Active Indicator
$S0106A	14454	Chassis 1 Slot 6 Active Indicator
$S0107A	14455	Chassis 1 Slot 7 Active Indicator
$S0108A	14456	Chassis 1 Slot 8 Active Indicator
$S0109A	14457	Chassis 1 Slot 9 Active Indicator
$S0110A	14458	Chassis 1 Slot 10 Active Indicator
$S0111A	14459	Chassis 1 Slot 11 Active Indicator
$S0112A	14460	Chassis 1 Slot 12 Active Indicator
$S0113A	14461	Chassis 1 Slot 13 Active Indicator
$S0114A	14462	Chassis 1 Slot 14 Active Indicator
$S0115A	14463	Chassis 1 Slot 15 Active Indicator
$S0116A	14464	Chassis 1 Slot 16 Active Indicator

Chassis 1 Load/Fuse Indicator Aliases

This table lists the aliases that identify the Load/Fuse indicators for chassis 1.

Variable	Alias	Description
$S0105B	14469	Chassis 1 Slot 5 Load/Fuse Indicator
$S0106B	14470	Chassis 1 Slot 6 Load/Fuse Indicator
$S0107B	14471	Chassis 1 Slot 7 Load/Fuse Indicator
$S0108B	14472	Chassis 1 Slot 8 Load/Fuse Indicator
$S0109B	14473	Chassis 1 Slot 9 Load/Fuse Indicator
$S0110B	14474	Chassis 1 Slot 10 Load/Fuse Indicator
$S0111B	14475	Chassis 1 Slot 11 Load/Fuse Indicator
$S0112B	14476	Chassis 1 Slot 12 Load/Fuse Indicator
$S0113B	14477	Chassis 1 Slot 13 Load/Fuse Indicator
$S0114B	14478	Chassis 1 Slot 14 Load/Fuse Indicator
$S0115B	14479	Chassis 1 Slot 15 Load/Fuse Indicator

Chassis 1 Installed Aliases

This table lists the aliases that identify whether slots are installed for chassis 1.

Variable	Alias	Description
$S0104I	14484	Chassis 1 Slot 4 Installed
$S0105I	14485	Chassis 1 Slot 5 Installed
$S0106I	14486	Chassis 1 Slot 6 Installed
$S0107I	14487	Chassis 1 Slot 7 Installed
$S0108I	14488	Chassis 1 Slot 8 Installed
$S0109I	14489	Chassis 1 Slot 9 Installed
$S0110I	14490	Chassis 1 Slot 10 Installed
$S0111I	14491	Chassis 1 Slot 11 Installed
$S0112I	14492	Chassis 1 Slot 12 Installed
$S0113I	14493	Chassis 1 Slot 13 Installed
$S0114I	14494	Chassis 1 Slot 14 Installed
$S0115I	14495	Chassis 1 Slot 15 Installed
$S0116I	14496	Chassis 1 Slot 16 Installed

Chassis 2 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 2.

Variable	Alias	Description
$S0201P	14513	Chassis 2 Slot 1 Pass Indicator
$S0202P	14514	Chassis 2 Slot 2 Pass Indicator
$S0203P	14515	Chassis 2 Slot 3 Pass Indicator
$S0204P	14516	Chassis 2 Slot 4 Pass Indicator
$S0205P	14517	Chassis 2 Slot 5 Pass Indicator
$S0206P	14518	Chassis 2 Slot 6 Pass Indicator
$S0207P	14519	Chassis 2 Slot 7 Pass Indicator
$S0208P	14520	Chassis 2 Slot 8 Pass Indicator
$S0209P	14521	Chassis 2 Slot 9 Pass Indicator
$S0210P	14522	Chassis 2 Slot 10 Pass Indicator
$S0211P	14523	Chassis 2 Slot 11 Pass Indicator
$S0212P	14524	Chassis 2 Slot 12 Pass Indicator
$S0213P	14525	Chassis 2 Slot 13 Pass Indicator
$S0214P	14526	Chassis 2 Slot 14 Pass Indicator
$S0215P	14527	Chassis 2 Slot 15 Pass Indicator
$S0216P	14528	Chassis 2 Slot 16 Pass Indicator

Chassis 2 Fault Indicator Aliases

This table lists the aliases that identify the Fault indicators for chassis 2.

Variable	Alias	Description
$S0201F	14529	Chassis 2 Slot 1 Fault Indicator
$S0202F	14530	Chassis 2 Slot 2 Fault Indicator
$S0203F	14531	Chassis 2 Slot 3 Fault Indicator
$S0204F	14532	Chassis 2 Slot 4 Fault Indicator
$S0205F	14533	Chassis 2 Slot 5 Fault Indicator
$S0206F	14534	Chassis 2 Slot 6 Fault Indicator
$S0207F	14535	Chassis 2 Slot 7 Fault Indicator
$S0208F	14536	Chassis 2 Slot 8 Fault Indicator
$S0209F	14537	Chassis 2 Slot 9 Fault Indicator
$S0210F	14538	Chassis 2 Slot 10 Fault Indicator

Variable	Alias	Description
$S0211F	14539	Chassis 2 Slot 11 Fault Indicator
$S0212F	14540	Chassis 2 Slot 12 Fault Indicator
$S0213F	14541	Chassis 2 Slot 13 Fault Indicator
$S0214F	14542	Chassis 2 Slot 14 Fault Indicator
$S0215F	14543	Chassis 2 Slot 15 Fault Indicator
$S0216F	14544	Chassis 2 Slot 16 Fault Indicator

Chassis 2 Active Indicator Aliases

This table lists the aliases that identify the Active indicators for chassis 2.

Variable	Alias	Description
$S0201A	14545	Chassis 2 Slot 1 Active Indicator
$S0202A	14546	Chassis 2 Slot 2 Active Indicator
$S0203A	14547	Chassis 2 Slot 3 Active Indicator
$S0204A	14548	Chassis 2 Slot 4 Active Indicator
$S0205A	14549	Chassis 2 Slot 5 Active Indicator
$S0206A	14550	Chassis 2 Slot 6 Active Indicator
$S0207A	14551	Chassis 2 Slot 7 Active Indicator
$S0208A	14552	Chassis 2 Slot 8 Active Indicator
$S0209A	14553	Chassis 2 Slot 9 Active Indicator
$S0210A	14554	Chassis 2 Slot 10 Active Indicator
$S0211A	14555	Chassis 2 Slot 11 Active Indicator
$S0212A	14556	Chassis 2 Slot 12 Active Indicator
$S0213A	14557	Chassis 2 Slot 13 Active Indicator
$S0214A	14558	Chassis 2 Slot 14 Active Indicator
$S0215A	14559	Chassis 2 Slot 15 Active Indicator
$S0216A	14560	Chassis 2 Slot 16 Active Indicator

Chassis 2 Load/Fuse Indicator Aliases

This table lists the aliases that identify the Load/Fuse indicators for chassis 2.

Variable	Alias	Description
$S0201B	14561	Chassis 2 Slot 1 Load/Fuse Indicator
$S0202B	14562	Chassis 2 Slot 2 Load/Fuse Indicator
$S0203B	14563	Chassis 2 Slot 3 Load/Fuse Indicator
$S0204B	14564	Chassis 2 Slot 4 Load/Fuse Indicator
$S0205B	14565	Chassis 2 Slot 5 Load/Fuse Indicator
$S0206B	14566	Chassis 2 Slot 6 Load/Fuse Indicator
$S0207B	14567	Chassis 2 Slot 7 Load/Fuse Indicator
$S0208B	14568	Chassis 2 Slot 8 Load/Fuse Indicator
$S0209B	14569	Chassis 2 Slot 9 Load/Fuse Indicator
$S0210B	14570	Chassis 2 Slot 10 Load/Fuse Indicator
$S0211B	14571	Chassis 2 Slot 11 Load/Fuse Indicator
$S0212B	14572	Chassis 2 Slot 12 Load/Fuse Indicator
$S0213B	14573	Chassis 2 Slot 13 Load/Fuse Indicator
$S0214B	14574	Chassis 2 Slot 14 Load/Fuse Indicator
$S0215B	14575	Chassis 2 Slot 15 Load/Fuse Indicator
$S0216B	14576	Chassis 2 Slot 16 Load/Fuse Indicator

Chassis 2 Installed Aliases

This table lists the aliases that identify whether the slot is installed for chassis 2.

Variable	Alias	Description
$S0201I	14577	Chassis 2 Slot 1 Installed
$S0202I	14578	Chassis 2 Slot 2 Installed
$S0203I	14579	Chassis 2 Slot 3 Installed
$S0204I	14580	Chassis 2 Slot 4 Installed
$S0205I	14581	Chassis 2 Slot 5 Installed
$S0206I	14582	Chassis 2 Slot 6 Installed
$S0207I	14583	Chassis 2 Slot 7 Installed
$S0208I	14584	Chassis 2 Slot 8 Installed
$S0209I	14585	Chassis 2 Slot 9 Installed
$S0210I	14586	Chassis 2 Slot 10 Installed

Variable	Alias	Description
$S0211I	14587	Chassis 2 Slot 11 Installed
$S0212I	14588	Chassis 2 Slot 12 Installed
$S0213I	14589	Chassis 2 Slot 13 Installed
$S0214I	14590	Chassis 2 Slot 14 Installed
$S0215I	14591	Chassis 2 Slot 15 Installed
$S0216I	14592	Chassis 2 Slot 16 Installed

Chassis 3 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 3.

Variable	Alias	Description
$S0301P	14609	Chassis 3 Slot 1 Pass Indicator
$S0302P	14610	Chassis 3 Slot 2 Pass Indicator
$S0303P	14611	Chassis 3 Slot 3 Pass Indicator
$S0304P	14612	Chassis 3 Slot 4 Pass Indicator
$S0305P	14613	Chassis 3 Slot 5 Pass Indicator
$S0306P	14614	Chassis 3 Slot 6 Pass Indicator
$S0307P	14615	Chassis 3 Slot 7 Pass Indicator
$S0308P	14616	Chassis 3 Slot 8 Pass Indicator
$S0309P	14617	Chassis 3 Slot 9 Pass Indicator
$S0310P	14618	Chassis 3 Slot 10 Pass Indicator
$S0311P	14619	Chassis 3 Slot 11 Pass Indicator
$S0312P	14620	Chassis 3 Slot 12 Pass Indicator
$S0313P	14621	Chassis 3 Slot 13 Pass Indicator
$S0314P	14622	Chassis 3 Slot 14 Pass Indicator

Chassis 3 Fault Indicator Aliases

This table lists the aliases that identify the Fault indicators for chassis 3.

Variable	Alias	Description
$S0301F	14625	Chassis 3 Slot 1 Fault Indicator
$S0302F	14626	Chassis 3 Slot 2 Fault Indicator
$S0303F	14627	Chassis 3 Slot 3 Fault Indicator
$S0304F	14628	Chassis 3 Slot 4 Fault Indicator
$S0305F	14629	Chassis 3 Slot 5 Fault Indicator
$S0306F	14630	Chassis 3 Slot 6 Fault Indicator
$S0307F	14631	Chassis 3 Slot 7 Fault Indicator
$S0308F	14632	Chassis 3 Slot 8 Fault Indicator
$S0309F	14633	Chassis 3 Slot 9 Fault Indicator
$S0310F	14634	Chassis 3 Slot 10 Fault Indicator
$S0311F	14635	Chassis 3 Slot 11 Fault Indicator
$S0312F	14636	Chassis 3 Slot 12 Fault Indicator
$S0313F	14637	Chassis 3 Slot 13 Fault Indicator
$S0314F	14638	Chassis 3 Slot 14 Fault Indicator
$S0315F	14639	Chassis 3 Slot 15 Fault Indicator
$S0316F	14640	Chassis 3 Slot 16 Fault Indicator

Chassis 3 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 3.

Variable	Alias	Description
$S0301A	14641	Chassis 3 Slot 1 Active Indicator
$S0302A	14642	Chassis 3 Slot 2 Active Indicator
$S0303A	14643	Chassis 3 Slot 3 Active Indicator
$S0304A	14644	Chassis 3 Slot 4 Active Indicator
$S0305A	14645	Chassis 3 Slot 5 Active Indicator
$S0306A	14646	Chassis 3 Slot 6 Active Indicator
$S0307A	14647	Chassis 3 Slot 7 Active Indicator
$S0308A	14648	Chassis 3 Slot 8 Active Indicator
$S0309A	14649	Chassis 3 Slot 9 Active Indicator
$S0310A	14650	Chassis 3 Slot 10 Active Indicator

Variable	Alias	Description
$S0311A	14651	Chassis 3 Slot 11 Active Indicator
$S0312A	14652	Chassis 3 Slot 12 Active Indicator
$S0313A	14653	Chassis 3 Slot 13 Active Indicator
$S0314A	14654	Chassis 3 Slot 14 Active Indicator
$S0315A	14655	Chassis 3 Slot 15 Active Indicator
$S0316A	14656	Chassis 3 Slot 16 Active Indicator

Chassis 3 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 3.

Variable	Alias	Description
$S0301B	14657	Chassis 3 Slot 1 Load/Fuse Indicator
$S0302B	14658	Chassis 3 Slot 2 Load/Fuse Indicator
$S0303B	14659	Chassis 3 Slot 3 Load/Fuse Indicator
$S0304B	14660	Chassis 3 Slot 4 Load/Fuse Indicator
$S0305B	14661	Chassis 3 Slot 5 Load/Fuse Indicator
$S0306B	14662	Chassis 3 Slot 6 Load/Fuse Indicator
$S0307B	14663	Chassis 3 Slot 7 Load/Fuse Indicator
$S0308B	14664	Chassis 3 Slot 8 Load/Fuse Indicator
$S0309B	14665	Chassis 3 Slot 9 Load/Fuse Indicator
$S0310B	14666	Chassis 3 Slot 10 Load/Fuse Indicator
$S0311B	14667	Chassis 3 Slot 11 Load/Fuse Indicator
$S0312B	14668	Chassis 3 Slot 12 Load/Fuse Indicator
$S0313B	14669	Chassis 3 Slot 13 Load/Fuse Indicator
$S0314B	14670	Chassis 3 Slot 14 Load/Fuse Indicator
$S0315B	14671	Chassis 3 Slot 15 Load/Fuse Indicator
$S0316B	14672	Chassis 3 Slot 16 Load/Fuse Indicator

Chassis 3 Installed Aliases

This table lists the aliases that identify whether the slot is installed for chassis 3.

Variable	Alias	Description
$S0301I	14673	Chassis 3 Slot 1 Installed
$S0302I	14674	Chassis 3 Slot 2 Installed
$S0303I	14675	Chassis 3 Slot 3 Installed
$S0304I	14676	Chassis 3 Slot 4 Installed
$S0305I	14677	Chassis 3 Slot 5 Installed
$S0306I	14678	Chassis 3 Slot 6 Installed
$S0307I	14679	Chassis 3 Slot 7 Installed
$S0308I	14680	Chassis 3 Slot 8 Installed
$S0309I	14681	Chassis 3 Slot 9 Installed
$S0310I	14682	Chassis 3 Slot 10 Installed
$S0311I	14683	Chassis 3 Slot 11 Installed
$S0312I	14684	Chassis 3 Slot 12 Installed
$S0313I	14685	Chassis 3 Slot 13 Installed
$S0314I	14686	Chassis 3 Slot 14 Installed
$S0315I	14687	Chassis 3 Slot 15 Installed
$S0316I	14688	Chassis 3 Slot 16 Installed

Chassis 4 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 4.

Variable	Alias	Description
$S0401P	14705	Chassis 4 Slot 1 Pass Indicator
$S0402P	14706	Chassis 4 Slot 2 Pass Indicator
$S0403P	14707	Chassis 4 Slot 3 Pass Indicator
$S0404P	14708	Chassis 4 Slot 4 Pass Indicator
$S0405P	14709	Chassis 4 Slot 5 Pass Indicator
$S0406P	14710	Chassis 4 Slot 6 Pass Indicator
$S0407P	14711	Chassis 4 Slot 7 Pass Indicator
$S0408P	14712	Chassis 4 Slot 8 Pass Indicator
$S0409P	14713	Chassis 4 Slot 9 Pass Indicator
$S0410P	14714	Chassis 4 Slot 10 Pass Indicator

Variable	Alias	Description
$S0411P	14715	Chassis 4 Slot 11 Pass Indicator
$S0412P	14716	Chassis 4 Slot 12 Pass Indicator
$S0413P	14717	Chassis 4 Slot 13 Pass Indicator
$S0414P	14718	Chassis 4 Slot 14 Pass Indicator
$S0415P	14719	Chassis 4 Slot 15 Pass Indicator
$S0416P	14720	Chassis 4 Slot 16 Pass Indicator

Chassis 4 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 4.

Variable	Alias	Description
$S0401F	14721	Chassis 4 Slot 1 Fault Indicator
$S0402F	14722	Chassis 4 Slot 2 Fault Indicator
$S0403F	14723	Chassis 4 Slot 3 Fault Indicator
$S0404F	14724	Chassis 4 Slot 4 Fault Indicator
$S0405F	14725	Chassis 4 Slot 5 Fault Indicator
$S0406F	14726	Chassis 4 Slot 6 Fault Indicator
$S0407F	14727	Chassis 4 Slot 7 Fault Indicator
$S0408F	14728	Chassis 4 Slot 8 Fault Indicator
$S0409F	14729	Chassis 4 Slot 9 Fault Indicator
$S0410F	14730	Chassis 4 Slot 10 Fault Indicator
$S0411F	14731	Chassis 4 Slot 11 Fault Indicator
$S0412F	14732	Chassis 4 Slot 12 Fault Indicator
$S0413F	14733	Chassis 4 Slot 13 Fault Indicator
$S0414F	14734	Chassis 4 Slot 14 Fault Indicator
$S0415F	14735	Chassis 4 Slot 15 Fault Indicator
$S0416F	14736	Chassis 4 Slot 16 Fault Indicator

Chassis 4 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 4.

Variable	Alias	Description
$S0401A	14737	Chassis 4 Slot 1 Active Indicator
$S0402A	14738	Chassis 4 Slot 2 Active Indicator
$S0403A	14739	Chassis 4 Slot 3 Active Indicator
$S0404A	14740	Chassis 4 Slot 4 Active Indicator
$S0405A	14741	Chassis 4 Slot 5 Active Indicator
$S0406A	14742	Chassis 4 Slot 6 Active Indicator
$S0407A	14743	Chassis 4 Slot 7 Active Indicator
$S0408A	14744	Chassis 4 Slot 8 Active Indicator
$S0409A	14745	Chassis 4 Slot 9 Active Indicator
$S0410A	14746	Chassis 4 Slot 10 Active Indicator
$S0411A	14747	Chassis 4 Slot 11 Active Indicator
$S0412A	14748	Chassis 4 Slot 12 Active Indicator
$S0413A	14749	Chassis 4 Slot 13 Active Indicator
$S0414A	14750	Chassis 4 Slot 14 Active Indicator
$S0415A	14751	Chassis 4 Slot 15 Active Indicator
$S0416A	14752	Chassis 4 Slot 16 Active Indicator

Chassis 4 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 4.

Variable	Alias	Description
$S0401B	14753	Chassis 4 Slot 1 Load/Fuse Indicator
$S0402B	14754	Chassis 4 Slot 2 Load/Fuse Indicator
$S0403B	14755	Chassis 4 Slot 3 Load/Fuse Indicator
$S0404B	14756	Chassis 4 Slot 4 Load/Fuse Indicator
$S0405B	14757	Chassis 4 Slot 5 Load/Fuse Indicator
$S0406B	14758	Chassis 4 Slot 6 Load/Fuse Indicator
$S0407B	14759	Chassis 4 Slot 7 Load/Fuse Indicator
$S0408B	14760	Chassis 4 Slot 8 Load/Fuse Indicator
$S0409B	14761	Chassis 4 Slot 9 Load/Fuse Indicator
$S0410B	14762	Chassis 4 Slot 10 Load/Fuse Indicator

Variable	Alias	Description
$S0411B	14763	Chassis 4 Slot 11 Load/Fuse Indicator
$S0412B	14764	Chassis 4 Slot 12 Load/Fuse Indicator
$S0413B	14765	Chassis 4 Slot 13 Load/Fuse Indicator
$S0414B	14766	Chassis 4 Slot 14 Load/Fuse Indicator
$S0415B	14767	Chassis 4 Slot 15 Load/Fuse Indicator
$S0416B	14768	Chassis 4 Slot 16 Load/Fuse Indicator

Chassis 4 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 4.

Variable	Alias	Description
$S0401I	14769	Chassis 4 Slot 1 Installed
$S0402I	14770	Chassis 4 Slot 2 Installed
$S0403I	14771	Chassis 4 Slot 3 Installed
$S0404I	14772	Chassis 4 Slot 4 Installed
$S0405I	14773	Chassis 4 Slot 5 Installed
$S0406I	14774	Chassis 4 Slot 6 Installed
$S0407I	14775	Chassis 4 Slot 7 Installed
$S0408I	14776	Chassis 4 Slot 8 Installed
$S0409I	14777	Chassis 4 Slot 9 Installed
$S0410I	14778	Chassis 4 Slot 10 Installed
$S0411I	14779	Chassis 4 Slot 11 Installed
$S0412I	14780	Chassis 4 Slot 12 Installed
$S0413I	14781	Chassis 4 Slot 13 Installed
$S0414I	14782	Chassis 4 Slot 14 Installed
$S0415I	14783	Chassis 4 Slot 15 Installed
$S0416I	14784	Chassis 4 Slot 16 Installed

Chassis 5 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 5.

Variable	Alias	Description
$S0501P	14801	Chassis 5 Slot 1 Pass Indicator
$S0502P	14802	Chassis 5 Slot 2 Pass Indicator
$S0503P	14803	Chassis 5 Slot 3 Pass Indicator
$S0504P	14804	Chassis 5 Slot 4 Pass Indicator
$S0505P	14805	Chassis 5 Slot 5 Pass Indicator
$S0506P	14806	Chassis 5 Slot 6 Pass Indicator
$S0507P	14807	Chassis 5 Slot 7 Pass Indicator
$S0508P	14808	Chassis 5 Slot 8 Pass Indicator
$S0509P	14809	Chassis 5 Slot 9 Pass Indicator
$S0510P	14810	Chassis 5 Slot 10 Pass Indicator
$S0511P	14811	Chassis 5 Slot 11 Pass Indicator
$S0512P	14812	Chassis 5 Slot 12 Pass Indicator
$S0513P	14813	Chassis 5 Slot 13 Pass Indicator
$S0514P	14814	Chassis 5 Slot 14 Pass Indicator
$S0515P	14815	Chassis 5 Slot 15 Pass Indicator
$S0516P	14816	Chassis 5 Slot 16 Pass Indicator

Chassis 5 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 5.

Variable	Alias	Description
$S0501F	14817	Chassis 5 Slot 1 Fault Indicator
$S0502F	14818	Chassis 5 Slot 2 Fault Indicator
$S0503F	14819	Chassis 5 Slot 3 Fault Indicator
$S0504F	14820	Chassis 5 Slot 4 Fault Indicator
$S0505F	14821	Chassis 5 Slot 5 Fault Indicator
$S0506F	14822	Chassis 5 Slot 6 Fault Indicator
$S0507F	14823	Chassis 5 Slot 7 Fault Indicator
$S0508F	14824	Chassis 5 Slot 8 Fault Indicator
$S0509F	14825	Chassis 5 Slot 9 Fault Indicator
$S0510F	14826	Chassis 5 Slot 10 Fault Indicator

Variable	Alias	Description
$S0511F	14827	Chassis 5 Slot 11 Fault Indicator
$S0512F	14828	Chassis 5 Slot 12 Fault Indicator
$S0513F	14829	Chassis 5 Slot 13 Fault Indicator
$S0514F	14830	Chassis 5 Slot 14 Fault Indicator
$S0515F	14831	Chassis 5 Slot 15 Fault Indicator
$S0516F	14832	Chassis 5 Slot 16 Fault Indicator

Chassis 5 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 5.

Variable	Alias	Description
$S0501A	14833	Chassis 5 Slot 1 Active Indicator
$S0502A	14834	Chassis 5 Slot 2 Active Indicator
$S0503A	14835	Chassis 5 Slot 3 Active Indicator
$S0504A	14836	Chassis 5 Slot 4 Active Indicator
$S0505A	14837	Chassis 5 Slot 5 Active Indicator
$S0506A	14838	Chassis 5 Slot 6 Active Indicator
$S0507A	14839	Chassis 5 Slot 7 Active Indicator
$S0508A	14840	Chassis 5 Slot 8 Active Indicator
$S0509A	14841	Chassis 5 Slot 9 Active Indicator
$S0510A	14842	Chassis 5 Slot 10 Active Indicator
$S0511A	14843	Chassis 5 Slot 11 Active Indicator
$S0512A	14844	Chassis 5 Slot 12 Active Indicator
$S0513A	14845	Chassis 5 Slot 13 Active Indicator
$S0514A	14846	Chassis 5 Slot 14 Active Indicator
$S0515A	14847	Chassis 5 Slot 15 Active Indicator
$S0516A	14848	Chassis 5 Slot 16 Active Indicator

Chassis 5 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 5.

Variable	Alias	Description
$S0501B	14849	Chassis 5 Slot 1 Load/Fuse Indicator
$S0502B	14850	Chassis 5 Slot 2 Load/Fuse Indicator
$S0503B	14851	Chassis 5 Slot 3 Load/Fuse Indicator
$S0504B	14852	Chassis 5 Slot 4 Load/Fuse Indicator
$S0505B	14853	Chassis 5 Slot 5 Load/Fuse Indicator
$S0506B	14854	Chassis 5 Slot 6 Load/Fuse Indicator
$S0507B	14855	Chassis 5 Slot 7 Load/Fuse Indicator
$S0508B	14856	Chassis 5 Slot 8 Load/Fuse Indicator
$S0509B	14857	Chassis 5 Slot 9 Load/Fuse Indicator
$S0510B	14858	Chassis 5 Slot 10 Load/Fuse Indicator
$S0511B	14859	Chassis 5 Slot 11 Load/Fuse Indicator
$S0512B	14860	Chassis 5 Slot 12 Load/Fuse Indicator
$S0513B	14861	Chassis 5 Slot 13 Load/Fuse Indicator
$S0514B	14862	Chassis 5 Slot 14 Load/Fuse Indicator
$S0515B	14863	Chassis 5 Slot 15 Load/Fuse Indicator
$S0516B	14864	Chassis 5 Slot 16 Load/Fuse Indicator

Chassis 5 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 5.

Variable	Alias	Description
$S0501I	14865	Chassis 5 Slot 1 Installed
$S0502I	14866	Chassis 5 Slot 2 Installed
$S0503I	14867	Chassis 5 Slot 3 Installed
$S0504I	14868	Chassis 5 Slot 4 Installed
$S0505I	14869	Chassis 5 Slot 5 Installed
$S0506I	14870	Chassis 5 Slot 6 Installed
$S0507I	14871	Chassis 5 Slot 7 Installed
$S0508I	14872	Chassis 5 Slot 8 Installed
$S0509I	14873	Chassis 5 Slot 9 Installed
$S0510I	14874	Chassis 5 Slot 10 Installed

Variable	Alias	Description
$S0511I	14875	Chassis 5 Slot 11 Installed
$S0512I	14876	Chassis 5 Slot 12 Installed
$S0513I	14877	Chassis 5 Slot 13 Installed
$S0514I	14878	Chassis 5 Slot 14 Installed
$S0515I	14879	Chassis 5 Slot 15 Installed
$S0516I	14880	Chassis 5 Slot 16 Installed

Chassis 6 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 6.

Variable	Alias	Description
$S0601P	14897	Chassis 6 Slot 1 Pass Indicator
$S0602P	14898	Chassis 6 Slot 2 Pass Indicator
$S0603P	14899	Chassis 6 Slot 3 Pass Indicator
$S0604P	14900	Chassis 6 Slot 4 Pass Indicator
$S0605P	14901	Chassis 6 Slot 5 Pass Indicator
$S0606P	14902	Chassis 6 Slot 6 Pass Indicator
$S0607P	14903	Chassis 6 Slot 7 Pass Indicator
$S0608P	14904	Chassis 6 Slot 8 Pass Indicator
$S0609P	14905	Chassis 6 Slot 9 Pass Indicator
$S0610P	14906	Chassis 6 Slot 10 Pass Indicator
$S0611P	14907	Chassis 6 Slot 11 Pass Indicator
$S0612P	14908	Chassis 6 Slot 12 Pass Indicator
$S0613P	14909	Chassis 6 Slot 13 Pass Indicator
$S0614P	14910	Chassis 6 Slot 14 Pass Indicator
$S0615P	14911	Chassis 6 Slot 15 Pass Indicator
$S0616P	14912	Chassis 6 Slot 16 Pass Indicator

Chassis 6 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 6.

Variable	Alias	Description
$S0601F	14913	Chassis 6 Slot 1 Fault Indicator
$S0602F	14914	Chassis 6 Slot 2 Fault Indicator
$S0603F	14915	Chassis 6 Slot 3 Fault Indicator
$S0604F	14916	Chassis 6 Slot 4 Fault Indicator
$S0605F	14917	Chassis 6 Slot 5 Fault Indicator
$S0606F	14918	Chassis 6 Slot 6 Fault Indicator
$S0607F	14919	Chassis 6 Slot 7 Fault Indicator
$S0608F	14920	Chassis 6 Slot 8 Fault Indicator
$S0609F	14921	Chassis 6 Slot 9 Fault Indicator
$S0610F	14922	Chassis 6 Slot 10 Fault Indicator
$S0611F	14923	Chassis 6 Slot 11 Fault Indicator
$S0612F	14924	Chassis 6 Slot 12 Fault Indicator
$S0613F	14925	Chassis 6 Slot 13 Fault Indicator
$S0614F	14926	Chassis 6 Slot 14 Fault Indicator
$S0615F	14927	Chassis 6 Slot 15 Fault Indicator
$S0616F	14928	Chassis 6 Slot 16 Fault Indicator

Chassis 6 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 6.

Variable	Alias	Description
$S0601A	14929	Chassis 6 Slot 1 Active Indicator
$S0602A	14930	Chassis 6 Slot 2 Active Indicator
$S0603A	14931	Chassis 6 Slot 3 Active Indicator
$S0604A	14932	Chassis 6 Slot 4 Active Indicator
$S0605A	14933	Chassis 6 Slot 5 Active Indicator
$S0606A	14934	Chassis 6 Slot 6 Active Indicator
$S0607A	14935	Chassis 6 Slot 7 Active Indicator
$S0608A	14936	Chassis 6 Slot 8 Active Indicator
$S0609A	14937	Chassis 6 Slot 9 Active Indicator
$S0610A	14938	Chassis 6 Slot 10 Active Indicator

Variable	Alias	Description
$S0611A	14939	Chassis 6 Slot 11 Active Indicator
$S0612A	14940	Chassis 6 Slot 12 Active Indicator
$S0613A	14941	Chassis 6 Slot 13 Active Indicator
$S0614A	14942	Chassis 6 Slot 14 Active Indicator
$S0615A	14943	Chassis 6 Slot 15 Active Indicator
$S0616A	14944	Chassis 6 Slot 16 Active Indicator

Chassis 6 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 6.

Variable	Alias	Description
$S0601B	14945	Chassis 6 Slot 1 Load/Fuse Indicator
$S0602B	14946	Chassis 6 Slot 2 Load/Fuse Indicator
$S0603B	14947	Chassis 6 Slot 3 Load/Fuse Indicator
$S0604B	14948	Chassis 6 Slot 4 Load/Fuse Indicator
$S0605B	14949	Chassis 6 Slot 5 Load/Fuse Indicator
$S0606B	14950	Chassis 6 Slot 6 Load/Fuse Indicator
$S0607B	14951	Chassis 6 Slot 7 Load/Fuse Indicator
$S0608B	14952	Chassis 6 Slot 8 Load/Fuse Indicator
$S0609B	14953	Chassis 6 Slot 9 Load/Fuse Indicator
$S0610B	14954	Chassis 6 Slot 10 Load/Fuse Indicator
$S0611B	14955	Chassis 6 Slot 11 Load/Fuse Indicator
$S0612B	14956	Chassis 6 Slot 12 Load/Fuse Indicator
$S0613B	14957	Chassis 6 Slot 13 Load/Fuse Indicator
$S0614B	14958	Chassis 6 Slot 14 Load/Fuse Indicator
$S0615B	14959	Chassis 6 Slot 15 Load/Fuse Indicator
$S0616B	14960	Chassis 6 Slot 16 Load/Fuse Indicator

Chassis 6 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 6.

Variable	Alias	Description
$S0601I	14961	Chassis 6 Slot 1 Installed
$S0602I	14962	Chassis 6 Slot 2 Installed
$S0603I	14963	Chassis 6 Slot 3 Installed
$S0604I	14964	Chassis 6 Slot 4 Installed
$S0605I	14965	Chassis 6 Slot 5 Installed
$S0606I	14966	Chassis 6 Slot 6 Installed
$S0607I	14967	Chassis 6 Slot 7 Installed
$S0608I	14968	Chassis 6 Slot 8 Installed
$S0609I	14969	Chassis 6 Slot 9 Installed
$S0610I	14970	Chassis 6 Slot 10 Installed
$S0611I	14971	Chassis 6 Slot 11 Installed
$S0612I	14972	Chassis 6 Slot 12 Installed
$S0613I	14973	Chassis 6 Slot 13 Installed
$S0614I	14974	Chassis 6 Slot 14 Installed
$S0615I	14975	Chassis 6 Slot 15 Installed
$S0616I	14976	Chassis 6 Slot 16 Installed

Chassis 7 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 7.

Variable	Alias	Description
$S0701P	14993	Chassis 7 Slot 1 Pass Indicator
$S0702P	14994	Chassis 7 Slot 2 Pass Indicator
$S0703P	14995	Chassis 7 Slot 3 Pass Indicator
$S0704P	14996	Chassis 7 Slot 4 Pass Indicator
$S0705P	14997	Chassis 7 Slot 5 Pass Indicator
$S0706P	14998	Chassis 7 Slot 6 Pass Indicator
$S0707P	14999	Chassis 7 Slot 7 Pass Indicator
$S0708P	15000	Chassis 7 Slot 8 Pass Indicator
$S0709P	15001	Chassis 7 Slot 9 Pass Indicator
$S0710P	15002	Chassis 7 Slot 10 Pass Indicator

Variable	Alias	Description
$S0711P	15003	Chassis 7 Slot 11 Pass Indicator
$S0712P	15004	Chassis 7 Slot 12 Pass Indicator
$S0713P	15005	Chassis 7 Slot 13 Pass Indicator
$S0714P	15006	Chassis 7 Slot 14 Pass Indicator
$S0715P	15007	Chassis 7 Slot 15 Pass Indicator
$S0716P	15008	Chassis 7 Slot 16 Pass Indicator

Chassis 7 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 7.

Variable	Alias	Description
$S0701F	15009	Chassis 7 Slot 1 Fault Indicator
$S0702F	15010	Chassis 7 Slot 2 Fault Indicator
$S0703F	15011	Chassis 7 Slot 3 Fault Indicator
$S0704F	15012	Chassis 7 Slot 4 Fault Indicator
$S0705F	15013	Chassis 7 Slot 5 Fault Indicator
$S0706F	15014	Chassis 7 Slot 6 Fault Indicator
$S0707F	15015	Chassis 7 Slot 7 Fault Indicator
$S0708F	15016	Chassis 7 Slot 8 Fault Indicator
$S0709F	15017	Chassis 7 Slot 9 Fault Indicator
$S0710F	15018	Chassis 7 Slot 10 Fault Indicator
$S0711F	15019	Chassis 7 Slot 11 Fault Indicator
$S0712F	15020	Chassis 7 Slot 12 Fault Indicator
$S0713F	15021	Chassis 7 Slot 13 Fault Indicator
$S0714F	15022	Chassis 7 Slot 14 Fault Indicator
$S0715F	15023	Chassis 7 Slot 15 Fault Indicator
$S0716F	15024	Chassis 7 Slot 16 Fault Indicator

Chassis 7 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 7.

Variable	Alias	Description
$S0701A	15025	Chassis 7 Slot 1 Active Indicator
$S0702A	15026	Chassis 7 Slot 2 Active Indicator
$S0703A	15027	Chassis 7 Slot 3 Active Indicator
$S0704A	15028	Chassis 7 Slot 4 Active Indicator
$S0705A	15029	Chassis 7 Slot 5 Active Indicator
$S0706A	15030	Chassis 7 Slot 6 Active Indicator
$S0707A	15031	Chassis 7 Slot 7 Active Indicator
$S0708A	15032	Chassis 7 Slot 8 Active Indicator
$S0709A	15033	Chassis 7 Slot 9 Active Indicator
$S0710A	15034	Chassis 7 Slot 10 Active Indicator
$S0711A	15035	Chassis 7 Slot 11 Active Indicator
$S0712A	15036	Chassis 7 Slot 12 Active Indicator
$S0713A	15037	Chassis 7 Slot 13 Active Indicator
$S0714A	15038	Chassis 7 Slot 14 Active Indicator
$S0715A	15039	Chassis 7 Slot 15 Active Indicator
$S0716A	15040	Chassis 7 Slot 16 Active Indicator

Chassis 7 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 7.

Variable	Alias	Description
$S0701B	15041	Chassis 7 Slot 1 Load/Fuse Indicator
$S0702B	15042	Chassis 7 Slot 2 Load/Fuse Indicator
$S0703B	15043	Chassis 7 Slot 3 Load/Fuse Indicator
$S0704B	15044	Chassis 7 Slot 4 Load/Fuse Indicator
$S0705B	15045	Chassis 7 Slot 5 Load/Fuse Indicator
$S0706B	15046	Chassis 7 Slot 6 Load/Fuse Indicator
$S0707B	15047	Chassis 7 Slot 7 Load/Fuse Indicator
$S0708B	15048	Chassis 7 Slot 8 Load/Fuse Indicator
$S0709B	15049	Chassis 7 Slot 9 Load/Fuse Indicator
$S0710B	15050	Chassis 7 Slot 10 Load/Fuse Indicator

Variable	Alias	Description
$S0711B	15051	Chassis 7 Slot 11 Load/Fuse Indicator
$S0712B	15052	Chassis 7 Slot 12 Load/Fuse Indicator
$S0713B	15053	Chassis 7 Slot 13 Load/Fuse Indicator
$S0714B	15054	Chassis 7 Slot 14 Load/Fuse Indicator
$S0715B	15055	Chassis 7 Slot 15 Load/Fuse Indicator
$S0716B	15056	Chassis 7 Slot 16 Load/Fuse Indicator

Chassis 7 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 7.

Variable	Alias	Description
$S0701I	15057	Chassis 7 Slot 1 Installed
$S0702I	15058	Chassis 7 Slot 2 Installed
$S0703I	15059	Chassis 7 Slot 3 Installed
$S0704I	15060	Chassis 7 Slot 4 Installed
$S0705I	15061	Chassis 7 Slot 5 Installed
$S0706I	15062	Chassis 7 Slot 6 Installed
$S0707I	15063	Chassis 7 Slot 7 Installed
$S0708I	15064	Chassis 7 Slot 8 Installed
$S0709I	15065	Chassis 7 Slot 9 Installed
$S0710I	15066	Chassis 7 Slot 10 Installed
$S0711I	15067	Chassis 7 Slot 11 Installed
$S0712I	15068	Chassis 7 Slot 12 Installed
$S0713I	15069	Chassis 7 Slot 13 Installed
$S0714I	15070	Chassis 7 Slot 14 Installed
$S0715I	15071	Chassis 7 Slot 15 Installed
$S0716I	15072	Chassis 7 Slot 16 Installed

Chassis 8 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 8.

Variable	Alias	Description
$S0801P	15089	Chassis 8 Slot 1 Pass Indicator
$S0802P	15090	Chassis 8 Slot 2 Pass Indicator
$S0803P	15091	Chassis 8 Slot 3 Pass Indicator
$S0804P	15092	Chassis 8 Slot 4 Pass Indicator
$S0805P	15093	Chassis 8 Slot 5 Pass Indicator
$S0806P	15094	Chassis 8 Slot 6 Pass Indicator
$S0807P	15095	Chassis 8 Slot 7 Pass Indicator
$S0808P	15096	Chassis 8 Slot 8 Pass Indicator
$S0809P	15097	Chassis 8 Slot 9 Pass Indicator
$S0810P	15098	Chassis 8 Slot 10 Pass Indicator
$S0811P	15099	Chassis 8 Slot 11 Pass Indicator
$S0812P	15100	Chassis 8 Slot 12 Pass Indicator
$S0813P	15101	Chassis 8 Slot 13 Pass Indicator
$S0814P	15102	Chassis 8 Slot 14 Pass Indicator
$S0815P	15103	Chassis 8 Slot 15 Pass Indicator
$S0816P	15104	Chassis 8 Slot 16 Pass Indicator

Chassis 8 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 8.

Variable	Alias	Description
$S0801F	15105	Chassis 8 Slot 1 Fault Indicator
$S0802F	15106	Chassis 8 Slot 2 Fault Indicator
$S0803F	15107	Chassis 8 Slot 3 Fault Indicator
$S0804F	15108	Chassis 8 Slot 4 Fault Indicator
$S0805F	15109	Chassis 8 Slot 5 Fault Indicator
$S0806F	15110	Chassis 8 Slot 6 Fault Indicator
$S0807F	15111	Chassis 8 Slot 7 Fault Indicator
$S0808F	15112	Chassis 8 Slot 8 Fault Indicator
$S0809F	15113	Chassis 8 Slot 9 Fault Indicator
$S0810F	15114	Chassis 8 Slot 10 Fault Indicator

Variable	Alias	Description
$S0811F	15115	Chassis 8 Slot 11 Fault Indicator
$S0812F	15116	Chassis 8 Slot 12 Fault Indicator
$S0813F	15117	Chassis 8 Slot 13 Fault Indicator
$S0814F	15118	Chassis 8 Slot 14 Fault Indicator
$S0815F	15119	Chassis 8 Slot 15 Fault Indicator
$S0816F	15120	Chassis 8 Slot 16 Fault Indicator

Chassis 8 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 8.

Variable	Alias	Description
$S0801A	15121	Chassis 8 Slot 1 Active Indicator
$S0802A	15122	Chassis 8 Slot 2 Active Indicator
$S0803A	15123	Chassis 8 Slot 3 Active Indicator
$S0804A	15124	Chassis 8 Slot 4 Active Indicator
$S0805A	15125	Chassis 8 Slot 5 Active Indicator
$S0806A	15126	Chassis 8 Slot 6 Active Indicator
$S0807A	15127	Chassis 8 Slot 7 Active Indicator
$S0808A	15128	Chassis 8 Slot 8 Active Indicator
$S0809A	15129	Chassis 8 Slot 9 Active Indicator
$S0810A	15130	Chassis 8 Slot 10 Active Indicator
$S0811A	15131	Chassis 8 Slot 11 Active Indicator
$S0812A	15132	Chassis 8 Slot 12 Active Indicator
$S0813A	15133	Chassis 8 Slot 13 Active Indicator
$S0814A	15134	Chassis 8 Slot 14 Active Indicator
$S0815A	15135	Chassis 8 Slot 15 Active Indicator
$S0816A	15136	Chassis 8 Slot 16 Active Indicator

Chassis 8 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 8.8

Variable	Alias	Description
$S0801B	15137	Chassis 8 Slot 1 Load/Fuse Indicator
$S0802B	15138	Chassis 8 Slot 2 Load/Fuse Indicator
$S0803B	15139	Chassis 8 Slot 3 Load/Fuse Indicator
$S0804B	15140	Chassis 8 Slot 4 Load/Fuse Indicator
$S0805B	15141	Chassis 8 Slot 5 Load/Fuse Indicator
$S0806B	15142	Chassis 8 Slot 6 Load/Fuse Indicator
$S0807B	15143	Chassis 8 Slot 7 Load/Fuse Indicator
$S0808B	15144	Chassis 8 Slot 8 Load/Fuse Indicator
$S0809B	15145	Chassis 8 Slot 9 Load/Fuse Indicator
$S0810B	15146	Chassis 8 Slot 10 Load/Fuse Indicator
$S0811B	15147	Chassis 8 Slot 11 Load/Fuse Indicator
$S0812B	15148	Chassis 8 Slot 12 Load/Fuse Indicator
$S0813B	15149	Chassis 8 Slot 13 Load/Fuse Indicator
$S0814B	15150	Chassis 8 Slot 14 Load/Fuse Indicator
$S0815B	15151	Chassis 8 Slot 15 Load/Fuse Indicator
$S0816B	15152	Chassis 8 Slot 16 Load/Fuse Indicator

Chassis 8 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 8.

Variable	Alias	Description
$S0801I	15153	Chassis 8 Slot 1 Installed
$S0802I	15154	Chassis 8 Slot 2 Installed
$S0803I	15155	Chassis 8 Slot 3 Installed
$S0804I	15156	Chassis 8 Slot 4 Installed
$S0805I	15157	Chassis 8 Slot 5 Installed
$S0806I	15158	Chassis 8 Slot 6 Installed
$S0807I	15159	Chassis 8 Slot 7 Installed
$S0808I	15160	Chassis 8 Slot 8 Installed
$S0809I	15161	Chassis 8 Slot 9 Installed
$S0810I	15162	Chassis 8 Slot 10 Installed

Variable	Alias	Description
$S0811I	15163	Chassis 8 Slot 11 Installed
$S0812I	15164	Chassis 8 Slot 12 Installed
$S0813I	15165	Chassis 8 Slot 13 Installed
$S0814I	15166	Chassis 8 Slot 14 Installed
$S0815I	15167	Chassis 8 Slot 15 Installed
$S0816I	15168	Chassis 8 Slot 16 Installed

Chassis 9 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 9.

Variable	Alias	Description
$S0901P	15185	Chassis 9 Slot 1 Pass Indicator
$S0902P	15186	Chassis 9 Slot 2 Pass Indicator
$S0903P	15187	Chassis 9 Slot 3 Pass Indicator
$S0904P	15188	Chassis 9 Slot 4 Pass Indicator
$S0905P	15189	Chassis 9 Slot 5 Pass Indicator
$S0906P	15190	Chassis 9 Slot 6 Pass Indicator
$S0907P	15191	Chassis 9 Slot 7 Pass Indicator
$S0908P	15192	Chassis 9 Slot 8 Pass Indicator
$S0909P	15193	Chassis 9 Slot 9 Pass Indicator
$S0910P	15194	Chassis 9 Slot 10 Pass Indicator
$S0911P	15195	Chassis 9 Slot 11 Pass Indicator
$S0912P	15196	Chassis 9 Slot 12 Pass Indicator
$S0913P	15197	Chassis 9 Slot 13 Pass Indicator
$S0914P	15198	Chassis 9 Slot 14 Pass Indicator
$S0915P	15199	Chassis 9 Slot 15 Pass Indicator
$S0916P	15200	Chassis 9 Slot 16 Pass Indicator

Chassis 9 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 9.

Variable	Alias	Description
$S0901F	15201	Chassis 9 Slot 1 Fault Indicator
$S0902F	15202	Chassis 9 Slot 2 Fault Indicator
$S0903F	15203	Chassis 9 Slot 3 Fault Indicator
$S0904F	15204	Chassis 9 Slot 4 Fault Indicator
$S0905F	15205	Chassis 9 Slot 5 Fault Indicator
$S0906F	15206	Chassis 9 Slot 6 Fault Indicator
$S0907F	15207	Chassis 9 Slot 7 Fault Indicator
$S0908F	15208	Chassis 9 Slot 8 Fault Indicator
$S0909F	15209	Chassis 9 Slot 9 Fault Indicator
$S0910F	15210	Chassis 9 Slot 10 Fault Indicator
$S0911F	15211	Chassis 9 Slot 11 Fault Indicator
$S0912F	15212	Chassis 9 Slot 12 Fault Indicator
$S0913F	15213	Chassis 9 Slot 13 Fault Indicator
$S0914F	15214	Chassis 9 Slot 14 Fault Indicator
$S0915F	15215	Chassis 9 Slot 15 Fault Indicator
$S0916F	15216	Chassis 9 Slot 16 Fault Indicator

Chassis 9 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 9.

Variable	Alias	Description
$S0901A	15217	Chassis 9 Slot 1 Active Indicator
$S0902A	15218	Chassis 9 Slot 2 Active Indicator
$S0903A	15219	Chassis 9 Slot 3 Active Indicator
$S0904A	15220	Chassis 9 Slot 4 Active Indicator
$S0905A	15221	Chassis 9 Slot 5 Active Indicator
$S0906A	15222	Chassis 9 Slot 6 Active Indicator
$S0907A	15223	Chassis 9 Slot 7 Active Indicator
$S0908A	15224	Chassis 9 Slot 8 Active Indicator
$S0909A	15225	Chassis 9 Slot 9 Active Indicator
$S0910A	15226	Chassis 9 Slot 10 Active Indicator

Variable	Alias	Description
$S0911A	15227	Chassis 9 Slot 11 Active Indicator
$S0912A	15228	Chassis 9 Slot 12 Active Indicator
$S0913A	15229	Chassis 9 Slot 13 Active Indicator
$S0914A	15230	Chassis 9 Slot 14 Active Indicator
$S0915A	15231	Chassis 9 Slot 15 Active Indicator
$S0916A	15232	Chassis 9 Slot 16 Active Indicator

Chassis 9 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 9.9

Variable	Alias	Description
$S0901B	15233	Chassis 9 Slot 1 Load/Fuse Indicator
$S0902B	15234	Chassis 9 Slot 2 Load/Fuse Indicator
$S0903B	15235	Chassis 9 Slot 3 Load/Fuse Indicator
$S0904B	15236	Chassis 9 Slot 4 Load/Fuse Indicator
$S0905B	15237	Chassis 9 Slot 5 Load/Fuse Indicator
$S0906B	15238	Chassis 9 Slot 6 Load/Fuse Indicator
$S0907B	15239	Chassis 9 Slot 7 Load/Fuse Indicator
$S0908B	15240	Chassis 9 Slot 8 Load/Fuse Indicator
$S0909B	15241	Chassis 9 Slot 9 Load/Fuse Indicator
$S0910B	15242	Chassis 9 Slot 10 Load/Fuse Indicator
$S0911B	15243	Chassis 9 Slot 11 Load/Fuse Indicator
$S0912B	15244	Chassis 9 Slot 12 Load/Fuse Indicator
$S0913B	15245	Chassis 9 Slot 13 Load/Fuse Indicator
$S0914B	15246	Chassis 9 Slot 14 Load/Fuse Indicator
$S0915B	15247	Chassis 9 Slot 15 Load/Fuse Indicator
$S0916B	15248	Chassis 9 Slot 16 Load/Fuse Indicator

Chassis 9 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 9.

Variable	Alias	Description
$S0901I	15249	Chassis 9 Slot 1 Installed
$S0902I	15250	Chassis 9 Slot 2 Installed
$S0903I	15251	Chassis 9 Slot 3 Installed
$S0904I	15252	Chassis 9 Slot 4 Installed
$S0905I	15253	Chassis 9 Slot 5 Installed
$S0906I	15254	Chassis 9 Slot 6 Installed
$S0907I	15255	Chassis 9 Slot 7 Installed
$S0908I	15256	Chassis 9 Slot 8 Installed
$S0909I	15257	Chassis 9 Slot 9 Installed
$S0910I	15258	Chassis 9 Slot 10 Installed
$S0911I	15259	Chassis 9 Slot 11 Installed
$S0912I	15260	Chassis 9 Slot 12 Installed
$S0913I	15261	Chassis 9 Slot 13 Installed
$S0914I	15262	Chassis 9 Slot 14 Installed
$S0915I	15263	Chassis 9 Slot 15 Installed
$S0916I	15264	Chassis 9 Slot 16 Installed

Chassis 10 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 10.

Variable	Alias	Description
$S1001P	15281	Chassis 10 Slot 1 Pass Indicator
$S1002P	15282	Chassis 10 Slot 2 Pass Indicator
$S1003P	15283	Chassis 10 Slot 3 Pass Indicator
$S1004P	15284	Chassis 10 Slot 4 Pass Indicator
$S1005P	15285	Chassis 10 Slot 5 Pass Indicator
$S1006P	15286	Chassis 10 Slot 6 Pass Indicator
$S1007P	15287	Chassis 10 Slot 7 Pass Indicator
$S1008P	15288	Chassis 10 Slot 8 Pass Indicator
$S1009P	15289	Chassis 10 Slot 9 Pass Indicator
$S1010P	15290	Chassis 10 Slot 10 Pass Indicator

Variable	Alias	Description
$S1011P	15291	Chassis 10 Slot 11 Pass Indicator
$S1012P	15292	Chassis 10 Slot 12 Pass Indicator
$S1013P	15293	Chassis 10 Slot 13 Pass Indicator
$S1014P	15294	Chassis 10 Slot 14 Pass Indicator
$S1015P	15295	Chassis 10 Slot 15 Pass Indicator
$S1016P	15296	Chassis 10 Slot 16 Pass Indicator

Chassis 10 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 10.

Variable	Alias	Description
$S1001F	15297	Chassis 10 Slot 1 Fault Indicator
$S1002F	15298	Chassis 10 Slot 2 Fault Indicator
$S1003F	15299	Chassis 10 Slot 3 Fault Indicator
$S1004F	15300	Chassis 10 Slot 4 Fault Indicator
$S1005F	15301	Chassis 10 Slot 5 Fault Indicator
$S1006F	15302	Chassis 10 Slot 6 Fault Indicator
$S1007F	15303	Chassis 10 Slot 7 Fault Indicator
$S1008F	15304	Chassis 10 Slot 8 Fault Indicator
$S1009F	15305	Chassis 10 Slot 9 Fault Indicator
$S1010F	15306	Chassis 10 Slot 10 Fault Indicator
$S1011F	15307	Chassis 10 Slot 11 Fault Indicator
$S1012F	15308	Chassis 10 Slot 12 Fault Indicator
$S1013F	15309	Chassis 10 Slot 13 Fault Indicator
$S1014F	15310	Chassis 10 Slot 14 Fault Indicator
$S1015F	15311	Chassis 10 Slot 15 Fault Indicator
$S1016F	15312	Chassis 10 Slot 16 Fault Indicator

Chassis 10 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 10.

Variable	Alias	Description
$S1001A	15313	Chassis 10 Slot 1 Active Indicator
$S1002A	15314	Chassis 10 Slot 2 Active Indicator
$S1003A	15315	Chassis 10 Slot 3 Active Indicator
$S1004A	15316	Chassis 10 Slot 4 Active Indicator
$S1005A	15317	Chassis 10 Slot 5 Active Indicator
$S1006A	15318	Chassis 10 Slot 6 Active Indicator
$S1007A	15319	Chassis 10 Slot 7 Active Indicator
$S1008A	15320	Chassis 10 Slot 8 Active Indicator
$S1009A	15321	Chassis 10 Slot 9 Active Indicator
$S1010A	15322	Chassis 10 Slot 10 Active Indicator
$S1011A	15323	Chassis 10 Slot 11 Active Indicator
$S1012A	15324	Chassis 10 Slot 12 Active Indicator
$S1013A	15325	Chassis 10 Slot 13 Active Indicator
$S1014A	15326	Chassis 10 Slot 14 Active Indicator
$S1015A	15327	Chassis 10 Slot 15 Active Indicator
$S1016A	15328	Chassis 10 Slot 16 Active Indicator

Chassis 10 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 10.

Variable	Alias	Description
$S1001B	15329	Chassis 10 Slot 1 Load/Fuse Indicator
$S1002B	15330	Chassis 10 Slot 2 Load/Fuse Indicator
$S1003B	15331	Chassis 10 Slot 3 Load/Fuse Indicator
$S1004B	15332	Chassis 10 Slot 4 Load/Fuse Indicator
$S1005B	15333	Chassis 10 Slot 5 Load/Fuse Indicator
$S1006B	15334	Chassis 10 Slot 6 Load/Fuse Indicator
$S1007B	15335	Chassis 10 Slot 7 Load/Fuse Indicator
$S1008B	15336	Chassis 10 Slot 8 Load/Fuse Indicator
$S1009B	15337	Chassis 10 Slot 9 Load/Fuse Indicator
$S1010B	15338	Chassis 10 Slot 10 Load/Fuse Indicator

Variable	Alias	Description
$S1011B	15339	Chassis 10 Slot 11 Load/Fuse Indicator
$S1012B	15340	Chassis 10 Slot 12 Load/Fuse Indicator
$S1013B	15341	Chassis 10 Slot 13 Load/Fuse Indicator
$S1014B	15342	Chassis 10 Slot 14 Load/Fuse Indicator
$S1015B	15343	Chassis 10 Slot 15 Load/Fuse Indicator
$S1016B	15344	Chassis 10 Slot 16 Load/Fuse Indicator

Chassis 10 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 10.

Variable	Alias	Description
$S1001I	15345	Chassis 10 Slot 1 Installed
$S1002I	15346	Chassis 10 Slot 2 Installed
$S1003I	15347	Chassis 10 Slot 3 Installed
$S1004I	15348	Chassis 10 Slot 4 Installed
$S1005I	15349	Chassis 10 Slot 5 Installed
$S1006I	15350	Chassis 10 Slot 6 Installed
$S1007I	15351	Chassis 10 Slot 7 Installed
$S1008I	15352	Chassis 10 Slot 8 Installed
$S1009I	15353	Chassis 10 Slot 9 Installed
$S1010I	15354	Chassis 10 Slot 10 Installed
$S1011I	15355	Chassis 10 Slot 11 Installed
$S1012I	15356	Chassis 10 Slot 12 Installed
$S1013I	15357	Chassis 10 Slot 13 Installed
$S1014I	15358	Chassis 10 Slot 14 Installed
$S1015I	15359	Chassis 10 Slot 15 Installed
$S1016I	15360	Chassis 10 Slot 16 Installed

Chassis 11 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 11.

Variable	Alias	Description
$S1101P	15377	Chassis 11 Slot 1 Pass Indicator
$S1102P	15378	Chassis 11 Slot 2 Pass Indicator
$S1103P	15379	Chassis 11 Slot 3 Pass Indicator
$S1104P	15380	Chassis 11 Slot 4 Pass Indicator
$S1105P	15381	Chassis 11 Slot 5 Pass Indicator
$S1106P	15382	Chassis 11 Slot 6 Pass Indicator
$S1107P	15383	Chassis 11 Slot 7 Pass Indicator
$S1108P	15384	Chassis 11 Slot 8 Pass Indicator
$S1109P	15385	Chassis 11 Slot 9 Pass Indicator
$S1110P	15386	Chassis 11 Slot 10 Pass Indicator
$S1111P	15387	Chassis 11 Slot 11 Pass Indicator
$S1112P	15388	Chassis 11 Slot 12 Pass Indicator
$S1113P	15389	Chassis 11 Slot 13 Pass Indicator
$S1114P	15390	Chassis 11 Slot 14 Pass Indicator
$S1115P	15391	Chassis 11 Slot 15 Pass Indicator
$S1116P	15392	Chassis 11 Slot 16 Pass Indicator

Chassis 11 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 11.

Variable	Alias	Description
$S1101F	15393	Chassis 11 Slot 1 Fault Indicator
$S1102F	15394	Chassis 11 Slot 2 Fault Indicator
$S1103F	15395	Chassis 11 Slot 3 Fault Indicator
$S1104F	15396	Chassis 11 Slot 4 Fault Indicator
$S1105F	15397	Chassis 11 Slot 5 Fault Indicator
$S1106F	15398	Chassis 11 Slot 6 Fault Indicator
$S1107F	15399	Chassis 11 Slot 7 Fault Indicator
$S1108F	15400	Chassis 11 Slot 8 Fault Indicator
$S1109F	15401	Chassis 11 Slot 9 Fault Indicator
$S1110F	15402	Chassis 11 Slot 10 Fault Indicator

Variable	Alias	Description
$S1111F	15403	Chassis 11 Slot 11 Fault Indicator
$S1112F	15404	Chassis 11 Slot 12 Fault Indicator
$S1113F	15405	Chassis 11 Slot 13 Fault Indicator
$S1114F	15406	Chassis 11 Slot 14 Fault Indicator
$S1115F	15407	Chassis 11 Slot 15 Fault Indicator
$S1116F	15408	Chassis 11 Slot 16 Fault Indicator

Chassis 11 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 11.

Variable	Alias	Description
$S1101A	15409	Chassis 11 Slot 1 Active Indicator
$S1102A	15410	Chassis 11 Slot 2 Active Indicator
$S1103A	15411	Chassis 11 Slot 3 Active Indicator
$S1104A	15412	Chassis 11 Slot 4 Active Indicator
$S1105A	15413	Chassis 11 Slot 5 Active Indicator
$S1106A	15414	Chassis 11 Slot 6 Active Indicator
$S1107A	15415	Chassis 11 Slot 7 Active Indicator
$S1108A	15416	Chassis 11 Slot 8 Active Indicator
$S1109A	15417	Chassis 11 Slot 9 Active Indicator
$S1110A	15418	Chassis 11 Slot 10 Active Indicator
$S1111A	15419	Chassis 11 Slot 11 Active Indicator
$S1112A	15420	Chassis 11 Slot 12 Active Indicator
$S1113A	15421	Chassis 11 Slot 13 Active Indicator
$S1114A	15422	Chassis 11 Slot 14 Active Indicator
$S1115A	15423	Chassis 11 Slot 15 Active Indicator
$S1116A	15424	Chassis 11 Slot 16 Active Indicator

Chassis 11 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 11.

Variable	Alias	Description
$S1101B	15425	Chassis 11 Slot 1 Load/Fuse Indicator
$S1102B	15426	Chassis 11 Slot 2 Load/Fuse Indicator
$S1103B	15427	Chassis 11 Slot 3 Load/Fuse Indicator
$S1104B	15428	Chassis 11 Slot 4 Load/Fuse Indicator
$S1105B	15429	Chassis 11 Slot 5 Load/Fuse Indicator
$S1106B	15430	Chassis 11 Slot 6 Load/Fuse Indicator
$S1107B	15431	Chassis 11 Slot 7 Load/Fuse Indicator
$S1108B	15432	Chassis 11 Slot 8 Load/Fuse Indicator
$S1109B	15433	Chassis 11 Slot 9 Load/Fuse Indicator
$S1110B	15434	Chassis 11 Slot 10 Load/Fuse Indicator
$S1111B	15435	Chassis 11 Slot 11 Load/Fuse Indicator
$S1112B	15436	Chassis 11 Slot 12 Load/Fuse Indicator
$S1113B	15437	Chassis 11 Slot 13 Load/Fuse Indicator
$S1114B	15438	Chassis 11 Slot 14 Load/Fuse Indicator
$S1115B	15439	Chassis 11 Slot 15 Load/Fuse Indicator
$S1116B	15440	Chassis 11 Slot 16 Load/Fuse Indicator

Chassis 11 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 11.

Variable	Alias	Description
$S1101I	15441	Chassis 11 Slot 1 Installed
$S1102I	15442	Chassis 11 Slot 2 Installed
$S1103I	15443	Chassis 11 Slot 3 Installed
$S1104I	15444	Chassis 11 Slot 4 Installed
$S1105I	15445	Chassis 11 Slot 5 Installed
$S1106I	15446	Chassis 11 Slot 6 Installed
$S1107I	15447	Chassis 11 Slot 7 Installed
$S1108I	15448	Chassis 11 Slot 8 Installed
$S1109I	15449	Chassis 11 Slot 9 Installed
$S1110I	15450	Chassis 11 Slot 10 Installed

Variable	Alias	Description
$S1111I	15451	Chassis 11 Slot 11 Installed
$S1112I	15452	Chassis 11 Slot 12 Installed
$S1113I	15453	Chassis 11 Slot 13 Installed
$S1114I	15454	Chassis 11 Slot 14 Installed
$S1115I	15455	Chassis 11 Slot 15 Installed
$S1116I	15456	Chassis 11 Slot 16 Installed

Chassis 12 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 12.

Variable	Alias	Description
$S1201P	15473	Chassis 12 Slot 1 Pass Indicator
$S1202P	15474	Chassis 12 Slot 2 Pass Indicator
$S1203P	15475	Chassis 12 Slot 3 Pass Indicator
$S1204P	15476	Chassis 12 Slot 4 Pass Indicator
$S1205P	15477	Chassis 12 Slot 5 Pass Indicator
$S1206P	15478	Chassis 12 Slot 6 Pass Indicator
$S1207P	15479	Chassis 12 Slot 7 Pass Indicator
$S1208P	15480	Chassis 12 Slot 8 Pass Indicator
$S1209P	15481	Chassis 12 Slot 9 Pass Indicator
$S1210P	15482	Chassis 12 Slot 10 Pass Indicator
$S1211P	15483	Chassis 12 Slot 11 Pass Indicator
$S1212P	15484	Chassis 12 Slot 12 Pass Indicator
$S1213P	15485	Chassis 12 Slot 13 Pass Indicator
$S1214P	15486	Chassis 12 Slot 14 Pass Indicator
$S1215P	15487	Chassis 12 Slot 15 Pass Indicator
$S1216P	15488	Chassis 12 Slot 16 Pass Indicator

Chassis 12 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 12.

Variable	Alias	Description
$S1201F	15489	Chassis 12 Slot 1 Fault Indicator
$S1202F	15490	Chassis 12 Slot 2 Fault Indicator
$S1203F	15491	Chassis 12 Slot 3 Fault Indicator
$S1204F	15492	Chassis 12 Slot 4 Fault Indicator
$S1205F	15493	Chassis 12 Slot 5 Fault Indicator
$S1206F	15494	Chassis 12 Slot 6 Fault Indicator
$S1207F	15495	Chassis 12 Slot 7 Fault Indicator
$S1208F	15496	Chassis 12 Slot 8 Fault Indicator
$S1209F	15497	Chassis 12 Slot 9 Fault Indicator
$S1210F	15498	Chassis 12 Slot 10 Fault Indicator
$S1211F	15499	Chassis 12 Slot 11 Fault Indicator
$S1212F	15500	Chassis 12 Slot 12 Fault Indicator
$S1213F	15501	Chassis 12 Slot 13 Fault Indicator
$S1214F	15502	Chassis 12 Slot 14 Fault Indicator
$S1215F	15503	Chassis 12 Slot 15 Fault Indicator
$S1216F	15504	Chassis 12 Slot 16 Fault Indicator

Chassis 12 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 12.

Variable	Alias	Description
$S1201A	15505	Chassis 12 Slot 1 Active Indicator
$S1202A	15506	Chassis 12 Slot 2 Active Indicator
$S1203A	15507	Chassis 12 Slot 3 Active Indicator
$S1204A	15508	Chassis 12 Slot 4 Active Indicator
$S1205A	15509	Chassis 12 Slot 5 Active Indicator
$S1206A	15510	Chassis 12 Slot 6 Active Indicator
$S1207A	15511	Chassis 12 Slot 7 Active Indicator
$S1208A	15512	Chassis 12 Slot 8 Active Indicator
$S1209A	15513	Chassis 12 Slot 9 Active Indicator
$S1210A	15514	Chassis 12 Slot 10 Active Indicator

Variable	Alias	Description
$S1211A	15515	Chassis 12 Slot 11 Active Indicator
$S1212A	15516	Chassis 12 Slot 12 Active Indicator
$S1213A	15517	Chassis 12 Slot 13 Active Indicator
$S1214A	15518	Chassis 12 Slot 14 Active Indicator
$S1215A	15519	Chassis 12 Slot 15 Active Indicator
$S1216A	15552	Chassis 12 Slot 16 Active Indicator

Chassis 12 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 12.

Variable	Alias	Description
$S1201B	15521	Chassis 12 Slot 1 Load/Fuse Indicator
$S1202B	15522	Chassis 12 Slot 2 Load/Fuse Indicator
$S1203B	15523	Chassis 12 Slot 3 Load/Fuse Indicator
$S1204B	15524	Chassis 12 Slot 4 Load/Fuse Indicator
$S1205B	15525	Chassis 12 Slot 5 Load/Fuse Indicator
$S1206B	15526	Chassis 12 Slot 6 Load/Fuse Indicator
$S1207B	15527	Chassis 12 Slot 7 Load/Fuse Indicator
$S1208B	15528	Chassis 12 Slot 8 Load/Fuse Indicator
$S1209B	15529	Chassis 12 Slot 9 Load/Fuse Indicator
$S1210B	15530	Chassis 12 Slot 10 Load/Fuse Indicator
$S1211B	15531	Chassis 12 Slot 11 Load/Fuse Indicator
$S1212B	15532	Chassis 12 Slot 12 Load/Fuse Indicator
$S1213B	15533	Chassis 12 Slot 13 Load/Fuse Indicator
$S1214B	15534	Chassis 12 Slot 14 Load/Fuse Indicator
$S1215B	15535	Chassis 12 Slot 15 Load/Fuse Indicator
$S1216B	15536	Chassis 12 Slot 16 Load/Fuse Indicator

Chassis 12 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 12.

Variable	Alias	Description
$S1201I	15537	Chassis 12 Slot 1 Installed
$S1202I	15538	Chassis 12 Slot 2 Installed
$S1203I	15539	Chassis 12 Slot 3 Installed
$S1204I	15540	Chassis 12 Slot 4 Installed
$S1205I	15541	Chassis 12 Slot 5 Installed
$S1206I	15542	Chassis 12 Slot 6 Installed
$S1207I	15543	Chassis 12 Slot 7 Installed
$S1208I	15544	Chassis 12 Slot 8 Installed
$S1209I	15545	Chassis 12 Slot 9 Installed
$S1210I	15546	Chassis 12 Slot 10 Installed
$S1211I	15547	Chassis 12 Slot 11 Installed
$S1212I	15548	Chassis 12 Slot 12 Installed
$S1213I	15549	Chassis 12 Slot 13 Installed
$S1214I	15550	Chassis 12 Slot 14 Installed
$S1215I	15551	Chassis 12 Slot 15 Installed
$S1216I	15552	Chassis 12 Slot 16 Installed

Chassis 13 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 13.

Variable	Alias	Description
$S1301P	15569	Chassis 13 Slot 1 Pass Indicator
$S1302P	15570	Chassis 13 Slot 2 Pass Indicator
$S1303P	15571	Chassis 13 Slot 3 Pass Indicator
$S1304P	15572	Chassis 13 Slot 4 Pass Indicator
$S1305P	15573	Chassis 13 Slot 5 Pass Indicator
$S1306P	15574	Chassis 13 Slot 6 Pass Indicator
$S1307P	15575	Chassis 13 Slot 7 Pass Indicator
$S1308P	15576	Chassis 13 Slot 8 Pass Indicator
$S1309P	15577	Chassis 13 Slot 9 Pass Indicator
$S1310P	15578	Chassis 13 Slot 10 Pass Indicator

Variable	Alias	Description
$S1311P	15579	Chassis 13 Slot 11 Pass Indicator
$S1312P	15580	Chassis 13 Slot 12 Pass Indicator
$S1313P	15581	Chassis 13 Slot 13 Pass Indicator
$S1314P	15582	Chassis 13 Slot 14 Pass Indicator
$S1315P	15583	Chassis 13 Slot 15 Pass Indicator
$S1316P	15584	Chassis 13 Slot 16 Pass Indicator

Chassis 13 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 13.

Variable	Alias	Description
$S1301F	15585	Chassis 13 Slot 1 Fault Indicator
$S1302F	15586	Chassis 13 Slot 2 Fault Indicator
$S1303F	15587	Chassis 13 Slot 3 Fault Indicator
$S1304F	15588	Chassis 13 Slot 4 Fault Indicator
$S1305F	15589	Chassis 13 Slot 5 Fault Indicator
$S1306F	15590	Chassis 13 Slot 6 Fault Indicator
$S1307F	15591	Chassis 13 Slot 7 Fault Indicator
$S1308F	15592	Chassis 13 Slot 8 Fault Indicator
$S1309F	15593	Chassis 13 Slot 9 Fault Indicator
$S1310F	15594	Chassis 13 Slot 10 Fault Indicator
$S1311F	15595	Chassis 13 Slot 11 Fault Indicator
$S1312F	15596	Chassis 13 Slot 12 Fault Indicator
$S1313F	15597	Chassis 13 Slot 13 Fault Indicator
$S1314F	15598	Chassis 13 Slot 14 Fault Indicator
$S1315F	15599	Chassis 13 Slot 15 Fault Indicator
$S1316F	15600	Chassis 13 Slot 16 Fault Indicator

Chassis 13 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 13.

Variable	Alias	Description
$S1301A	15601	Chassis 13 Slot 1 Active Indicator
$S1302A	15602	Chassis 13 Slot 2 Active Indicator
$S1303A	15603	Chassis 13 Slot 3 Active Indicator
$S1304A	15604	Chassis 13 Slot 4 Active Indicator
$S1305A	15605	Chassis 13 Slot 5 Active Indicator
$S1306A	15606	Chassis 13 Slot 6 Active Indicator
$S1307A	15607	Chassis 13 Slot 7 Active Indicator
$S1308A	15608	Chassis 13 Slot 8 Active Indicator
$S1309A	15609	Chassis 13 Slot 9 Active Indicator
$S1310A	15610	Chassis 13 Slot 10 Active Indicator
$S1311A	15611	Chassis 13 Slot 11 Active Indicator
$S1312A	15612	Chassis 13 Slot 12 Active Indicator
$S1313A	15613	Chassis 13 Slot 13 Active Indicator
$S1314A	15614	Chassis 13 Slot 14 Active Indicator
$S1315A	15615	Chassis 13 Slot 15 Active Indicator
$S1316A	15616	Chassis 13 Slot 16 Active Indicator

Chassis 13 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 13.

Variable	Alias	Description
$S1301B	15617	Chassis 13 Slot 1 Load/Fuse Indicator
$S1302B	15618	Chassis 13 Slot 2 Load/Fuse Indicator
$S1303B	15619	Chassis 13 Slot 3 Load/Fuse Indicator
$S1304B	15620	Chassis 13 Slot 4 Load/Fuse Indicator
$S1305B	15621	Chassis 13 Slot 5 Load/Fuse Indicator
$S1306B	15622	Chassis 13 Slot 6 Load/Fuse Indicator
$S1307B	15623	Chassis 13 Slot 7 Load/Fuse Indicator
$S1308B	15624	Chassis 13 Slot 8 Load/Fuse Indicator
$S1309B	15625	Chassis 13 Slot 9 Load/Fuse Indicator
$S1310B	15626	Chassis 13 Slot 10 Load/Fuse Indicator

Variable	Alias	Description
$S1311B	15627	Chassis 13 Slot 11 Load/Fuse Indicator
$S1312B	15628	Chassis 13 Slot 12 Load/Fuse Indicator
$S1313B	15629	Chassis 13 Slot 13 Load/Fuse Indicator
$S1314B	15630	Chassis 13 Slot 14 Load/Fuse Indicator
$S1315B	15631	Chassis 13 Slot 15 Load/Fuse Indicator
$S1316B	15632	Chassis 13 Slot 16 Load/Fuse Indicator

Chassis 13 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 13.

Variable	Alias	Description
$S1301I	15633	Chassis 13 Slot 1 Installed
$S1302I	15634	Chassis 13 Slot 2 Installed
$S1303I	15635	Chassis 13 Slot 3 Installed
$S1304I	15636	Chassis 13 Slot 4 Installed
$S1305I	15637	Chassis 13 Slot 5 Installed
$S1306I	15638	Chassis 13 Slot 6 Installed
$S1307I	15639	Chassis 13 Slot 7 Installed
$S1308I	15640	Chassis 13 Slot 8 Installed
$S1309I	15641	Chassis 13 Slot 9 Installed
$S1310I	15642	Chassis 13 Slot 10 Installed
$S1311I	15643	Chassis 13 Slot 11 Installed
$S1312I	15644	Chassis 13 Slot 12 Installed
$S1313I	15645	Chassis 13 Slot 13 Installed
$S1314I	15646	Chassis 13 Slot 14 Installed
$S1315I	15647	Chassis 13 Slot 15 Installed
$S1316I	15648	Chassis 13 Slot 16 Installed

Chassis 14 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 14.

Variable	Alias	Description
$S1401P	15665	Chassis 14 Slot 1 Pass Indicator
$S1402P	15666	Chassis 14 Slot 2 Pass Indicator
$S1403P	15667	Chassis 14 Slot 3 Pass Indicator
$S1404P	15668	Chassis 14 Slot 4 Pass Indicator
$S1405P	15669	Chassis 14 Slot 5 Pass Indicator
$S1406P	15670	Chassis 14 Slot 6 Pass Indicator
$S1407P	15671	Chassis 14 Slot 7 Pass Indicator
$S1408P	15672	Chassis 14 Slot 8 Pass Indicator
$S1409P	15673	Chassis 14 Slot 9 Pass Indicator
$S1410P	15674	Chassis 14 Slot 10 Pass Indicator
$S1411P	15675	Chassis 14 Slot 11 Pass Indicator
$S1412P	15676	Chassis 14 Slot 12 Pass Indicator
$S1413P	15677	Chassis 14 Slot 13 Pass Indicator
$S1414P	15678	Chassis 14 Slot 14 Pass Indicator
$S1415P	15679	Chassis 14 Slot 15 Pass Indicator
$S1416P	15680	Chassis 14 Slot 16 Pass Indicator

Chassis 14 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 14.

Variable	Alias	Description
$S1401F	15681	Chassis 14 Slot 1 Fault Indicator
$S1402F	15682	Chassis 14 Slot 2 Fault Indicator
$S1403F	15683	Chassis 14 Slot 3 Fault Indicator
$S1404F	15684	Chassis 14 Slot 4 Fault Indicator
$S1405F	15685	Chassis 14 Slot 5 Fault Indicator
$S1406F	15686	Chassis 14 Slot 6 Fault Indicator
$S1407F	15687	Chassis 14 Slot 7 Fault Indicator
$S1408F	15688	Chassis 14 Slot 8 Fault Indicator
$S1409F	15689	Chassis 14 Slot 9 Fault Indicator
$S1410F	15690	Chassis 14 Slot 10 Fault Indicator

Variable	Alias	Description
$S1411F	15691	Chassis 14 Slot 11 Fault Indicator
$S1412F	15692	Chassis 14 Slot 12 Fault Indicator
$S1413F	15693	Chassis 14 Slot 13 Fault Indicator
$S1414F	15694	Chassis 14 Slot 14 Fault Indicator
$S1415F	15695	Chassis 14 Slot 15 Fault Indicator
$S1416F	15696	Chassis 14 Slot 16 Fault Indicator

Chassis 14 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 14.

Variable	Alias	Description
$S1401A	15697	Chassis 14 Slot 1 Active Indicator
$S1402A	15698	Chassis 14 Slot 2 Active Indicator
$S1403A	15699	Chassis 14 Slot 3 Active Indicator
$S1404A	15700	Chassis 14 Slot 4 Active Indicator
$S1405A	15701	Chassis 14 Slot 5 Active Indicator
$S1406A	15702	Chassis 14 Slot 6 Active Indicator
$S1407A	15703	Chassis 14 Slot 7 Active Indicator
$S1408A	15704	Chassis 14 Slot 8 Active Indicator
$S1409A	15705	Chassis 14 Slot 9 Active Indicator
$S1410A	15706	Chassis 14 Slot 10 Active Indicator
$S1411A	15707	Chassis 14 Slot 11 Active Indicator
$S1412A	15708	Chassis 14 Slot 12 Active Indicator
$S1413A	15709	Chassis 14 Slot 13 Active Indicator
$S1414A	15710	Chassis 14 Slot 14 Active Indicator
$S1415A	15711	Chassis 14 Slot 15 Active Indicator
$S1416A	15712	Chassis 14 Slot 16 Active Indicator

Chassis 14 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 14.

Variable	Alias	Description
$S1401B	15713	Chassis 14 Slot 1 Load/Fuse Indicator
$S1402B	15714	Chassis 14 Slot 2 Load/Fuse Indicator
$S1403B	15715	Chassis 14 Slot 3 Load/Fuse Indicator
$S1404B	15716	Chassis 14 Slot 4 Load/Fuse Indicator
$S1405B	15717	Chassis 14 Slot 5 Load/Fuse Indicator
$S1406B	15718	Chassis 14 Slot 6 Load/Fuse Indicator
$S1407B	15719	Chassis 14 Slot 7 Load/Fuse Indicator
$S1408B	15720	Chassis 14 Slot 8 Load/Fuse Indicator
$S1409B	15721	Chassis 14 Slot 9 Load/Fuse Indicator
$S1410B	15722	Chassis 14 Slot 10 Load/Fuse Indicator
$S1411B	15723	Chassis 14 Slot 11 Load/Fuse Indicator
$S1412B	15724	Chassis 14 Slot 12 Load/Fuse Indicator
$S1413B	15725	Chassis 14 Slot 13 Load/Fuse Indicator
$S1414B	15726	Chassis 14 Slot 14 Load/Fuse Indicator
$S1415B	15727	Chassis 14 Slot 15 Load/Fuse Indicator
$S1416B	15728	Chassis 14 Slot 16 Load/Fuse Indicator

Chassis 14 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 14.

Variable	Alias	Description
$S1401I	15729	Chassis 14 Slot 1 Installed
$S1402I	15730	Chassis 14 Slot 2 Installed
$S1403I	15731	Chassis 14 Slot 3 Installed
$S1404I	15732	Chassis 14 Slot 4 Installed
$S1405I	15733	Chassis 14 Slot 5 Installed
$S1406I	15734	Chassis 14 Slot 6 Installed
$S1407I	15735	Chassis 14 Slot 7 Installed
$S1408I	15736	Chassis 14 Slot 8 Installed
$S1409I	15737	Chassis 14 Slot 9 Installed
$S1410I	15738	Chassis 14 Slot 10 Installed

Variable	Alias	Description
$S1411I	15739	Chassis 14 Slot 11 Installed
$S1412I	15740	Chassis 14 Slot 12 Installed
$S1413I	15741	Chassis 14 Slot 13 Installed
$S1414I	15742	Chassis 14 Slot 14 Installed
$S1415I	15743	Chassis 14 Slot 15 Installed
$S1416I	15744	Chassis 14 Slot 16 Installed

Chassis 15 Pass Indicator Aliases

This table lists the aliases that identify the Pass indicators for chassis 15.

Variable	Alias	Description
$S1501P	15761	Chassis 15 Slot 1 Pass Indicator
$S1502P	15762	Chassis 15 Slot 2 Pass Indicator
$S1503P	15763	Chassis 15 Slot 3 Pass Indicator
$S1504P	15764	Chassis 15 Slot 4 Pass Indicator
$S1505P	15765	Chassis 15 Slot 5 Pass Indicator
$S1506P	15766	Chassis 15 Slot 6 Pass Indicator
$S1507P	15767	Chassis 15 Slot 7 Pass Indicator
$S1508P	15768	Chassis 15 Slot 8 Pass Indicator
$S1509P	15769	Chassis 15 Slot 9 Pass Indicator
$S1510P	15770	Chassis 15 Slot 10 Pass Indicator
$S1511P	15771	Chassis 15 Slot 11 Pass Indicator
$S1512P	15772	Chassis 15 Slot 12 Pass Indicator
$S1513P	15773	Chassis 15 Slot 13 Pass Indicator
$S1514P	15774	Chassis 15 Slot 14 Pass Indicator
$S1515P	15775	Chassis 15 Slot 15 Pass Indicator
$S1516P	15776	Chassis 15 Slot 16 Pass Indicator

Chassis 15 Fault Indicator Aliases

This table lists the aliases that identify Fault indicators for chassis 15.

Variable	Alias	Description
$S1501F	15777	Chassis 15 Slot 1 Fault Indicator
$S1502F	15778	Chassis 15 Slot 2 Fault Indicator
$S1503F	15779	Chassis 15 Slot 3 Fault Indicator
$S1504F	15780	Chassis 15 Slot 4 Fault Indicator
$S1505F	15781	Chassis 15 Slot 5 Fault Indicator
$S1506F	15782	Chassis 15 Slot 6 Fault Indicator
$S1507F	15783	Chassis 15 Slot 7 Fault Indicator
$S1508F	15784	Chassis 15 Slot 8 Fault Indicator
$S1509F	15785	Chassis 15 Slot 9 Fault Indicator
$S1510F	15786	Chassis 15 Slot 10 Fault Indicator
$S1511F	15787	Chassis 15 Slot 11 Fault Indicator
$S1512F	15788	Chassis 15 Slot 12 Fault Indicator
$S1513F	15789	Chassis 15 Slot 13 Fault Indicator
$S1514F	15790	Chassis 15 Slot 14 Fault Indicator
$S1515F	15791	Chassis 15 Slot 15 Fault Indicator
$S1516F	15792	Chassis 15 Slot 16 Fault Indicator

Chassis 15 Active Indicator Aliases

This table lists the aliases that identify Active indicators for chassis 15.

Variable	Alias	Description
$S1501A	15793	Chassis 15 Slot 1 Active Indicator
$S1502A	15794	Chassis 15 Slot 2 Active Indicator
$S1503A	15795	Chassis 15 Slot 3 Active Indicator
$S1504A	15796	Chassis 15 Slot 4 Active Indicator
$S1505A	15797	Chassis 15 Slot 5 Active Indicator
$S1506A	15798	Chassis 15 Slot 6 Active Indicator
$S1507A	15799	Chassis 15 Slot 7 Active Indicator
$S1508A	15800	Chassis 15 Slot 8 Active Indicator
$S1509A	15801	Chassis 15 Slot 9 Active Indicator
$S1510A	15802	Chassis 15 Slot 10 Active Indicator

Variable	Alias	Description
$S1511A	15803	Chassis 15 Slot 11 Active Indicator
$S1512A	15804	Chassis 15 Slot 12 Active Indicator
$S1513A	15805	Chassis 15 Slot 13 Active Indicator
$S1514A	15806	Chassis 15 Slot 14 Active Indicator
$S1515A	15807	Chassis 15 Slot 15 Active Indicator
$S1516A	15808	Chassis 15 Slot 16 Active Indicator

Chassis 15 Load/Fuse Indicator Aliases

This table lists the aliases that identify Load/Fuse indicators for chassis 15.

Variable	Alias	Description
$S1501B	15809	Chassis 15 Slot 1 Load/Fuse Indicator
$S1502B	15810	Chassis 15 Slot 2 Load/Fuse Indicator
$S1503B	15811	Chassis 15 Slot 3 Load/Fuse Indicator
$S1504B	15812	Chassis 15 Slot 4 Load/Fuse Indicator
$S1505B	15813	Chassis 15 Slot 5 Load/Fuse Indicator
$S1506B	15814	Chassis 15 Slot 6 Load/Fuse Indicator
$S1507B	15815	Chassis 15 Slot 7 Load/Fuse Indicator
$S1508B	15816	Chassis 15 Slot 8 Load/Fuse Indicator
$S1509B	15817	Chassis 15 Slot 9 Load/Fuse Indicator
$S1510B	15818	Chassis 15 Slot 10 Load/Fuse Indicator
$S1511B	15819	Chassis 15 Slot 11 Load/Fuse Indicator
$S1512B	15820	Chassis 15 Slot 12 Load/Fuse Indicator
$S1513B	15821	Chassis 15 Slot 13 Load/Fuse Indicator
$S1514B	15822	Chassis 15 Slot 14 Load/Fuse Indicator
$S1515B	15823	Chassis 15 Slot 15 Load/Fuse Indicator
$S1516B	15824	Chassis 15 Slot 16 Load/Fuse Indicator

Chassis 15 Installed Slot Aliases

This table lists the aliases that identify whether the slot is installed for chassis 15.

Variable	Alias	Description
$S1501I	15825	Chassis 15 Slot 1 Installed
$S1502I	15826	Chassis 15 Slot 2 Installed
$S1503I	15827	Chassis 15 Slot 3 Installed
$S1504I	15828	Chassis 15 Slot 4 Installed
$S1505I	15829	Chassis 15 Slot 5 Installed
$S1506I	15830	Chassis 15 Slot 6 Installed
$S1507I	15831	Chassis 15 Slot 7 Installed
$S1508I	15832	Chassis 15 Slot 8 Installed
$S1509I	15833	Chassis 15 Slot 9 Installed
$S1510I	15834	Chassis 15 Slot 10 Installed
$S1511I	15835	Chassis 15 Slot 11 Installed
$S1512I	15836	Chassis 15 Slot 12 Installed
$S1513I	15837	Chassis 15 Slot 13 Installed
$S1514I	15838	Chassis 15 Slot 14 Installed
$S1515I	15839	Chassis 15 Slot 15 Installed
$S1516I	15840	Chassis 15 Slot 16 Installed

Aliases for ACM, NCM, and TCM Network Status

This table lists aliases for the ACM, NCM, and TCM network communication modules. All system aliases used to obtain NET 1 status ($NET1L, $NET1R, $N01OK - $N10OK and $N01RD - $N10RD) *always* reflect the status of NET 1 on the NCM or TCM. They are not used with the ACM. System aliases used to obtain NET 2 status ($NET2L and $NET2R) always reflect the status of NET 2 on the NCM or TCM whenever NCM or TCM modules are configured on the system. However, if *only* ACM modules are configured, these aliases reflect the status of NET 2 on the ACM modules.

Variable	Alias	Description (discrete values)
$NET1L	14081	NET 1 on left NCM or TCM is operational
$NET2L	14082	NET 2 on left NCM or TCM is operational[1]
$NET1R	14083	NET 1 on right NCM or TCM is operational
$NET2R	14084	NET 2 on right NCM or TCM is operational[1]
$N01OK	14098	Communication with node 1 are OK
$N02OK	14099	Communication with node 2 are OK
$N03OK	14100	Communication with node 3 are OK
$N04OK	14101	Communication with node 4 are OK
$N05OK	14102	Communication with node 5 are OK
$N06OK	14103	Communication with node 6 are OK
$N07OK	14104	Communication with node 7 are OK
$N08OK	14105	Communication with node 8 are OK
$N09OK	14106	Communication with node 9 are OK
$N10OK	14107	Communication with node 10 are OK
$N01RD	14130	Redundant Communication exist with node 1
$N02RD	14131	Redundant Communication exist with node 2
$N03RD	14132	Redundant Communication exist with node 3
$N04RD	14133	Redundant Communication exist with node 4
$N05RD	14134	Redundant Communication exist with node 5
$N06RD	14135	Redundant Communication exist with node 6
$N07RD	14136	Redundant Communication exist with node 7
$N08RD	14137	Redundant Communication exist with node 8
$N09RD	14138	Redundant Communication exist with node 9
$N10RD	14139	Redundant Communication exist with node 10

1.   Reflects status of NCM or TCM, unless only ACM modules are configured.

Aliases for System-Wide Information

This table lists aliases for system-wide information. These values are stored in 16-bit wide (integer) system status registers.

Variable	Alias	Description (integer values)
$Year	39633	Current year
$Month	39635	Current month
$Day	39637	Current day
$Hour	39639	Current hour
$Minute	39641	Current minute
$Second	39643	Current second
$msec	39645	Current millisecond
$WKday	39647	Current day of week (0 = Sunday to 6 = Saturday)
$keysw	39649	Main chassis keyswitch position: 　0 = Stop 　1 = Prog 　2 = Run 　3 = Remote
$SCNREQ	39651	Scan time (ms) selected in Setup Manager
$DELTA	39653	Measured scan time (ms) for latest scan
$SCNSUR	39655	Surplus scan time (averaged over last 100 scans)
$SCNOVR	39657	Number of overruns (averaged over last 100 scans)
State	39659	Program mode as follows: 　0 = Running 　1 = Halted 　2 = Paused
$Disabl	39675	Number of disabled variables (I/O points and memory variables)
$CPVer	39663	Minor version number of control program.
$CPVer	39664	Major version number of control program.

G

TCM Model 4351/4352 Configuration

Overview

The procedures in this appendix apply specifically to configuring the ports on the model 4351 or 4352 TCM, and should be followed in place of the TCM configuration procedures provided in the preceding chapters of this guide.

Note   If you have a model 4351A, 4351B, 4352A, 4352B, 4353, or 4354 TCM, *do not* use the procedures in this appendix.

Configuring TCM Ports

A single Tricon system supports a maximum of four TCMs, which must reside in two logical slots. You cannot install models 4351A, 4351B, 4352A, 4352B, 4353, or 4354 TCMs into a system with 4351 or 4352 TCMs, even if they are installed in different chassis. See the *Planning and Installation Guide for Tricon v9–v10 Systems* for detailed TCM installation guidelines.

TCM models 4351 (Copper)/4352 (Fiber) support the following protocols on network and serial ports.

Protocol	Network Ports	Serial Ports
TriStation	NET 2	Port 4
TSAA (UDP/IP)	NET 2	—[1]
Peer-to-Peer (UDP/IP)	NET 1	—
Peer-to-Peer (DLC)	NET 1	—
Modbus Slave (ASCII or RTU)	—	Any port
Modbus Master (RTU)	—	Any port
Modbus Master or Slave (TCP)	NET 2	—
GPS Time Synchronization	—	Port 1
Triconex Time Synchronization via DLC	NET 1	—
Triconex Time Synchronization via UDP/IP	NET 1	—
SNTP Triconex Time Synchronization	NET 2	—
Network Printing using Jet Direct	NET 2	—

1. — means the protocol is not available on this port.

To configure specific types of ports, see these topics:

- Configuring TCM Network Ports on page 252
- Configuring TCM Serial Ports on page 254
- Configuring TCM Peer-To-Peer Ports on page 256
- Configuring TCM Modbus TCP Ports on page 258

For additional information on configuring the TCM, see these topics:

- Using a Tricon TCM to Synchronize Time on page 260 for instructions on configuring the TCM to synchronize time.
- Configuring a Tricon TCM Printer Port for Printing on page 266 for instructions on configuring the TCM for use with a printer.

Note   Once TCM ports have been configured, *but prior to downloading the configuration to the controller*, you can change the existing TCM model to a different model TCM without losing your port settings. Note that you can switch only from a 4351 to a 4352, or vice-versa.

However, once the configuration has been downloaded to the controller, you cannot change the TCM model installed in the Tricon without downloading a new configuration.

Configuring TCM Network Ports

This procedure explains how to configure network ports on a Tricon TCM.

Procedure

1 Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2 Double-click the slot where the TCM module is installed and then click Setup.

The TCM Setup dialog box appears.

3 Click the Network tab.
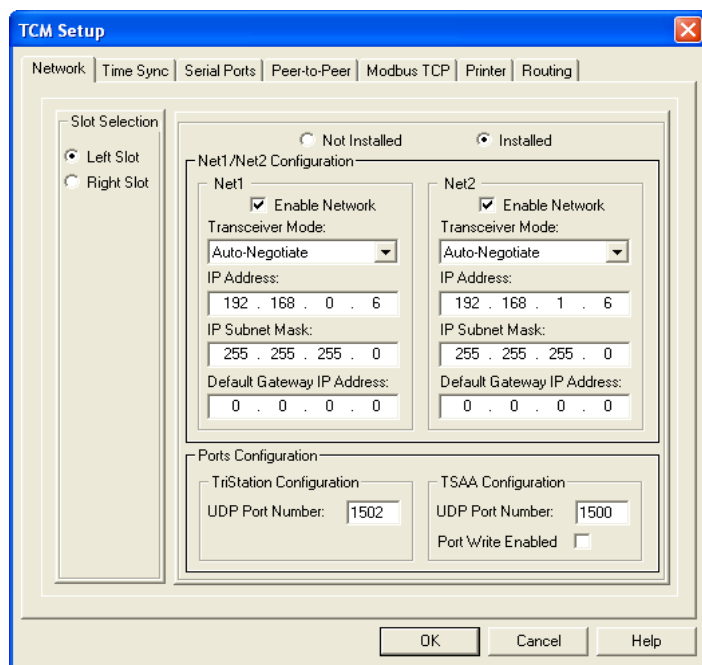
4 Specify these properties.

Property	Action
Slot Selection	Select the slot where the TCM module you want to configure is installed.
Not Installed, Installed	Click Installed to enable configuration of the module. Clicking Not Installed resets all options to their default state and makes them unavailable for configuration. The default is Not Installed.
Enable Network	Select the check box to enable the network port to be configured.

Property	Action
Transceiver Mode	Select the communication mode. The default is Auto-Negotiate.
	If you have a model 4352 TCM with fiber connectors, you **must** select 100 Mbps as the communication mode. The 4352 module cannot connect at 10 Mbps.
IP Address	Enter the IP Address for the port. NET 1 and NET 2 cannot use the same IP address. The default for NET 1 is 192.168.1.0; for NET 2 is 192.168.1.1.
IP Subnet Mask	If needed, enter the IP address for the subnet. The default is 255.255.255.0.
Default Gateway IP Address	If needed, enter the IP address for the default gateway. The default is 0.0.0.0.
TriStation Configuration: UDP Port Number	The UDP port to use for the TriStation connection. The default is 1502.
TSAA Configuration: UDP Port Number	The UDP port to use for TSAA connections, including DDE Server, SOE Recorder, and OPC Server. The default is 1500.
Port Write Enabled	This option applies only to model 4351A and 4352A TCMs.

5 Click OK to save your changes.

Note Changes to TCM IP addresses are not effective until the existing connection is closed and a new connection is opened. Once a connection is opened, it remains open until you close it, even if the IP address is changed via a download change operation.

Configuring TCM Serial Ports

This procedure explains how to configure serial ports on a Tricon TCM.

Procedure

1 Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2 Double-click the slot where the TCM module is installed and then click Setup.

The TCM Setup dialog box appears.

3 Click the Serial tab.

4 Specify these properties.

Property	Action
Port Selection	Click the port to be configured. Ports can be configured only for a slot with an installed module.
Protocol	Select the communication protocol for the port: • All ports can use Modbus Master, Modbus Slave ASCII, Modbus Slave RTU. • Only port 1 can use GPS. This port is automatically configured for GPS when you enable time synchronization. See Using a Tricon TCM to Synchronize Time on page 260. • Only port 4 can use TriStation.

Property	Action
Port Write Enabled	Available only if Modbus Slave (ASCII or RTU) is selected as the communication protocol. Select this check box if you want to allow Modbus writes to this slave port. The default is cleared (the port is read-only).
Modbus Slave Address	If you selected Modbus Slave RTU or ASCII, enter the number of the Modbus slave device. The default is 1.
Baud Rate	Enter the communication rate for the port. The default is 9600.
Data Bits	Select 8 or 7 bits. The default is 8. Available only with Modbus Slave ASCII.
Stop Bits	Select 1 or 2 bits. The default is 1 bit.
Parity	Select the type of parity for the port. The default is Odd.
Transceiver Mode	Select RS-485 or RS-232. The default is RS232. On port 4 when TriStation is selected as the protocol, RS-485 is not available
Handshake	Select None or Hardware; the default is None.
Termination Options	Select the type of termination used with cables. Only available with RS-485 Transceiver Mode. The default is None.
FP Ordering	Select the order to be used with floating point numbers. The default is Low 16 Bits First.
Modbus (Minimum and Maximum) Range	Enter the minimum and maximum values to be used for the Modbus alias range. The default minimum is 0. The default maximum is 32,767.
Master Logical Port	Enter the port number that the TCM will use in the Modbus Master functions to access the port. Only available for Modbus Master.

5 Click OK to save your changes.

Note Even if port 4 is set to Not Configured (the default value), it can still be used to connect to the Tricon via TriStation. This is useful when you are unable to connect via a network connection.

Configuring TCM Peer-To-Peer Ports

This procedure explains how to configure the IP address for controllers communicating on a Peer-to-Peer network through a Tricon TCM.

Procedure

1 Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2 Double-click the slot where the TCM module is installed and then click Setup.

The TCM Setup dialog box appears.

3 Click the Peer-to-Peer tab.
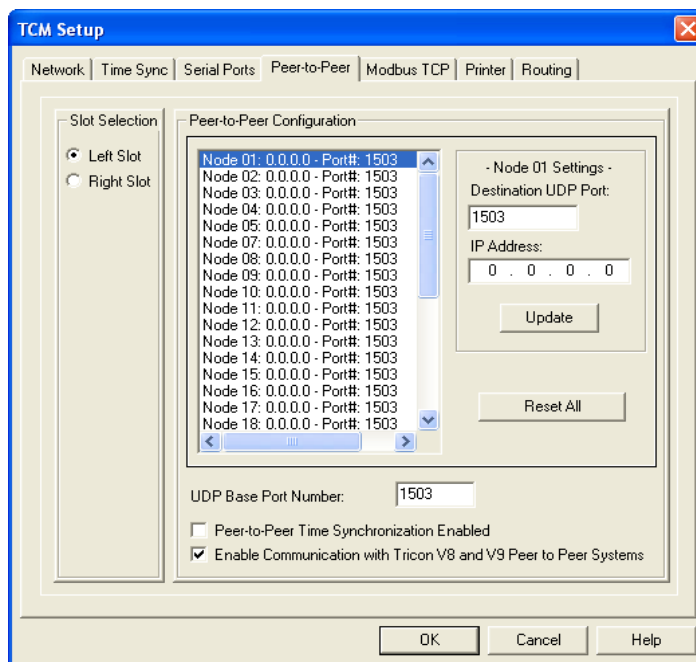
4 Under Slot Selection, select the module (slot) you want to configure Peer-to-Peer ports for.

5 Select a node (controller), and specify these properties.

Property	Action
Destination UDP Port	Enter the UDP port number for each controller to be communicated with on the Peer-to-Peer network. This must be the same number that the controller uses as its UDP Base Port Number.
IP Address	Enter the IP address for the controller.

6 Click Update to apply the new settings for the selected node.

7 Repeat steps 4 through 6 for each node to be included in the network.

Note If necessary, click Reset All to reset *all* node settings for the selected slot to their default, unconfigured state.

8   Once all nodes have been configured, specify these properties (applicable to all nodes on the Peer-to-Peer network).

Property	Action
UDP Base Port Number	Enter the UDP base port number for the controller. Enter 0 to disable Peer-to-Peer over UDP/IP on the network.
	The default is 1503. UDP port numbers must be unique.
Peer-to-Peer Time Synchronization Enabled	Select the check box to enable time synchronization across the Peer-to-Peer network. See Using a Tricon TCM to Synchronize Time on page 260 for more information.
Enable Communication with Tricon V8 and V9 Peer-to-Peer Systems	Select the check box to enable communication with Tricon version 8 and 9 systems. The default is cleared. Available only for a module installed in the left slot.

9   Click OK to save your changes.

Configuring TCM Modbus TCP Ports

This procedure explains how to configure Modbus TCP ports on a Tricon TCM, which enables Modbus communication through network ports.

Procedure

1   Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2   Double-click the slot where the TCM module is installed and then click Setup.

The TCM Setup dialog box appears.

3   Click the Modbus TCP tab.
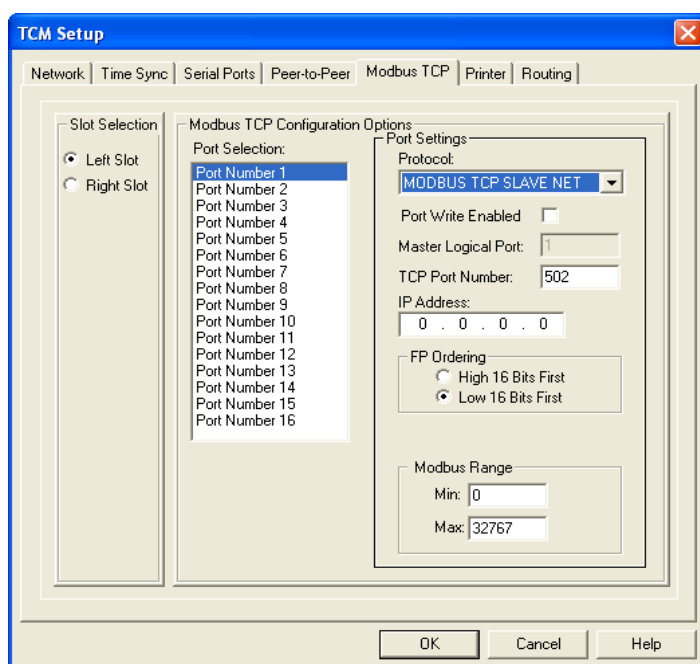
4   Under Slot Selection, select the module (slot) you want to configure Modbus TCP ports for.

5   Select a port and specify these properties.

Property	Action
Protocol	Select the communication protocol for the port. Options include Modbus TCP Master and Modbus TCP Slave Net.
Port Write Enabled	Available only if Modbus TCP Slave is selected as the communication protocol. Select this check box if you want to allow Modbus writes to this slave port. The default is cleared (the port is read-only).
Master Logical Port	Enter the number of the Modbus Master node. Available only with Modbus TCP Master protocol.
TCP Port	Enter the number for the TCP port. The default is 502.

Property	Action
IP Address	If the port uses Modbus Master protocol, enter the IP address of the slave node.
	If the port uses Modbus Slave protocol, enter either of these:
	• To accept communication from any Modbus Master, leave the IP address as 0.0.0.0.
	• To accept communication only from a defined Modbus Master, enter the specific master IP address.
FP Ordering	Select the ordering to use for floating point numbers.
Modbus (Minimum and Maximum) Range	Enter the minimum and maximum for the modbus alias range. Available only with Modbus TCP Slave Net.

6 Click OK to save your changes.

Using a Tricon TCM to Synchronize Time

This procedure explains how to enable time synchronization on a TCM. Time synchronization can be enabled using the following protocols:

- GPS
- SNTP
- Triconex Time Synchronization via DLC or UDP/IP on a Peer-to-Peer network

In a redundant network of Triconex controllers that each have two TCMs installed, you can implement redundant time synchronization by configuring time synchronization for both TCM modules (both left and right slots). Time synchronization can be enabled only for a single logical slot.

If the TCM is installed in the COM slot, you configure time synchronization only for the left slot (there is no redundancy when installed in the COM slot).

Configuring GPS Time Synchronization on the TCM

This procedure explains how to configure a TCM to enable time synchronization through the Global Positioning System (GPS) by using the Trimble Acutime Gold GPS smart antenna.

CAUTION	To ensure the accuracy of GPS time adjustments, the Tricon clock must be set to within 10 minutes of the correct local time.

If the TCM is in a Peer-to-Peer network, it can also be used as the master node for time synchronization of other controllers on the network. In this configuration, the master node TCM synchronizes time with the GPS, and any slave nodes on the Peer-to-Peer network synchronize their time with the master TCM. In this way, all nodes on the Peer-to-Peer network are synchronized with GPS time.

If the TCM is acting as a slave node on a Peer-to-Peer network, it *cannot* be configured for GPS time synchronization. Slave nodes synchronize their time *only* to the master node on the Peer-to-Peer network, and reject all other time change requests.

GPS time synchronization uses Serial Port 1 on the TCM.

Procedure

1 Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2 Double-click the slot where the TCM module is installed and then click Setup.

The TCM Setup dialog box appears.

3 Click the Time Sync tab.

4 Under Slot Selection, click Left Slot. You must configure the module in the left slot first.

5 Under Time Synchronization Configuration, select GPS.

If you previously configured Port 1 to use a Modbus protocol, selecting GPS will reset Port 1 to use the GPS protocol.

6   (Optional) If you have a redundant TCM installed in the right slot, under Slot Selection, click Right Slot, and then select GPS Redundant.

   Note   The module in the right slot can be configured only if it has been installed and if the module in the left slot has already been configured for GPS time synchronization.

7   Click OK to save your changes.

Enabling the TCM as a Master Node for Triconex Time Synchronization (Optional)

If you also want the TCM to be able to act as a master node for time synchronization of other controllers on a Peer-to-Peer network (using Triconex Time Synchronization) do the following:

1   In the Configuration tree, click Operating Parameters.

2   Select the Enable Tricon Node Time Synchronization check box.

Configuring SNTP Time Synchronization on the TCM

This procedure explains how to configure TCM time synchronization to an SNTP server.

If the TCM is in a Peer-to-Peer network, it can also be used as the master node for time synchronization of other controllers on the network. In this configuration, the master node TCM synchronizes time with the SNTP server, and any slave nodes on the Peer-to-Peer network synchronize their time with the master TCM. In this way, all nodes on the Peer-to-Peer network are synchronized with SNTP time.

If the TCM is acting as a slave node on a Peer-to-Peer network, it *cannot* be configured for SNTP time synchronization. Slave nodes synchronize their time *only* to the master node on the Peer-to-Peer network, and reject all other time change requests.

Procedure

1   Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2   Double-click the slot where the TCM module is installed and then click Setup. The TCM Setup dialog box appears.

3   Click the Time Sync tab.
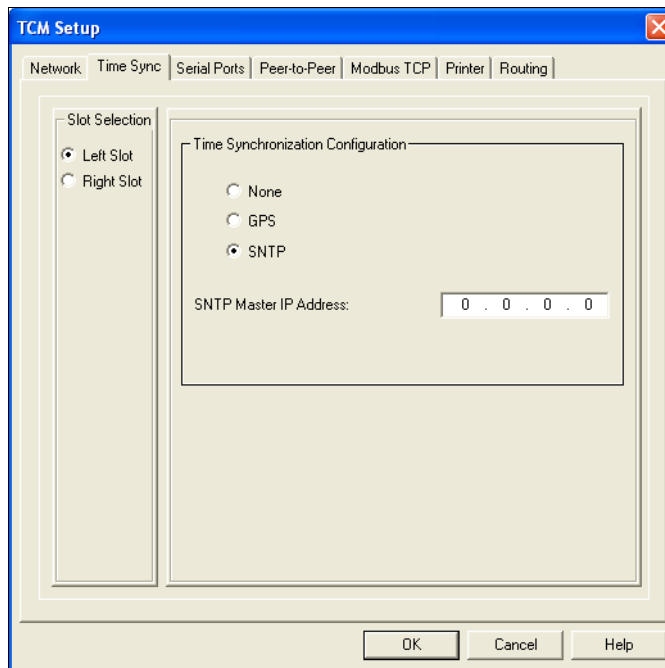
4   Under Slot Selection, click Left Slot. You must configure the module in the left slot first.

5   Select these properties.

Property	Action
Time Synchronization Configuration	Select SNTP. The default is None.

Property	Action
SNTP Master IP Address	Enter the IP address of the SNTP server to synchronize time with.

6 (Optional) If you have a redundant TCM installed in the right slot, under Slot Selection, click Right Slot, and then select these properties.

Property	Action
Time Synchronization Configuration	Select SNTP Redundant.
SNTP Master IP Address	Enter the IP address of the SNTP server to synchronize time with.

Note The module in the right slot can be configured only if it has been installed and if the module in the left slot has already been configured for SNTP time synchronization.

7 Click OK to save your changes.

Enabling the TCM as a Master Node for Triconex Time Synchronization (Optional)

If you also want the TCM to be able to act as a master node for time synchronization of other controllers on a Peer-to-Peer network (using Triconex Time Synchronization) do the following:

1 In the Configuration tree, click Operating Parameters.

2 Select the Enable Tricon Node Time Synchronization check box.

Configuring Triconex Time Synchronization on the TCM

In a Peer-to-Peer network, Triconex Time Synchronization can be used to synchronize time across controllers on a network. The controller with the lowest node number serves as the master node.

The master node can also synchronize its time with a GPS or an SNTP server. In this configuration, the master node synchronizes time with the GPS or SNTP server, and any slave nodes on the Peer-to-Peer network synchronize their time with the master node. In this way, all nodes on the Peer-to-Peer network are synchronized with GPS or SNTP time.

Note Currently, when a Trident controller is on a Peer-to-Peer network using Triconex Time Synchronization, with a Tricon TCM acting as a master node, the Trident will not correctly synchronize its time to the master node.

Configuring a Master Node

This procedure describes how to configure the TCM as a master node on the Peer-to-Peer network when GPS or SNTP time synchronization is **not** being used.

If you want the master node to synchronize to a GPS or SNTP server, use the procedures in the these sections:

- Configuring GPS Time Synchronization on the TCM on page 260
- Configuring SNTP Time Synchronization on the TCM on page 262

Procedure

1 Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2 Double-click the slot where the TCM module is installed and then click Setup. The TCM Setup dialog box appears.

3 Click the Time Sync tab.

4 Under Time Synchronization Configuration, select None.

5 Click OK to save your changes.

6 In the Configuration tree, click Operating Parameters.

7 Select the Enable Tricon Node Time Synchronization check box.

This allows the controller to participate as a master node in time synchronization across the Peer-to-Peer network.

Configuring a Slave Node

This procedure describes how to configure the TCM as a slave node on the Peer-to-Peer network.

Procedure

1   Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2   Double-click the slot where the TCM module is installed and then click Setup.

The TCM Setup dialog box appears.

3   Click the Peer-to-Peer tab.
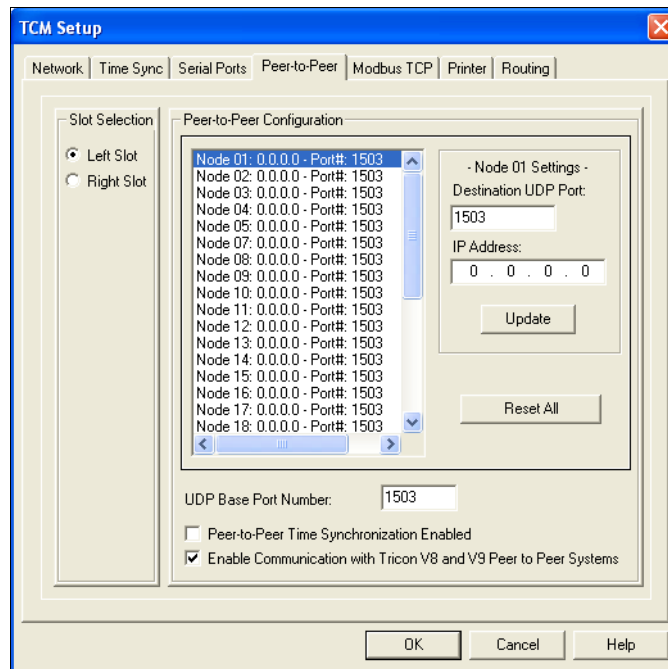
4   Under Slot Selection, click Left Slot.

5   Select the Peer-to-Peer Time Synchronization Enabled check box.

6   Click OK to save your changes.

7   In the Configuration tree, click Operating Parameters.

8   Select the Enable Tricon Node Time Synchronization check box.

This allows the controller to participate as a slave node in time synchronization across the Peer-to-Peer network.

Configuring a Tricon TCM Printer Port for Printing

This procedure explains how to configure a Tricon TCM port that is connected to a Centronics-compatible printer. You do not need the printer driver that may have come with the printer package.

Procedure

1 Expand the Controller tree, double-click Configuration, and expand Hardware Allocation.

2 Double-click the slot where the TCM module is installed and then click Setup.

The TCM Setup dialog box appears.

3 Click the Printer tab.
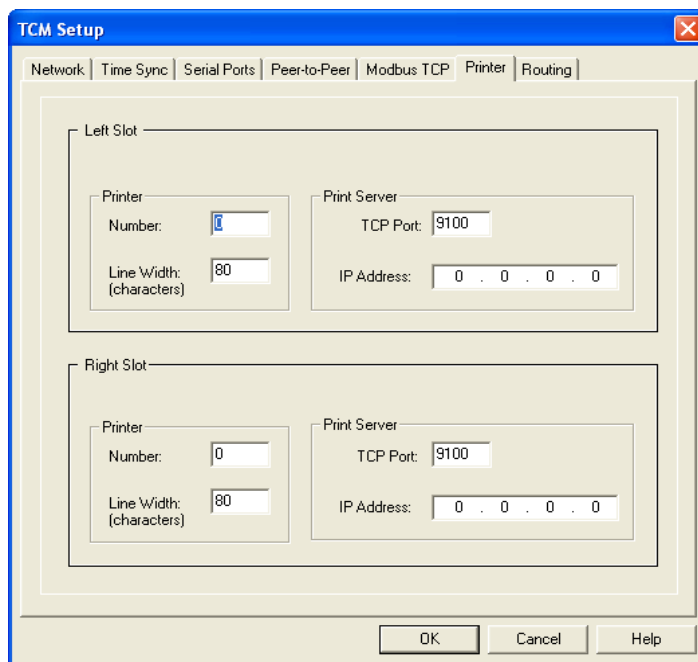
4 Specify these properties for the module installed in the Left Slot.

Property	Action
Printer Number	Enter the number for the printer; can only be 5 or 10. The default is 0, meaning a printer is not configured.
Line Width	Enter the number of characters to be printed on a line. The default is 80 characters.
TCP Port	Enter the number of the TCP port for the print server. The default is 9100 for an HP printer.
IP Address	Enter the IP address of the printer server.

5 If a module is also installed in the Right Slot, repeat step 4 for that module.

6 Click OK to save your changes.

10Base2

The standard for an Ethernet LAN capable of transmitting 10 megabits of data per second through thin coaxial cables, to a maximum distance of 656 feet (200 meters).

10BaseT

The standard for an Ethernet LAN capable of transmitting 10 megabits of data per second through twisted-pair wire.

100BaseTX

The predominant standard for a Fast Ethernet LAN capable of transmitting 100 megabits of data per second through Category 5 twisted-pair cable only.

ACM

Stands for the Advanced Communication Module, which is a Tricon communication module that acts as an interface to a Foxboro Intelligent Automation (I/A) Series DCS.

alias

A five-digit number that can be used by an external device to read or write to an input, output, or memory point in a controller. Alias is a convention of the Modbus protocol.

application

In TriStation 1131, an application is the compiled code (built from program elements and configuration information) that is downloaded to and runs in a Triconex controller.

ARP

Stands for Address Resolution Protocol which is a TCP/IP protocol used to obtain the physical address of a node on an Ethernet network. A client station broadcasts an ARP request onto the network with the IP address of the target node it wants to communicate with. The node with that address responds by sending back its physical address so that packets can be transmitted to it.

AUI

Attachment Unit Interface. A coaxial cable connected to a transceiver that plugs into a 15-pin socket on the network interface card (NIC), to a maximum distance of 328 feet (100 meters).

bin

An address range of aliased variables in Triconex controllers, based on Class and Type combinations.

Centronics

A standard 36-pin parallel interface for connecting printers and other devices to a computer.

client/server

 An architecture in which the client (PC or workstation) is the requesting machine and the server is the supplying machine, both of which are connected by means of a local area network (LAN) or wide area network (WAN).

closed network

 A network designed for maximum safety which includes only Triconex devices. A Peer-to-Peer network is an example of a closed network.

communication path

 The route between any two nodes. Same as line, channel, link, or circuit.

communication protocol

 Hardware and software standards that govern data transmission between two computers or communications devices. There are several layers (levels) of functionality in a protocol. Each layer may be available as a separate software component, or several layers may be combined into one.

controller

 A Triconex controller includes Main Processors, communication and I/O modules, and field termination panels.

CTS signal

 In Modbus communication, an RS-232 signal sent from the receiving station to the transmitting station which indicates it is ready to accept data.

data bits

 The number of bits used to represent one character of data. When a Modbus slave transmits ASCII text, either seven or eight bits can be used. When a Modbus master or slave uses the RTU mode, eight data bits are required.

data transfer time

 In a Peer-to-Peer network, the time required to initiate a send operation, send the data over the network, and get an acknowledgment from the receiving controller.

DCS

 Stands for distributed control system, which is a system that controls a process and provides status information to an operator.

default gateway

 A router that forwards all messages not addressed to stations within the local subnet.

duplex

 See *full duplex* and *half duplex*.

EICM

 Stands for Enhanced Intelligent Communication Module, which is a Tricon communication module that enables serial communication.

Ethernet

A type of computer network which is defined by the IEEE 802.3 standard. An Ethernet network is typically a shared media LAN. All stations on the segment share the total bandwidth, which is either 10 megabits (Ethernet), 100 megabits (Fast Ethernet) or 1,000 megabits (Gigabit Ethernet) per second.

exception condition

In Modbus communication, a programming or operation error which involves an illegal or illogical query by the master.

exception response

In Modbus communication, the response of a slave to a programming or operation error.

Fast Ethernet

Another name for 100BaseTX Ethernet communication. Fast Ethernet transmits data at 100 megabits per second rather than 10 megabits per second as in regular Ethernet. Fast Ethernet operates in a LAN (local area network) that shares the 100 megabit per second bandwidth with all transmitting stations.

fiber

Glass or plastic threads used to transmit data. A fiber-optic cable consists of a bundle of glass threads. Fiber-optic cables have a much greater bandwidth than copper cables, so they can carry more data. They are also less susceptible than copper cables to interference. Fiber-optic cables allow data to be transmitted digitally rather than analogically.

FM

Stands for Factory Mutual Research is an independent third-party product testing and the development of engineering guidelines.

full duplex

Serial communication using two pairs of wires—one pair for Modbus reads and the other pair for Modbus writes. Called 4-wire in TriStation.

function block

A Program Organization Unit (POU) that defines a set of input and output parameters that can be used as connections to other blocks and internal variables. Function blocks define an algorithm (code) that runs each time the function block is executed. The data contained in a function block is persistent from one execution of the function block to the next.

gateway

A computer that performs protocol conversion between different types of networks or applications. For example, a gateway can convert a TCP/IP packet to a NetWare IPX packet and vice versa.

GPS

Stands for Global Positioning System which is a system of 24 satellites for identifying earth locations, launched by the U.S. Department of Defense. The GPS is used for navigation and is the most accurate time source for a local clock.

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.

half duplex

Serial communication using one pair of wires to transmit Modbus reads and writes. Called 2-wire in TriStation.

hardware handshake

Signals transmitted back and forth between two stations to coordinate the timing of data transmission.

hazardous location

Any location that contains, or has the potential to contain, an explosive or flammable atmosphere.

HIM

Stands for Hiway Interface Module, which is a Tricon communication module that acts as an interface to a Honeywell TDC-3000 control system.

hub

A connecting device in a network that joins communication lines together in a star configuration. Passive hubs are connecting units that add nothing to the data passing through them. Active hubs (multi-port repeaters) regenerate the data bits to maintain a strong signal. Intelligent hubs provide added functionality.

IP address

The unique 32-bit address of a computer attached to an Ethernet network. Every client and server in an Ethernet network requires an IP address which is either permanently assigned or dynamically assigned at startup.

JetDirect

A print server for LaserJet printers from HP which is available as an internal card or external unit. It supports its own proprietary printing protocol and several others, depending on the model. The JetAdmin printer management software is used to configure and control the JetDirect print server.

logical slot

In a Triconex chassis, a logical slot is a repository for a primary module, a hot-spare module, and their associated field termination component.

MAC address

The unique physical address of a network device that is programmed into the Network Interface Card (NIC) of the device when it is manufactured.

master

In Modbus communication, a device that initiates all query and response exchanges with the slave devices.

MAU

Stands for media adapter unit which is a device used to convert one type of Ethernet media to another.

message response time

For a TSAA client/server or Modbus master/slave data exchange, the time required to initiate and send a query and get a response from the receiving controller.

MII

Stands for media independent interface which is a bus used between network controllers and physical interfaces that is based on the MII interface specification.

Modbus protocol

An industry-standard master/slave protocol that is traditionally used for energy management, transfer line control, pipeline monitoring, and other rugged industrial processes. A Modbus communication link can use either the Remote Terminal (RTU) or ASCII mode of transmission.

module

An active field-replaceable unit consisting of an electronic circuit assembly housed in a metal spine. Also called *board* or *card.*

MT-RJ

MT-RJ is a duplex fiber-optic connector. It uses pins for alignment and has male and female versions. Multimode only.

multi-point

In Modbus communication, a link that interconnects three or more master or slave devices.

NCM

Stands for Network Communication Module, which is a Tricon communication module that enables network communication.

network topology

In a network, the pattern of interconnection between nodes; for example, a bus, ring or star configuration.

NIC

Stands for Network Interface Card which is a printed circuit board that plugs into both a client and a server device and controls the exchange of data between them. Also called a network adapter card.

node

In computer communication, a node is a network junction or connection point. For example, a Trident controller in an Ethernet network is a node. A terminal connected to a minicomputer or mainframe is a node.

node number

The physical address of a node.

OPC

Stands for OLE for Process Control which is a standard set of non-proprietary interfaces used to develop client/server programs. OPC supports interoperability between field devices and applications for process control, factory automation, and business.

open network

An Ethernet network to which Triconex controllers and other Ethernet devices, including routers and gateways to other networks, can be connected.

parallel port

A socket on a computer used to connect a printer or other parallel device to the computer's parallel interface.

parity checking

An error detection method that tests the integrity of digital data during transmission over a serial communication path. Parity checking counts the number of 1 bits in a one-byte data item and sets the parity bit (the ninth bit) to 0 or 1, resulting in an odd or even total number of bits.

path

In computer communication, the route between any two nodes. Also called line, channel, link, or circuit.

Peer-to-Peer protocol

An Ethernet-based Triconex protocol that allows two applications running on separate Triconex controllers to exchange a limited amount of process control data. Because a Peer-to-Peer network is restricted to Triconex controllers, the cable can be isolated and protected more securely than an Ethernet cable. A Peer-to-Peer network requires the use of Ethernet ports on NCM or TCM modules.

point-to-point

In Modbus communication, a link that connects one master or slave device to another.

port

An interface that enables communication with external devices. Triconex controllers include serial and Ethernet ports that must be configured in TriStation 1131.

print server

A hardware device with multiple Ethernet ports that enables a printer to be located anywhere in an Ethernet network.

process-tolerance time

The maximum length of time that can elapse before the control algorithms in a TriStation application fail to operate correctly.

protocol

Rules that govern transmitting and receiving of data. See communication protocol.

RARP

Stands for Reverse Address Resolution Protocol which is a TCP/IP protocol used by a diskless workstation to obtain its IP address.

redundancy

The practice of using a spare device in parallel with a primary device so that, if the primary device fails, the spare device is easily or automatically placed into service. Examples are redundant modules which protect against internal faults, redundant cables which protect against cable breakage, and redundant workstations which protect against network failures.

router

A device that forwards data packets from one local area network (LAN) or wide area network (WAN) to another. Based on routing tables and routing protocols, routers read the network address in each transmitted frame and decide how to send it based on factors like network traffic, speed, or bad lines.

RS-232

Stands for Recommended Standard 232 which is a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices in point-to-point configurations.

RS-422

Stands for Recommended Standard 422 which is a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices in point-to-point differential configurations.

RS-485

Stands for Recommended Standard 485 which is a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices in multi-point differential configurations.

RTS signal

In Modbus communication, an RS-232 signal sent from the transmitting station to the receiving station requesting permission to transmit.

scan surplus

A component of the scan time of a controller, the scan surplus is the time left after the executable elements and communication messages have been processed. The scan surplus should be positive. If the scan surplus is negative, the scan time should be increased.

scan time

The time required by a controller for the cycle of required control functions. The scan time includes input poll time; execution time for all executable elements in the TriStation project; processing time for TriStation and Peer-to-Peer messages, TSAA writes, and Modbus writes; and output poll time.

slave

In Modbus communication, a device that is controlled by another device called the master. The master initiates all query and response exchanges, and the slave can only respond.

SMM

Stands for Safety Manager Module, which is a Tricon communication module that acts as an interface to a Honeywell Universal Control Network.

SNTP

Stands for Simple Network Time Protocol, an Internet standard protocol that assures accurate synchronization to the millisecond of computer clock times in a network of computers. Running as a continuous background client program on a computer, SNTP sends periodic time requests to servers, obtaining server time stamps and using them to adjust the client's clock.

station

A computer, workstation or terminal in a network. Also called a node.

subnet

A division of a network into an interconnected, but independent, segment (domain) to improve performance and security. Typically, Triconex controllers are configured in a subnet that is part of a large network for process control.

subnet mask

The addressing method used to split networks into subnets. The mask is a binary pattern that subdivides a single IP address into a subnet number and a new host number. A typical subnet mask is 255.255.255.0, which means that 254 Class C addresses are available.

TCM

Stands for Tricon Communication Module, which is a Tricon module that enables network and serial communication for Tricon controllers.

TCP/IP

Stands for Transmission Control Protocol/Internet Protocol which is the global standard communication protocol for the Internet. Can also be used for private networks such as corporate intranets and distributed control systems.

TCP/IP is a routable protocol, which means that all messages contain not only the address of the destination station, but the address of a destination network. This allows TCP/IP messages to be sent to multiple networks within an organization or around the world, hence its use in the Internet.

time synchronization

A Triconex protocol used to establish and maintain a synchronized, network-wide time basis. A controller's time can be synchronized with the master node in a network of Tricon or Trident controllers, or with a Distributed Control System (DCS).

transceiver

A transmitter and receiver of analog or digital signals, such as a transponder or network adapter.

TriStation protocol

A Triconex master/slave protocol in which the master (a TriStation PC) communicates with the slave (a Triconex controller) over an Ethernet network. TriStation communicates with the Main

Processors in order to download the application to the Triconex controller and upload diagnostic information.

TSAA

Stands for Triconex System Access Application, a protocol that enables client/server communication between Triconex controllers and PCs. Two client/server programs, OPC Server and DDE Server, use TSAA protocol to exchange data with Triconex controllers. TSAA protocol can also be used to write other programs for accessing Trident points.

UDP/IP

Stands for User Datagram Protocol/Internet Protocol (UDP/IP), which are protocols for the Transport and Network layers of the OSI network model.

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