INSTALLATION INSTRUCTIONS

Original Issue Date: **6/05**
Model: **TS 880 Transfer Switches with TSC 800 Controllers**
Market: **ATS**
Subject: **Communications Interface Module GM41200-KA1**

Introduction

This document covers installation and operation of the Communication Interface Module (CIM) and THS 2000 Software for the TSC 800 transfer switch controller. A Table of Contents appears on the last page.

These instructions apply to Version 3.0 of the Communication Interface Module (CIM). For other product versions, contact the manufacturer to obtain applicable instruction manuals.

The remote communication system with the CIM 3.0 and Modbus™ protocol provides remote monitoring and control of TSC microprocessor-based controllers as used in the power generation industry. The system consists of two main components as follows:

1. Communication Interface Module (CIM): The CIM provides the hardware and software interface between a Modbus™-compliant device (customer-supplied) and the specific microprocessor-based controllers as used at a generator site.
2. Remote Terminal Unit (RTU): An RTU is a device that directly operates the equipment at a generator site. These devices are the actual microprocessor-based controllers (e.g. TSC 800 transfer switch controller).

Figure 1 depicts a typical remote communication system.

Some advanced features of the remote communication system with the CIM 3.0 module and Modbus™ protocol are as follows:

1. One CIM module can control and monitor up to 10 RTUs at a generator site using a single direct serial/phone link.
2. Configuration of all communication system setpoints is done using software.
3. CIM Port #2 can be configured for RS-232, RS-422, or RS-485 serial communication types. RS-485 communication allows multiple CIMs to be interconnected to any Modbus™ RS-485 network. RS-485 is recommended for the best distance and noise immunity. Port #2 has a hardware protocol auto-detection option that removes the confusion of determining whether the port is in RS-232 or RS-485 mode. Just plug in and communicate (assuming the baud rate etc. is set correctly).

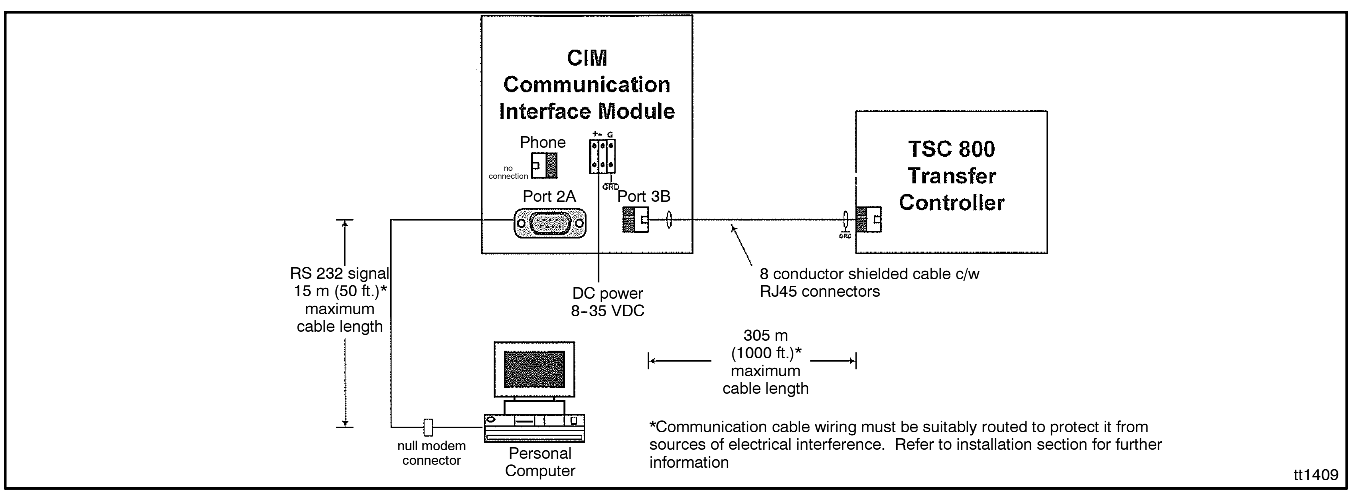

Figure 1 RTU Site

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4. Security features have been implemented to allow password protection. However these features along with auto-detection and modem functionality can be bypassed with a fixed Modbus™ option that is intended for direct PLC function where remote access is not necessary.

5. With onboard modem support, CIM 3.0 offers remote telephone connectivity with auto callout and pager support with up to 32 characters. Up to 3 phone numbers can be programmed into the CIM for remote THS software connection or pager notification. In the case of a failed connection, retries can be specified.

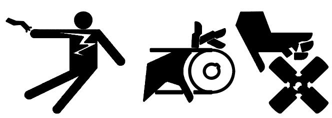
Note: Throughout this document, CIMs and TSC 800s are generically referred to as remotes.

Further information on the Modbus™ protocol support on the CIM can be found in Section 3 and at the Modicon website (www.modicon.com).

Safety Precautions

Observe the following safety precautions while installing the kit.

WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (–) lead first. Reconnect the negative (–) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

1 Communication Interface Module

1.1 CIM Specifications

- Power supply: 8 to 35VDC, negative ground
- Power consumption: 5 watts (max.)
- Operating temperature: -15°C to 50°C (5°F to 122°F)
- Storage temperature: -40°C to 85°C (-40°F to 185°F)
- Environmental: NEMA 1
- Vibration: 1 g, 5-250Hz
- Humidity: 5%-95% noncondensing
- Dimensions, W x H x D, mm (in.): 150 x 180 x 50 (5.91 x 7.09 x 1.96)
- Internal Modem 14.4k baud, Hayes™ AT set compatible
- Communication Ports Hardware Port 1 Telephone T/R Port 2 RS-232/-422/-485 asynch., 1200-19200 baud Port 3 RS-422, asynchronous 4800 baud
- Communication Ports Software Protocol:
  - Port 1: Telephone
  - Port 2: Modbus™ Protocol
  - Port 3: TTI T-Net Protocol

Specifications are subject to change without notice.

1.2 CIM General Description

The Communication Interface Module (CIM) is an advanced communication interface device for remote communication to the latest generation of microprocessor-based engine generator and transfer switch control products. One CIM module can communicate with networked TSC 800 transfer controllers. The serial communication ports can be used for direct connection to a personal computer (port #2) or to other remote connected devices (port #3). An internal modem is available with the CIM, which provides direct connection to a telephone system.

The CIM provides the following advanced features:

1. Dedicated microprocessor-based design provides fast operation without restricting RTU operation.

2. One CIM module can provide interface to a complete networked RTU system. This leads to a single telephone line connection per site rather than typical multiple line solutions.

3. Internal 14.4k baud modem available for direct connection to telephone system.

4. Flexible design provides two fully configurable serial ports.

5. Standard plug-in telephone RJ45/RJ11 type jacks and DB9 computer ports provide simple interconnection to system.

6. The ability to callout to a software host station or pager when an RTU fault occurs frees the user from continual monitoring. It also allows for immediate remote response to problems.

1.3 CIM Hardware Interface

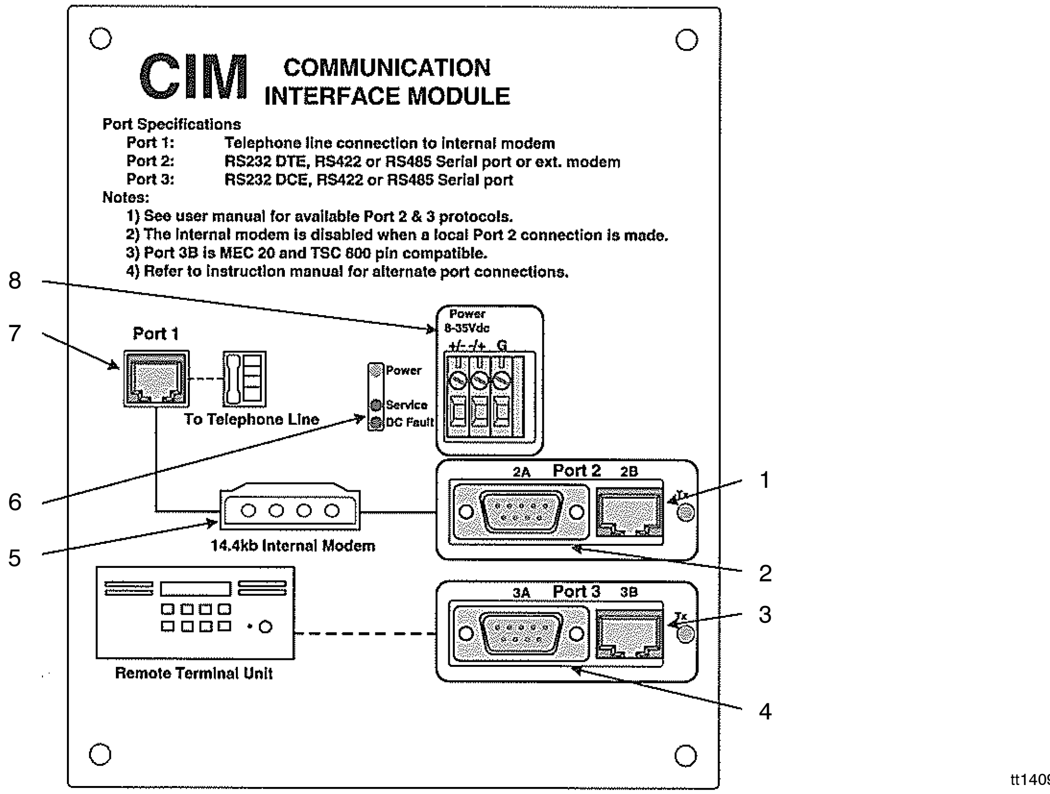
The main features of the CIM are described in the following sections with reference to Figure 2.

1.3.1 Port 2B

Port 2B may be interconnected to an RTU or Personal computer (PC). Port 2B can be configured to RS-232 or RS-485/-422 type transmission signal. When a personal computer is connected to Port 2B, a null modem cable or connector must be used. When the CIM modules' internal modem is used, port 2B is disabled. This port uses an 8-pin RJ45 plug-in connector. An LED indicator is provided to signal when the port is communicating. Port 2B is internally wired in parallel with Port 2A.

1.3.2 Port 2A

Port 2A may be interconnected to an RTU or PC. Port 2A can be configured to RS-232 or RS-485/-422 type transmission signal. When a personal computer is connected to Port 2A, a null modem cable or connector must be used in series with the PC cable. When the CIM modules' internal modem is used, port 2A is disabled. This port uses a 9-pin standard DB9 female plug-in connector. An LED indicator is provided to signal when the port is Transmitting. Port 2A is internally wired in parallel with Port 2B.



1. Port 2B
2. Port 2A
3. Port 3B
4. Port 3A
5. Internal modem
6. Diagnostic LEDs
7. Telephone port
8. DC power input

Figure 2 CIM Features

1.3.3 Port 3B

This port may be interconnected to an RTU. Port 3B utilizes an RS-422 type transmission signal that is compatible with TSC 800 controllers. The standard connection for a TSC 800 controller (RTU) application is for port 3B to be connected to the RTU. This port uses an 8-pin RJ45 plug-in connector and allows for a direct connection to TSC 800 controller. Port 3B is internally wired in parallel with Port 3A.

1.3.4 Port 3A

This port may be interconnected to an RTU or directly to a PC. Port 3A utilizes an RS-422 type transmission signal that is compatible with TSC 800 controller. The standard connection for a TSC 800 controller (RTU) application is for port 3A to be connected to the RTU. This port uses a 9-pin DB9 female connector. Port 3A is internally wired in parallel with Port 3B.

Note: CIM Port 2 cannot be used concurrently with the modem (CIM Port 1). An RS-232 or RS-422 cable can be connected to the CIM, but cannot be active if the modem is to be used. An RS-485 connection will effectively disable the modem whether it is active or inactive.

1.3.5 Internal Modem

The CIM is provided with an internal 14.4k baud modem. The modem is internally connected between the telephone port and port 2A/B.

1.3.6 Diagnostic LEDs

The CIM module provides diagnostic LED lights are described as follows:

1. Power: This LED is illuminated whenever the CIM has correct DC supply voltage applied.
2. Service: This LED illuminates when the CIM has an internal fault in which the unit must require service.
3. DC Fault: This LED is illuminated whenever the CIMs internal power supply has shut down due to an internal fault or an external overvoltage condition from the DC supply input. To reset a DC fault, the DC supply voltage must be removed for 30 seconds, then reapplied.

1.3.7 Telephone Port

The telephone port is used to interconnect to a telephone system. This port is internally connected to a 14.4 Chased modem. This port uses a 6-pin RJ11 plug-in jack connection.

1.3.8 DC Power Input

Terminals are provided for DC power input to the CIM module. Power input is non-polarity sensitive and can range from 8–35 VDC.

1.4 Telephone Port 1

Detail pin numbers and usage designations for the telephone port are shown in Figure 3.

1.5 Port 2A/B

Detail pin numbers and usage designations for Port number 2A/B are shown in Figure 4.

1.6 Port 3A/B

Detail pin numbers and usage designations for Port number 3A/B are as listed in Figure 5.

Port 1A RJ11 No.	Signal Type, Telephone	Direction
1	No Connection	No Connection
2	No Connection	No Connection
3	TIP	Input/output
4	Ring	Input/output
5	No Connection	No Connection
6	No Connection	No Connection

Figure 3 Telephone Port

RJ45 No.	DB9 No.	RS-485 Half-Duplex (pending)	RS-422 Full-Duplex (pending)	RS-232 (DTE)	Direction
1	1	Sa’	Rxa	CD	Input
2	2	Sb’	Rxb	Rx	Input
3	3	Sb	Txb	Tx	Output
4	4	Sa	Txa	DTR	Output
5	5	Ground	Ground	GND	Passive
6	6	NC	NC	DSR	Input
7	7	NC	NC	RTS	Output
8	8	NC	NC	CTS	Input
N/A	9			RI	N/C

Figure 4 Port 2 A/B

RJ45 No.	DB9 No.	RS-485 Half-Duplex (pending)	RS-422 Full-Duplex (pending)	RS-232 (DCE)	Direction
1	1	Sa	Txa	CD	Output
2	2	Sb	Txb	Tx	Output
3	3	Sb’	Rxb	Rx	Input
4	4	Sa’	Rxa	DSR	Input
5	5	Ground	Ground	GND	Passive
6	6	NC	NC	DTR	Output
7	7	NC	NC	CTS	Input
8	8	NC	NC	RTS	Output
N/A	9			RI	N/C

Figure 5 Port 3 A/B

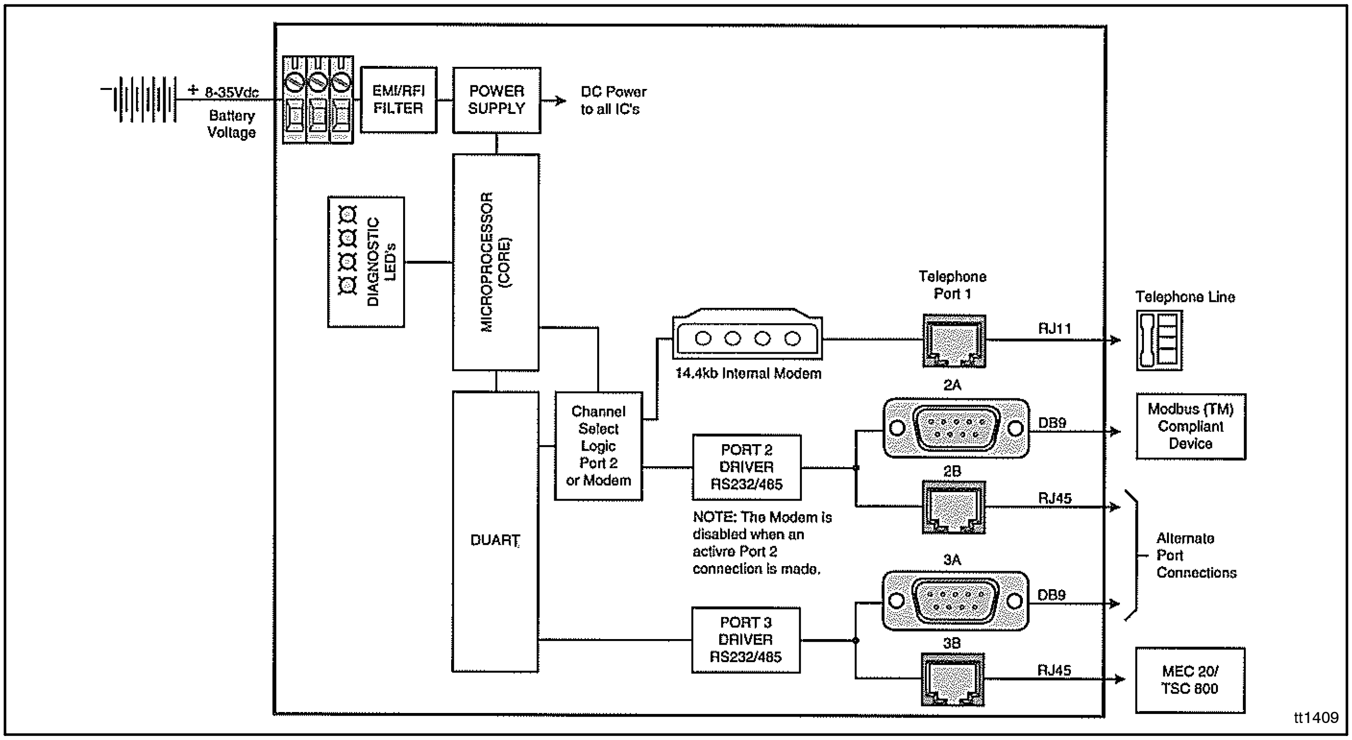


Figure 6 CIM Block Diagram

1.7 CIM Operation Functions

The CIM module provides the following main functions when used in a communication system:

1. RTU and Modbus™ Device Interface: The CIM is the main communication interface component between a Modbus™ compliant device and the remote terminal units. The CIM provides the necessary hardware interface (i.e. COM Ports) as well as the Modbus™ software protocol interface.

2. Protocol Data Processing: The CIM receives incoming communication signals from various types of RTUs and processes the data into the specific Modbus™ language as required for the application. The processed data then gets transferred to the applicable port and transmitted to a remote Modbus™ compliant device.

3. CIM Configuration: The CIM stores vital information in non-volatile FLASH memory pertaining to a specific RTU site as defined by the user. Stored information includes, site name, site passwords, and auto callout phone numbers (3).

4. RTU Polling: The CIM module will automatically poll connected RTUs to determine their operating status and to signal an auto callout (callout is only operational when the modem feature is operational) to the remote Modbus™ compliant device to alert a user of an abnormal condition.

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1.8 CIM Installation

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Hazardous voltage.
Will cause severe injury or death.

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Disconnect all power sources before opening the enclosure.

Note: Installations must be done according to the NEC and all applicable electrical regulation codes.

The following installation guidelines are provided for general information only pertaining to typical site installations. For specific site installation information, consult the manufacturer as required.

Trained and qualified personnel must install and service the CIM.

1.8.1 Battery Supply Input

The CIM can operate on any battery supply from 8-35VDC nominal. Wiring from the system battery to the CIM should conform to the following guidelines to avoid possible communication module malfunction and/or damage.

Avoid wiring from the engine start terminals; wiring should go directly from the battery terminals to the control panel where the CIM module is located (to avoid voltage drop in the starter cables and starter motor commutation noise).

Note: The battery charger must be turned off before battery cables are removed from the battery (i.e. for servicing). Failure to do so may subject the control panel to an overvoltage condition in which damage may result.

Under noisy environments (i.e. as engines with high voltage ignitions, etc.), wiring from battery should be a twisted pair of #14 AWG (2.5 mm^2) wires.

The use of AC or DC operated solenoids or relays in control systems can sometimes cause high voltage spikes on the DC power supply, which may cause electronic devices to fail. Transient suppression devices are recommended for all inductive devices sharing wiring or if physically located near the CIM module. For DC operated relays or solenoids, use a suitably rated counter EMF diode (or commonly known as freewheeling diode). For AC operated relays or solenoids, use a suitably rated metal oxide varistor (MOV) or capacitor/resistor suppressor.

1.8.2 Remote Communication Wiring

All communication interconnecting wiring to/from the CIM Module shall utilize #22 AWG-8 wire, twisted, shielded cable with RJ45 connectors.

All remote communication wiring outside the control panel must be run in separate conduit and shall not be located near AC power cables to prevent pickup of induced voltages.

1.8.3 Dielectric Testing

Do not perform any high voltage dielectric testing on the CIM connected in the circuit as serious damage will occur to the module.

1.8.4 Mounting Location/Installation

The CIM Module is designed for mounting directly onto a control panel inner subpanel. Considerations should be given for the following:

1. The controller should be installed in a dirt free, dry location away from extreme heat sources.
2. Adequate space should be provided around the CIM module for control wiring.

1.8.5 Mounting Dimensions

The CIM mounting dimensions are shown in Figure 7.

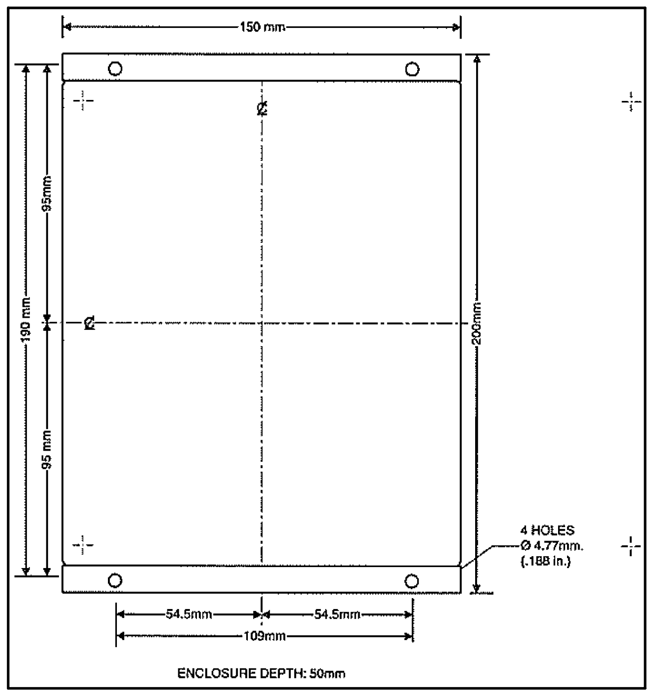

Figure 7 Mounting Dimensions

1.8.6 RS-232 and RS-485422 Wiring

This section describes the cabling necessary to connect a host PC to a CIM using RS-232 and to connect to an RS-485 or RS-422 network.

Host PC Connection

The host PC connection to the CIM requires a null-modem adapter, as both devices believe they are DTE. See Figure 8 and Figure 9.

DTE	DB-25	DB-9	CIM
GND	1	n/c	GND
TXD	2	2	RXD
RXD	3	3	TXD
RTS	4	8	CTS
CTS	5	7	RTS
DSR, DCD	6, 8	4	DTR
SG	7	5	SG
DTR	20	6, 1	DSR, DCD

Figure 8 Host PC DB-25 To CIM DB-9

DTE	DB-9	DB-9	CIM
TXD	3	2	RXD
RXD	2	3	TXD
RTS	47	8	CTS
CTS	8	7	RTS
DSR, DCD	1, 6	4	DTR
SG	5	5	SG
DTR	4	6, 1	DSR, DCD

Figure 9 Host PC DB-9 To CIM DB-9

RS-485/-422 Connection

The following hardware configuration is required for 4-wire RS-485/-422 from port 2 on the CIM to an RS-232 port on a computer:

- The following parts are connected in order from the RS-232 side (computer) to the RS-485/-422 side (the CIM).
- RS-232 to RS-485 or RS-422 adapter (set to DCE)
- DB-25 to RJ45 adapter (or custom cable) for RS-422/-485 on the CIM port 2(see below wiring).

Ensure that the correct handshaking signals are connected on the RS-232 side of the RS-485/-422 converter. Many RS-485 converters use the RTS line to control the transmitter (which must be tristated during receive mode). It is important to insure that the converter is configured correctly and the correct handshaking lines are wiring appropriately. If the handshaking lines (RTS) are not wired correctly the connection may appear to work but damage may occur and communications may be unreliable over time. See Figure 10 or Figure 11.

DB-25 from RS-422 Converter		CIM Port 2	
Signal	**Pin**	**Pin**	**Signal**
TXB+	14	1	RXB+
TXA-	2	2	RXA-
RXA-	5	3	TXA-
RXB+	17	4	TXB+
GND (optional)	7	5	GND

Figure 10 RS-422 Handshaking

DB-25 from RS-485 Converter		CIM Port 2	
Signal	**Pin**	**Pin**	**Signal**
TXB+, RXB+ (jumpered)	14, 17	1, 4	RXB+,TXB+ (jumpered)
TXA-, RXA- (jumpered)	2, 5	2, 3	RXA-, TXA- (jumpered)
GND (optional)	7	5	GND
Note that the RS-232 side of the RS-485 converter will most likely require the RTS line be connected along with TX, RX and GND.			

Figure 11 RS-485 Handshaking

1.9 CIM Troubleshooting

Service procedures must be undertaken by qualified personnel only!

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Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

1.9.1 Database Reinitialization

If state of the internal database is unknown a reset to factory default conditions can be done by the following procedure:

1. Remove power from the CIM.

2. Remove the CIM back cover.

3. Connect a wire from the CIM ground terminal located next to the power connections.

4. Connect the other end of the ground wire to the test point located on the bottom of the daughter board (the daughter board is plugged into the bottom of the CIM motherboard) located on the bottom of the CIM that should be visible with the bottom cover removed.

5. With the bottom test point grounded carefully apply power to the CIM for at least 2 seconds. You may now remove power and reassemble the CIM. The CIM has defaulted back to factory settings.

1.9.2 Troubleshooting Table

Refer to Figure 12. Consult the factory for any detailed information or for any problems not listed. Read and follow all safety precautions.

Symptom	Corrective Action
CIM does not power up even with correct DC power applied.	Check that there are no wiring errors/short circuits connected to the CIM. Note: The CIM Module contains an electronic fuse that triggers upon an overload or overvoltage condition and does not reset until the supply voltage is removed.
Failure to communicate with PC (direct connected).	Verify all communication cables are connected to the correct ports.
	Ensure that the RTU (TSC 800) is connected to Port 3 on the CIM.
	When direct connection is used from port 2A to a PC, ensure a null modem cable or connector is used. (see Host PC Connection in Section 2.6.3).
	Verify all settings in the THS 2000 software program are correct. Critical settings are as follows:
	Port 3 baud rate—4800.
	Controller address—THS software setting and controller setting must match.
	Site Name—THS software setting and CIM setting must match. Note: factory default setting in CIM is "site."
	Site Password—THS software setting and CIM setting must match. Note: factory defeat setting in CIM is "user."
	RTU site may be busy calling out if an alarm condition is present on the controller. Reset all fault conditions at the controller and set for automatic mode to cancel the auto call out condition.
Failure to communicate with PC (modem connected).	Verify PC modem operates correctly (test independently with another software system).
	Verify PC modem is set for 9600 baud operation.
	Ensure phone numbers programmed for both PC site location and RTU equipment location are correct.
Failure to communicate with PC.	If you encounter difficulty connecting to a CIM with the Host software make sure the CIM is not trying to callout. When the CIM is trying to callout to the Host sites it will not respond to outside requests for connection. In this situation the user can be patient and make repeated attempts at connection until the CIM has exhausted its phone numbers and retries (can be over 12 min. in some cases with 3 numbers and 3 retries). Or the user can let the host successfully callout to the Host software. After the phone numbers are successfully attempted or retries are exhausted the CIM will go back into a log-in ready state. If time is important, the CIM may be power cycled, for a brief time after the CIM power is restored (after the 2 quick blinks on the Port 2 LED) the CIM will be log-in ready. However the CIM will eventually go into a callout state to report the site alarm situation.
	The above situation is the most common cause for not being able to establish a connection to the CIM. For testing and configuration it is recommended that the callout function be disabled until it is required, this will eliminate the frustration described above.
Site RTU fails to auto callout to PC.	Verify the connected controller is programmed for the specific auto callout function (i.e. common alarm, common shutdown or common fail).
	Verify the Host software is in auto answer mode, see Section 2.6.6, Auto Answer Configuration.
Port configuration changes do not work.	The CIM port configuration changes will not go into effect until the CIM has been power cycled.
	For Modbus™ communications ensure that the CIM is being addressed with the correct node address. The factory default CIM node address is '1', this should not be confused with the RTU node addresses connected to Port 3 of the CIM.

Figure 12 CIM Troubleshooting

2 THS 2000 Software Program

The THS 2000 software program remotely controls and monitors a transfer switch control system. The THS 2000 program operates on an IBM-compatible Personal Computer with the following operating systems:

- Microsoft Windows 95™
- Microsoft Windows 98™
- Microsoft Windows NT™ 4.0
- Microsoft Windows 2000

The THS 2000 software program uses a manufacturer-designed protocol to communicate to TSC 800 ATS control system. A site consists of a single Communication Interface Module (CIM) and one or more associated Remote Terminal Unit (RTU) controllers.

The THS 2000 software is designed to allow a direct connection (via RS-232, RS-422 or RS-485) to Port 2 of the CIM or a remote connection (via a host PC modem) with the internal modem of the CIM on Port 1. The host PC modem must already be configured before attempting a remote connection. See the operating system help for installing and configuring modems.

Version 3.1 of the THS 2000 software is intended for operation with Version 3.0 of the CIM, but also provides support for previous versions of the CIM.

2.1 Definitions

Item	Definition
CIM	Communications interface module; the communications hub for a site.
Dialog box	Interactive window allowing the user to view or change settings.
Modbus™	Industry-standard serial automation protocol defined by Modicon, part of Schneider Automation, Inc.
RTU	Remote terminal unit; in this context, a TSC 800.
TSC 800	Transfer switch controller
Site	CIM and one or more connected RTUs,
Site list	List of remote sites, primarily used for auto answer and multiple CIM sites.

2.2 Improvements

A number of improvements have been made to this version of the THS 2000 software. Most of the improvements correspond to added features of CIM Version 3.0, but some of the changes are applicable to the previous version of the CIM. See Communication Interface Module for more information on device-specific features and Section 3, CIM Protocol, for the Modbus™ protocol.

The most notable improvement is the use of the Modbus™ protocol for communications to the CIM.

The new features in THS 2000 software are:

- Support for new CIM 3.0 Modbus™ protocol as well as previous CIM protocol versions.
- Automatic RTU (TSC 800) discovery on logon. This will eliminate the need for the user to program the individual node address and controller type for each site (CIM). See Controller Discovery in Section 2.6.5.
- Support for these additional CIM 3.0 features:
  - 32 character telephone numbers for callout (see Section 2.6.6, Auto Answer Configuration).
  - Call all numbers option for CIM callout (see Section 2.6.6, Auto Answer Configuration).
  - CIM Port 2 auto-detect feature for the hardware protocol (see CIM Port 2 in Section 2.6.4).
  - Bounded controller addresses for faster detection (see CIM Advanced in Section 2.6.4).
- CIM Port 2 can now be configured for speeds from 1200 bps up to 19.2 KB/sec., instead of being fixed at 9600 bps. This works for old CIM versions as well.
- Support for multiple remote callout sites. THS Versions 1.0 and 1.1 software only support auto answer for a single site. A system with two CIM sites that can call out would not work correctly. This has been fixed by adding multiple sites to a single THS 2000 software file. The calling-in CIM is then identified from the loaded set of sites. See Section 2.6.2, Site List Management.
- Improved communications reliability over noisy communication lines.

THS 2000 Version 3.1 software adds the ability to connect directly to an RTU, bypassing the CIM. A maximum of one RTU or TSC 800 is allowed. The auto answer feature of THS 2000 software is not supported in this mode, as it is a function of the CIM. The auto discovery of controllers is likewise not available. See Section 2.8, CIM Bypass Wiring, for a wiring description.

Modbus™ is a trademark of Schneider Electric.

2.3 Computer System Requirements

The supported operating systems are:

- Microsoft Windows 95™, Service Release 2 or later.
- Microsoft Windows 98™.
- Microsoft Windows NT™ 4.0 Workstation or Server, Service Pack 3 or later.
- Microsoft Windows 2000.

A minimum of 2 MB of hard drive space on the chosen installation drive is necessary for proper operation.

A modem that is fully supported by the operating system is required for remote operation. It is important that the correct modem driver software is installed correctly.

An FIFO-enabled serial-port is required for direct connections.

Microsoft Internet Explorer™ 4.01 or later is recommended for use with the online help. However, Microsoft Internet Explorer 3.02 is sufficient if the hhupd.exe file, included with the THS 2000 software distribution, is run first; this executable is provided by Microsoft for updating help file support.

2.4 Installation

The THS 2000 software consists of two files, the THS3v0.EXE file and the THS3v0.CHM file. Copy both files to a directory on your hard drive, such as C:\THS. The first file, THS3v0.EXE, is the THS 2000 executable. You can make a link to this file on your desktop by dragging and dropping the THS3v0.EXE from the explorer to the desktop. The second file, THS3v0.CHM, is the online help file.

If you are using Microsoft Internet Explorer 3.02, the file hhupd.exe will be required to execute and update a system file for HTML Help support. That file is not required if Microsoft Internet Explorer 4.01 or later is installed.

2.5 Quick Start

This section will get you up and running the THS 2000 software quickly and easily and covers the simple tasks that are necessary to communicate with a site. More advanced topics will be covered in a later section.

1. Start THS 2000 software.

   Double click on the THS 2000 icon (THS3v0.EXE) to start the program. See Section 2.4, Installation.

2. Logon.

   The *Password* dialog box will appear as shown in Figure 13. Type in your password and click the *OK* button or just click the *OK* button if you have not programmed any passwords yet. There are no passwords configured initially, so click on *OK* to continue if you are running for the first time.

   See Section 2.6.1, Passwords, and Starting and Logging On in Section 2.7.1.

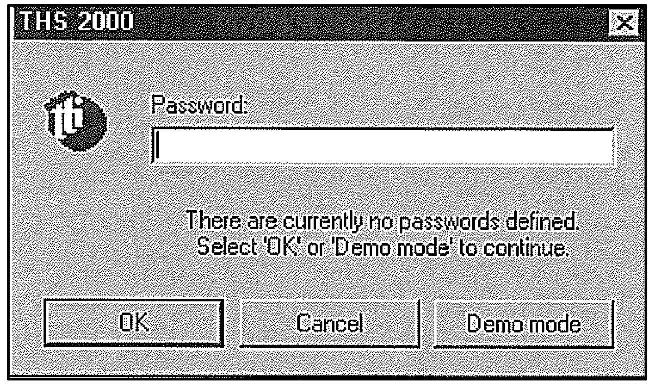

Figure 13 Password Dialog Box

3. Set host connection method.

   Select the *Connect* command from the Site menu (or toolbar button or press F9). This command will normally bring up a list of accessible sites; however, if no sites are defined, you will be required to choose a host connection method. This dialog box in Figure 14.

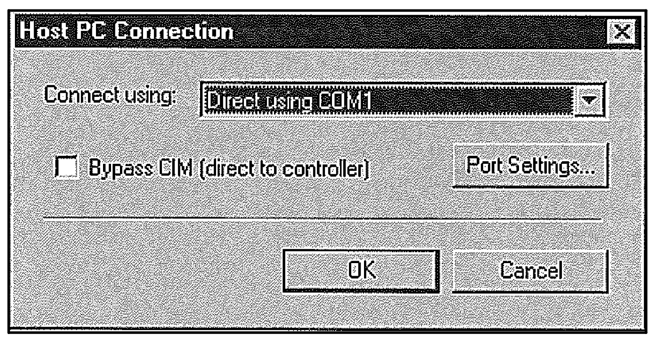

Figure 14 Host Connection Dialog Box

Select your connection method, either a specific modem (e.g. *Hayes Accura 288 V.34 + FAX)* or a serial port (e.g. *Direct using COM1*). If you select a direct communications port, you are also able to modify the port settings. The default settings are likely sufficient for now, so click the *OK* button.

See Host Connection in Section 2.6.3.

4. Enter site properties.

Once the connection method is established, you will be prompted for the site properties, such as site name, as shown in Figure 15. This allows you to enter the first site in the site list.

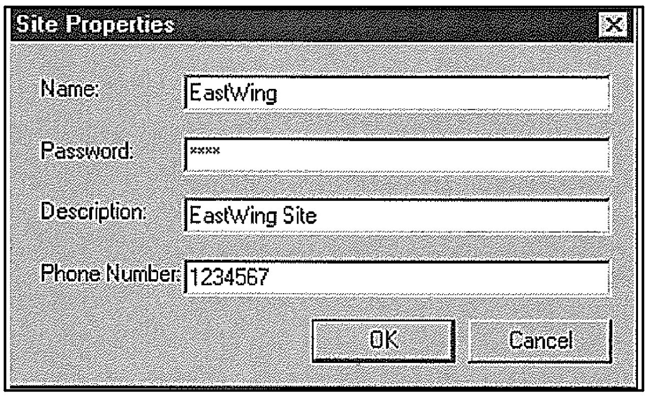

Figure 15 Site Properties

The name and password fields correspond to the name and password already programmed into the CIM that is managing the remote site. The description field is optional and can be used to describe the site. The phone number is entered for a remote site.

The name and password parameters must match the CIM on the intended site. The default name is *site* and the default password is *user*. These parameters are case insensitive. See Site Properties in Section 2.6.3.

5. Connect to site.

The next dialog box displays the list of sites, as shown in Figure 16. At this point, there is only one site and it's already selected. From this dialog you can add, remove and modify site properties; modify the connection method; and connect to the selected site. Clicking on the Connect button will begin the connection process. If you experience problems connecting to the remote site, please refer to Section 2.9, Troubleshooting. See Connecting A Site in Section 2.7.2.

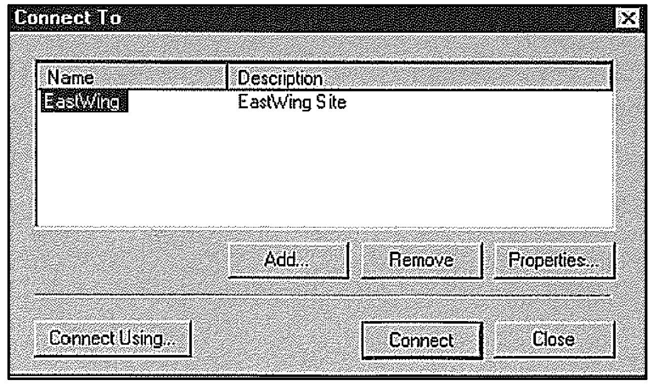

Figure 16 Connect to Site

6. Identify controllers.

Once you are connected to the remote site, you need to identify the controllers on the site. If you are running CIM 3.0 or higher, the THS 2000 software will offer the controllers that have already been discovered, as shown in Figure 17. You merely need to accept the controller list to have them added to the site. If you are running an older CIM, you must identify and add the controllers manually; see Adding A Controller in Section 2.6.5.

At this point, you are connected and communicating with the CIM and its controllers. The status bar at the bottom of the window will flicker and display a message similar to *Connected to EastWing.*

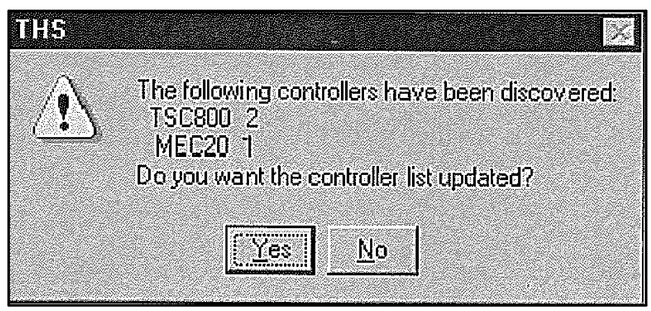

Figure 17 Controller List

7. View controller data.

A set of buttons at the top of the window will contain the word *List* and the number of each controller. This is the Controller Bar. Clicking a button on the Controller Bar selects the current view in the main part of the window. The list-view is a list of all the controllers and the controller views are representations of an individual controller.

When the selected site is connected, the dot in the middle of the controller bar button will indicate the status of the controller (green, yellow, red, or black).

See Controller Views in Section 2.7.3.

8. Issue controller commands.

   Once connected to a site, commands can be issued to controllers through the *TSC 800 Command* menu items under the *Controller* menu.

   See Controller Commands in Section 2.7.3.

9. Save/restore site list information.

   The current site list can be saved by using the *Save* or *Save As* commands under the *File* menu or the toolbar button.

   A previously saved site list file can be retrieved using the *Open* command from the *File* menu or the numbered recent file list under the *File* menu or the toolbar button.

   See Saving A Site List and Opening An Existing Site List in Section 2.6.2.

2.6 Configuration

The THS 2000 software allows the configuration of passwords, lists of sites, the CIM, and the auto answer feature. Configuration of THS 2000 software site lists and other parameters is generally done once and then used many times in an operational capacity.

2.6.1 Passwords

The THS 2000 program can be secured with the use of passwords. The password levels are:

1. Read Only. The read only user can only monitor an RTU site and may not change any settings or modes of operation.

2. Read/Write. The read/write user can monitor an RTU site and may change any settings or modes of operation as desired.

3. Master. The master read/write user can monitor an RTU site and may change any settings or modes of operation as desired. The master read/write user can also view or modify the lower-level security passwords.

The *Options* item under the *Tools* menu will present the user with master security level with a choice that allows the passwords to be modified, as shown in Figure 18. For a user with less than the master security level, that menu item is grayed-out.

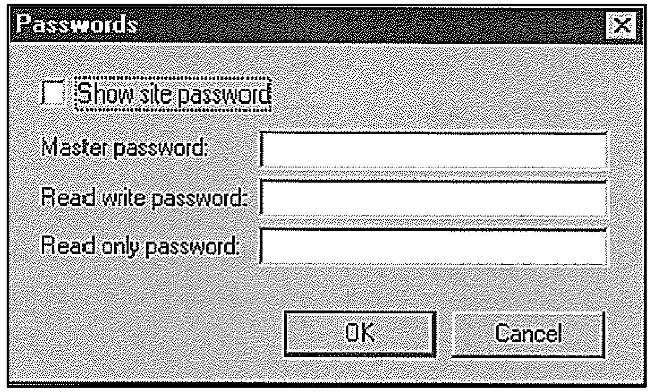

Figure 18 Tools—>Options—>Passwords (master security level required)

The site passwords are normally shown as a series of asterisks (*), but can be shown in actual letters by enabling the show-site-password check box.

2.6.2 Site List Management

THS 2000 software allows you to create, save, and reopen site lists. A site list is a collection of one or more sites that are all accessed through the same host modem. A site list can also be configured for auto answer, allowing any of the listed remote sites to call THS 2000 software in case of an alarm condition.

The list of sites, site properties, connection method, and auto answer settings are all stored in the .THS file. This file can be created, opened, and saved from THS 2000 software.

Creating A New Site List

A new site list can be created using the *New* command from the *File* menu (or toolbar button). This command will bring up the *Site Properties* dialog, as shown in Figure 19, for the first site in the site list.

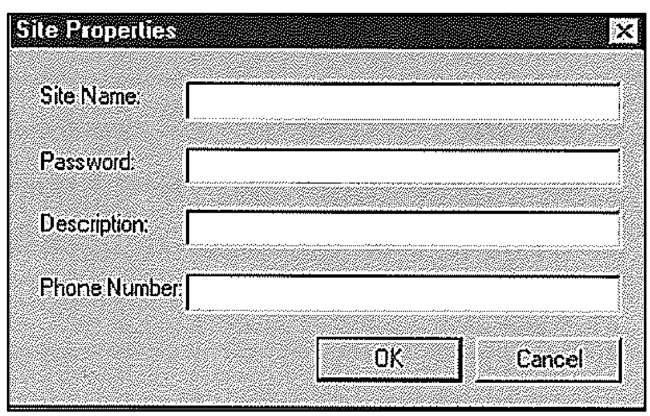

Figure 19 Site Properties Dialog Box

The name and password fields correspond to the name and password already programmed into the CIM that is managing the remote site. All of the site names within a site list must be unique. The description field is optional. The phone number is entered for a remote site.

Opening An Existing Site List

An existing site list can be opened using the *Open* command from the *File* menu (or the toolbar button). This command will bring up the conventional Windows dialog allowing you to select a file to open.

The *File* menu also stores the most recently used four site list files. These can be opened directly by selecting the file name from the *File* menu or using the shortcut key sequence ALT-F followed by the number (1-4) of the desired file.

Note: Files created by previous versions of THS 2000 software can be opened, but they will only contain a single site in the site list. If this file is modified and saved, you will no longer be able to open it from previous versions of THS 2000 software.

Saving A Site List

A site list can be saved to disk by using the *Save* or *Save As* commands from the *File* menu (or the toolbar button). These commands will invoke the standard Windows dialog for saving a file.

Note: Files saved by this version of software will not be readable by previous versions of THS 2000 software.

2.6.3 Site Configuration

Viewing and modifying the site configuration begins with the *Connect* item under the *Site* menu. This action will produce the list of sites (see Section 2.6.2, Site List Management), as exemplified in Figure 20. From this dialog box, new sites can be added to the site list, sites can be removed from the site list, or a site's properties viewed or modified. The host connection method can also be viewed or modified. In addition, the site is connected (see Connecting A Site in Section 2.7.2) from this dialog.

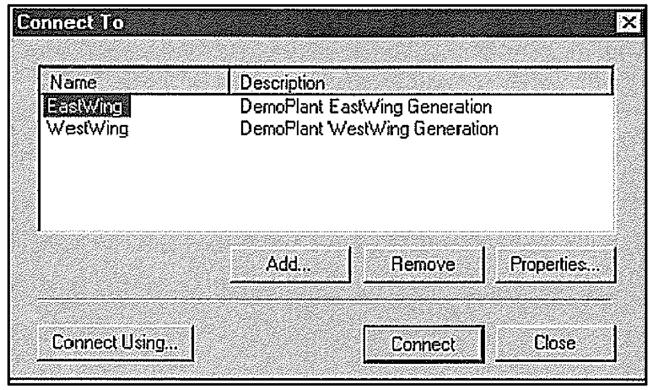

Figure 20 Connect to Dialog Box

Adding A Site

Electing to add a site by clicking the *Add* button of the *Connect To* dialog box will present you with the *Site Properties* dialog box depicted in Figure 19. This allows you to enter the name and password of the new site, which is the name and password of the CIM on that site. The description can be any descriptive text. The phone-number can only be entered for a host connection that is a modem (see Host Connection in Section 2.6.3).

The password field is normally shown as all asterisks (*), but can be made to display the actual letters (see Section 2.6.1, Passwords).

Removing A Site

Clicking the *Remove* button of the *Connect To* dialog box will cause THS 2000 software to ask you if you really want to remove the selected site. Choosing the affirmative option will delete the selected site from the site list.

Site Properties

Selecting the *Properties* button of the *Connect To* dialog box will bring up the *Site Properties* dialog box, as in Adding A Site (above), but with the details of the selected site, as shown in Figure 21.

This dialog box can also be displayed by right clicking on the name of the site in the site list dialog.

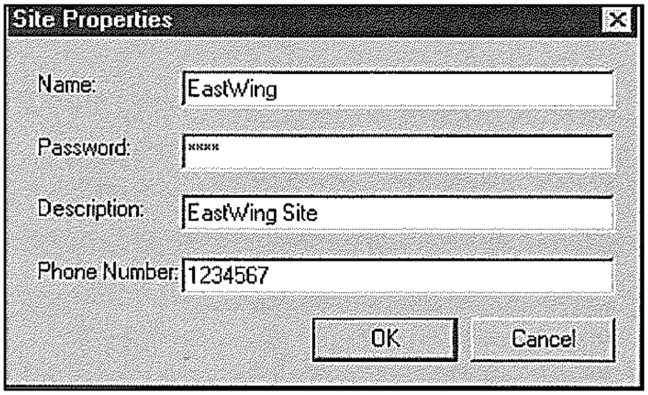

Figure 21 Site Properties (with Details)

Host Connection

The host connection method can be changed from the *Connect Using* command of the *Site* menu or the *Connect Using* button of the *Connect To* dialog box (see Connecting A Site in Section 2.7.2). This command will bring up the *Host PC Connection* dialog box, as shown in Figure 22.

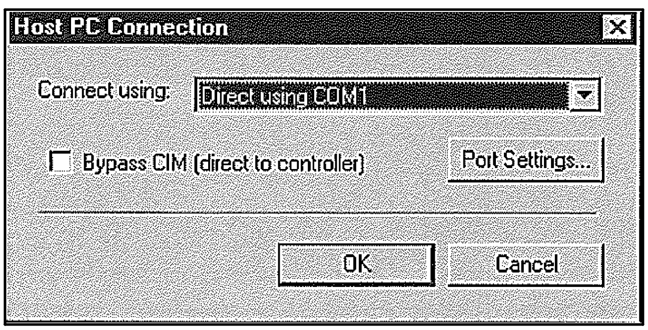

Figure 22 Host PC Connection Box

In the list-box, you can select any modems or communication ports that are recognized by the operating system. Modems can be added and configured in the Modem entry in the Windows Control Panel (see the operating system documentation).

In THS 2000 Version 3.1 software, an additional option allows THS 2000 software to bypass the CIM and connect to a single controller or TSC 800. For a direct connection using one of the serial ports, the baud rate is automatically set to 4800 to match a direct controller connection. The CIM bypass mode does not allow THS 2000 to receive alarm callouts from the site.

If a direct communication port is selected, the *Port Settings* button will be clickable. Selecting the *Port Settings* button will bring up the *Port Settings* dialog box, as shown in Figure 23, where advanced communications parameters can be viewed and modified.

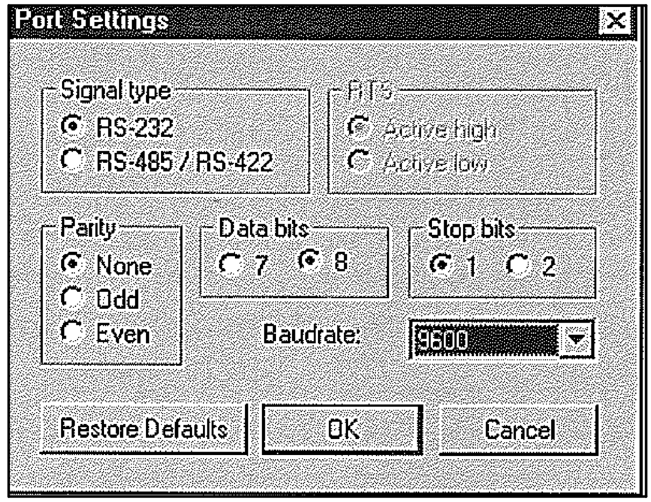

Figure 23 Port Settings Box

Supported baud rates are 1200, 2400, 4800, 9600, 14400, and 19200. The *Restore Defaults* button set the parameters to RS-232 signal type, no parity, 8 data bits, 1 stop bit, and 9600 baud.

The RTS activation is only applicable under RS-485. This defines the level of the RTS line that is used by RS-232 to RS-485 converters to signal a transmission. Unless otherwise specified, this should be active high for most converters.

These parameters must be matched to the Port 2 configuration of the CIM on the site (see CIM Port 2 in Section 2.6.4).

Changes to the port settings do not take effect until the site is reconnected.

2.6.4 Communications Interface Module Settings

The heart of communications to a remote site is the CIM. All the remote controllers and TSC 800s are attached to this device. Normally, the CIM is not connected to the host computer. The normal operation for the CIM is to poll the status of each controller and attempt to discover new controllers. When the status of a controller indicates an alarm condition, the CIM can be programmed to call the host and report that an alarm condition exists.

When connected to a host computer running THS 2000 software, the CIM discontinues its polling and allows the THS 200 software to interrogate the controllers.

The CIM can be configured by selecting the *CIM Properties* item in the *Site* menu. This will bring up the *Current Site Properties* dialog box. This window is a tabbed collection of dialogs that query and display different parameters from the CIM, including the site information, version, port configuration, and callout phone numbers.

When a value is modified, the *Apply* button will become clickable. Clicking the *Apply* button will send the changes to the CIM. Also, clicking the *OK* button will send the changes to the CIM if you answer yes to the *save changes* question. Hitting the *Cancel* button will abort any changes that have not yet been written. After the new values are written to the CIM, they are read from the CIM and displayed.

Some of the CIMs properties screens contain a *Refresh* button that will simply re-read the data from the CIM.

For more information on the CIM, see Communication Interface Module.

CIM Site

Selecting the *CIM Site* tab in the *Current Site Properties* dialog box will produce a display similar to that shown in Figure 24. The F2 key (or the toolbar button) can also be used to select the *Current Site Properties* dialog box. From here, you can enter the site name and site password that will be used by the site connection described in Connecting A Site in Section 2.7.2.

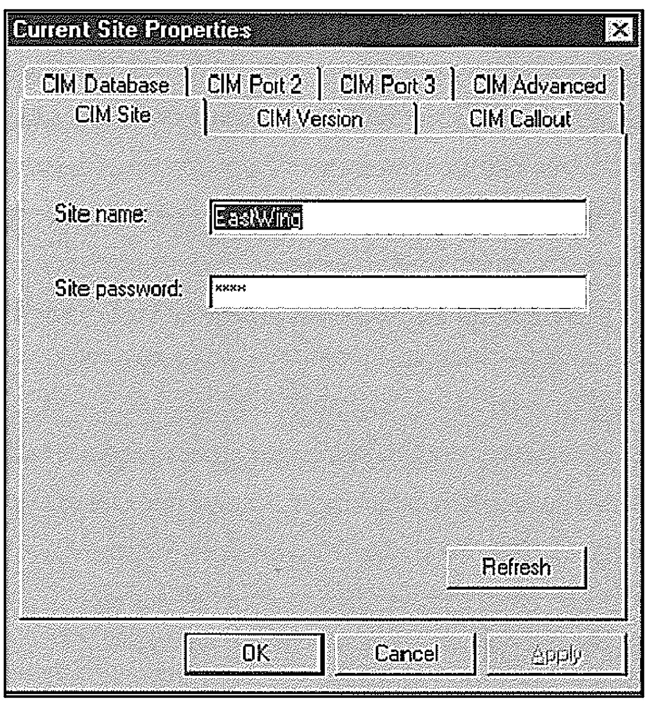

Figure 24 CIM Site

The name and password fields have a maximum length of 16 characters and case does not matter. CIM versions prior to CIM 3.0 are limited to 12 characters for the site name and 8 characters for the password.

Note: All CIMs that are intended for callout operation to the same site list must have unique site names.

CIM Version

The *CIM version* tab simply reads and displays the version information, including the serial number. This may be useful for future compatibility issues and service.

Note: CIM versions prior to Version 3.0 did not have a serial-number or Modbus™ support; these fields appears as *N/A* when communicating with one of these older devices.

CIM Callout

The *CIM Callout* tab configured the callout feature, which allows the CIM to call the host in case of an alarm condition. The dialog box is depicted in Figure 25. Refer to Section 2.7.5, Auto Answer Operation, for more information on CIM callout and THS 2000 software auto answer features.

Note: CIM versions prior to Version 3.0 did not support the call-all-numbers feature; this option is grayed-out for those devices. Also, in older CIM versions, all the phone numbers shared the same number of attempts; this is reflected in this dialog box by tying all the attempts choices together, so if one is changed, they are all changed.

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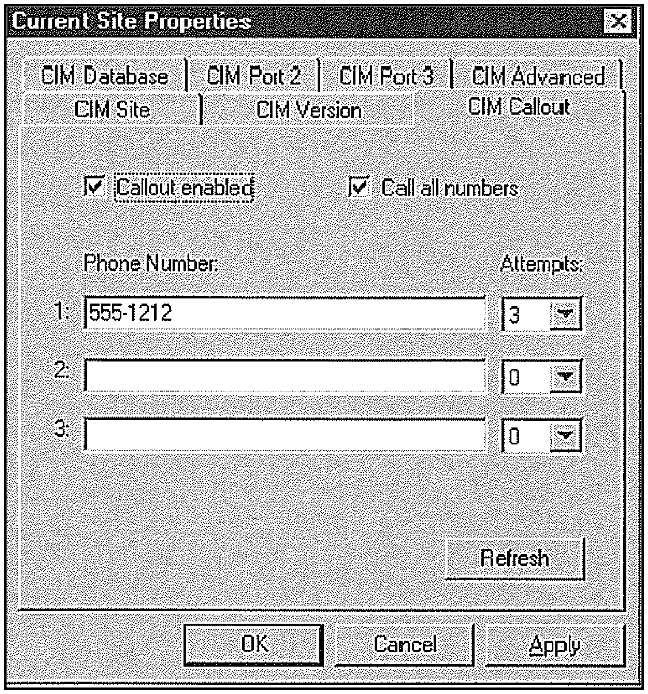

Figure 25 CIM Callout

CIM Database

All the properties of the CIM described in this section are stored in an internal database. This database, and therefore the CIM properties, can be reset to factory default values by initializing the database. The command to initialize the database can be found in the *CIM Database* tab of the *Current Site Properties* dialog box, as shown in Figure 26.

Note: This feature is provided as a last resort. It should not be invoked unless you know what you are doing or you are under the guidance of a qualified service person.

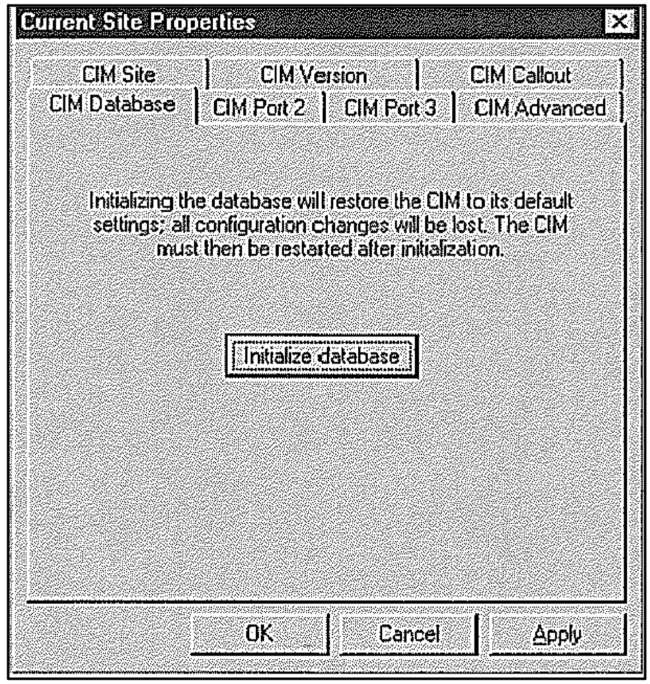

Figure 26 CIM Database

CIM Port 2

A CIM connected directly to a PC host or a Programmable Logic Controller (PLC) is connected serially to Port 2. The serial connection parameters are under the *CIM Port 2* tab of the *Current Site Properties* dialog box, as shown in Figure 27.

The signal type indicates the type of physical connection between the host and CIM. The *RS-232/Modem* option indicates that a connection is via a standard RS-232 cable or the internal modem (CIM Port 1). The *RS-422* and *RS-485* options are for multi-drop networks. The auto-detect option will allow the CIM to attempt to decide for itself which physical connection is in use. The default signal type is auto-detect.

The other parameters are standard serial type parameters, including parity, data bit size, stop bits, and baud rate. The baud rate values can be *1200, 2400, 4800*, *9600, 14400, and 19200*. The receive timeout parameter describes the amount of time after receiving the last byte of the packet until the packet is processed internally.

The *Restore Defaults* button will restore all parameters to their initial values (no parity, 8 data bits, 1 stop bit, 9600 baud, and 20 millisecond receive timeout.

The *Fixed Modbus ™ Mode* option is for enabling the fixed Modbus™ mode for operation with a PLC. Once in fixed Modbus™ mode, the CIM no longer requires a

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password to logon, it is essentially always logged in to save the PLC from having to do so. All modem functions are disabled when in fixed Modbus™ mode as well, to prevent unauthorized remote access. The only way to disable fixed Modbus™ mode is to connect directly (via RS-232 or RS-485) with the THS 2000 software, which will disable fixed Modbus™ mode when attempting to log in to the CIM.

Note: The receive timeout and auto-detect signal type features were not supported in previous versions of the CIM and, therefore, their values appears grayed-out and read only when examined by the THS 2000 software.

The protocol used on Port 2 is Modbus™, as described in Section 3, CIM Protocol.

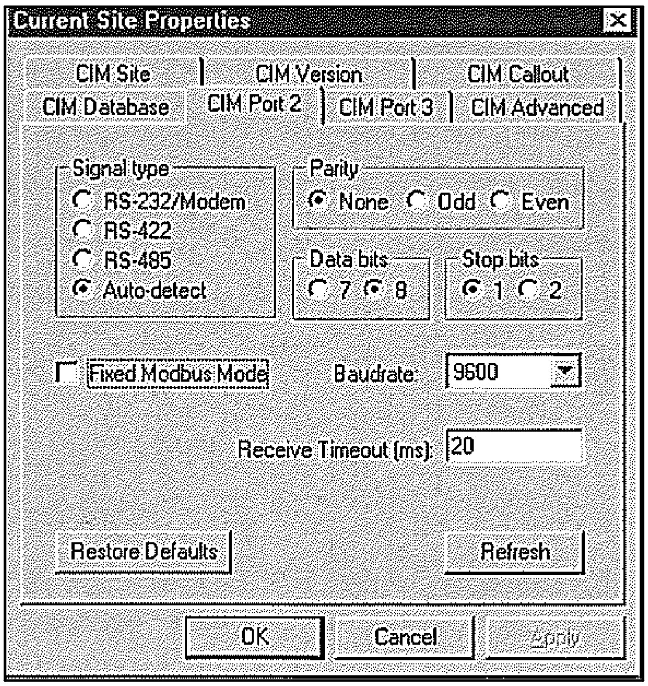

Figure 27 CIM Port 2

CIM Port 3

The Port 3 of the CIM is used to communicate with the controllers on the site. The parameters for this port can be found under the *CIM Port 3* tab in the *Current Site Properties* dialog box, as shown in Figure 28.

These values are currently read only; you may not change any of these values, they are fixed.

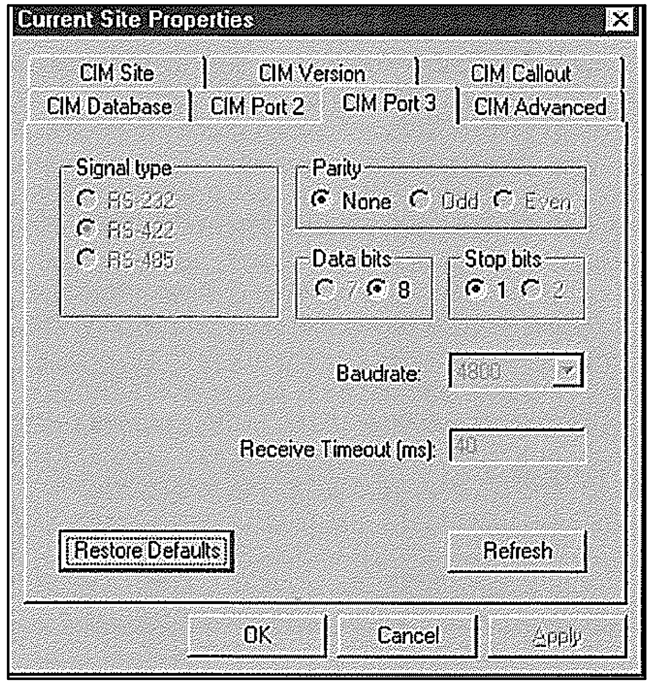

Figure 28 CIM Port 3

CIM Advanced

The *CIM Advanced* tab of the *Current Site Properties* dialog box allows you to change some of the more advanced features of the CIM, such as Modbus™ characteristics and controller polling. The dialog box is shown in Figure 29.

The top box contains properties unique to the Modbus™ operation of the CIM (see Section 3, CIM Protocol). The *Slave ID* is the ID used by the PLC to reference the CIM; the valid range for a Modbus™ slave device is 1-247.

The *Poll Bounds* parameters are for changing the behavior of the controller discovery polling. Controllers have an address range of 1 to 255, but there is a limit of 10 controllers per site. *The Poll Bounds* parameters reduce the range of addresses that the CIM must poll in order to discover new devices. Reducing this range to the expected values of the controllers, such as 1 to 10, speeds up response time.

The Response Delay parameter dictates the amount of time, in milliseconds, to wait before sending a response.

Note: The advanced features described here are only supported in CIM Version 3.0. When THS 2000 software is communicating with an older CIM, the *CIM Advanced* dialog box is not available.

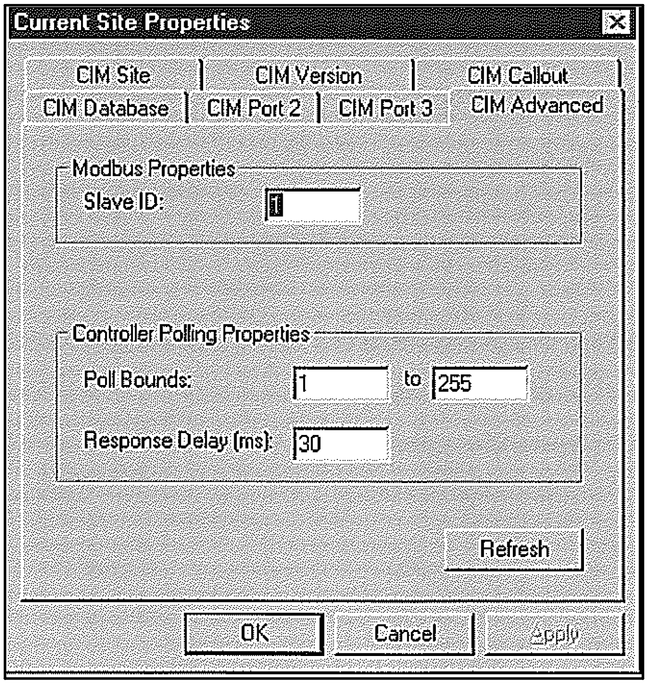

Figure 29 CIM Advanced

2.6.5 Controller Configuration

This section deals with the adding and removing of controllers. The controller currently supported by the THS 2000, and the CIM is the TSC 800 transfer switch controller.

Controller Discovery

The THS 2000 Version 3.0 software, in conjunction with the CIM Version 3.0, supports automatic controller discovery. When THS 2000 software establishes a connection to a remote CIM, it interrogates the CIM for the list of controllers present on this site. The user is then prompted to accept this list of controllers or continue with the controllers already loaded.

Versions of the CIM prior to Version 3.0 do not support the controller discovery, and controllers must be added manually as explained next in Adding A Controller.

Adding A Controller

Selecting the *Add* option from the *Controller* menu allows you to add a TSC 800 controller to the site from the *Add Controller* dialog box, as shown in Figure 30.

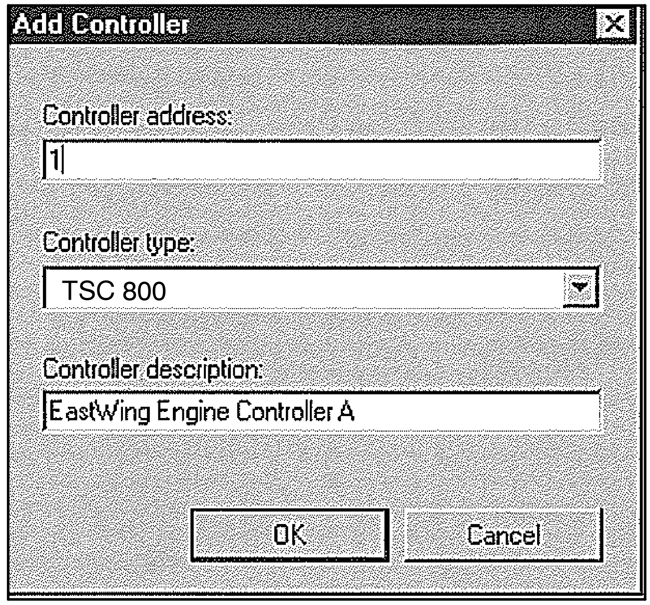

Figure 30 Add Controller Dialog Box

The controller address can be between 1 and 255, with no duplicates allowed. The controller type is TSC 800. The description can be any descriptive text you wish.

Removing A Controller

Removing a controller is accomplished by selecting the *Remove* item from the *Controller* menu which brings up the *Remove Controller* dialog box, as shown in Figure 31.

The controller to be deleted is selected from the list presented.

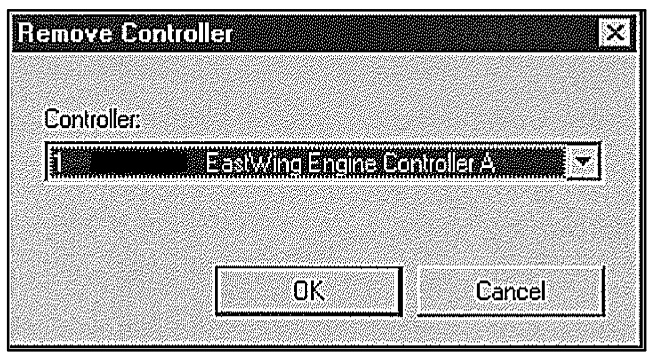

Figure 31 Remove Controller Dialog Box

Controller Properties

A controller's properties can be examined by selecting the *Properties* item of the *Controller* menu. This brings up a menu from which you can choose the controller to be examined, as shown in Figure 32.

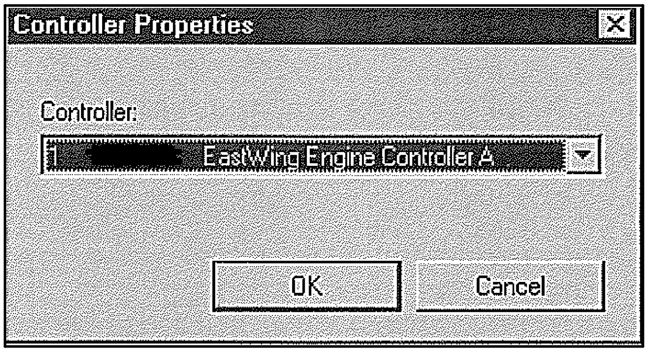

Figure 32 Controller Properties

After the controller is selected and the *OK* button is clicked, the TSC 800 dialog box is presented. From this window, the description can be modified and other properties, such as the controller address and the fault labels, can be viewed.

The *TSC 800 properties* dialog box is shown in Figure 33. From here, the controller description can be modified. Additional properties, such as the controller address, can be viewed.

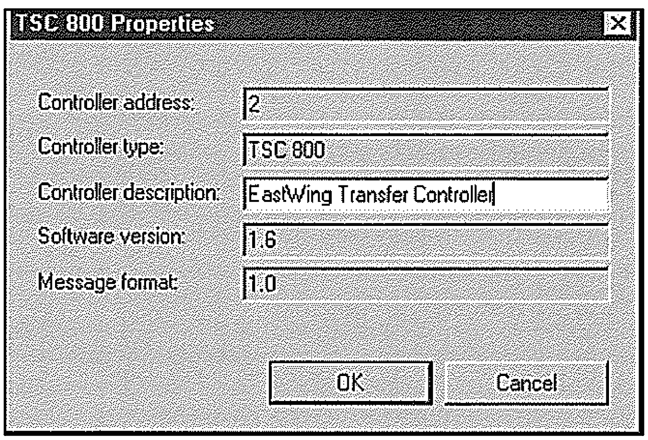

Figure 33 TSC 800 Properties

2.6.6 Auto Answer Configuration

An important feature of remote modem sites is the ability to dial the host and report an alarm condition. The host site can be configured from the *Auto Answer Settings* command of the *Site* menu, as shown in Figure 34.

When the auto answer feature is enabled, the THS 2000 software will accept calls from any site in the currently loaded site list.

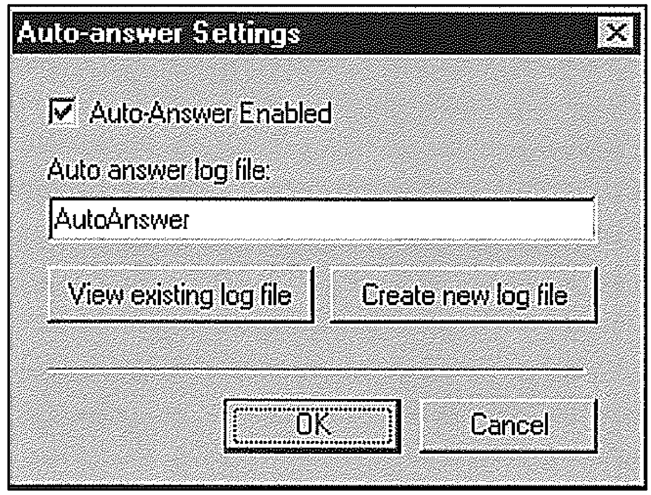

Figure 34 Auto-Answer Settings

2.7 Operation

2.7.1 Basics

This section describes the basic functionality of the THS 2000 software, from logging on to user interface to accessing the online help. See Section 2.5, Quick Start, for a fast get-up-and-running breakdown.

Starting And Logging On

Double clicking the THS 2000 icon starts the THS 2000 software. A splash screen indicating the version and related information is displayed for a short period. You will then be prompted to enter a password, as shown in Figure 35.

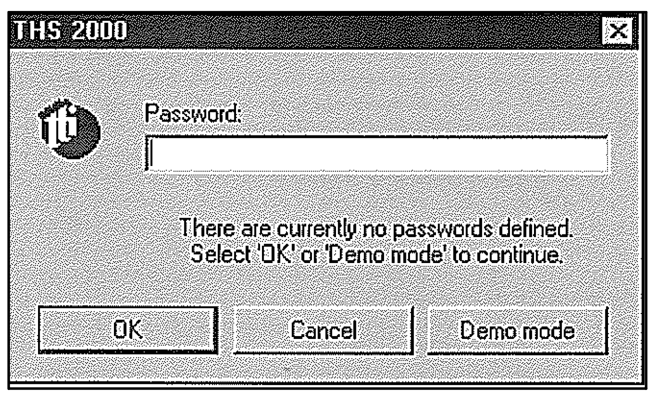

Figure 35 Enter Password

The THS 2000 software logon process allows for three different levels of security, depending on the password you entered. The levels are read only, read/write, and master (see Section 2.6.1, Passwords, for more information).

You also have the option of selecting *Demo mode,* which allows you to create some simulated controllers and otherwise operates as if you had read only security privileges.

The Interface

The main THS 2000 interface is shown in Figure 36. It is a relatively standard Windows-based application with a title bar, main menu, toolbar, and status bar, as well as a controller bar and a special viewing area.

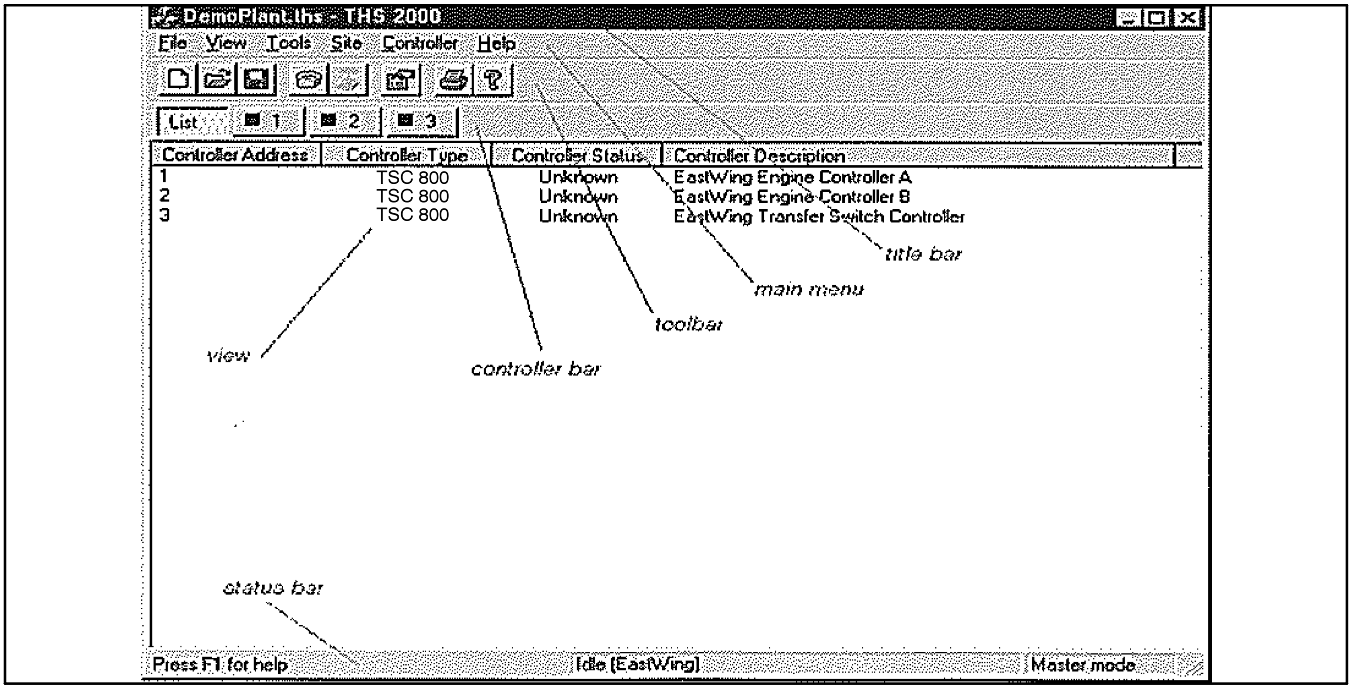

Figure 36 Main THS 2000 Interface

Title Bar

The title bar displays the currently loaded site list file. The site list file is a collection of one or more generation sites that has been configured and saved previously. The site list file can be opened, saved, and printed from the main menu or toolbar. The THS 2000 software site list files have the file extension .THS.

Main Menu

The main menu provides access to the THS 2000 software commands. Some commands are available only under certain circumstances; when the command is not available, it is grayed-out. For example, you will not be able to add a controller (*Add* from the Controller menu) until you have created an initial site (*Connect* from the *Site* menu or *New* from the *File* menu).

The main menu commands are also available using ALT key combinations; the underlined character indicates the key to press in combination with the ALT key. Many of the important commands are available using function keys; these are indicated in the pulldown menus.

Toolbar

The toolbar provides instant access to many important menu commands. When the mouse pointer is floated over the tool item, a tool tip is displayed in the status line portion of the status bar.

Controller Bar

The controller bar contains a button called List and a button for each controller on the site. The controller buttons are labeled using the controller's identification number (ID). Pressing a button on the controller bar will change the view to display the selected controller or the controller list view.

When the selected site is connected, the dot in the middle of the controller bar button will indicate the status of the controller (green, yellow, red, or black).

Status Bar

The status bar displays status messages and indicates connection status and security status. The status line displays tool tips and various status messages. The connection status indicates the state of the current connection, such as Idle or Connected to EastWing. The security status indicates with which security level you have logged on.

View

The view area displays one of two different views. The list view shows a tabular list of the controllers on the selected site. The controller view displays data from the TSC 800.

Accessing Help

The command *Contents* from the *Help* menu, the toolbar button, or the F1 key will bring up an online reference.

Exiting

The *Exit* command from the *File* menu will exit THS 2000, disconnecting any outstanding connections.

2.7.2 Connecting Sites

A site is made up of a single CIM connected to one or more controllers. Connecting to a site is the same as connecting to a CIM. From the user's point of view, the CIM is the site. This section describes how sites are connected and disconnected, as well as various properties of the CIM and the host connection.

Only a single site from the site list can be connected at a time.

Connecting A Site

A site can be connected using the *Connect* command from the *Site* menu, the toolbar button, or the F9 key. This will bring up the *Connect To* dialog box depicted in Figure 37.

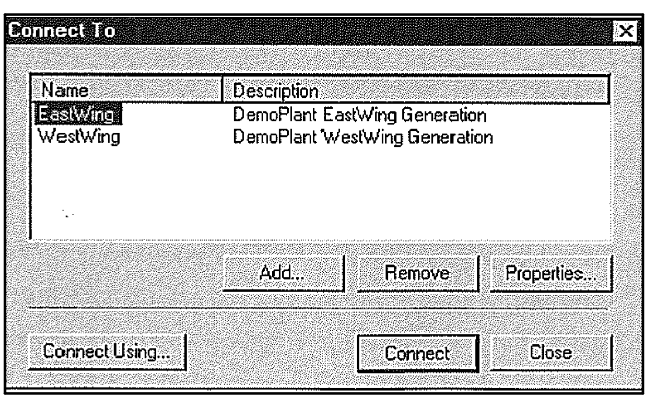

Figure 37 Connect to Dialog Box

This dialog box lists each site contained in the currently loaded site list and allows you to select the site to which a connection is desired. Clicking the *Connect* button will initiate a connection attempt. In addition, double clicking on the site name will initiate a connection attempt.

In addition, sites can be added to or removed from the site list or simply have their properties modified. A button labeled *Connect Using* is provided to jump to the host connection settings (see Host Connection in Section 2.6.3).

Disconnecting A Site

Selecting the *Disconnect* command from the *Site* menu, the toolbar button, or the F10 key will disconnect the currently connected site. This includes hanging up the phone line for a modem connection.

2.7.3 Viewing And Commanding Controllers

The main function of the CIM is to facilitate communication to the controllers present on the site. The controller currently supported by the CIM is the TSC 800 transfer switch controller. The main view of the THS 2000 software provides a simulated front panel of a single controller.

Controllers can be added, removed, and examined from menu commands.

Controller Views

The bulk of the THS 2000 software window is the view area. This area can be a simple list of the controllers or a more detailed representation of a single controller. The controller bar buttons are used to select the desired controller or the controller-list (see also The Interface in Section 2.7.1).

The controller bar contains a button called *List* and a button for each controller on the site. The controller buttons are labeled using the controller's ID. Pressing a button on the controller bar will change the view to display the selected controller or the controller list view.

When the selected site is connected, the dot in the middle of the controller bar button will indicate the status of the controller (green, yellow, red, or black).

Figure 38 shows the view of a TSC 800 connected to a remote CIM. The black part of the view is a direct emulation of the TSC 800 front panel. The faults and values are displayed and updated frequently.

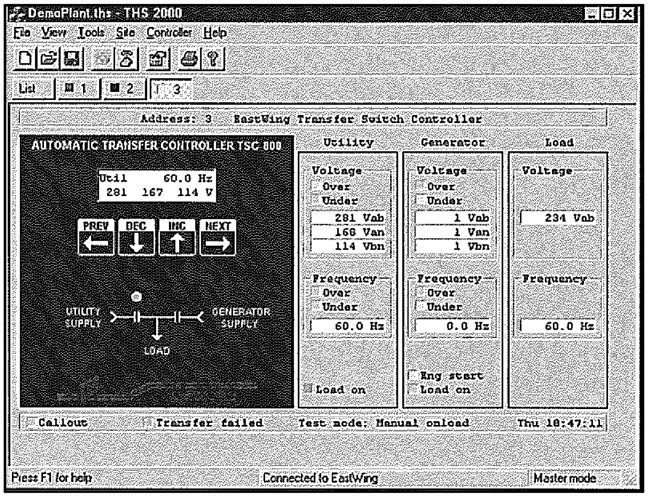

Figure 38 THS 2000 Main View

Controller Commands

The controller can also be commanded to perform control functions remotely. The control functions can be found under the *TSC 800 Command* item of the *Controller* menu. The commands for the TSC 800 are shown in Figure 39.

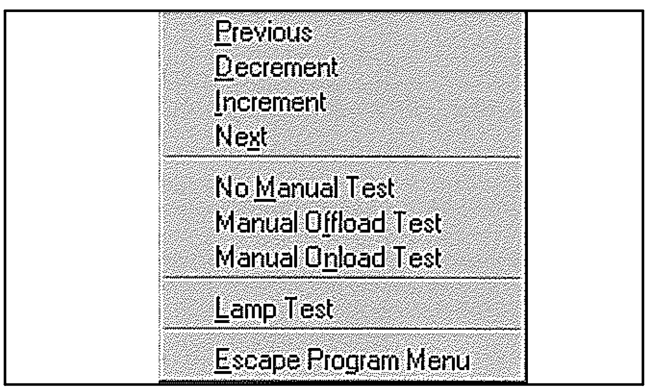

Figure 39 TSC 800 Commands

2.7.4 Printing

Using the print command (the *Print* item from the *File* menu or the toolbar button) while viewing a controller will print the currently displayed values in a simple text format. The print command will print the list of controllers when invoked while viewing the controller list.

2.7.5 Auto Answer Operation

When a remote CIM senses that a controller desires a Callout, it will start the calling out sequence. The CIM will dial its stored phone numbers X amount of times until it makes a connection (see CIM Callout in Section 2.6.4). The site where the CIM belongs must currently exist in the site list of the THS 2000 software program.

When an auto answer connection is established, an event is registered in the *Auto Answer* dialog box, as shown in Figure 40, and logged in the auto answer log file (see Section 2.6.6, Auto Answer Configuration).

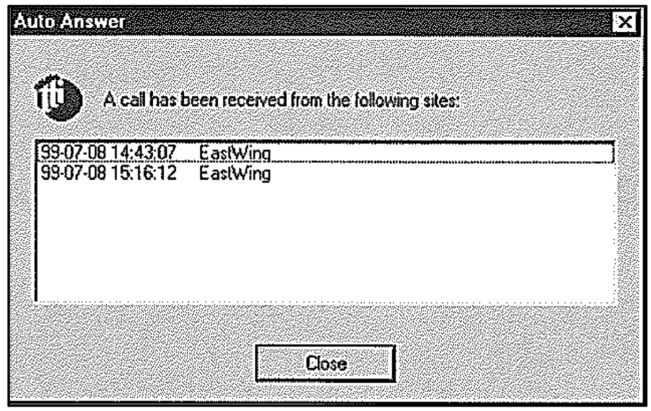

Figure 40 Auto Answer Dialog Box

When a site has connected, it will remain connected for two minutes just as if connected by the operator. During this time, the operator can view the controllers and determine the cause of the alarm. The status bar will also display a countdown of the remaining connection time in seconds.

2.8 CIM Bypass Wiring

The CIM bypass connection mode of operation has a different wiring scheme than a standard CIM connection. The two possible methods of connection are:

1. Direct. From computer to controller. The direct connection bypass mode is shown in Figure 41.

2. Modem. From computer to local modem to remote modem to controller. The modem connection bypass mode is shown in Figure 42.

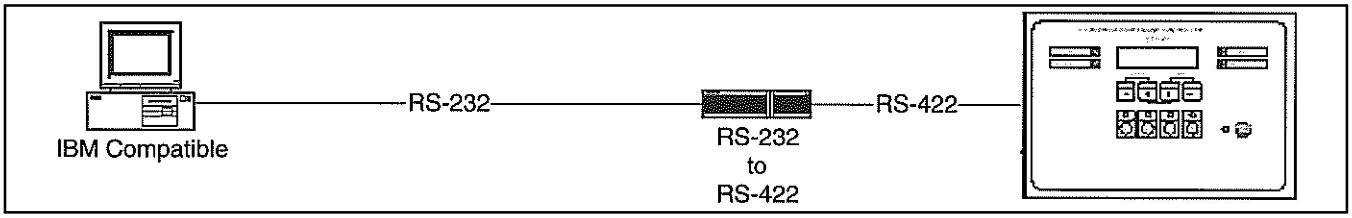

Figure 41 Direct Connection

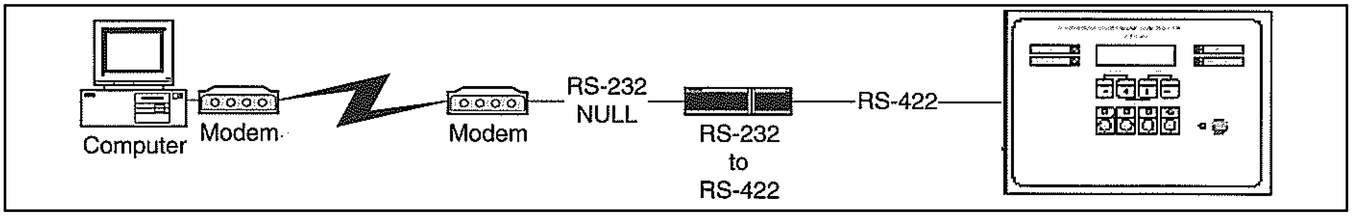

Figure 42 Model Connection

An RS-232 to RS-422 converter is required to convert the signal from the computer or modem. The required wiring from the RS-422 side of the convert to the RJ-45 connection on the controller is as shown in Figure 43.

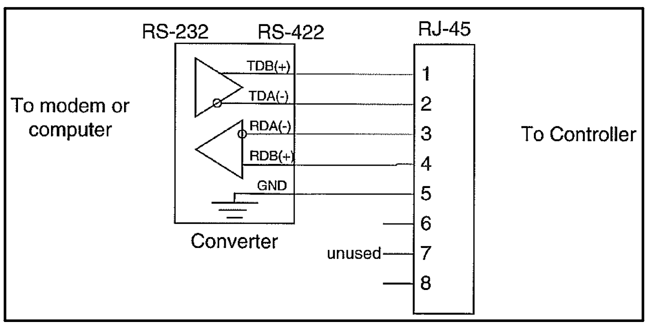

Figure 43 Wiring, RS-422 to RJ-45

The RS-232 NULL connection between the modem and the converter must pass all handshake signals, as shown in Figure 44.

The modem must store configuration in a nonvolatile storage medium (such as FLASH). The modem must be configured for the following features:

- Auto answer.
- Connect at 4800 bps only (no fallback).
- Echo disabled.
- No error correction.
- No compression.

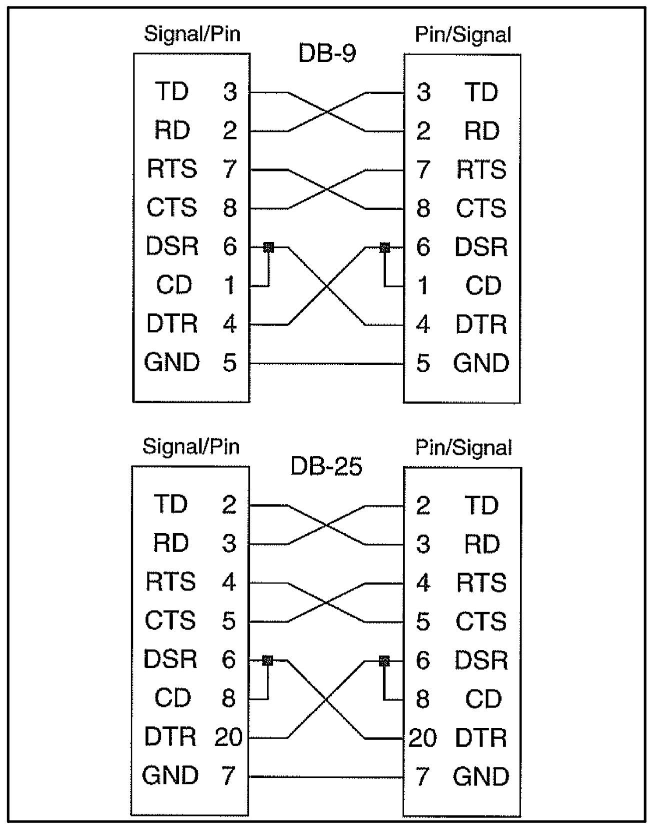

Figure 44 Null Connection, Model-Converter

All RS-232 to RS-422 converters and modems are not created equal. The recommended parts are: 3Com USRobotics V.90 56K Faxmodem and B&B Electronics RS-232/RS-485 Converter Model 485PTBR (also an RS-422 converter). Configure the modem prior to operation with the DIP switches set as shown in Figure 45 and the following initialization strings:

AT Q0 E0 V1 X4 &K0 &D0 &M0 &B0 &H0 &R1 &N4

AT S0=1

AT &W0

Switch	Position
1	DOWN
2	UP
3	DOWN
4	DOWN
5	UP
6	UP
7	UP
8	DOWN
DOWN is on.	

Figure 45 Modem Configuration

2.9 THS 2000 Troubleshooting

Symptom	Corrective Action
Cannot communicate with the site.	See Section 1.9, CIM Troubleshooting, for possible solutions.
THS 2000 software locks up.	The Host software may lock-up if auto answer mode is on when running in direct mode; the Host software is trying to write to a modem when it may not be present. The solution is to disable auto answer (see Section2.6.6 Auto Answer Configuration).
Unable to view online help: *The THS 2000 help file (THS3v0.chm) could not be located.*	Check that Microsoft Internet Explorer 4.01 or later is installed. Ensure that the THS3v0.CHM file is located in the same directory as the THS3v0.EXE file.
Unable to view online help: *Unable to load a file called hhctrl.ocx.*	You need to run the hhupd.exe file included with the THS 2000 software distribution diskettes.

3 CIM Protocol

3.1 Introduction

This protocol document is applicable to Version 3.0 of the Communication Interface Module.

The Communication Interface Module (CIM) provides the hardware and software interface between a Modbus™ compliant master device (customer-supplied) and the specific Remote Terminal Units (RTUs) as used at a generator site.

The RTU in this context is a device that directly operates the equipment at a generator site. These devices are the actual microprocessor-based controllers and includes the TSC 800 transfer switch controller.

Note: This instruction manual provides detailed information on the CIM 3.0 Modbus™ protocol. For detailed information on the CIM 3.0 hardware and installation, see Communication Interface Module. For information on operating CIM 3.0 using the THS2000 3.0 software program, see Section 2, THS 2000 Software Program. For more information on specific RTU devices, refer to their associated instruction manuals.

For more information on the Modbus™ protocol, visit the Modicon web site at www.modicon.com. The communications protocol is split into the physical layer, the datalink layer, and the application layer.

3.2 Physical Layer

At the physical layer, the CIM device is connected to a Modbus™ master through CIM Port 2 (DB-9 or RJ-45) which is configurable to RS-232/-485/-422 and up to 19200 baud.

The TSC 800s connect to the CIM (host) through an RS-422 interface via an RJ-45 connector to CIM port 3b. Up to 10 remotes can be connected to a single CIM (host), as shown in Figure 46.

The remote's receive lines are always enabled. The remote's transmit lines are only enabled while transmitting.

There is no hardware flow control.

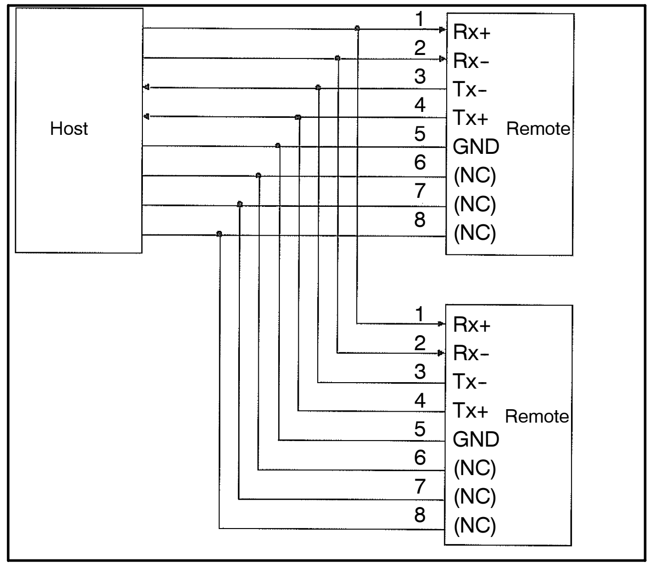

Figure 46 Connections, CIM (Host) to TSC 800 Controllers (Remotes)

3.3 Datalink Layer

Note: Unless noted otherwise, all fields described in this document contain unsigned binary data stored in big-endian (most significant byte first) format. Any unused fields contain zeroes. When describing the fields, FALSE equals zero and TRUE equals nonzero.

At the Datalink Layer, the host (master) is responsible for polling the CIMs. The host sends request packets to the remotes, and the remotes respond with response packets. The communication format describes an interface with the CIM database.

Unfortunately due to processing limitations, response packets from the CIM to the host can have up to 25 ms gaps in the data. The CIM response data is shifted out in 16 character increments. In some cases, it can take up to 25 ms to shift out the next 16 character buffer.

The host pretransmit delay is the minimum time required between the reception of the last byte of a frame (response) and the transmission of the first byte of a new frame (request). The values in Figure 47 show the necessary pretransmit delays to ensure reliable transmission of data to the CIM.

Baud Rate	Delay (ms)
1200	130
2400	80
4800	40
9600	30
14400	30
19200	30

Figure 47 Pretransmit Delays

The typical CIM and TSC 800 data is accessible through direct register read and writes.

3.3.1 Preset Multiple Registers (Type 16)

The preset multiple registers packet is used to write specific values to the controllers. Numeric values are shown in hexadecimal. For CRC Calculation, see Section 3.15. The packet format for this request is shown below.

ss	10	aaaa	pppp	bb	rrrr....rrrr	cccc
ss						
	CIM 20 ID (00 to FF)					
aaaa						
	Starting register (4aaaa)					
pppp						
	Register count (number of points)					
bb						
	Number of bytes (register count x 2)					
rrrr						
	Register data (16 bit data)					
cccc						
	CRC-16 (see CRC Calculation)					

Preset Multiple Registers Response

The response to this packet is shown below.

ss	10	aaaa	pppp	cccc
ss				
	CIM 20 ID (00 to FF)			
aaaa				
	Starting register (4aaaa; same number as the write packet)			
pppp				
	Register count (same number as the write packet)			
cccc				
	CRC-16 (see CRC Calculation)			

Example: Remote Key Press Operation

SEND:

ss	10	0200	0001	02	kknn	cccc
ss						
	CIM 20 ID (OO to FF)					
kk						
	Keystroke number					
nn						
	Number of times to repeat keystroke					
cccc						
	CRC-16 (see CRC Calculation)					

RECEIVE:

ss	10	0200	0001	cccc
ss				
	CIM 20 ID (OO to FF)			
cccc				
	CRC-16 (see CRC Calculation)			

It is also recommended to follow up with a Display Valid Flag read to ensure the operation was successful before proceeding. The CIM does attempt multiple operations in the case of a bad packet. However, if the Display Valid Flag is not valid after 900 ms, a retry should be performed.

3.3.2 Read Holding Registers (Type 3)

The read holding register request is used for read data from the controller. Numeric values are shown in hexadecimal.

Read Holding Registers Request

Field addressing is done with the following format:

ss	03	aaaa	pppp	cccc
ss				
	CIM 20 ID (OO to FF)			
aaaa				
	Starting register (4aaaa)			
pppp				
	Register count			
cccc				
	CRC-16 (see CRC Calculation)			

Read Holding Registers Response

ss	03	bb	rrrr....rrrr	cccc
ss				
	CIM 20 ID (OO to FF)			
bb				
	Response byte count (register count x 2)			
rrrr				
	Register data (16 bit data)			
cccc				
	CRC-16 (see CRC Calculation)			

Example: Read Registers 200 To 201

SEND:

ss	03	0200	0002	cccc
ss				
	CIM ID (OO to FF)			
cccc				
	CRC-16 (see CRC Calculation)			

RECEIVE:

ss	03	04	aaaa	bbbb	cccc
ss					
	CIM ID (OO to FF)				
aaaa					
	Register 200 data				
bbbb					
	Register 201 data				
cccc					
	CRC-16 (see CRC Calculation)				

3.4 Application Layer

At the application layer, the master controller sends request messages to the CIMs, and the CIMs respond with response messages. The only time the user needs to be concerned with the CIM is when CIM configuration parameters need to be modified.

The CIM port configuration table is used to change the port type (RS-232/-485/-422) and data protocol options such as baud rate, start bits, stop bits, and parity. The CIM port configuration table consists of 2 records that define CIM port 2 and port 3 options.

All register values are in hexadecimal notation. With certain Modbus™ interfaces you may be required to use a decimal value. In Modbus™ terminology, a zero does not exist in the decimal register list; therefore, many PLC/ software interfaces may require you to convert the Hex to decimal and then add one. (Example: 100Hex —> 257 not 256). The actual packet will include the below listed value with the *4* chopped off. The 4xxxx is another Modbus™ terminology that is not used in the actual protocol, only the lower 4 digits are converted and used in the packet description.

Values in bold typeface are the default values for their respective fields.

3.5 Data Types And Formats

Figure 48 describes the possible return data types and formats for Modbus™ registers defined in the CIM.

A register data value consists of two bytes: the most significant (MSB) and the least significant (LSB). Data values are arranged with the MSB first (called big-endian).

Data Type	Register Count	Maximum Range	Description
Boolean	1	0 or nonzero	Boolean value: 0 = false, nonzero = true
Enum	1	0 to max-range	Enumeration: range from 0 to some maximum
Uint8	1	0-255	Unsigned 8-bit integer (allowable values can be further limited)
Uint16	1	0-65535	Unsigned 16-bit integer (allowable values can be further limited)
String	n	Special	Character (0-255) string, ordered: MSB1, LSB1, MSB2, LSB2, ...
Struct	n	Special	Structure; definition depends on register range; ordered: MSB1 = byte0, LSB1 = byte1, MSB2 = byte2, LSB2 = byte3, ...

Figure 48 Data Types

Modbus™ is a trademark of Schneider Electric.

3.6 CIM Port Configuration

The Modbus™ Configuration table in Figure 49 is used specifically to assign a node address (CIM ID) to the individual CIM unit. This is used in multiple CIM configurations. The CIMs are slaves to any device connected to Port 2. However, the CIM acts like a Master to anything connected to Port 3. Communication to the individual remotes will be done by communicating to the CIM.

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
Port#2 Bitrate	40257	100	1	enum	0 = 57600, 1 = 38400, 2 = 19200, 3 = 14400, 4 = 9600, 5 = 4800, 6 = 2400, 7 = 1200
Port#2 Bits/char	40258	101	1	uint8	7 to 8 (8)
Port#2 Stopbits	40259	102	1	uint8	1 to 2 (1)
Port#2 Parity	40260	103	1	enum	0 = Odd, 1 = Even, 2 = None, 3 = Mark, 4 = Space
Port#2 Rx Timeout	40261	104	1	uint16	0 to 65535 (20)
Port#2 Line Protocol	40262	105	1	enum	0 = RS-232, 1 = RS-422, 2 = RS-485, 3 = auto-detect
Port#3 Bitrate	40289	120	1	enum	0 = 57600, 1 = 38400, 2 = 19200, 3 = 14400, 4 = 9600, 5 = 4800, 6 = 2400, 7 = 1200
Port#3 Bits/char	40290	121	1	uint8	7 to 8 (8)
Port#3 Stopbits	40291	122	1	uint8	1 to 2 (1)
Port#3 Parity	40292	123	1	enum	0 = Odd, 1 = Even, 2 = None, 3 = Mark, 4 = Space
Port#3 Rx Timeout	40293	124	1	uint16	0 to 65535 (40)
Port#3 Line Protocol	40294	125	1	enum	0 = RS-232, 1 = RS-422, 2 = RS-485

Figure 49 Modbus™ Configuration Table

3.7 CIM General Configuration

The CIM ID is only used for programming CIM features, it is transparent when communicating with the TSC 800s.

The Poll Bounds structure has the following format:

byte 0 = upper bound; default 255
byte 1 = lower bound; default 0.

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
CIM ID	40321	140	1	uint8	0 to 255 (1)
CIM response delay (ms)	40322	141	1	uint16	0 to 5000 (30)
Poll bounds	40323	142	1	struct	see below
Call out enable	40324	143	1	boolean	0 = disabled, 1 = enabled
Call out mode	40325	144	1	enum	0 = connect once, 1 = connect to all

3.8 CIM Passwords

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
Site Name	40337-40345	150-158	9	String	Max-length = 18 bytes
THS mode password	40346-40354	159-161	9	String	Max-length = 18 bytes
Modbus™ mode password	40355-40363	162-16A	9	String	Max-length = 18 bytes

3.9 CIM Login

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
Requested link protocol	40385	180	1	enum	0 = THS, 1 = Modbus™, 2 = Fixed-Modbus™
Requested line protocol	40386	181	1	enum	0 = logoff, 1 = RS-232, 2 = RS-422, 3 = RS-485, 4 = modem
Login request password	40387-40395	182-18A	9	string	Max-length = 18 bytes

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3.10 CIM About

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
Device Type identifier	40417	1A0	1	enum	Value = 0xC53A
4 character device name	40418-40419	1A1-1A2	2	string	max-length = 4 bytes; ”CIM3”
Call out requested	40420	1A3	1	boolean	1 = call out requested
Serial Number (64bit binary)	40421-40424	1A4-1A7	4	struct	structure-length is 8 bytes; value is factory set
THS software version (upper)	40425	1A8	1	uint16	0 to 65535
THS software version (lower)	40426	1A9	1	uint16	0 to 65535
THS protocol version (upper)	40427	1AA	1	uint16	0 to 65535
THS protocol version (lower)	40428	1AB	1	uint16	0 to 65535
Modbus™ software version (upper)	40429	1AC	1	uint16	0 to 65535
Modbus™ software version (lower)	40430	1AD	1	uint16	0 to 65535
Modbus™ protocol version (upper)	40431	1AE	1	uint16	0 to 65535
Modbus™ protocol version (lower)	40432	1AF	1	uint16	0 to 65535

3.11 CIM RTU List

The slave address and type are encoded in the following 2-byte structure:

Byte 0 = slave type (0 = none, 2 = TSC 800)
Byte 1 = slave address (0 to 255).

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
Reason for last callout	41281	500	1	enum	0 = RTU requested callout, 1 = RTU removed, 2 = RTU added, 3 = bad slave response
Slave 1 address and type	41282	501	1	struct	see below
Slave 2 address and type	41283	502	1	struct	see below
Slave 3 address and type	41284	503	1	struct	see below
Slave 4 address and type	41285	504	1	struct	see below
Slave 5 address and type	41286	505	1	struct	see below
Slave 6 address and type	41287	506	1	struct	see below
Slave 7 address and type	41288	507	1	struct	see below
Slave 8 address and type	41289	508	1	struct	see below
Slave 9 address and type	41290	509	1	struct	see below
Slave 10 address and type	41291	50A	1	struct	see below

3.12 CIM Callout

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
Phone number 1	41537-41553	600-610	17	string	Max-length = 34 bytes
Callout attempts count 1	41554	611	1	uint8	0 to 9 (3)
Phone number 2	41555-41571	612-622	17	string	Max-length = 34 bytes
Callout attempts count 2	41572	623	1	uint8	0 to 9 (3)
Phone number 3	41573-41589	623-634	17	string	Max-length = 34 bytes
Callout attempts count 3	41590	635	1	uint8	0 to 9 (3)

3.13 TSC 800 Register Tables

Specific TSC 800 data is received by addressing the TSC 800 and accessing the appropriate registers listed below. Using a TSC 800 address of *0* will cause all TSC 800s to respond to the request. This is usually reserved for communication with a single TSC 800 with an unknown address. Otherwise TSC 800 addresses range from 1-255; however, only ten RTUs (TSC 800) can be connected to an individual CIM.

Field	Register (Decimal)	Address (Hex)	Register Count	Data Format	Value
TSC 800 Key Press (write only reg)	41025	400	1	uint16	See TSC 800 Press Key
TSC 800 Valid Data/Display	41026	401	1	uint8	See TSC 800 Valid Data/Display
TSC 800 Version	41027-41029	402-404	3	struct	See TSC 800 Get Version
TSC 800 Summary	41030-41036	405-40B	6	struct	See TSC 800 Get Summary
TSC 800 Analog Group	41037-41049	40C-418	13	struct	See TSC 800 Get Analog Values
TSC 800 Display Group 0	41050-41057	419-420	8	string	See TSC 800 Display Details
TSC 800 Display Group 1	41058-41065	421-428	8	string	See TSC 800 Display Details

3.14 TSC 800 Messages (Version 1.0)

The following sections describe in detail the data registers mentioned in Section 3.13. For single byte data the actual byte location in the registers is included in the above mentioned tables.

3.14.1 TSC 800 Press Key

This message is used to remotely press a key on a TSC 800s front panel. It is also used to get the characters displayed on a TSC 800s LCD. The request message has the following data bytes:

Field	Description
Byte 0	This field contains the key, as follows: 0 = Null (This value is used to get the characters displayed on the LCD without pressing any of the keys). 1 = Lamp test 2 = Previous 3 = Decrement 4 = Increment 5 = Next 6 = No manual test 7 = Manual offload test 8 = Manual onload test 9 = Escape from program menu 10-255 = Unused
Byte 1	This field contains the number of times the key is to be pressed.

The response message contains the current display contents.

3.14.2 TSC 800 Valid Data/Display

The data/display valid byte (byte 1, LSB) is used to determine the following.

1. If bit 0 is set (1), the Current Data in the registers is valid.
2. If bit 1 is set (1), the Display Data is valid (i.e. the last Keypress command has executed successfully).

3.14.3 TSC 800 Get Version

This message is used to get the version information from a TSC 800. The request message does not have any data bytes. The response message has the following data bytes:

Field	Description
Byte 0	*** PAD ***
Byte 1	This field contains the remote type, as follows: 1 = TSC 800 2-255 = Undefined
Byte 2	This field contains the major TSC 800 message format version number.
Byte 3	This field contains the minor TSC 800 message format version number.
Byte 4	This field contains the major software version number.
Byte 5	This field contains the minor software version number.

3.14.4 TSC 800 Get Summary

This message is used to get the summary information from a TSC 800. The request message does not have any data bytes. The response message has the following data bytes:

Field	Description
Byte 0, Byte 1	This field contains the summary bitmap, as follows: Bit 15 contains TRUE if a callout is required. Bit 14 contains TRUE if dual prime mode, and FALSE if standard mode. Bit 13 contains TRUE if Src2 prime, and FALSE if Src1 prime. Bit 12 contains TRUE if a transfer switch failure has occurred. Bit 11 is unused in standard mode. This bit contains TRUE if the Src1 Start output is enabled in dual prime mode. Bit 10 contains TRUE if the Src2 Start output is enabled. Bit 9 contains TRUE if the Src1 Pretransfer output is enabled. Bit 8 contains TRUE if the Src2 Pretransfer output is enabled. Bit 7 contains TRUE if the Src1 Transfer output is enabled. Bit 6 contains TRUE if the Src2 Transfer output is enabled. Bit 5 contains TRUE if the Load On Src1 input is enabled. Bit 4 contains TRUE if the Load On Src2 input is enabled. Bits 3-0 are unused.
Byte 2	This field contains the test mode, as follows: 0 = None 1 = Switch offload test 2 = Switch onload test 3 = Switch off 4 = Manual offload test 5 = Manual onload test 6 = Auto offload test 7 = Auto onload test 8-255 = Unused
Byte 3	This field contains the system status, as follows: 0 = Src1 start delay 1 = Src2 start delay 2 = Src1 warmup delay 3 = Src2 warmup delay 4 = Pretransfer delay 5 = Finding neutral 6 = Neutral delay 7 = Transferring 8 = Transfer failed, press lamptest 9 = Posttransfer delay 10 = Src1 return delay 11 = Src2 return delay 12 = Src1 cooling 13 = Src2 cooling 14 = Src1 auto, Src2 auto 15 = Src1 auto, Src2 failed 16 = Src1 auto, Src2 normal 17 = Src1 auto, Src2 offload test 18 = Src1 auto, Src2 onload test 19 = Src1 auto, Src2 ready 20 = Src1 auto, Src2 running

Field	Description
Byte 3	21 = Src1 auto, Src2 starting 22 = Src1 auto, Src2 switch off 23 = Src1 failed, Src2 auto 24 = Src1 failed, Src2 failed 25 = Src1 failed, Src2 normal 26 = Src1 failed, Src2 offload test 27 = Src1 failed, Src2 onload test 28 = Src1 failed, Src2 ready 29 = Src1 failed, Src2 running 30 = Src1 failed, Src2 starting 31 = Src1 failed, Src2 switch off 32 = Src1 normal, Src2 auto 33 = Src1 normal, Src2 failed 34 = Src1 normal, Src2 normal 35 = Src1 normal, Src2 offload test 36 = Src1 normal, Src2 onload test 37 = Src1 normal, Src2 ready 38 = Src1 normal, Src2 running 39 = Src1 normal, Src2 starting 40 = Src1 normal, Src2 switch off 41 = Src1 offload test, Src2 auto 42 = Src1 offload test, Src2 failed 43 = Src1 offload test, Src2 normal 44 = Src1 offload test, Src2 offload test 45 = Src1 offload test, Src2 onload test 46 = Src1 offload test, Src2 ready 47 = Src1 offload test, Src2 running 48 = Src1 offload test, Src2 starting 49 = Src1 offload test, Src2 switch off 50 = Src1 onload test, Src2 auto 51 = Src1 onload test, Src2 failed 52 = Src1 onload test, Src2 normal 53 = Src1 onload test, Src2 offload test 54 = Src1 onload test, Src2 onload test 55 = Src1 onload test, Src2 ready 56 = Src1 onload test, Src2 running 57 = Src1 onload test, Src2 starting 58 = Src1 onload test, Src2 switch off 59 = Src1 ready, Src2 auto 60 = Src1 ready, Src2 failed 61 = Src1 ready, Src2 normal 62 = Src1 ready, Src2 offload test 63 = Src1 ready, Src2 onload test 64 = Src1 ready, Src2 ready 65 = Src1 ready, Src2 running 66 = Src1 ready, Src2 starting 67 = Src1 ready, Src2 switch off 68 = Src1 running, Src2 auto 69 = Src1 running, Src2 failed 70 = Src1 running, Src2 normal 71 = Src1 running, Src2 offload test 72 = Src1 running, Src2 onload test 73 = Src1 running, Src2 ready 74 = Src1 running, Src2 running 75 = Src1 running, Src2 starting 76 = Src1 running, Src2 switch off 77 = Src1 starting, Src2 auto 78 = Src1 starting, Src2 failed 79 = Src1 starting, Src2 normal 80 = Src1 starting, Src2 offload test 81 = Src1 starting, Src2 onload test 82 = Src1 starting, Src2 ready 83 = Src1 starting, Src2 running 84 = Src1 starting, Src2 starting

Field	Description
Byte 3	85 = Src1 starting, Src2 switch off 86 = Src1 switch off, Src2 auto 87 = Src1 switch off, Src2 failed 88 = Src1 switch off, Src2 normal 89 = Src1 switch off, Src2 offload test 90 = Src1 switch off, Src2 onload test 91 = Src1 switch off, Src2 ready 92 = Src1 switch off, Src2 running 93 = Src1 switch off, Src2 starting 94 = Src1 switch off, Src2 switch off 95-255 = Unused
Byte 4, Byte 5	This field contains the system status timer value (in seconds).
Byte 6, Byte 7	This field contains the fault state bitmap. Each bit contains TRUE if the associated fault is active. The bits are defined as follows: Bits 15-8 are unused. Bit 7 is Src2 overfrequency. Bit 6 is Src2 underfrequency. Bit 5 is Src2 overvoltage. Bit 4 is Src2 undervoltage. Bit 3 is Src1 overfrequency. Bit 2 is Src1 underfrequency. Bit 1 is Src1 overvoltage. Bit 0 is Src1 undervoltage.
Byte 8, Byte 9	This field contains the fault visible bitmap. Each bit contains TRUE if the associated fault is visible. The bits are defined as follows: Bits 15-8 are unused. Bit 7 is Src2 overfrequency. Bit 6 is Src2 underfrequency. Bit 5 is Src2 overvoltage. Bit 4 is Src2 undervoltage. Bit 3 is Src1 overfrequency.
Byte 8, Byte 9	Bit 2 is Src1 underfrequency. Bit 1 is Src1 overvoltage. Bit 0 is Src1 undervoltage.
Byte 10	This field contains the day of the week of the system time, as follows: 0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday 7-255 = Unused
Byte 11	This field contains the hour of the system time. Valid values are 0-59.
Byte 12	This field contains the minute of the system time. Valid values are 0-59.
Byte 13	This field contains the second of the system time. Valid values are 0-59.

3.14.5 TSC 800 Get Analog Values

This message is used to get the analog values from a TSC 800. The request message does not have any data bytes. The response message has the following data bytes:

Field	Description
Byte 0, Byte 1	This field contains the analog values bitmap, as follows: Bit 15 contains TRUE if 3 phase mode, and FALSE if 1 phase mode. Bits 14-0 are unused.
Byte 2, Byte 3	This field contains the Src1 phase AB voltage (in volts).
Byte 4, Byte 5	3 phase mode: This field contains the Src1 phase BC voltage (in volts). 1 Phase mode: This field contains the Src1 phase AN voltage (in volts).
Byte 6, Byte 7	3 phase mode: This field contains the Src1 phase CA voltage (in volts). 1 Phase mode: This field contains the Src1 phase BN voltage (in volts).
Byte 8, Byte 9	This field contains the Src1 frequency (in tenths of hertz).
Byte 10, Byte 11	This field contains the Src2 phase AB voltage (in volts).
Byte 12, Byte 13	3 phase mode: This field contains the Src2 phase BC voltage (in volts). 1 Phase mode: This field contains the Src2 phase AN voltage (in volts).
Byte 14, Byte 15	3 phase mode: This field contains the Src2 phase CA voltage (in volts). 1 Phase mode: This field contains the Src2 phase BN voltage (in volts).
Byte 16, Byte 17	This field contains the Src2 frequency (in tenths of hertz).
Byte 18, Byte 19	This field contains the load phase AB voltage (in volts).
Byte 20, Byte 21	This field is unused.
Byte 22, Byte 23	This field is unused.
Byte 24, Byte 25	This field contains the load frequency (in tenths of hertz).

3.14.6 TSC 800 Display Details

The display details are broken into two groups. Group 0 contains the 16 ASCII characters from the top line of the TSC 800 display. Group 1 contains the 16 ASCII characters from the bottom line of the display. There are too many individual display messages to list here; however, some basic messages should be described. The two most useful messages are *nonvalid* and *valid*. This is mainly used for confirmation that a keystroke has been sent and received by the TSC 800 correctly. See Figure 50 and Figure 51.

Field	Description
Byte 0 to Byte 15	This field contains the ASCII characters from the LCD top line.

Figure 50 Group 0

Field	Description
Byte 0 to Byte 15	This field contains the ASCII characters from the LCD bottom line.

Figure 51 Group1

3.15 CRC Calculation

The Cyclical Redundancy Check (CRC) calculation used by Modbus™ is commonly called the CRC-16 algorithm. Refer to *A Painless Guide to CRC Error Detection Algorithms* by Ross N. Williams for more detailed information. Using the terminology of that paper, the CRC algorithm used by the CIM is:

Name : CRC−16
Width : 16
Poly : 8005
Init : FFFF
RefIn : True
RefOut : True
XorOut : 0000
Check : BB3D

The following is a C code implementation of the CRC-16 method:

```
unsigned short CalculateCrc(unsigned char *pAddress, int nByteCount)

{

  unsigned short wCrcValue = 0xffff;

  while (nByteCount−−)

  {

    wCrcValue ^ =  *pAddress;

    for (int i = 0; i < 8; i++)

    {

      if (wCrcValue & 1)

      {

        wCrcValue >> =  1;

        wCrcValue ^ =  0xa001;

      }

      else

      {

        wCrcValue >> =  1;

      }

    }

    pAddress++;

  }

  return wCrcValue;

}
```

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