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SIEMENS

SIMATIC TIWAY 1

TI505 Network Interface Module

User Manual

Order Number: PPX:TIWAY–8124–2
Manual Assembly Number: 2587871–0053
Second Edition

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Preface

MANUAL OVERVIEW

This manual contains the information necessary to install and operate the SIMATIC® TI505™ Network Interface Module (NIM). The following information is provided.

- NIM specifications
- Installation and testing procedures
- Operating instructions and descriptions
- SIMATIC® TIWAY™ I primitive descriptions and examples

MANUAL ORGANIZATION

This manual is organized as follows:

- CHAPTER 1 — TIWAY I OVERVIEW contains an overview of the TIWAY I network and an explanation of how the TI505 NIM operates within this network.
- CHAPTER 2 — NETWORK DESIGN CONSIDERATIONS describes possible network design configurations, and the use of modems with TIWAY I. Local Line cabling, biasing, and termination are also discussed.
- CHAPTER 3 — INSTALLATION describes NIM installation and diagnostic procedures.
- CHAPTER 4 — NIM PRIMITIVES describes NIM operation and the primitive subset supported by the NIM.
- APPENDIX A — SIMATIC® PM550™ CIM REQUIREMENTS contains procedures for Local Line biasing and termination for networks that contain a mixture of TI505 NIMs and PM550 Computer Interface Modules (CIM).
- APPENDIX B — NETWORK CONFIGURATION DATA SHEET contains a form that will help you plan your network.
- APPENDIX C — NETWORK EVALUATION FORM contains a TIWAY network evaluation form. You can submit the completed form to Siemens for a network evaluation.

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- APPENDIX D — SPECIFICATIONS provides general specifications for the TI505 NIM
- APPENDIX E — PRIMITIVE EXAMPLES provides a simple primitive example in normal and extended addressing modes.

RELATED PUBLICATIONS

The following publications contain additional information on TIWAY I and TIWAY I compatible products. To order these publications, contact your Siemens Industrial Automation, Inc. distributor or sales office. If you need assistance in contacting your distributor or sales office in the United States, call 1–800–964–4114.

	Siemens Manual Number
SIMATIC TIWAY I Host Adapter User Manual	PPX:TIWAY–8102
SIMATIC TIWAY I Host Software Programming Manual	
for DEC™ PDP™–11	PPX:TIWAY–8107
for TI® and IBM® Personal Computers	PPX:TIWAY–8108
for DEC™ VAX™ UNILINK™	PPX:TIWAY–8123
PM550 Network Interface Module User Manual	PPX:550–8110
SIMATIC® 5TI™ Network Interface Module User Manual	PPX:5TI–8105
SIMATIC® UNILINK™ Host Adapter User Manual	PPX:TIWAY–8121
SIMATIC® TIWAY I TI500™ NIM User Manual	PPX:TIWAY–8110

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Chapter 1
TIWAY 1 Overview

1.1 TIWAY I FEATURES

TIWAY I is an industrial Local Area Network (LAN) designed to satisfy today's factory and plant requirements for data acquisition and control of manufacturing processes. It is a significant enhancement of the Siemens "Local Line," which supports the PM550 Programmable Controllers (P/Cs) and DS 990 computer products.

The TIWAY I network provides a reliable and flexible communication architecture. Two communication media options are available:

- RS-232-C/423 — provides modem interface for large geographic coverage.
- Local Line — provides high noise immunity for networks up to 25,000 feet (7620 meters).

Throughout this manual, the following networking terms are used.

- HDLC — TIWAY I High-level Data Link Control data communications procedures with CRC–16 error-checking and message-length error-checking
- Primary — HDLC network manager (TIWAY I Host Adapter, TIWAY I Gateway, or UNILINK Host Adapter with the Network Manager function)
- Secondary — device operating as an HDLC secondary slave (NIMs, UNILINK Secondary Adapters, UNILINK Host Adapter acting as a Secondary)
- Attached device — P/C, robot, etc. (a P/C connected to the NIM, robot connected to a UNILINK Secondary Adapter)
- Host — computer or intelligent device establishing network communications.

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1.1 TIWAY I OPTIONS

TIWAY I network products provide a number of options.

- TIWAY I networks can be configured for short distances or a long distances.
- Redundant or single media transmission is available.
- Baud rates from 110 baud to 115.2K baud are available.
- TIWAY I devices can operate with modems in either full or half duplex mode, synchronously or asynchronously.
- Both NRZ and NRZI data encoding are available.

1.2 SYSTEM BLOCK DIAGRAM

Figure 1Figure 1 illustrates the basic system block diagram of a TIWAY I Network. System components include:

- Host System Interfaces (including Host Adapters, Gateways, and Network Control Modules)
- Siemens Programmable Controller Network Interface Modules (NIMs)
- UNILINK Secondary Adapters for interfacing non-Siemens products to the TIWAY I Network

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1.3 TIWAY I UNIVERSAL COMMAND LANGUAGE, UCL

TIWAY I provides a Universal Command Language for all communication on the network. The UCL consists of a set of high-level request/response transactions known as Primitives. Primitives are used for:

- Reading and writing data
- Acquiring status of devices attached to the network
- Performing control operations on attached devices

The Host issues requests (Primitives) to the NIMs and Secondary Adapters. The secondaries then perform the requested operations on the attached devices and return the appropriate response to the Host to complete the transaction. See Figure 1.

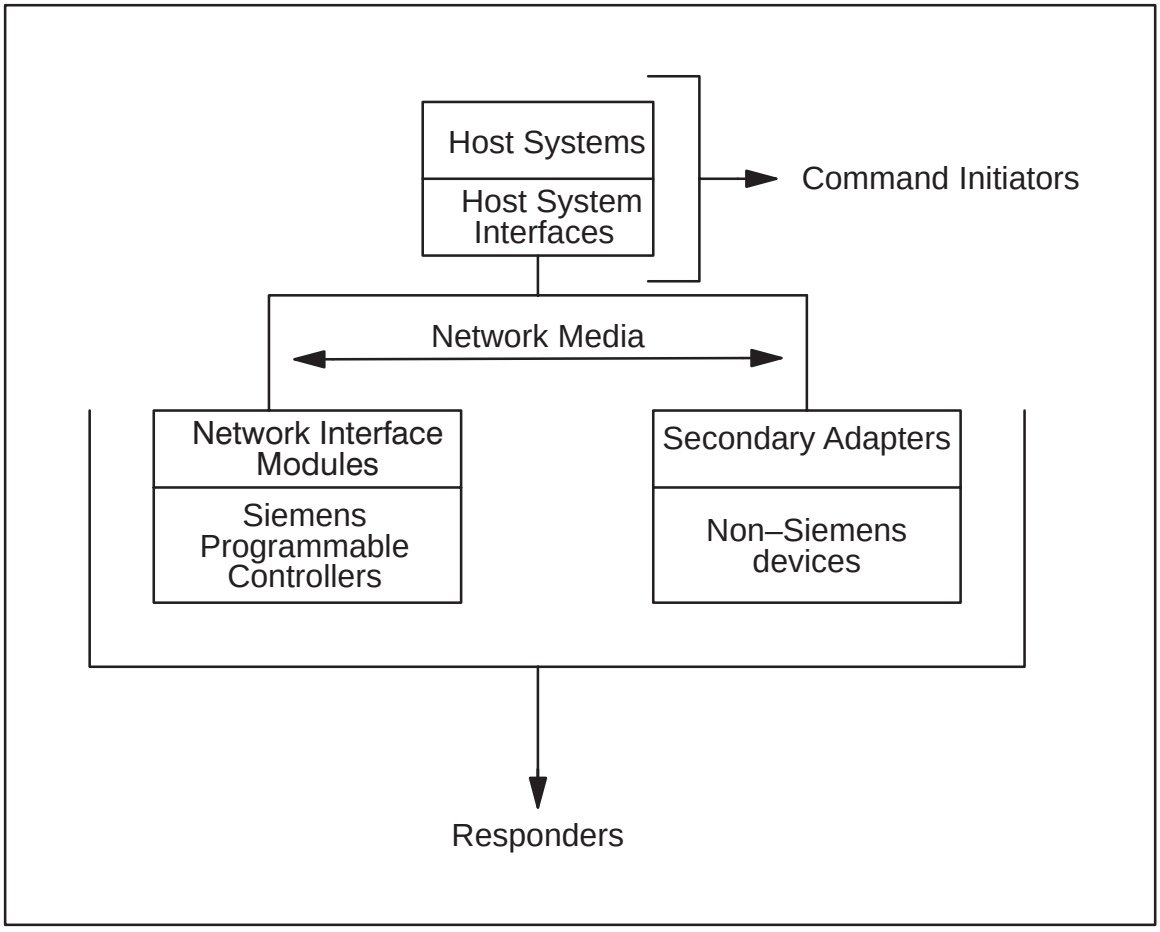


Figure 1 TIWAY I System Block Diagram

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1.4 THE TI505 NIM

The TI505 NIM is the TIWAY I Network Interface Module for the SIMATIC TI505 Programmable Controllers. See Chapter 3 for a specific listing of controllers supported by the TI505 NIM.

The TI505 NIM provides several features which ensure maximum network signal integrity.

- Each communication port is provided with a "Jabberstop" circuit to disable the port's transmitter in the event of a communication port failure. This helps minimize failures resulting in continuous network transmission which would dominate the communication channel.
- The NIM provides data integrity checking of network communications.
- The NIM meets several stringent noise and environmental specifications.
- Built-in diagnostics aid in troubleshooting NIM failures and problems. Chapter 3 provides a description of the diagnostics.

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The TI505 NIM provides redundant TIWAY I communication ports. Each of the following models supports a specific type of network communication media.

PPX: Number	Port A	Port B
PPX:505−7339	Local Line	Local Line
PPX:505−7340	RS-232-C/423	RS-232-C/423

The RS-232-C/423 media interface is configured as Data Terminal Equipment (DTE) and is used to connect the NIM to Data Communication Equipment (DCE) for operation with modems. This interface uses RS-423 drivers and receivers and operates at RS-423-A signal levels (+5 or –5 volts). These levels are also RS-232-C compatible. The pin assignments for the RS-232-C port are given in Chapter 2.

The Local Line interface is a differential line port for use with shielded twisted pair cable. The Local Line interface provides line isolation and high noise immunity for installations up to 10,000 feet (25,000 feet depending on system loading and baud rate selection). The Local Line interface is recommended for applications where electrical noise may be a problem.

Redundancy is supported for either choice of media.

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Figure 2 is a simplified block diagram of the TI505 NIM. The media interface blocks are intentionally left unlabeled because the type of media interface depends on which NIM model you are using. The blocks are described as follows.

- Special Function Interface Controller (SFIC) — delivers and receives P/C communications.
- NIM controller — translates the communication (between Primitives and the P/C communication language).
- Communications controller — supervises data transactions between the NIM and the network host.

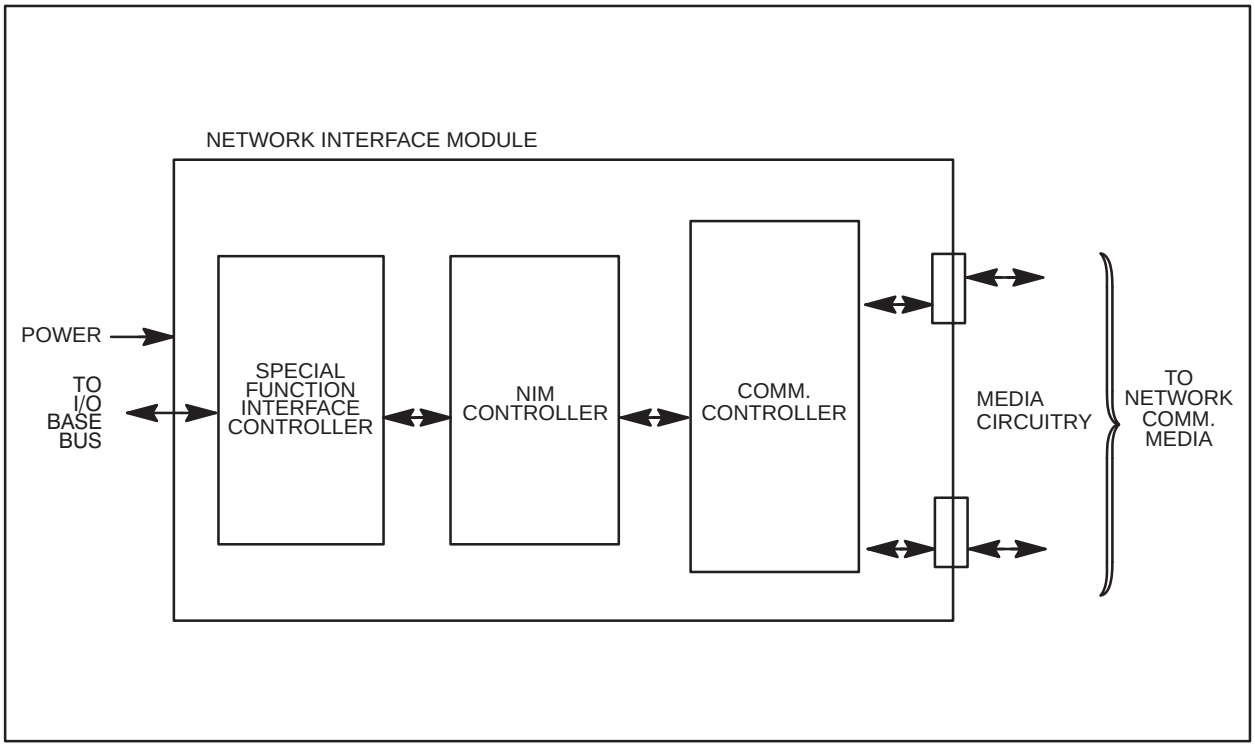


Figure 2 NIM Simplified Block Diagram

The basic difference in the NIM models is the configuration of the media circuitry.

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Chapter 2

Network Design Considerations

2.1 TIWAY I NETWORK CONFIGURATION

TIWAY I is a multi-drop communication network which consists of a main trunk cable (the “spine”) and dropline cables. The network can connect up to 254 secondaries (e.g., TI505 P/Cs) to a host computer. The TI505 NIM provides the interface to the network host, enabling the host and the P/C to communicate with each other.

Also included with this manual is a “TIWAY I Network Configuration Data Sheet” (Appendix B). This will assist you in maintaining a complete, up-to-date record of the configuration of your network, which is especially important if you are using several different types of secondaries.

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2.1.1 Communication Media

The following signal-transmission media are supported by TIWAY I:

- RS-232-C/423 dedicated lease-line modem interface in which no dial-up is necessary, providing extended (cross-continental) geographic coverage.
- RF or short-haul modem link-ups (cross-plant or cross-town coverage).
- Siemens Local Line (up to 25,000 feet).

NOTE

TIWAY I does not directly support dial-up modems which require Modem Control Commands for communication switchover. This can be done, but specific equipment is required to dial the remote number from the host device.

You can select from either type of media for the network, but you cannot mix the types of media.

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The selection of the network communication media depends primarily on the geographic distance to be spanned. The main TIWAY I trunk can be up to 10,000 feet long (25,000 feet depending on system loading and baud rate selection), and can have up to 254 droplines. Each dropline can be up to 100 feet long. For distances exceeding 25,000 feet, RS-232-C/423 media interfaces and modems should be used.

NOTE

The proper installation of your communication media requires careful planning and design. If you need assistance, a site survey is available from Siemens Industrial Automation, Inc. Simply fill out and return the enclosed "TIWAY I Network Evaluation Form", (Appendix C).

2.1.2 Media Redundancy

Media redundancy is supported for RS-232-C and Local Line NIMs. This means you can have backup communication media, in case of unforeseen cable problems or accidents. In order to achieve true redundancy, you must have *completely* redundant network media (network trunk lines, tap housings, drop lines, and modems). For example, if you need Local Line cable redundancy, you will need one PPX:505–7339 TI505 NIM, two separate twisted pair trunk (spine) cables, and a T-Tap and dropline for each port on the NIM.

The primary reason for using media redundancy is to permit communications on an alternate channel when the main channel fails. The redundant media connection does not allow two independent networks to communicate with the same NIM.

The NIM will respond over the same channel that received the network command. For example, if the Host sends the command to Port A, the NIM will respond through Port A.

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2.2 RS-232-C CABLE INSTALLATION

The physical layer in TIWAY I provides a modem interface for synchronous or asynchronous modems at data transmission rates up to 115.2K bits per second.

2.2.1 RS-232-C Connections

The modem interface provides standard signals, as defined in Table 2Table 3 for control of two-way alternate data transmission using both half and full duplex modems.The modem interface is a standard “Type E” DTE configuration as defined in Section 5 of EIA RS-232-C. This interface uses a male (plug) 25-pin D-type connector on the communication cable. The circuits and pin assignments for the RS-232-C connector are shown in Table 3.

Table 3 RS-232-C Connections

Pin	ISO#	RS-232-C Name – Function
1	101	AA – Protective Ground (chassis)
2	103	BA – Transmitted Data
3	104	BB – Received Data
4	105	CA – Request to Send (RTS)
5	106	CB – Clear to Send (CTS)
6	107	CC – Data Set Ready (DSR)
7	102	AB – Signal Ground
8	109	CF – Received Line Signal Detector/ Data Carrier Detect (RLSD/DCD)
15	114	DB – Transmitter Signal Element Timing
17	115	DD – Receiver Signal Element Timing
20	108/2	CD – Data Terminal Ready (DTR)

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2.2.2 RS-232-C Timing Considerations

If you use the TI505 NIM with a dedicated short-haul RF modem, the NIM has a one-second time-out between the transmission of its RS-232-C Request to Send (RTS) and the RS-232-C Clear to Send (CTS) response.

This time-out value is set at one second to enable the RF device to switch from receive to transmit without losing access to the transmission media.

NOTE

This extended time-out feature is an important consideration when selecting a TIWAY I-compatible RF Modem. Transmitter/Receiver turnaround time must be less than the one second network time-out.

An additional half-second delay from Clear to Send (CTS) to start of transmission can be added by setting the Keydelay Switch to the open position. (Chapter 3 provides additional information concerning dipswitch settings.) This may be required to allow the transmitter to reach full power before start of transmission. There is also a one-second wait period for DCD to turn off in a half duplex modem.

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2.3 LOCAL LINE CABLE INSTALLATION

The following paragraphs describe Local Line characteristics and installation guidelines.

2.3.1 Local Line Characteristics

The TIWAY I Local Line is a physical signaling technique (baseband, differential current drive) which operates over shielded, twisted-pair cabling. The Local Line cable may be up to 25,000 feet long, depending on loading and baud rate selection. It uses tap housings to simplify the addition of network connections. The Local Line is designed to operate with shielded, twisted-pair cable which has a characteristic impedance of 124 ohms.

Taps and 9-pin connectors are supplied with the Local Line, but extras may be necessary for cable splicing. Suggested cable routing procedures are provided later in this chapter.

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The interface cable should have a male, 9-pin D-type receptacle with pin assignments as shown in Table 4.

Table 4 Pin Assignments for Local Line Connectors

Pin	Name	Description
1		No connection
2		No connection
3	Shield	Cable shield and signal common
4		No connection
5		No connection
6	LLM+	Positive biased signal line
7		No connection
8		No connection
9	LLM–	Negative biased signal line

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2.3.2 Local Line Cable

The TIWAY I local line network cable consists of a main cable or spine with droplines or taps for each Secondary. Interrelated network variables having direct influence on network performance are:

- Maximum trunk cable length
- Cable type
- Tap length
- Tap spacing
- Number of secondaries
- Maximum baud rates

Siemens recommends Belden® 9860 twisted pair cabling, or its equivalent, for use as the Local Line network spine. Belden 9271, or its equivalent, should be used for the dropline. Brands other than those listed here will be specified by Siemens on request.

CAUTION

All local and national electrical codes and fire codes should be observed when installing wiring.

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Figure 1 illustrates the relationship of cable distance to the number of secondaries for different baud rates for two types of twisted pair cable. Note that the cable distance (in thousands of feet) is shown vertically; the maximum number of units that may be attached is shown horizontally.

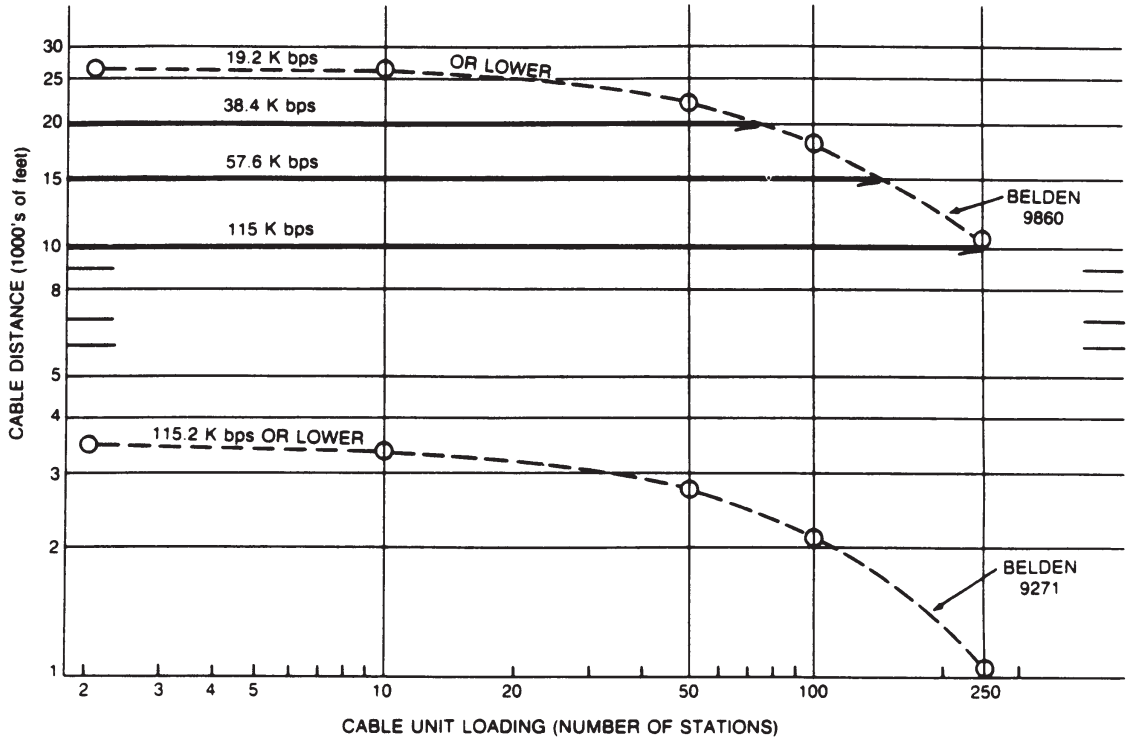


Figure 1 Number of Local Line Secondaries versus Cable Length

As shown in Figure 2Figure 1, when you use Belden 9860 cable (or its equivalent), up to 75 stations can be attached to a network operating at 38K bps and having a spine length of 20,000 feet. At 115.2K bps, the maximum length of a Local Line network having 254 stations is 10,000 feet.

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2.3.3 Local Line Tap Housings

The tap housing, shown in Figure 2, is made by Siemens specifically for its Local Line network. The tap housing can be mounted rigidly to a NEMA panel or other enclosure. It can also be used to splice cables in a cable tray without being rigidly mounted. The tap housing not only allows an orderly connection to the TIWAY I network, but also contains terminating resistors, resists moisture, relieves strain, and provides noise isolation for attached cabling.

Tap housings are included for each Local Line port; however, extras may be ordered from your Applications Engineering Distributor or from Siemens. Order PPX:500–5606.

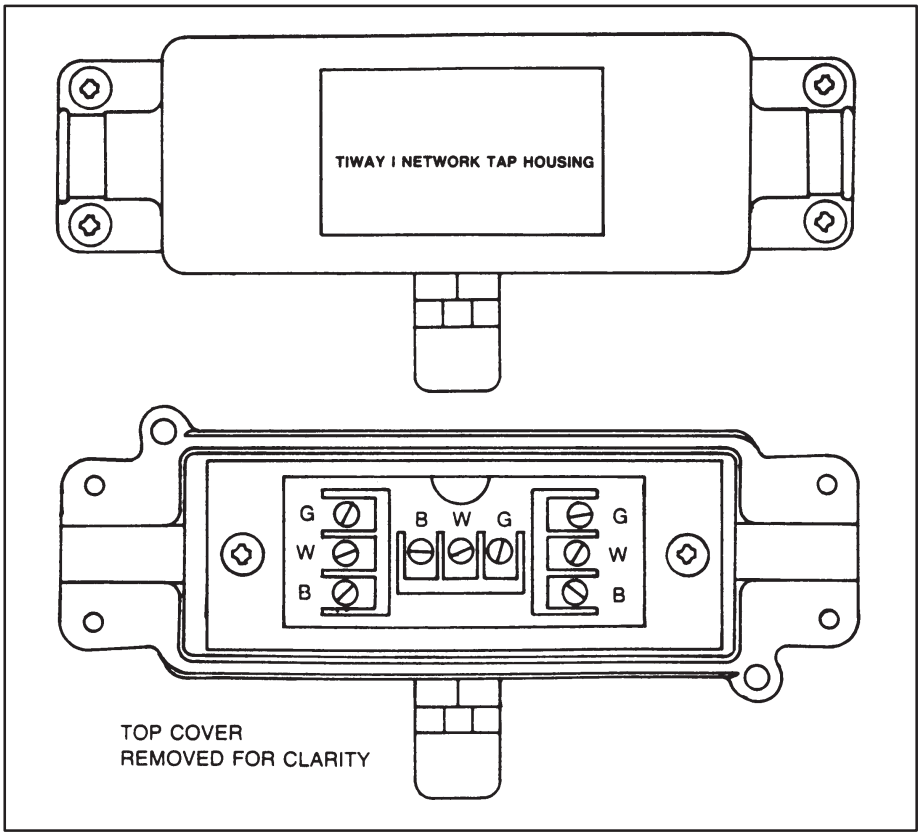


Figure 2 TIWAY I Tap Housing

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With the cover removed from the PPX:500–5606 Tap Housing, note that there are three sets of terminals, and that each set is labeled G (Ground), W (White), and B (Blue). (See Figure 2Figure 2.) One set of these terminals is for the incoming Local Line twisted pair; the center set is for the drop line; and the remaining set is used to connect the Local Line to the following node, or to terminate the Local Line if the tap housing is the last one on the network trunk.

For consistency in installation, always connect the LLM+ (Pin 6 of the Local Line Connector) to the white strand of the twisted pair and to the terminal marked “W” in the tap housing. Connect the blue strand to the LLM– (Pin 9 of the Local Line Connector) and to the terminal marked “B” in the tap housing. The Cable Shield and Signal Common should be connected to Pin 3 of the Local Line connector and to terminal “G” inside the tap housing.

NOTE

All Siemens tap housings contain factory-installed termination resistors. If the tap housing is not used to terminate the Local Line, the terminating resistors must be removed when the output cable is attached.

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2.3.4 Planning Considerations

Some major points to consider during the planning phase of a Local Line network are as follows:

- From the start, allow for system growth. This means making provisions for the attachment of additional computing devices by routing cables through all probable areas of future plant expansion.
- Always make the network flexible enough to allow for re-arrangement of plant equipment.
- Since network system noise is usually picked up by the interconnecting wiring, try to avoid routing the communization wiring near noise sources such as large motor starters, high current switches, and transformers.
- If cable redundancy is desired, the two cables should never be routed along the same path, since the environmental or other factors which disable one cable will very likely disable the second.
- A detailed record of design and routing should be created and maintained. This record should be complete enough to enable a user to trace and physically locate all cable paths and hardware components.

2.3.5 Local Line Tap Spacing

To calculate the minimum distance between tap nodes, use the length of the dropline at the last tap node. A tap node consists of either a single tap on the TIWAY I trunk cable or a pair of taps separated by less than the minimum tap node separation distance. The minimum distance between a given tap node and the next tap node on the network is equal to one-half the length of the longer drop line at the given node.

No limit is placed on the number of NIMs that can be daisy-chained to form a drop line off the main trunk as long as the resulting drop length is no greater than 100 feet. Figure 3 illustrates three typical examples of tap spacing.

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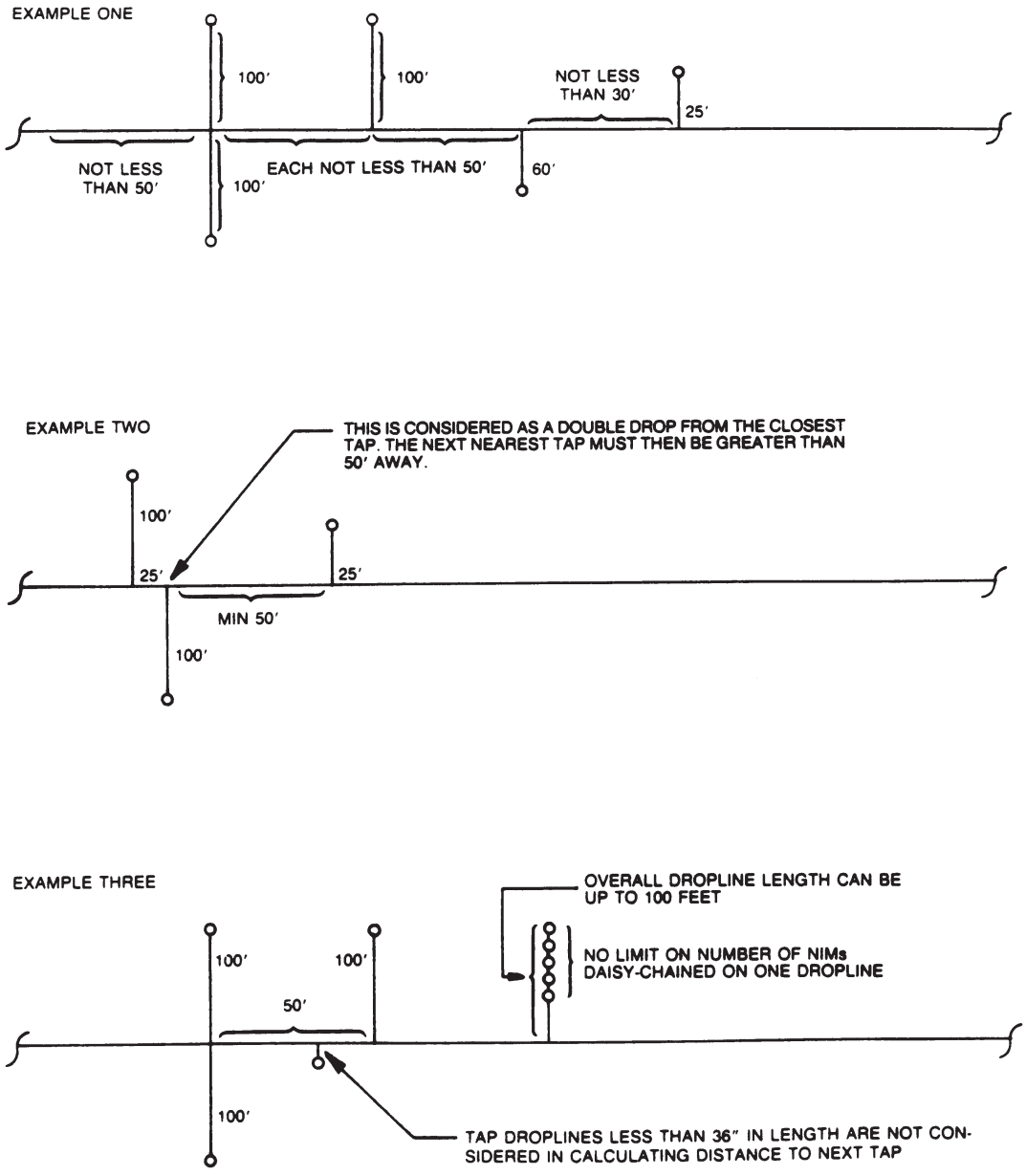


Figure 3 Tap Spacing Examples

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2.3.6 Cable Routing

Cable routing should be planned as if the path between all stations on the network were free of obstructions. Next, modify the first routing to account for obstructions, then calculate the amount of cable needed.

CAUTION

All local and national electrical codes and fire codes should be observed when installing wiring.

In general, there are three types of network cabling routes:

- Under-floor
- In-ceiling
- Surface ducting

Any choice of these three routes may be used on a single network. The choice is often determined by whether the building (or buildings) in which the network is being installed is new construction, or is an existing building. The following paragraphs describe some of the advantages and disadvantages of each type of cable routing.

2.3.6.1 Under-floor Routing

For under-floor routing, the cable can be enclosed within ducts or, with raised flooring, in the “open air.” Under-floor systems enclosed in ducts are usually expensive, and while they are better-protected against unauthorized taps than are “open air” systems, they often make future expansion of the network more difficult and expensive.

“Open air” under-floor cabling systems usually provide good access and allow maximum network expansion and flexibility.

2.3.6.2 In-ceiling Routing

For in-ceiling routing, network cables are usually supported in troughs or with hooks and clamps every 10 or 15 feet. In-ceiling installations provide flexibility, usually cost less, and provide easy access.

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In-ceiling cable networks are not always practical. In-ceiling installations can be difficult and sometimes dangerous in areas without drop ceilings (or that have unusually high ceilings). Also, closed ceiling systems usually trap dust and other debris, which makes cable maintenance difficult.

2.3.6.3 Surface Duct Routing

Surface ducting for network cabling is usually installed along the baseboards or is attached to walls at desktop height. While surface ducting protects cables from both physical and EMI effects, it may also require that network computing devices be positioned near a wall.

2.3.7 Obstructions

Aside from physical obstructions such as posts, walls, and partitions, electrical interference should also be avoided.

In general, network cabling should never come into direct contact with any electrical conductor, and if cabling is installed inside a conduit, the conduit should be grounded in accordance with applicable electrical codes. Keep at least three feet between all network cabling and the following:

- Power lines carrying 440 volts or greater
- Generators
- Electric motors
- Transformers
- Electric welders
- Induction furnaces and heaters
- Rectifiers
- All sources of microwave radiation
- Fluorescent lighting
- Teletypes

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2.4 LOCAL LINE BIASING

In certain network configurations, the Local Line must be biased to raise its noise immunity and to prevent oscillations of receivers connected to the line.

The need to apply a bias voltage to the Local Line depends on the interface configuration of your network.

2.4.1 Biasing Configurations

It is very likely that you will have a mixture of TI505, SIMATIC TI500, and PM550 P/Cs on your network. Three different Local Line media biasing combinations exist, based on the number and type of interface devices used with the P/Cs. Possible combinations are

- Installations consisting solely of self-biased devices.
- Installations consisting of both switch-biased and self-biased devices. (Some older TIWAY I devices have Bias Switches.)
- Installations with PM550 CIMs.

This section covers self-biased and switch-biased configurations only. (All TI505 NIMs are self-biasing.) Appendix A discusses biasing and terminating a Local Line having all three types of devices.

CAUTION

If a switch-biased Local Line interface port is unused (i.e., in a case where no redundant Local Line is installed) the Bias Switch on the unused port must be turned ON to prevent the entry of spurious noise into the NIM.

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2.4.2 Networks with only Self-biased Devices

This configuration exists when all TIWAY I Devices on the network are self-biasing (i.e., they do not have a Bias Switch.) In this case, the position on the line of the interface devices does not matter.

2.4.3 Networks with a Single Switch-biased Device

This configuration exists when only one TIWAY I Device on the Local Line has the Bias Switch, and all other devices are self-biasing. The position of the switch-biased device on the line does not matter, but its Bias Switch must be on.

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2.4.4 Networks with Two or More Switch-biased Devices

This configuration exists when multiple switch-biased TIWAY I Devices are attached to the network, and they should be positioned as described in the following paragraphs.

If two or more devices having the Bias Switch are attached, place one at each end of the Local Line, and turn on each Bias Switch.

All other devices having a Bias Switch can then be placed anywhere on the network, with the Bias Switches turned off for the port being used. See Figure 4.

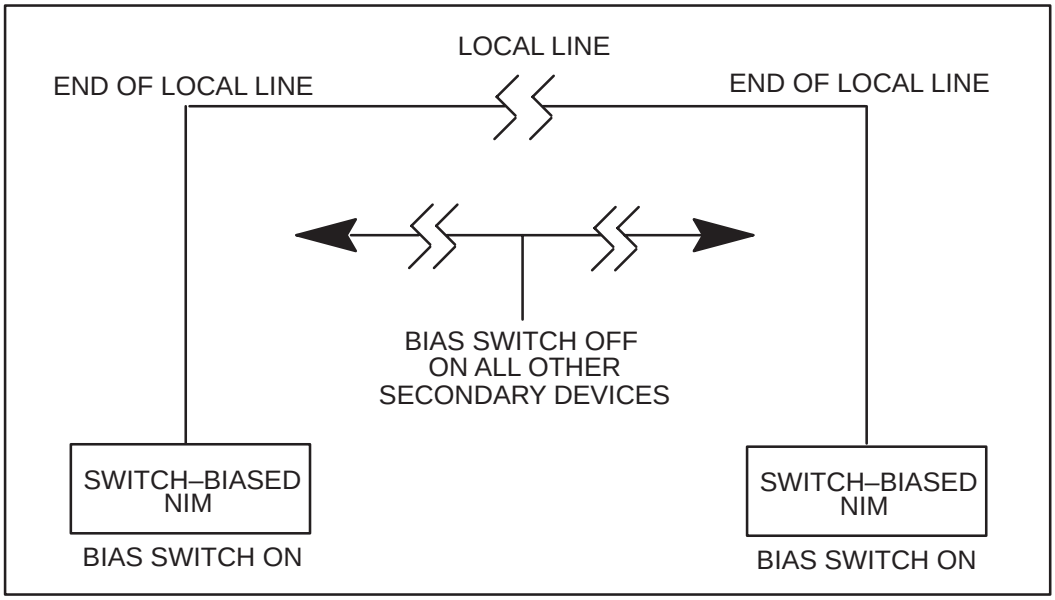


Figure 4 Local Line with Two or More Switch-biased NIMs

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2.4.5 Terminating the Local Line

The TIWAY I Local Line is designed to operate with shielded, twisted-pair cable which has a characteristic impedance of 124 ohms. In all configurations, the Local Line must be properly terminated at both ends of the trunk to prevent an impedance mismatch which could result in signal reflections on the line. Termination is required regardless of the number or type of devices attached to the network.

NOTE

In the special case of a PM550 using a CIM as its interface to the network, see Appendix A for detailed line biasing and termination instructions, which vary from those listed here.

Termination of the Local Line must be at the tap housings at the extreme ends of the network spine, and is accomplished as follows:

1. The factory-installed termination resistors in the tap housing (see Figure 5) are left in place in the tap housing which is to be used to terminate the Local Line.
2. If the termination resistors are used and the attached TIWAY I device has a Bias Switch, the Bias Switch should be set to the ON position.

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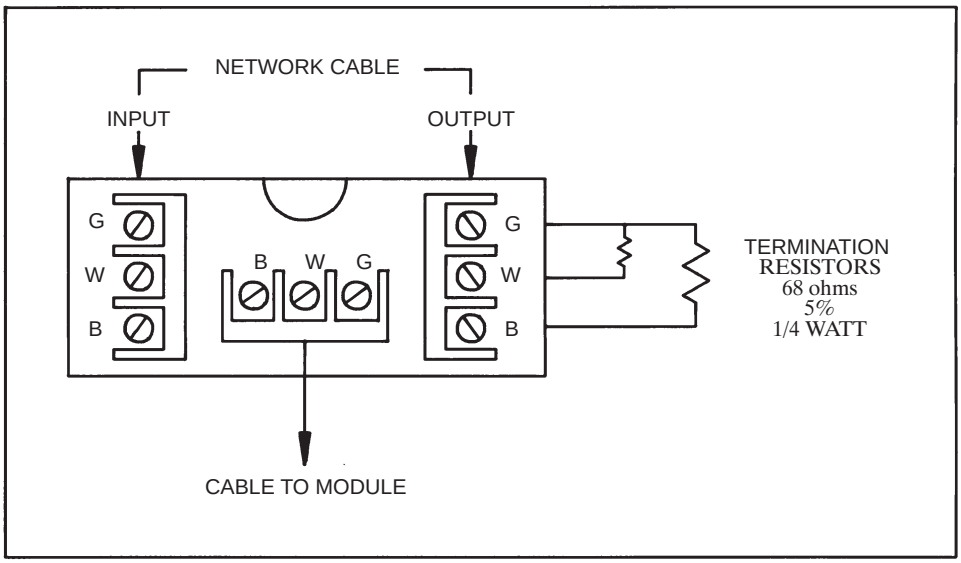


Figure 5 Terminating the Local Line

NOTE

All Siemens tap housings contain factory-installed terminating resistors. If the tap housing is not used to terminate the Local Line, the terminating resistors must be removed when the output cable is attached.

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Chapter 3
Installation

3.1 GENERAL REQUIREMENTS

The following requirements must be met in order to install and use a TI505 NIM:

1. The appropriate NIM should be selected.
   - PPX:505–7339 (Redundant Local Line)
   - PPX:505–7340 (Redundant RS-232-C)
2. The TI505 NIM must be used with a model SIMATIC® TI525™ or SIMATIC® TI535™ P/C. For full NIM capabilities, the P/C software release level should be greater than (or equal to) the following releases.

   TI525 Release 2.2
   TI535 Release 1.0

   If you cannot determine whether your P/C release is compatible with the TI505 NIM, contact your Siemens Industrial Automation, Inc. distributor or sales office for assistance. If you need assistance in contacting your distributor or sales office in the United States, call 1–800–964–4114.
3. The communication configurations of all devices attached to the network must match; i.e., they should each have the same data rate, encoding, etc.
4. Calculate the I/O base power budget to make sure that there is enough power to operate all the modules installed in the base. Table 1 provides the power requirements for all currently available TI505 I/O modules.

NOTE

If you are not going to install your NIM immediately, store it in an antistatic bag until you are ready for installation.

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Table 1 TI505 Component Power Requirements

	Power Available (in watts)	
	+5 V	–5 V
PPX:505–6660 Power Supply	55	3.75

PPX: Number	Description	DC Power Required (in watts)	
		+5 V	–5 V
PPX:505–6830	IOCC	5.0	0.1
PPX:505–6840	Distributed Base Controller	5.0	0.1
PPX:505–4008	24 VAC Input (8 point)	2.0	—
PPX:505–4016	24 VAC Input (16 point)	2.0	—
PPX:505–4032	24 VAC Input (32 point)	2.0	—
PPX:505–4108	LVDC/TTL Input (8 point)	2.0	—
PPX:505–4116	LVDC/TTL Input (16 point)	2.0	—
PPX:505–4132	LVDC/TTL Input (32 point)	2.0	—
PPX:505–4208	110 VAC Input (8 point)	2.0	—
PPX:505–4216	110 VAC Input (16 point)	2.0	—
PPX:505–4232	110 VAC Input (32 point)	2.0	—
PPX:505–4308	24 VDC Input (8 point)	2.0	—
PPX:505–4316	24 VDC Input (16 point)	2.0	—
PPX:505–4332	24 VDC Input (32 point)	2.0	—
PPX:505–4408	220 VAC Input (8 point)	2.0	—
PPX:505–4416	220 VAC Input (16 point)	2.0	—
PPX:505–4432	220 VAC Input (32 point)	2.0	—

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Table 1 TI505 Component Power Requirements (Continued)

PPX: Number	Description	DC Power Required (in watts)	
		+5 V	–5 V
PPX:505–4508	24 VDC Output (8 point)	2.5	—
PPX:505–4516	24 VDC Output (16 point)	2.5	—
PPX:505–4532	24 VDC Output (32 point)	2.5	—
PPX:505–4608	110 VAC Output (8 point)	2.5	—
PPX:505–4616	110 VAC Output (16 point)	2.5	—
PPX:505–4632	110 VAC Output (32 point)	2.5	—
PPX:505–4708	24 VDC Output (8 point)	5.0	—
PPX:505–4716	24 VDC Output (16 point)	5.0	—
PPX:505–4732	24 VDC Output (32 point)	5.0	—
PPX:505–4808	220 VAC Output (8 point)	5.0	—
PPX:505–4816	220 VAC Output (16 point)	5.0	—
PPX:505–4832	220 VAC Output (32 point)	5.0	—
PPX:505–4908	Relay Output Form C (8 point)	2.5	—
PPX:505–4916	Relay Output Form A (16 point)	2.5	—
PPX:505–4932	Relay Output Form A (32 point)	2.5	—
PPX:505–6010	Input Simulator	2.0	—
PPX:505–6011	Output Simulator	2.5	—
PPX:505–6108	Analog Input	4.0	—
PPX:505–6202	Analog Output (2 point)	2.5	—
PPX:505–6204	Analog Output (4 point)	5.0	—
PPX:505–6208	Analog Output (8 point)	5.0	—
PPX:505–6308	Word Input	4.0	—
PPX:505–6408	Word Output	5.0	—
PPX:505–7339	Local Line Network Interface	8.0	—
PPX:505–7340	RS-232–C Network Interface	8.0	0.250

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3.2 INSTALLING THE NIM

To place a NIM into your TI505 system, you have to select the NIM communication parameters, install the NIM in the TI505 I/O base, connect the communication cables to the NIM, and initialize the system for operation. The Programmable Controller (P/C) and the programming device should be in place before you install a NIM.

WARNING

Do not insert or remove the NIM while power is applied to the P/C system, since doing this may cause personal injury, alter P/C memory, cause a P/C fatal error, or damage the module.

The following steps summarize the NIM installation.

1. Disconnect power to the P/C system (I/O base, power supply, etc.).
2. Set the configuration dipswitches and LOCAL/REMOTE switch.
3. Insert the module into the base and secure it with the bezel screws.
4. Power up the P/C system.
5. Use the NIM diagnostics and LED status indicators to be sure the module is operating correctly.
6. Use a programming device to verify that the NIM is logged into the P/C.
7. Connect the network cables to the NIM.

The following paragraphs provide detailed information for each step.

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3.3 SETTING THE DIPSWITCHES

As Figure 1 illustrates, there are two blocks of dipswitches on the TI505 NIM. The block of eight switches is the NIM Network Address Selection switch. The block of ten switches is the Network Configuration Parameters switch. Note that the switches are numbered from left to right (when the switches are facing you). When setting up your NIM, use the configuration data sheet in Appendix B of this manual to record important configuration information.

NOTE

The configuration and address switch settings are read only once following a power-up or reset. Be sure to reset the NIM following any change in dipswitch settings or P/C memory reconfiguration.

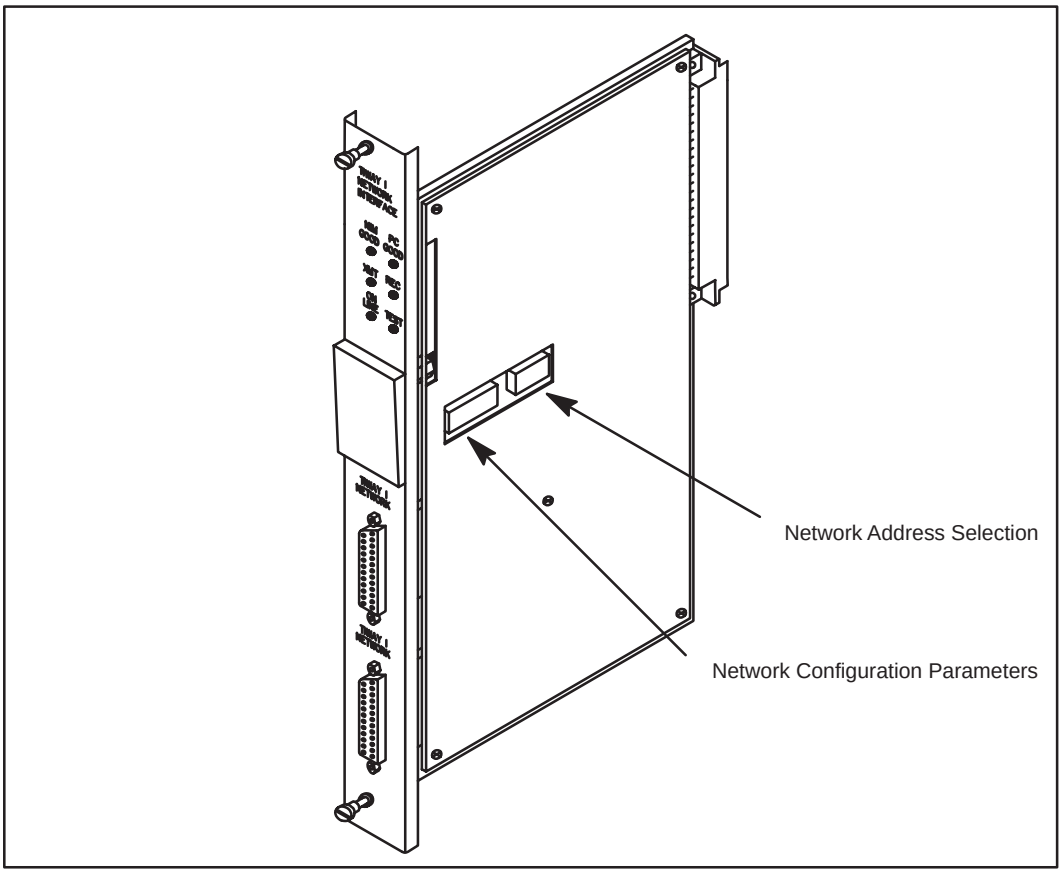


Figure 1 NIM Dipswitches

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Figure 2 provides a summary of the dipswitch settings. The following paragraphs provide detailed information about the parameters selected by each switch.

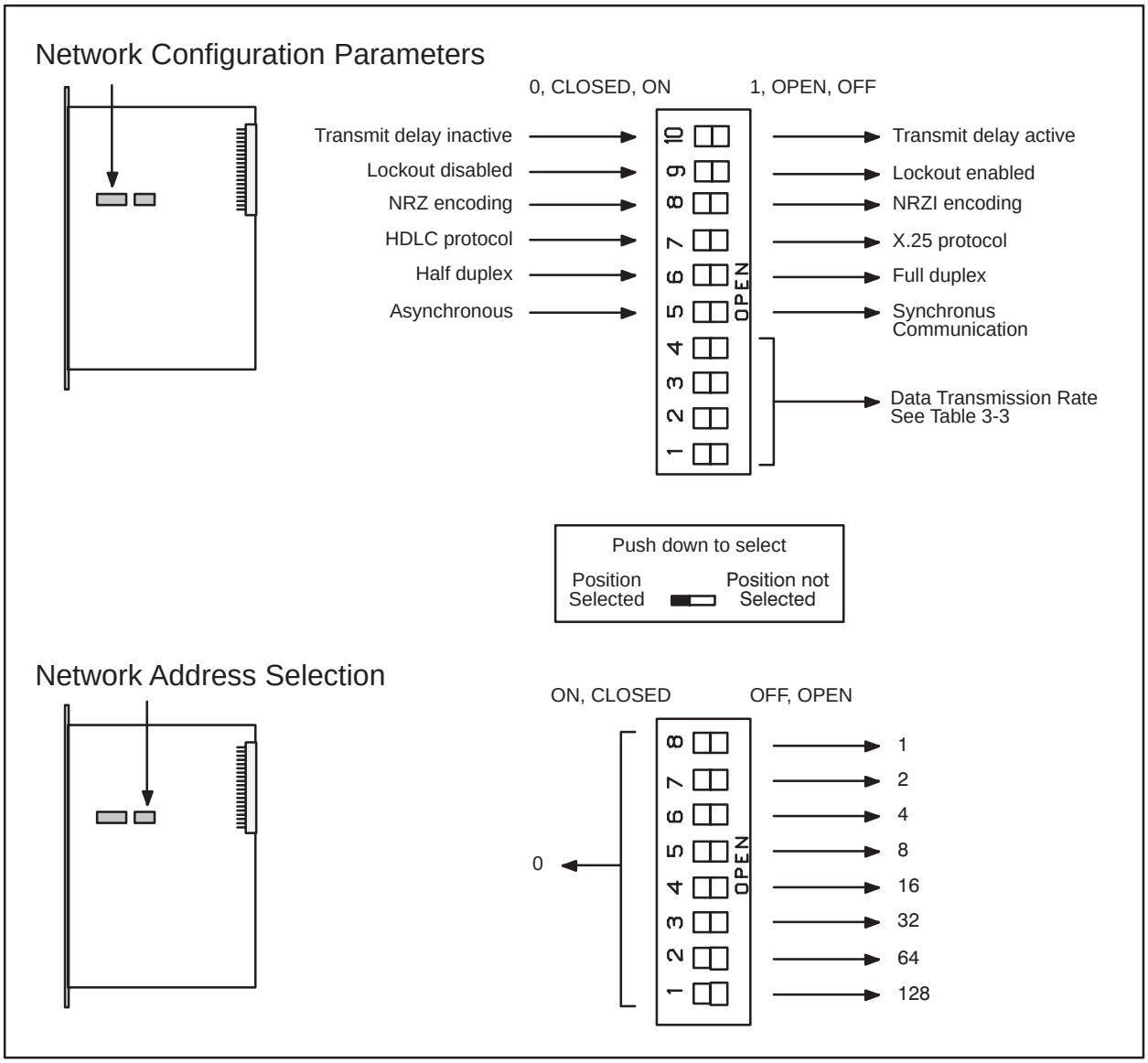


Figure 2 Dipswitch Summary

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3.3.1 Selecting the Network Address

Each TIWAY I Network Secondary must have a unique binary network address. The range of valid addresses is 1 to 254 (0000 0001 to 1111 1110 on switches 1–8 of the Network Address Selection dipswitch). Selecting addresses 0 or 255 (0000 0000 or 1111 1111) on the Network Address Selection dipswitch will cause the NIM to initialize in a test mode, and the NIM will fail to operate properly. See Table 2A for address values (bit weight) of each switch and Table 2B for addressing examples.

Table 2 Network Address Selection

Table 3–2A Bit Weight

		Open	Closed
LSB	SW8	1	0
	SW7	2	0
	SW6	4	0
	SW5	8	0
	SW4	16	0
	SW3	32	0
	SW2	64	0
MSB	SW1	128	0

Table 3–2B Address Examples

	1	25	203
SW8	Open	Open	Open
SW7	Closed	Closed	Open
SW6	Closed	Closed	Closed
SW5	Closed	Open	Open
SW4	Closed	Open	Closed
SW3	Closed	Closed	Closed
SW2	Closed	Closed	Open
SW1	Closed	Closed	Open

3.3.2 Selecting Network Configuration Parameters

The Network Configuration Parameters dipswitch is used to select the parameters that define the network communication environment. Several switches on the Network Configuration Parameters dipswitch are ignored during Local Line operation. These switches are noted in the following descriptions.

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3.3.2.1 Data Transmission Rate

Network Configuration Parameter switches 1 through 4 select the data transmission rate. All devices on the network must be configured to communicate at the same data rate. The data rates corresponding to the switch settings are shown in Table 3.

For synchronous operation in RS-232-C communication, the rate of data transmission is established by the modem. When setting switches one through four, select a data rate which matches that of the modem exactly. If this is not possible, select the next lower data rate below that of the modems. (See the paragraph on Synchronous/Asynchronous Selection.)

Table 3 Network Data Rate Switch Settings

SWITCH SETTINGS				DATA RATE (BPS)
SW1	SW2	SW3	SW4	
0	0	0	0	110
0	0	0	1	110
0	0	1	0	110
0	0	1	1	110
0	1	0	0	110
0	1	0	1	150
0	1	1	0	300
0	1	1	1	600
1	0	0	0	1200
1	0	0	1	2400
1	0	1	0	4800
1	0	1	1	9600
1	1	0	0	19,200
1	1	0	1	38,400
1	1	1	0	57,600
1	1	1	1	115,200

0 – closed = on
1 – open = off

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3.3.2.2 Synchronous / Asynchronous Selection

Network Configuration Parameter switch 5 selects synchronous or asynchronous operation for modems.

For synchronous modem communication, the NIM receives the transmit and receive timing signals from the modem via transmit signal timing element (DB), and receive signal timing element (DD). If the modem data rate does not match the TIWAY data rate exactly, the data rate select switches should be set to a rate that is the next lower data rate from the modem. For example, if a 56,000 bps synchronous modem is used, a data rate of 38,400 bps should be selected on the NIM. To select synchronous operation, set the switch to the open position (towards the bottom of the dipswitch).

For asynchronous operation, the transmit and receive timing elements are generated within the NIM.

Synchronous operation is not valid for Local Line operation. When you use the Local Line medium, this switch must be in the asynchronous position (towards the top of the dipswitch, closed, indicates asynchronous; towards the bottom of the dipswitch, open, is synchronous).

3.3.2.3 Full / Half Duplex

Network Configuration Parameter switch 6 selects full or half duplex operation when communicating over an RS-232-C data link. When half duplex is selected (switch 6 is, closed, towards the top of the dipswitch) the NIM waits for the Data Carrier Detect (DCD) control signal from the modem to go inactive before activating the Request To Send (RTS) control signal. If full duplex operation is selected, the timing relationship between DCD and RTS will be ignored.

When the Local Line communication media is used, this switch is ignored since no externally supplied communication control signals are supplied.

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3.3.2.4 X.25 / HDLC

Network Configuration Parameter switch 7 selects the communication protocol. The HDLC protocol is activated when the switch is closed, or positioned towards the top of the dipswitch. The X.25 protocol is only activated when this switch is set open, or positioned towards the bottom of the dipswitch. The X.25 protocol is not used with the TIWAY I or UNILINK Host Adapter, although it is an option when communicating with any Primary supporting this protocol.

3.3.2.5 NRZ / NRZI

Network Configuration Parameter switch 8 selects the method of data encoding used on the physical communication medium. The NRZI method of data encoding provides a mechanism for the proper decoding of received data in an asynchronous communication environment. In fact, NRZ encoding will not work satisfactorily except in the case of synchronous RS-232-C communication. When using Local Line, or asynchronous RS-232-C, NRZI encoding must be used. Either type of encoding may be used with synchronous RS-232-C communication. To select NRZI encoding, the switch should be open, or positioned towards the top of the dipswitch. To select NRZ encoding, the switch should be closed, or positioned towards the bottom of the dipswitch.

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3.3.2.6 Lockout / Enable

Network Configuration Parameter switch 9 enables the P/C to “lockout” the NIM during time-critical operations. This function is not needed normally. During lockout, the NIM will not communicate with the P/C. The actual mechanism is as follows:

1. The P/C “sees” the NIM as an 8 channel discrete output module on the I/O portion of the scan.
2. If the P/C is to “lockout” the NIM during a time critical scan, it can set the image register address that corresponds to the 8th output of the module. If switch 9 of the NIM is open (positioned towards the bottom of the dipswitch) the NIM will not communicate with the P/C as long as the 8th output is set.

   The TI505 P/Cs allow you to configure the specific I/O addresses. You have to configure the I/O before you can determine the lockout bit address. See your P/C manual for details on I/O configuration.
3. In your Relay Ladder Logic (RLL) program, re-enable NIM to P/C communication by turning the output off after the P/C is able to resume communication with the NIM.

3.3.2.7 Transmit Delay or Keydelay

Network Configuration Parameter switch 10 provides a delay of 500 milliseconds (following the receipt of Clear to Send (CTS) from a modem) before any data is transmitted. This delay may be required in radio modem installations to permit the transmitter to reach full power before transmitting data. This delay is activated when the key delay switch is set open (positioned towards the bottom of the dipswitch). This switch setting is ignored for Local Line operation.

If you are using a radio modem that requires time to reach full power and you do not set this switch to provide the delay, erratic operation may occur.

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3.4 INSERTING THE MODULE INTO THE BASE

It is advisable to install the NIM in the slot adjacent to the CPU (Central Processing Unit). This provides the following advantages.

- Easier access to switches and connectors
- Better LED indicator visibility
- Reduced electrical noise susceptibility

To avoid causing electrostatic damage to the Printed Circuit Board (PCB) components, do not touch the PCB while inserting the module into the base.

WARNING

To minimize the risk of personal injury or equipment damage, always disconnect all system power before removing or installing I/O modules.

Complete the following steps to install the module.

1. Disconnect power to the P/C system.
2. Position the module so that the front bezel is facing you. (See Figure 3.)
3. Hold the top and bottom of the bezel and carefully slide the module into the slot; pushing it all the way into the base. If you have inserted the module correctly, you will feel a slight increase in resistance as the module connects to the base plane connector.
4. Use a flat-head screwdriver to tighten the screws at the top and bottom of the bezel. The bezel screws ground the module to the base. Do not overtighten the screws.
5. Power-up the P/C system.

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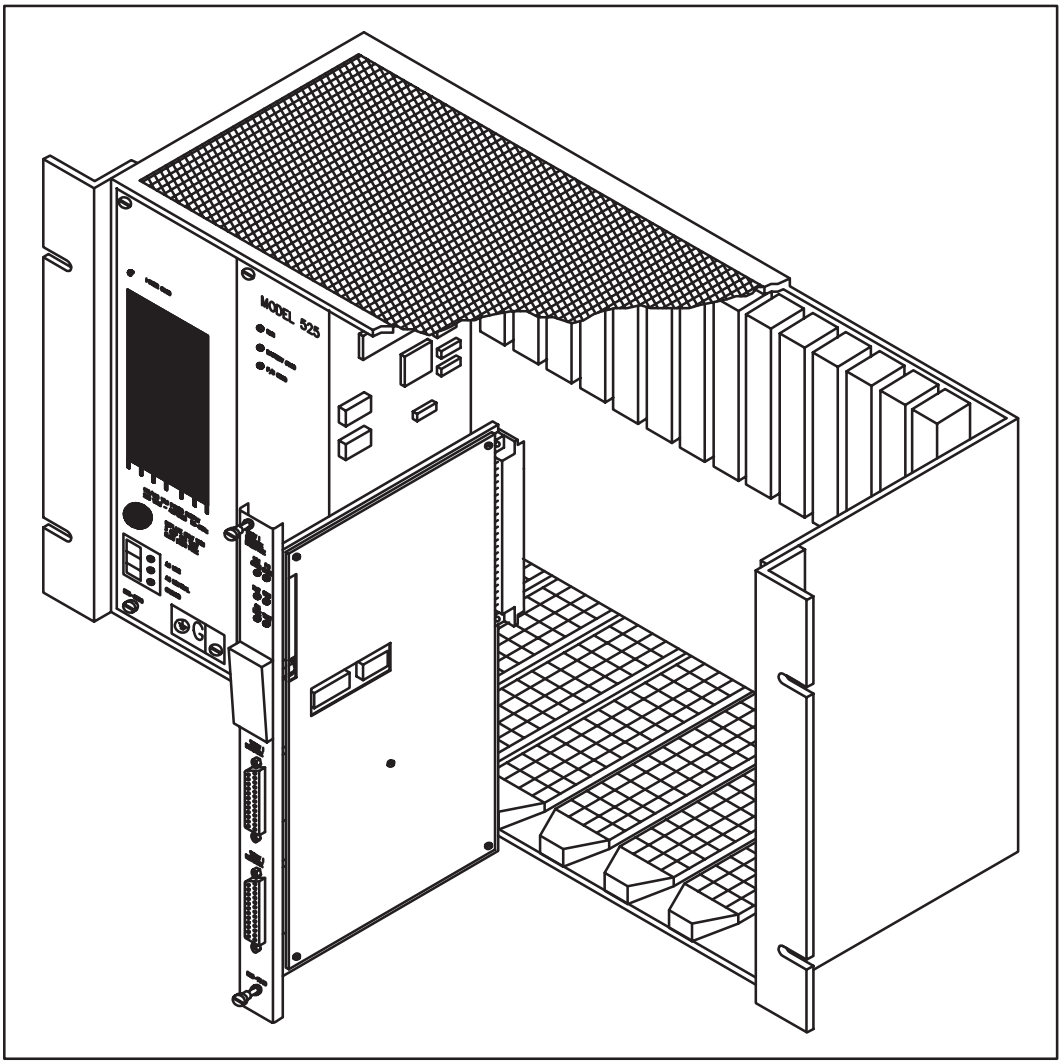


Figure 3 Installing the NIM in the I/O Base

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3.5 NIM SWITCHES

There are three switches located under the hinged switch cover. These switches, which are shown in Figure 3Figure 4, are labeled RESET, TEST and LOCAL/REMOTE.

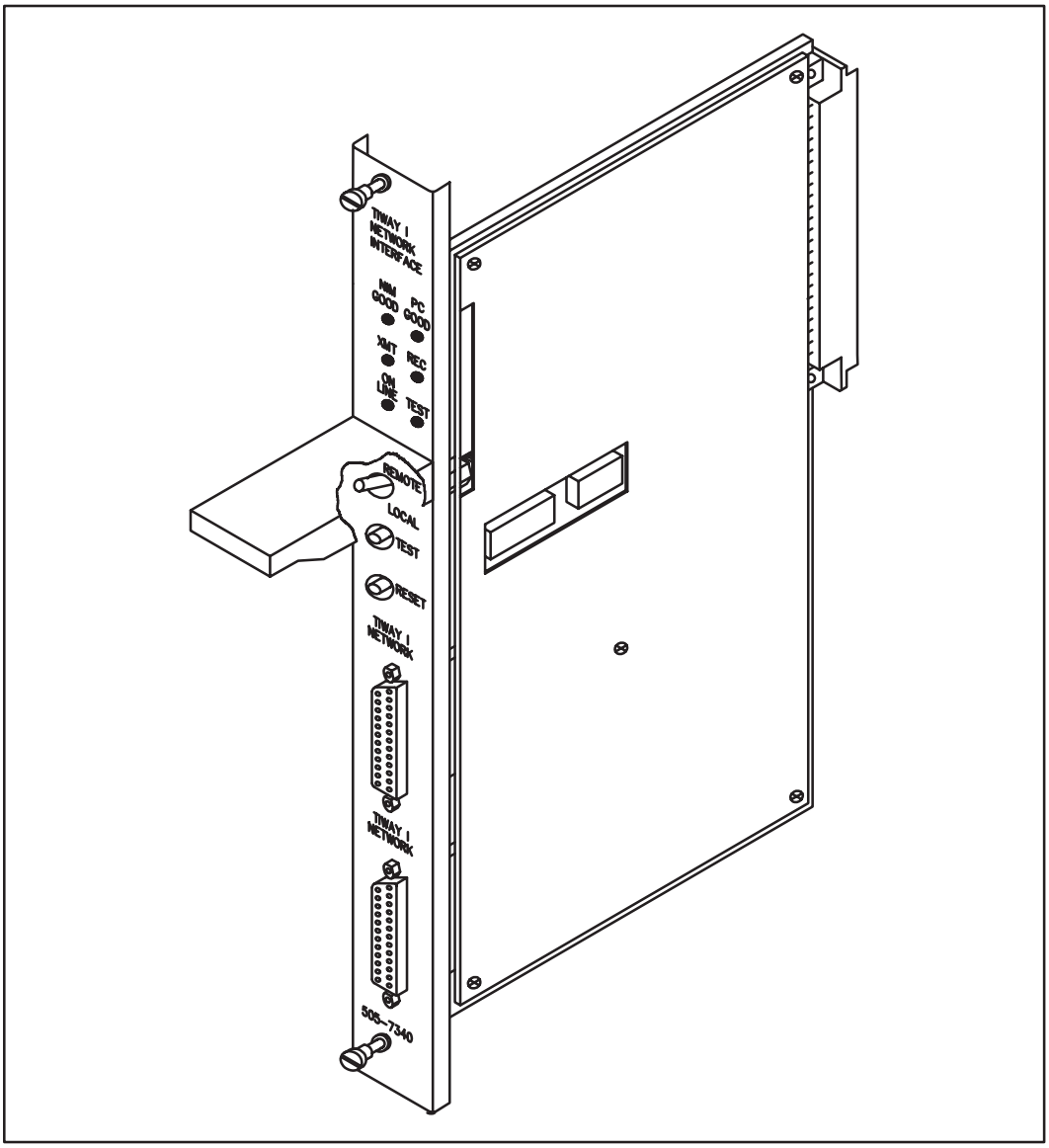


Figure 3Figure 4 NIM Switches

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3.5.1 Reset

This switch is a momentary contact switch which resets the NIM and initiates the power-up diagnostics. This switch causes all indicators to be on for approximately 1 second. Then all indicators, with the exception of the TEST indicator, are extinguished for approximately 10 seconds. During this time, the NIM runs a series of diagnostic tests to verify the hardware components of the NIM.

A successful completion of these tests will leave only the NIM GOOD and PC GOOD indicators on. If the TEST LED remains on, initiate the NIM diagnostics to determine the source of the error.

The RESET switch should always be pressed after you change the configuration or address selection dipswitches. This can be done by pressing the RESET switch, or by sending a Secondary HDLC Disconnect command from the host (which causes a reset to occur), followed by a Secondary Connect command. If you remove the NIM from the base to change the configuration, the NIM will automatically be reset when power is returned to the system.

3.5.2 Test

This switch will cause a series of diagnostic tests to be executed *if* the LOCAL/REMOTE switch is in the LOCAL position. Make sure you disconnect all communication cables and install loopback connectors (part no. 2641307–0001) on any RS-232-C communication ports before running these diagnostics. See the paragraph on TI505 NIM Diagnostics for additional information.

3.5.3 Local / Remote

When set to remote, this two-position switch enables the NIM to perform write operations to P/C memory. In the local position, the NIM cannot write to the P/C. In either position, the NIM can monitor P/C memory and mode of operation. The Local Mode will be indicated (after the NIM is brought online by the host computer) by a flashing ON LINE indicator. The Remote Mode will be indicated by a continuously illuminated ON LINE indicator when the NIM is on line.

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3.6 TI505 NIM DIAGNOSTICS

There are three levels of TI505 NIM diagnostics available.

- Power-up diagnostics
- Run time diagnostics
- User-initiated diagnostics

The TI505 NIM has six LED indicators that are used extensively during the diagnostics. The indicators, located above the switch cover, are shown in Figure 3Figure 5.

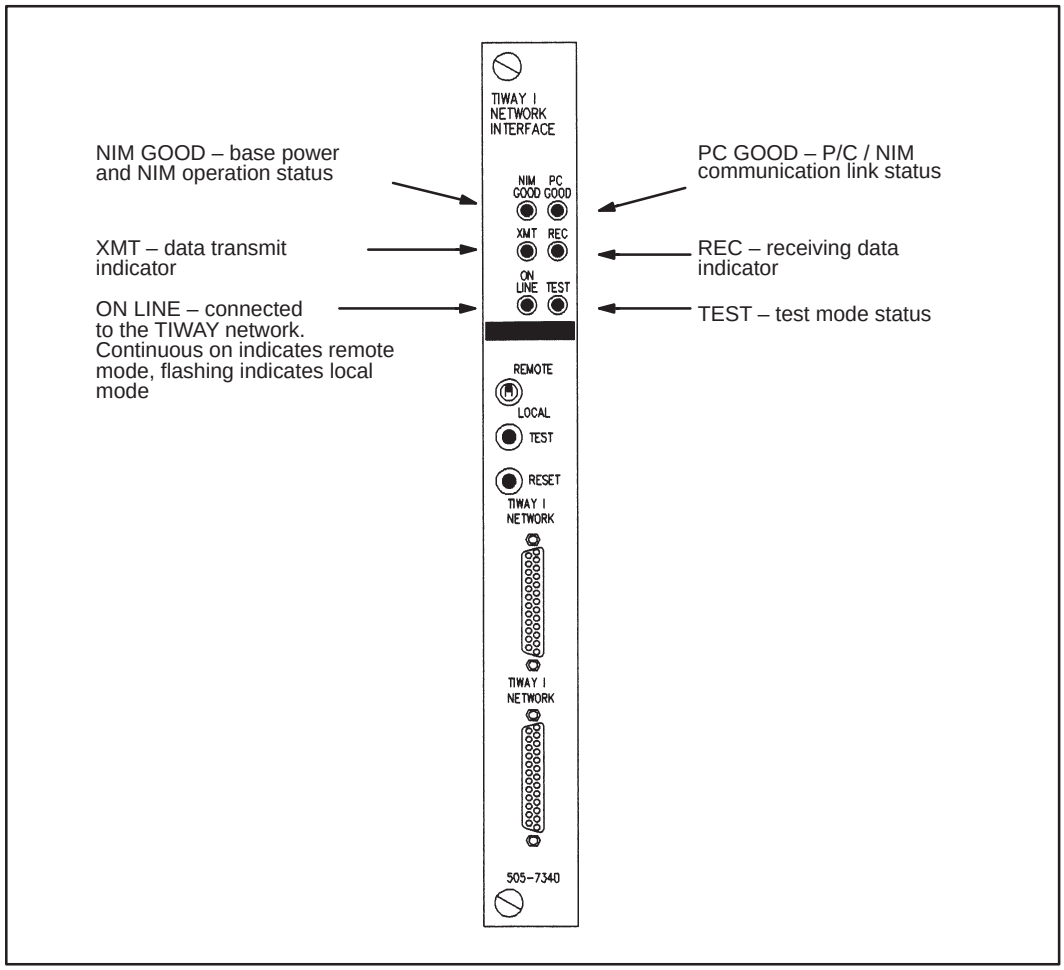


Figure 3Figure 5 NIM Status Indicators

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3.6.1 Power-Up Diagnostics

The TI505 NIM executes the power-up diagnostics in the following cases:

- Immediately following the application of +5VDC from the I/O base (power-up) as part of its initialization
- Any time the Reset switch is pressed
- Following an HDLC DISC command from the Primary (A UNILINK Adapter can be configured to disallow the disconnect command. See the *UNILINK Host Adapter User's Manual* for additional information.)

The power-up diagnostics checks the processor, performs a test of on-board RAM and ROM, and performs an internal loopback test of the communication ports. At the start of execution, all NIM LED indicators are turned on for approximately 1 second, then all except the TEST indicator are turned off for approximately 10 seconds.

If the power-up diagnostics are successful, the NIM GOOD LED will be on, and an attempt to establish communication with a TI505 P/C will be made. If this is successful, the PC GOOD LED will illuminate and the NIM is ready for normal network operation.

If the power-up diagnostics fail, the NIM will not respond to any communications attempts and the TEST LED will remain on.

If the TI505 P/C does not respond, the PC GOOD LED will remain extinguished, and the NIM will issue an Exception Response with Error Code 1A (communication not established with attached device) to any Primary initiating a P/C interactive command to this NIM.

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3.6.2 Run Time Diagnostics

The TI505 NIM monitors itself continuously during normal operation, as follows:

- The Operating System continuously performs a ROM integrity test as a background operation.
- The NIM periodically verifies that it is capable of communicating with the TI505 P/C.
- A Watchdog Timer circuit in the NIM helps protect against software lockup.

Failures detected in the ROM integrity test will cause the NIM GOOD LED to extinguish, and force the NIM into a failed state. In this condition the NIM goes to the Logically Disconnected State (LDS) and will always issue a Disconnect Mode (DM) response to any commands received.

If the NIM is communicating with the TIWAY network (ON LINE LED is on or flashing) and fails to communicate with the P/C, it reports this to the host computer with an Exception Response. Error Code 0A (attached device failed to respond) will be sent, and the PC GOOD LED will be extinguished. If communication is re-established, the NIM will return to Normal Response Mode and the PC GOOD LED will illuminate.

The Watchdog Timer circuit helps provide an extra measure of protection against network lockup due to a failed NIM. This circuit will force a reset if a failure occurs that prevents the operating software from executing normally. All indicators on the NIM will be extinguished, and the NIM will not respond to any network commands.

The communication boards include a “jabberstop circuit” which will disable the transmitter after 4096 state transitions on the line. This prevents a network lockup should the NIM fail.

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3.6.3 User-Initiated Diagnostics

You can initiate a complete test of the NIM hardware, including the communication ports. Complete the following steps to start the NIM diagnostics.

CAUTION

Since this test includes the communication ports, it is necessary that the NIM be disconnected from the TIWAY network.

1. Disconnect network cables from both NIM network ports.
2. Install loopback connectors (part no. 2641307–0001) on the NIM RS-232-C port(s).
3. Make certain the LOCAL/REMOTE switch is in the “Local” position.
4. Press the RESET switch.
5. Press the TEST switch.

At the start of the diagnostics, the TEST LED will be on, with all other LED indicators off. Then, after approximately ten seconds, all LED indicators will flash on and off for approximately two seconds. When the diagnostics are finished, the TEST LED will flash at a 2 HZ rate.

If the NIM completes the tests without errors, the following LED indicators will be on.

- NIM GOOD
- PC GOOD
- XMT
- RCV
- TEST (flashing)

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If the NIM fails the test, the following conditions apply.

1. If the NIM GOOD LED indicator is extinguished, then an internal NIM failure was detected.
2. If the PC GOOD LED indicator is extinguished, then a problem was found in attempting to communicate with a TI505 P/C.
3. If the XMT LED indicator is extinguished, a failure was detected on the bottom port (Port B). This could be due to a missing loopback connector.
4. If the RCV LED indicator is extinguished, a failure was detected on the top network port (Port A). This could be due to a missing loopback connector.

Following successful execution of the diagnostics, the network cable(s) should be connected to the NIM, the NIM Reset button should be pressed and the LOCAL/REMOTE switch should be returned to the correct setting (for your application). This will reinitialize the NIM, and it will return to normal operation.

If you need additional help, or information that is not included in this Technical Advisory, contact your Siemens Industrial Automation, Inc. distributor or sales agent. If you need assistance in contacting your distributor or sales office in the United States, call 800–964–4114. If additional technical assistance is needed, call the SIA Technical Services Group in Johnson City, Tennessee at 615–461–2522.

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3.7 MODULE LOGIN VERIFICATION

After the NIM has been installed and configured, you should verify that the NIM is logged into the P/C I/O map. (This is the first thing you should do if the PC GOOD LED is not lit.)

Connect a programming device to the P/C to verify P/C-module communication.

If you have a TI525 P/C system with a Video Programming Unit (or a SIMATIC® TISOFT™ package), press F3 for the CONFIO function, then F2 for SHOW, and then F7 for READ BASE. This sequence allows you to check all I/O points on the base where the NIM is installed.

Once you have entered the appropriate command, the P/C will respond with a chart listing all slots on the base and the inputs or outputs associated with each slot. If a row on the chart is blank, then the corresponding base slot does not contain a module.

To verify the installation, look in the chart for the slot number corresponding to the slot occupied by the module. If an "S" or "SF" (special function) and word memory locations appear on this line, the module is registered in the P/C memory and you can proceed with the usual operations. If the line is blank or erroneous, you should check the NIM to be sure it is firmly seated in the slot and enter the appropriate command again.

You can also use the PPX:505–7510 HIT (Handheld Intelligent Terminal) to verify that a module is operating correctly. Just use the HIT to read the appropriate status word (11–18) for the base the module is installed in. See the *Handheld Intelligent Terminal User's Manual* for detailed procedures.

If you need additional help, or information that is not included in this Technical Advisory, contact your Siemens Industrial Automation, Inc. distributor or sales agent. If you need assistance in contacting your distributor or sales office in the United States, call 800–964–4114. If additional technical assistance is needed, call the SIA Technical Services Group in Johnson City, Tennessee at 615–461–2522.

3.8 CONNECTING THE NETWORK CABLES

Network cabling should already be in place before NIM installation is begun. There are two communication ports on the TI505 NIM. The top port is port A, and the bottom port is port B. Plug the network interface cables into one of these two ports. For media redundancy, use both ports.

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Chapter 4
NIM Primitives

4.1 OVERVIEW

Primitives are high-level commands that allow a user to access like data types in all different Secondaries in the same manner. For example, a host computer can access image register memory in several different models of TI P/Cs with the same command. The Primitives remove as many differences as possible between the P/Cs, so that applications programs at the Primary (host) level may treat all TIWAY I Secondaries in the same manner.

Primitives provide several benefits.

- Primitives reduce the amount of host computer software needed to acquire data from the Secondaries.
- Primitives provide a standard communication protocol that allow you to communicate with different types of Secondaries and attached devices without custom software routines.
- Primitives allow more efficient use of the available network bandwidth by increasing the amount of data that is available in a single message. For example, with a single programming peripheral Task Code (P/C communication language), you might be able to access no more than 15 words of data. With some Primitives, up to 134 words can be accessed.
- Primitives reduce total system loading. This is possible because the NIMs can memorize data locations that are repeatedly accessed. Block and Record Gather Primitives make it possible to access a block of data previously defined and stored in the NIM.

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4.2 PURPOSE

Primitives serve as the command structure that a TIWAY I Primary uses to access (read or write) information in a TIWAY I Secondary. The Primitives defined in the following paragraphs serve these basic functional needs.

- Access and retrieve data
- Ascertain the status and configuration of attached devices
- Perform control operations on the attached device

4.3 STRUCTURE AND OPERATION

A Primitive consists of multiple fields that specify the Primitive's length and function, type and location of data to be accessed, and data to be transferred. In TIWAY I, a Primitive forms the information field of an HDLC Information frame (I) or Unnumbered Information frame (UI) if HDLC operation is selected. If X.25 operation is selected, the Primitive is contained in the User Data field of an X.25 Data Packet.

WARNING

When you write to memory, you may be directly affecting the process which is under control by the programmable controller. Before you make changes in memory, be certain that the changes which result in the controlled process will not endanger any personnel or equipment.

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Figure 1 illustrates the basic Primitive structure when HDLC operation is selected. There is a Request Format and a Response Format, as shown. The binary weight of the fields is detailed in Figure 2. All field lengths are multiples of 8 bits, which allows for octet testing of data link frames at the data link/media access control layer.

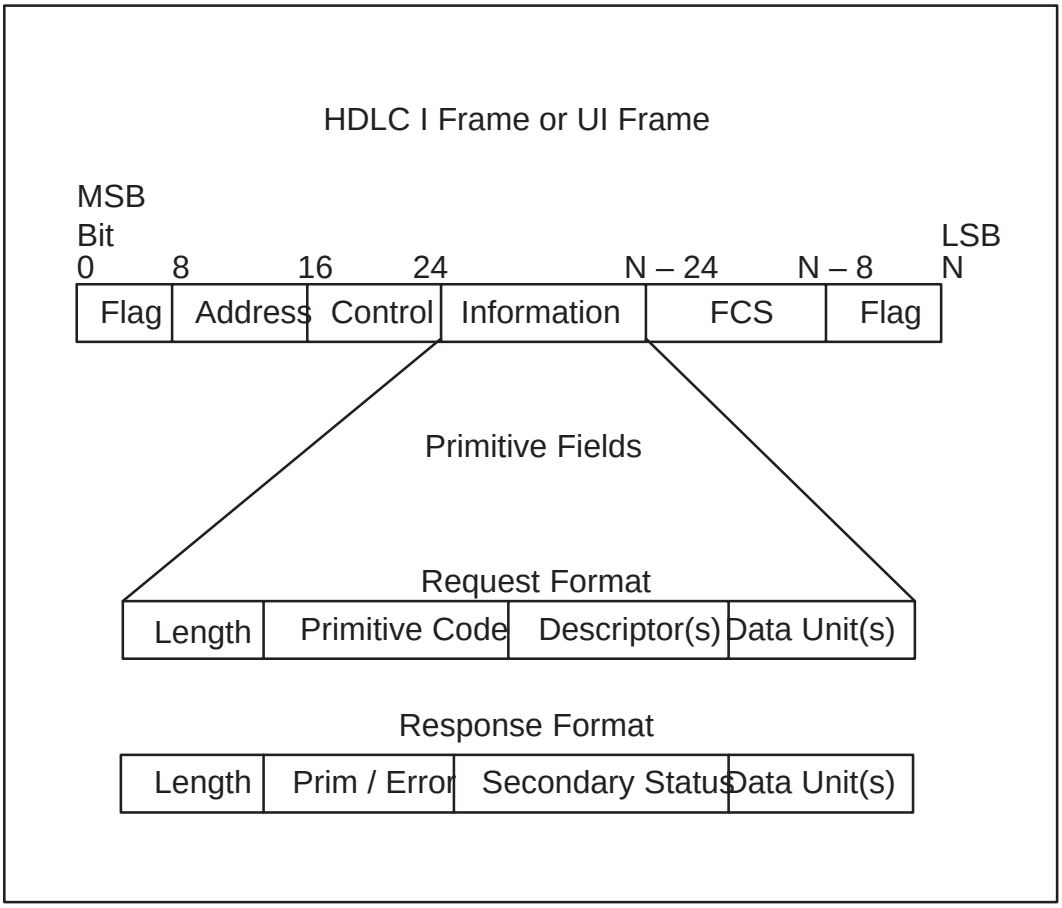


Figure 1 Basic Primitive Structure

The maximum length of the Information field is 273 bytes for the Series 505™ NIM. In the Request, the 273 bytes include the Length, Primitive code, Descriptor, and Data Unit fields. In the Response, the 273 bytes include the Length, Primitive Code/Error, Secondary Status, and Data Unit fields. In both formats, the 273 bytes exclude the protocol control fields. The actual length supported is dependent on the attached device type and must be ascertained with the Format Configuration Primitive 04.

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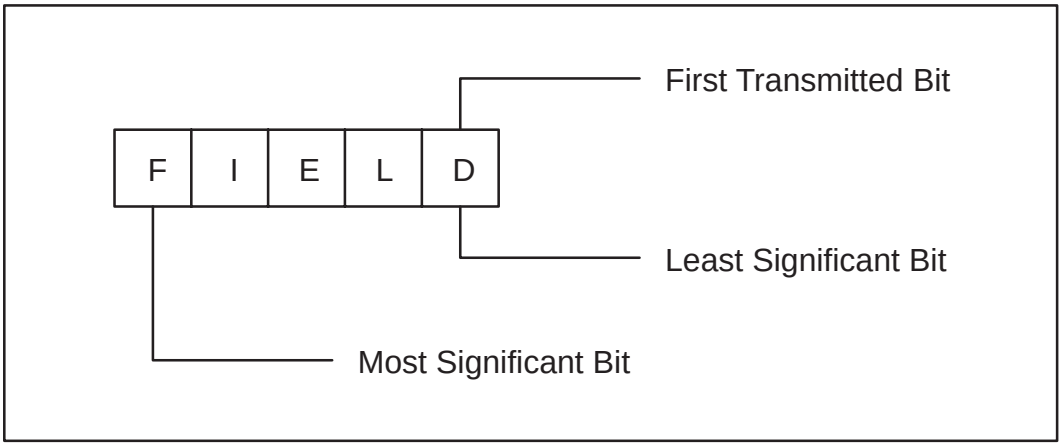


Figure 2 Binary Weight of the Fields

4.3.1 Normal Operation and Exceptions

Normal Primitive operation consists of a request and response sequence without exceptions. Exceptions are errors found in the interpretation or execution of a Primitive.

The normal operation of a Primitive is for the initiating (Host) station to form a request Primitive and address it to a Secondary on the network. If the request Primitive contains allowable descriptor and data unit fields, a legal Primitive Code for the attached device, and the correct Length Field value, then the Secondary will return a response Primitive of the proper format.

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An exception procedure is used when the addressed device finds fault with:

- The value of the Length field
- A Primitive format
- A data element type
- The execution of a Primitive

If a fault is found with the Length field, Primitive format, data element type or in the execution of the Primitive, the exception reason is returned with the Exception Primitive, which is Primitive Code 00.

4.3.2 Exception When Reading

The device performing the Primitive operation aborts execution of a Primitive when an exception condition is encountered, and returns the reason for the exception. The device requesting the Primitive should evaluate the message returned, take appropriate corrective measures, and attempt to retransmit the Primitive.

4.3.3 Exception When Writing

When an Exception Primitive is returned in response to a Write Primitive (P/C write, NIM block or record configuration, change state, etc.) you should verify that the actions were actually performed. You may have to send the Primitive again, since all, none, or part of the Primitive may have been executed prior to the failure. The station sending the Primitive should examine the exception reason, take appropriate corrective measures, and try to send the Primitive again.

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4.4 LOGICAL GROUPS

All Seimens' TIWAY Primitives fall into logical groups according to their function, as shown in Table 1. The TIWAY I Primitive subset is taken from the categories listed in Table 1.

Table 1 Logical Primitive Assignment

Function	Primitive Code (HEX) 16 Bit Addressing	Primitive Code (HEX) Extended Addressing
Exception and Status	00 — 0F	80 — 8F
Control	10 — 1F	90 — 9F
Read	20 — 2F	A0 — AF
Write	30 — 3F	B0 — BF
Program Modification Aids	40 — 4F	C0 — CF
Data Acquisition Primitives	50 — 6F	D0 — EF
Undefined	70 — 7E	F0 — FE
Expansion	7F	FF

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The subset of TIWAY I Primitives supported by the Series 505 NIM is given in Table 2. Future additions to this subset will be announced as they are implemented. Note that each of the following Primitives fits into the general categories listed in Table 1.

Table 2 Series 505 NIM Primitive Subset

Primitive Code (HEX)		
Non–extended Address	Extended Address	Type
00	80	Exception reporting
01	81	Native
02	82	Attached device / NIM status
03	83	Attached device type/configuration
04	84	Primitive format configuration
05	85	Packed native
10	90	Change state
20	A0	Read block (single contiguous block)
21	A1	Read random block
30	B0	Write block (single contiguous block)
31	B1	Write random block
50	D0	Define blocks (up to 32 separate blocks)
51	D1	Gather defined blocks
52	D2	Write and gather defined blocks
55	D5	Define records (up to 32 records)
56	D6	Gather defined records
57	D7	Write and gather defined records

You can use extended addresses by adding 80hex to the non-extended address primitive. With extended addresses, the AAAA field is expanded from sixteen bits to 32 bits (AAAAAAAA). This allows you to access data element locations beyond the non-extended limit of 65,535. With extended addresses, you can access up to 4,294,967,296 locations.

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4.5 FIELD DEFINITIONS

The basic Primitive Request and Response field formats are shown in Figure 3. Each of the basic field types shown is described in the following paragraphs.

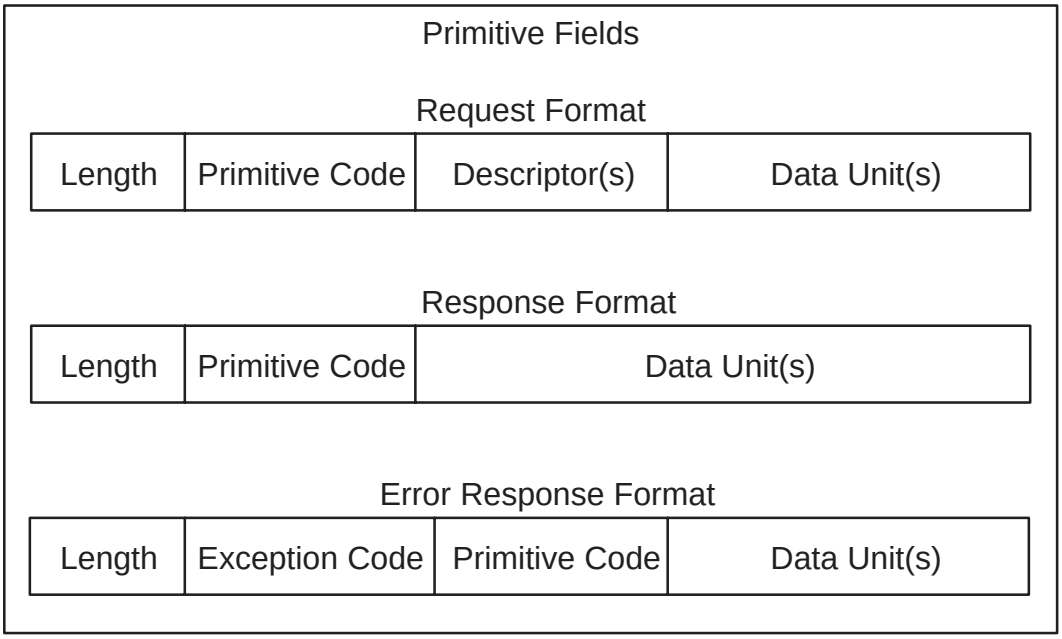


Figure 3 Primitive Request and Response Field Format

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4.5.1 Field Symbols

The symbols used in the remainder of this section to denote the different types of Primitive fields are summarized in Table 3.

The length of the field (in bytes) is represented by the number of characters in the field symbol. A byte is represented by two symbols. For example, the field LLLL is a two-byte (16 bit) field. Field symbols with ". . ." are variable length fields.

Table 3 Summary of Primitive Field Symbols

Symbol	Description
LLLL	Length field
PP	Primitive code
HH	Attached device status
TT	Data element types
NNNN	Number of data elements
AAAA or AAAA AAAA	Data element location
DDDD	Data unit(s)
XX	Number of user–defined structures requested
CC	User–defined structure number

4.5.2 Length Field – LLLL

The Length Field is a 16-bit field that represents the length (in bytes) of the Primitive, Descriptor(s), and Data Unit field(s). The Length Field is initialized by the Primary in transmissions to the NIM. It is also initialized by the NIM in transmissions to the Primary. (Example: the Length Field for a Primitive 02 request would have a value of 1.)

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4.5.3 Primitive Code Field – PP

The Primitive Code Field is eight bits long, which allows for 256 unique Primitives. The most significant bit of the Primitive field code designates whether extended addressing is in effect. If extended addressing is used, the data element location descriptor is a 32-bit field rather than the 16-bit field associated with non-extended addressing.

The Series 505 NIM currently supports a subset of the Primitives: 00, 01, 02, 03, 04, 05, 10, 20, 21, 30, 31, 50, 51, 52, 55, 56, and 57. The corresponding extended addressing codes are: 80, 81, 82, 83, 84, 85, 90, A0, A1, B0, B1, D0, D1, D2, D5, D6, and D7 (all values in hexadecimal). Detailed Primitive descriptions are provided later in this chapter.

4.5.4 Descriptor Field

Within the Descriptor Field are different fields to define the following: data element types, location or address of a data element, number of data elements to access, and the status of the attached device. The Descriptor Field may contain a single descriptor or multiple descriptors as required by the various Primitives.

Data Element Type — The length of the data element type descriptor field is eight bits. This field, labeled “TT”, is a code that corresponds to the different types of data found in the attached device. See Table 4Table 4 for a list of data element types.

Attached Device / NIM Status — The eight bit “HH” field designates the current status. The attached device status is updated by the NIM every four seconds. The most recent attached device status is returned in most Primitives. See the Status Primitive description for additional information.

Number of Data Elements to access — This 16 bit field is designated by “NNNN”. A value of one is interpreted as one location to be accessed. The length of a location is determined by the data element type. The number of locations requested should not exceed the maximum allowed for that device type (see Tables 4Table 4 and 4Table 5). If you are using packed discrete format, the data will be returned in groups of 8 bits. For example, if you request 10 data elements, 2 bytes will be returned.

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Data Element Location — Data element types are accessed by a location address, designated by “AAAA” or “AAAA AAAA”. In the Series 505 NIM, the location descriptor is a 16-bit value (32 bits if extended addressing is used in the Primitive code field). The allowable values for the data element location are from 1 to the maximum values shown in Table 5.

For TT Type 12 (Drum Count Preset) the format changes slightly. The format of the AAAA field for this type is:

AAAA = DD SS,
AAAA AAAA = DDDD SSSS (if using extended addressing)

where DD = Drum Number
SS = Step Number ($1 - 10_{16}$)

4.5.5 Basic Data Unit – DDDD

The definition of the Basic Data Unit Field is dependent upon the data element type specified in both the Descriptor Field and the Primitive format definition. The Basic Data Unit is designated “DDDD” or “DD” in this manual.

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4.6 DATA ELEMENT TYPES AND FORMATS

The data element types (TTs) and their length (in bytes) are defined in Table 4. Figure 4 through Figure 8 show the format of the data elements.

Table 4 Data Element Types and Lengths

TT	Data Element Type	Length (in bytes)
0	Instruction Memory (L)	2
1	Variable Memory (V)	2
2	Constant Memory (K)	2
3	Discrete Input (X)	1
4	Discrete Output (Y)	1
5	Control Register (CR)	1
6	Discrete Input Packed (X)	1
7	Discrete Output Packed (Y)	1
8	Control Register Packed (CR)	1
9	Word Input (WX)	2
A	Word Output (WY)	2
B	XY Force	1
C	CR Force	1
D	Word Force	3
E	Timer–Counter Preset (TCP)	2
F	Timer–Counter Current (TCC)	2
10	Drum Step Preset (DSP)	1
11	Drum Step Current (DSC)	1
12	Drum Count Preset (DCP)	2
17	Secondary System Status	4

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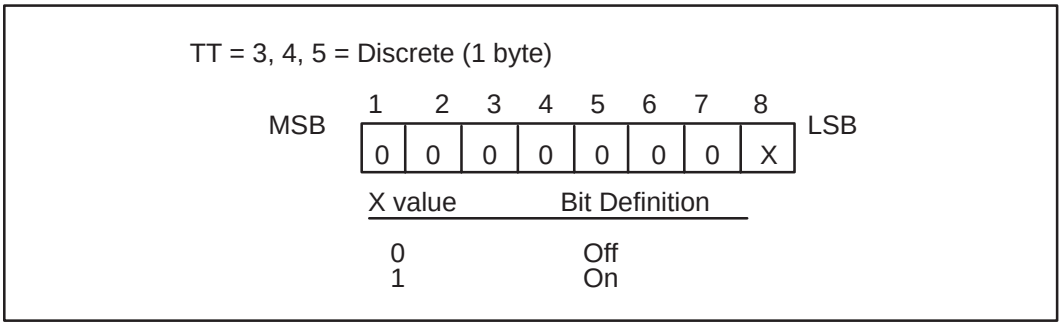
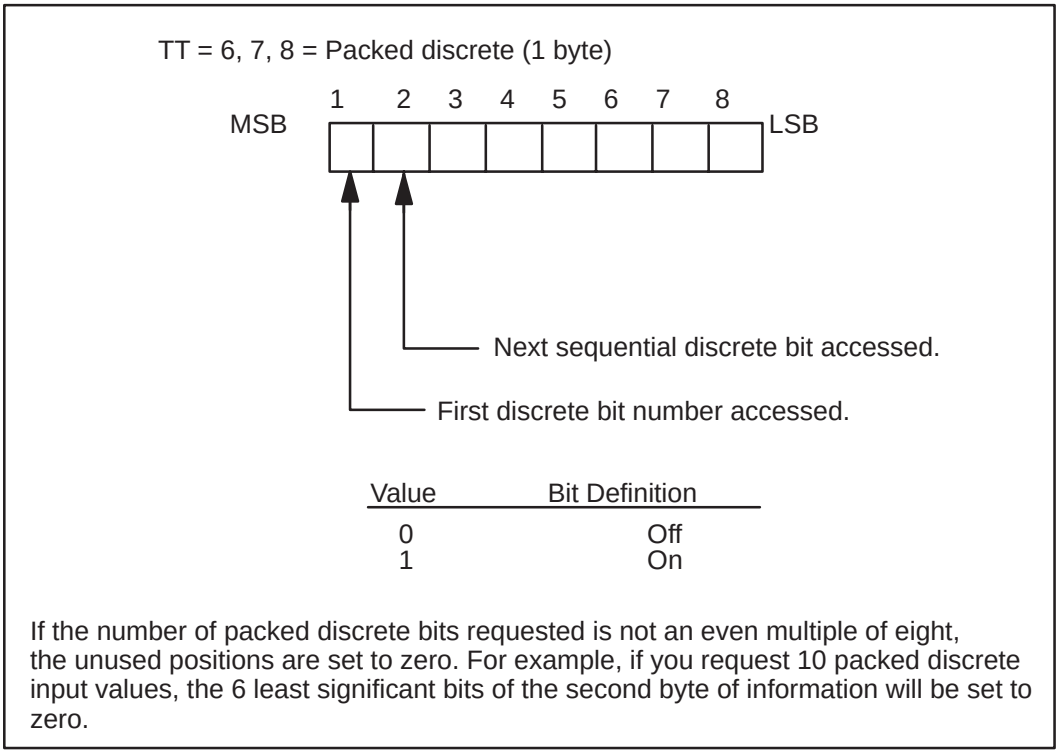


Figure 4 Discrete Data Element Format



If the number of packed discrete bits requested is not an even multiple of eight, the unused positions are set to zero. For example, if you request 10 packed discrete input values, the 6 least significant bits of the second byte of information will be set to zero.

Figure 5 Packed Discrete Data Element Format

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TT = D = Word force (3 bytes)

MM <DDDD> where,

MM is the forced state or forced action to take

MM value	Force state / action
00*	Unforced
01	Forced
FF**	Unforce

* If used in a Write Primitive, it can only write to an unforced word. It will not unforce a word, but it will change the word value

** Used only in Write Primitives to unforce a word. It does not have a DDDD value and the data length is 1 byte instead of 3 bytes.

DDDD is the word value and is not used when MM=FF

Figure 6 Forced Word Data Element Format

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TT = B, Discrete Force (1 byte)
C, CR Force (1 byte)

DD Value	Discrete Value	Force State
00	Off	Unforced
01	On	Unforced
80	Off	Force
81	On	Force
FF	—	Unforce*

Used only in a Write Primitive, unforces a forced data element location, but does not change the value

Figure 7 Forced Discrete and CR Data Element Format

TT = 17 = Secondary System Status (2 words)*



Each bit set to 1 indicates that the corresponding bit in word 2 is a reported status.



Status bits

A = 0 NIM in REMOTE mode
= 1 NIM in LOCAL mode

B = 0 P/C System in REMOTE mode
= 1 P/C System in LOCAL mode

C – P undefined (default to 0)

*This is a read–only data type

Figure 8 Secondary System Status Data Element Format

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4.7 DATA ELEMENT LOCATION RANGES

The maximum data element locations (AAAA field) for each data element type / P/C combination are provided in Table 5. For all the ranges in the table, the first legal value is 1; not zero. Values of zero are not supported.

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Table 5 Data Element Location Ranges

Data Type	P/C Type						
	PPX:525–1102	PPX:525–1104	PPX:525–1208	PPX:525–1212	PPX:535–1204	PPX:535–1212	NOTE
L Instruction TT = 00	2048	4096	8192	12000	4096	12000	
V Variable TT = 01	1024	2048	4096	5120	2048	5120	
K Constant TT = 02	0	0	0	0	0	0	A
Discrete I/O X, Y, X&Y Packed TT = 3,4,6,7	1023	1023	1023	1023	1023	1023	
Control Register CR, CR Packed TT = 5,8	511	511	511	1023	511	1023	
Word I/O WX, WY TT = 9,A	1023	1023	1023	1023	1023	1023	
Discrete Force TT = 0B	1023	1023	1023	1023	1023	1023	
CR Force TT = 0C	511	511	511	1023	511	1023	
Word Force TT = 0D	1023	1023	1023	1023	1023	1023	
Timer Counter TCC/TCP TT = E,F	256	256	256	400	256	400	
Drum DSP, DSC, DCP TT = 10,11,12	30	30	30	30	30	30	B
System Status TT = 17	1	1	1	1	1	1	

Notes

A. Entry of zero is non-supported or non-configured Data Type for the P/C.

B. There are 16 steps for each event drum in a P/C. The DCP (TT=12) data element location must specify both the drum number (1 to the maximum listed in this table) and the step (1–16). Section 4.5.4 describes this format.

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4.8 DATA FIELD LENGTH RESTRICTIONS

Table 6 and Table 7 provide the maximum number of bytes that can be gathered or written for Read and Write Primitives.

Table 6 Maximum Read Primitive Data Byte Length

	Read Primitive					
	20	21	51	52	56	57
Maximum number of bytes read per Primitive request.	269	268	265	265	268	268
(When using extended address)	269	268	265	265	268	268

Primitives requesting more than one data element type (TT, possible with Primitives 05, 21, 51, 52, 56, and 57) must be verified to contain a cumulative byte count of less than or equal to the byte counts in this table. Consult Table 4 for the number of bytes per data element, and Table 5 for data element locations.

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Table 7 Maximum Write Primitive Data Byte Length

	Write Primitive			
	30	31	52	57
Maximum number of bytes that may be written per Primitive request.	267	265*	263	265**
(When using extended address)	265	263*	261	263**

Consult Table 4Table 4 for the number in each data element, and Table 4Table 5
for the maximum available data element address.

* This number assumes that only one data block is requested. Use one of the following formulas for the general case of one or more data block:

Normal addressing: N = 270 – (5 * T)
Extended addressing: N = 270 – (7 * T)

where:

N = maximum number of bytes which may be written in this Primitive request.

T = total number of writes specified in this Primitive request.

** This number assumes that only one record is requested. Use the following formula for the general case of one or more records requested.

Normal addressing: N = 266 – C
Extended addressing: N = 264 – C

where:

C = total number of records in this Primitive.

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4.9 SERIES 505 NIM PRIMITIVE DESCRIPTIONS

The following paragraphs describe the NIM Primitives used in the Series 505 NIM. Refer to Table 2 for a complete list of the Primitives supported.

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4.9.1 Exception Primitive – Code 00

Primitive 00 returns the error status from a Secondary. For example, if a Primary tries to read variable memory at location 0000 in a Series 505 NIM, a Primitive 00 response would indicate that the memory address was out of range with an exception field of 0002.

Request: There is no request defined for this Primitive.

Response: LLLL 00 PP DDDD (TT is optional)

Symbol	*Value*	*Definition*
PP		Request Primitive code that contains the exception
DDDD	0	Primitive code is not implemented
	1	Data type (specified by TT) is not defined on the attached device
	2	Data element location (specified by TT) is out of range
	3	Primitive has excess data unit bytes
	4	Primitive has insufficient data unit bytes
	5	Number of information bytes received does not match the number of bytes specified in the field length
	6	Attached device is in wrong mode for Primitive execution
	7	User program in the attached device has disabled communication to the Series 505 NIM via the lock-out bit
	A	Attached device fails to respond
	E	Primitive not valid for the specified data type (TT)
	10	Number of locations requested exceeds the maximum allowed
	11	Number assigned to a data acquisition block or record is not within the supported block or record range
	12	Block or record number requested has not been defined
	13	Number of data bytes in the requested blocks or records exceeds the maximum number of bytes allowed by the primitive
	15	Primitive not allowed while NIM is in local mode
	16	TT not programmed in attached device

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Symbol	*Value*	*Definition*
DDDD	17	Attached device did not respond properly
	19	Resulting data element location formed by the starting address, plus the number of data element to access, is out of range specified by TT
	1A	Communication has not been established with the attached device
	1B	Store and forward buffer is full and the store and forward message was discarded
	1C	Data element field (specified by TT) is improperly formatted
	1D	Number of locations to access equals zero (NNNN = 0)
	23	Number of data blocks defined in a data acquisition record exceeds the maximum supported
	80DD	Exception generated in the attached device is not identified
TT		Optional data element type

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4.9.2 Native Primitive – Code 01

The Native Primitive 01 allows access to an attached device by using a Task Code which is unique to the specific device addressed. By using Primitive 01, you can embed a P/C-unique Task Code and access anything in P/C memory, for example, that a VPU can access.

Request: LLLL 01 DD. . .DD, where DDDD is the task code acceptable to the device being accessed.

Response: LLLL 01 HH DD. . .DD

Symbol	*Value*	*Definition*
HH		Operational status (see Status Primitive)
DDDD		Defined by the attached device

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4.9.3 Status Primitive – Code 02

Primitive 02 is the Status Primitive. It reports the current operational state of the attached device and NIM in a common format for all types of attached devices. The NIM gets a status update from the attached device every 4 seconds.

Request: LLLL 02

Response: LLLL 02 HH EE FF, where:

Symbol	*Value*	*Definition*
HH		Attached device operational status (mode)
	00	Operational and performing instruction data type and loop execution (RUN)
	01	Operational and performing instruction data type and loop execution with a non-fatal error detected (RUN with non-fatal error)
	02	Operational and not performing instruction data type execution with loop execution (PROGRAM)
	03	Operational and not performing instruction data type or loop execution (PROGRAM)
	04	Operational and not performing instruction data type execution with loop execution and a non-fatal error is detected (PROGRAM with non-fatal error)
	05	Operational and not performing instruction and data type or loop execution and a non-fatal error is detected (PROGRAM with a non-fatal error)
	80	Not operational due to a fatal error condition
EE		Attached device auxiliary power source (battery) status
	00	Auxiliary power source good
	01	Auxiliary power source status not available
	80	Auxiliary power source not good
FF		NIM operational status
	00	Operational
	01	Channel A is not functional
	02	Channel B is not functional

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4.9.4 Configuration Primitive – Code 03

Primitive 03 allows the Primary to identify the types of devices that exist on the network. For example, a Primitive 03 response from a TI525 P/C is different from a 5TI P/C response.

Request: LLLL 03

Response: LLLL 03 HH DDDD EEEE FFFF GGGG IIII JJJJ KKKK KKKK

Symbol	*Value*	*Definition*
HH		Attached device operational status
DDDD		Device type
	0000	SIMATIC 5TI
	0020	SIMATIC® TI520™
	002C	SIMATIC® TI520C™, PPX:525–1102
	0030	SIMATIC® TI530™
	003C	PPX:525–1104, PPX:525–1208, PPX:525–1212, SIMATIC® TI530C™, TI535
	0040	SIMATIC® TI540™
	0050	SIMATIC® TI550™
	0060	SIMATIC® TI560™
	0065	SIMATIC® TI565™
	007E	SIMATIC UNILINK Host Adapter
	0080	SIMATIC PM550
	0081	SIMATIC® PM551™
	0100	SIMATIC UNILINK Secondary Adapter
	0200	IT–111/121 Intelligent Tank Transmitter
	0204	IT–150 Hydrostatic Tank Transmitter
	0208	IT–160 Micro Remote Control Unit
EEEE	hex	Instruction data type memory size (4 bytes in extended)
FFFF	hex	Variable data type memory size (4 bytes in extended)
GGGG	hex	Constant data type memory size (4 bytes in extended)
IIII	hex	Local input/output memory size (4 bytes in extended)
JJJJ	hex	Global input/output memory size (4 bytes in extended)
KKKK ...	hex	Total memory size (excluding input and output)

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4.9.5 Primitive Format Configuration – Code 04

Primitive 04 is the Format Primitive that allows you to ascertain the maximum length (in bytes) of the Primitive acceptable to the Network Interface Module.

Request: LLLL 04

Response: LLLL 04 NNNN MM EE FF GG BB ... BB

Symbol	*Value*	*Definition*
NNNN		Primitive descriptor(s) and data unit(s) field length supported, in bytes (270 bytes is returned)
MM		Number of Data Acquisition Blocks supported by the NIM (For Primitives 50, 51, and 52, 32 is returned.)
EE		Number of Data Acquisition Records supported by the NIM (For Primitives 55, 56, and 57, 32 is returned.)
FF		Number of Data Type Definitions supported in each defined record in the NIM (For Primitives 55, 56, and 57, 32 is returned.)
GG		Floating Point Formats supported in the NIM
	00	No floating point support
	01	IBM Excess 64 format support
	02	IEEE Standard 754 format support
	03	Both IBM and IEEE format support
BB		16 byte Primitive support bit mask for the NIM. The MSB bit represents Primitive 0. Primitive values increment by 1 for each bit position. A one in a bit position indicates that the corresponding Primitive is supported. For example, if bit 3 is set to 1, then Primitive 02 is supported.

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4.9.6 Packed Native Primitive – Code 05

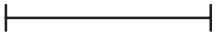
Primitive 05 allows one or more device task codes to be executed. Execution is aborted and an exception response returned if an exception occurs during processing. If an exception occurs during execution of any native task code, the error results are returned in the packed native response in the same position as in a normal response. Execution continues in this situation. Native task codes concerning “store” and “forward” are not supported.

Request: LLLL 05 CC DD ... DD



(repeated)

Response: LLLL 05 HH CC DD ... DD



(repeated)

Symbol	*Value*	*Definition*
HH		Attached device operational status
CC		Number of bytes in the task code field DD
DD		Task codes of the attached device

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4.9.7 Change State Primitive – Code 10

This Primitive allows you to change the operational state of the attached device. For example, you may enter the Run or Program modes with this Primitive.

NOTE

Issuing this command to enter the non-execution of instruction data type will cause specific attached devices to turn off or freeze their output systems, depending on the device. For an explanation of the modes of operation for a specific P/C, refer to the manual for that particular programmable controller.

Request: LLLL 10 DD, where

Symbol	*Value*	*Definition*
DD		Operational Status
	00	Enter execution of instruction data type and execution of loops state (RUN mode)
	01	Enter non-execution of instruction data type and execution of loop states (PROGRAM mode)
	02	Enter non-execution of instruction data type and loop state (PROGRAM mode)

Response: LLLL 10 HH

Symbol	*Value*	*Definition*
HH		Attached device operational status

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4.9.8 Read Block Primitive – Code 20

Primitive 20 is a command to read a single contiguous block of data in the attached device. Read Block will access contiguous data elements starting from a given data element location.

Request: LLLL 20 TT NNNN AAAA

Symbol	*Value*	*Definition*
TT		Data element type
NNNN		Number of locations
AAAA		Data element location

Response: LLLL 20 HH DD ... DD

Symbol	*Value*	*Definition*
HH		Attached device operational status
DD		Data

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4.9.9 Read Random Block Primitive – Code 21

Primitive 21 is a command to read several random blocks of contiguous memory.

NOTE

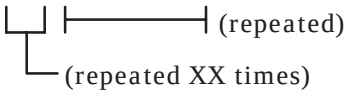
Data will not be returned for the blocks that were in error.

Request: LLLL 21 TT NNNN AAAA



Symbol	*Value*	*Definition*
TT		Data element type
NNNN		Number of locations
AAAA		Data element location

Response: LLLL 21 HH XX BB DD ... DD



Symbol	*Value*	*Definition*
HH		Attached device operational status
XX		Number of blocks not processed due to error
BB		Block numbers not processed due to error. This field only contains a value when the P/C is reporting a P/C error.
DD		Data requested

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4.9.10 Write Block Primitive – Code 30

Primitive 30 is the Write Block Primitive, which will replace a contiguous block of data starting from a given data element location with the data specified in the request.

Request: LLLL 30 TT AAAA DD ... DD

Symbol	*Value*	*Definition*
TT		Data element type
AAAA		Data element location
DD		Data

Response: LLLL 30 HH

Symbol	*Value*	*Definition*
HH		Attached device operational status

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4.9.11 Write Random Block Primitive – Code 31

Primitive 31 replaces several blocks of contiguous data with the data included in the request.

Request: LLLL 31 TT NNNN AAAA DD ... DD



Symbol	*Value*	*Definition*
TT		Data element type
NNNN		Number of locations
AAAA		Data element location
DD		Data

Response: LLLL 31 HH XX BB ... BB (BB is repeated XX times)

Symbol	*Value*	*Definition*
HH		Attached device operational status
XX		Number of block writes not completed due to error
BB		Block numbers not processed due to error, with the first block in the sequence referenced as block 1.

CAUTION

Blocks in error (specified by BB) may have been partially written before a failure occurred. Valid blocks will complete without returning a Primitive error.

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4.9.12 Block Data Acquisition Primitive Codes 50 51 52

The Block Data Acquisition Primitives allow predefined blocks of different data types to be accessed with a single Primitive without re-defining the blocks in each transaction. The Define Block Primitive (50) specifies the random blocks. The Gather Block Primitive (51) collects the data from specific blocks. The Write and Gather Block Primitive (52) combines these functions.

NOTE

The block definitions are destroyed in the event of a power loss or a hardware reset. This includes an HDLC DISC (issued by some Primaries during a Disconnect Secondary command). Any initialization or reinitialization procedures must use the Define Block Primitive to re-define the data acquisition blocks.

4.9.12.1 Define Block Primitive – Code 50

The Define Block Primitive specifies up to 32 random blocks of data elements. See Table 4Table 5 for the allowable data element location ranges. The blocks are referenced by number, ranging from 1 to 20 (hex). A block, once defined, can be re-defined to a different data element type and location by simply specifying that block number, and then providing the required information for a new block. A block can be restored to the initial state of "undefined" by setting the NNNN field to zero.

Request: LLLL 50 CC TT NNNN AAAA



Symbol	*Value*	*Definition*
CC		Block number (1 – 20 hex)
TT		Data element type
NNNN		Number of locations
AAAA		Data element location

Response: LLLL 50 HH

Symbol	*Value*	*Definition*
HH		Attached device operational status

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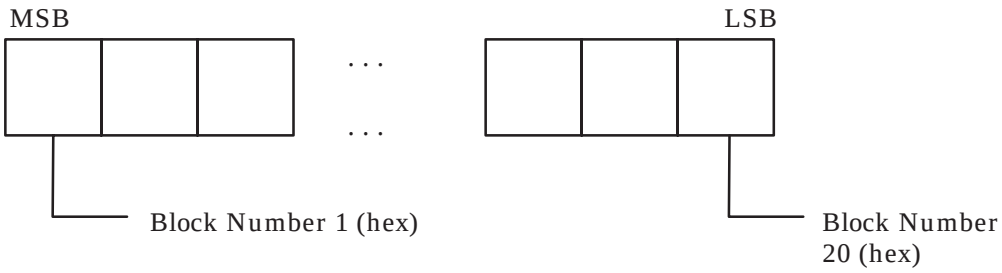
4.9.12.2 Gather Block Primitive – Code 51

The Gather Block Primitive specifies which blocks (as defined by the Define Block Primitive 50) will be read. The blocks are specified through a 32-bit mask (EEEEEEEE).

Each bit position in the bit mask corresponds to a block that was defined with Primitive 50, Define Block. A bit set to 1 indicates that the block is to be returned. A bit set to 0 means that the block will not be returned. You should not request more data than can be returned in a maximum length Primitive frame. The response will return the data associated with the requested blocks, beginning with the lowest block number and increasing to the highest block number. A data block separator is not provided in the response.

Request: LLLL 51 EEEEEEEE

where EEEEEEEE is 32 bits, defined as:



Response: LLLL 51 HH EEEEEEEE DD ... DD (repeated)

Symbol	*Value*	*Definition*
HH		Attached device operational status
EEEEEEEE		EEEEEEEE is a mask as defined by the Request Primitive
DD		Data defined by the block being read. The order of return of the blocks is from the lowest numbered block to the highest. For example, if blocks 2, 4, and A were requested, the first data block in the response specifies data which is associated with block 2, the next data block specifies data which is associated with block 4, etc.

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4.9.12.3 Write and Gather Block Primitive – Code 52

The Write and Gather Block Primitive specifies which blocks (as defined with Define Block Primitive 50) will be read. It also allows a user to replace any contiguous data element locations. The blocks to gather are specified through a 32-bit mask (EEEEEEEE).

In the bit mask position which corresponds to a block specified in the Define Block Primitive, a bit value of 1 indicates that the block is to be returned. A bit value of 0 means that the block will not be returned.

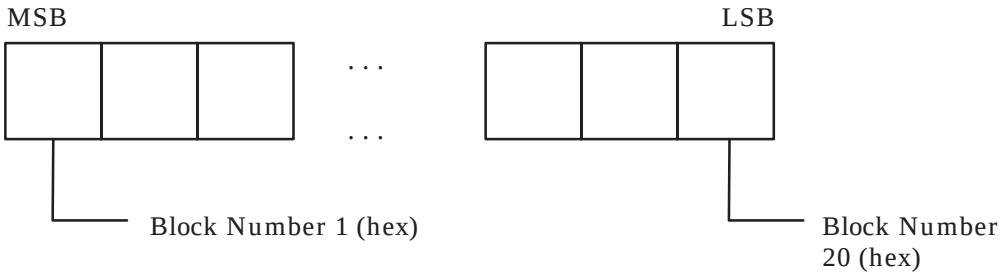
You should not request more data than can be returned in a maximum length Primitive frame. Following the mask are the descriptors associated with the write function, which is performed before the gather operation. The response will return the data associated with the requested blocks, beginning with the lowest block number and increasing to the highest block number. A data block separator is not provided in the response.

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Request: LLLL 52 EEEEEEEE TT AAAA DD ... DD

(repeated)

where EEEEEEEE is a 32 bit field defining the blocks to gather.



Symbol	*Value*	*Definition*
TT		Data element type for the write operation
AAAA		Data element location for the write operation
DD		Data for the write operation

Response: LLLL 52 HH EEEEEEEE DD ... DD

(repeated)

Symbol	*Value*	*Definition*
HH		Attached device operational status
EEEEEEEE		EEEEEEEE is a mask as defined by the Request Primitive
DD		Data defined by the block being read. The order of return of the blocks is from the lowest numbered block to the highest. For example, if blocks 2, 4, and A were requested, the first data block in the response specifies data which is associated with block 2, the next data block specifies data which is associated with block 4, etc. This field can be set to zero if you want to perform a write function without reading a block.

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4.9.13 Record Data Acquisition Primitive Codes 55 56 57

The Record Data Acquisition Primitives allow repetitive collection of multiple predefined blocks of data. The Define Record Primitive (55) allows multiple blocks of data to be defined as a single record. The Gather Record Primitive (56) collects the data blocks for the requested records. The Write and Gather Record Primitive (57) combines the functions of the Write Block Primitive (30) and the Gather Record Primitive (56).

NOTE

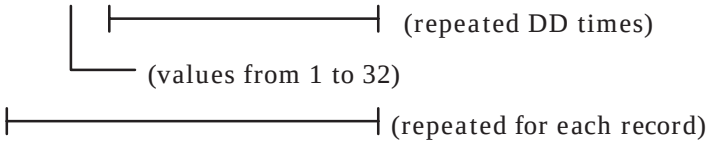
The record definitions are destroyed in the event of a power loss or a hardware reset or HDLC DISC command. Any initialization or re-initialization procedures must use the Define Record Primitive (55) to re-define the data acquisition records.

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4.9.13.1 Define Record Primitive – Code 55

The Define Record Primitive specifies up to 32 records with 32 blocks per record. The records are referenced by number, ranging from 1 (hex) to 20 (hex). A record, once defined, can be re-defined. A record may be restored to the initial state of "undefined" by specifying the number of Data type Definitions (DD – blocks) in the record as zero.

Request: LLLL 55 CC DD TT NNNN AAAA



Symbol	*Value*	*Definition*
CC		Number assigned to the record. The allowable range is 1 to 20 HEX.
DD		Number of data type definitions (blocks) for the record.
TT		Data element type
NNNN		Number of locations
AAAA		Data element location

The total byte count of data elements defined by the record(s) must not cause the gather record response to exceed the maximum Primitive frame length. See the paragraphs on Data Element Types and Formats for the number of bytes in each data type.

Response: LLLL 55 HH

Symbol	*Value*	*Definition*
HH		Attached device operational status

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4.9.13.2 Gather Record Primitive – Code 56

The Gather Record Primitive specifies which records (as defined by the Define Record Primitive 55) will be read. The records are specified by record numbers from 1 (hex) to 20 (hex). The total number of bytes returned by the record(s) must not cause the response to exceed the maximum frame length. The Response Primitive will return the data associated with the requested records, in the same order as they were requested. A data record or data type separator is not provided in the Response Primitive.

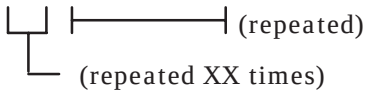
NOTE

Data will not be returned for records in error. Invalid records will cause a Primitive error.

Request: LLLL 56 XX CC (CC is repeated XX times)

Symbol	*Value*	*Definition*
XX		Number of records requested
CC		Record numbers requested

Response: LLLL 56 HH XX CC DD ... DD



Symbol	*Value*	*Definition*
HH		Attached device operational status
XX		Number of records in error
CC		Record numbers in error
DD		Data records returned without errors

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4.9.13.3 Write and Gather Record Primitive – Code 57

The Write and Gather Record Primitive specifies which records (as defined with Define Record Primitive 55) will be read. It also allows you to replace any contiguous data element locations. The Records are specified by record numbers from 1 to 20 (hex). The total number of bytes returned by the record(s) must not cause the response to exceed the maximum frame length.

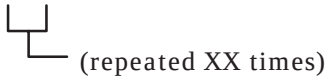
Following the record numbers are the descriptors associated with the write function. The write function is performed before the gather operation. The response returns the data associated with the requested records by starting with the lowest number record and increasing to the highest record. A data record or data type separator is not provided in the response.

NOTE

An exception will be returned if the write portion of this Primitive fails. No data will be returned for records in error or invalid read definitions.

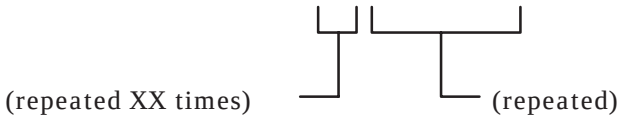
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Request: LLLL 57 XX CC TT AAAA DD ... DD



Symbol	*Value*	*Definition*
XX		Number of records to gather
CC		Record numbers to gather
TT		Data element type to write
AAAA		Data element location to write
DD		Data to write. Maximum DD ranges may vary depending on the number of records specified for the read function.

Response: LLLL 57 HH XX CC DD ... DD



Symbol	*Value*	*Definition*
HH		Attached device operational status
XX		Number of records in error
CC		Record numbers in error
DD		Data records returned without errors

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4.9.14 Summary of Primitives

Table 8 summarizes the Series 505 NIM Primitives.

Table 8 Summary of Primitives

Primitive		Format
Exception	Request	(None)
	Response	LLLL 00 PP DDDD (TT) (Optional)
Native	Request	LLLL 01 DD ... DD
	Response	LLLL 01 HH DD ... DD
Status	Request	LLLL 02
	Response	LLLL 02 HH EE FF
Configuration	Request	LLLL 03
	Response	LLLL 03 HH DDDD EEEE FFFF GGGG IIII JJJJ KKKK KKKK
Primitive Format Configuration	Request	LLLL 04
	Response	LLLL 04 NNNN MM EE FF GG BB ... BB 16 bytes
Packed Native	Request	LLLL 05 CC DD ... DD (repeated)
	Response	LLLL 05 HH CC DD ... DD (repeated)
Change State	Request	LLLL 10 DD
	Response	LLLL 10 HH
Read Block	Request	LLLL 20 TT NNNN AAAA
	Response	LLLL 20 HH DD ... DD
Read Random Block	Request	LLLL 21 TT NNNN AAAA (repeated)
	Response	LLLL 21 HH XX BB DD ... DD (repeated) (repeated XX times)
Write Block	Request	LLLL 30 TT AAAA DD ... DD
	Response	LLLL 30 HH

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Table 8 Summary of Primitives (cont.)

Primitive		Format
Write Random Block	Request	LLLL 31 TT NNNN AAAA DD ... DD (repeated)
	Response	LLLL 31 HH XX BB (BB is repeated XX times)
Define Block	Request	LLLL 50 CC TT NNNN AAAA (repeated)
	Response	LLLL 50 HH
Gather Block	Request	LLLL 51 EEEEEEEE
	Response	LLLL 51 HH EEEEEEEE DD ... DD (repeated)
Write and Gather Blocks	Request	LLLL 52 EEEEEEEE TT AAAA DD ... DD
	Response	LLLL 52 HH EEEEEEEE DD ... DD (repeated)
Define Record	Request	LLLL 55 CC DD TT NNNN AAAA (repeated DD times) (repeated up to 32 times)
	Response	LLLL 55 HH
Gather Record	Request	LLLL 56 XX CC (CC is repeated XX times)
	Response	LLLL 56 HH XX CC DD ... DD (repeated) (repeated XX times)
Write and Gather Record	Request	LLLL 57 XX CC TT AAAA DD ... DD (repeated XX times)
	Response	LLLL 57 HH XX CC DD ... DD (repeated) (repeated XX times)

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Table 9 summarizes the same Primitives listed in Table 8, but with extended addressing.

Table 9 Summary of Primitives (extended addressing)

Primitive		Format
Exception	Request	(None)
	Response	LLLL 00 PP DDDD (TT) (Optional)
Native	Request	LLLL 81 DD ... DD
	Response	LLLL 81 HH DD ... DD
Status	Request	LLLL 82
	Response	LLLL 82 HH EE FF
Configuration	Request	LLLL 83
	Response	LLLL 83 HH DDDD EEEE EEEE FFFF FFFF GGGG GGGG IIII IIII JJJJ JJJJ KKKK KKKK
Primitive Format Configuration	Request	LLLL 84
	Response	LLLL 84 NNNN MM EE FF GG BB ... BB 16 bytes
Packed Native	Request	LLLL 85 CC DD ... DD (repeated)
	Response	LLLL 85 HH CC DD ... DD (repeated)
Change State	Request	LLLL 90 DD
	Response	LLLL 90 HH
Read Block	Request	LLLL A0 TT NNNN AAAA AAAA
	Response	LLLL A0 HH DD ... DD
Read Random Block	Request	LLLL A1 TT NNNN AAAA AAAA (repeated)
	Response	LLLL A1 HH XX BB DD ... DD (repeated) (repeated XX times)
Write Block	Request	LLLL B0 TT AAAA AAAA DD ... DD
	Response	LLLL B0 HH

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Table 9 Summary of Primitives (cont.)

Primitive		Format
Write Random Block	Request	LLLL B1 TT NNNN AAAA AAAA DD ... DD (repeated)
	Response	LLLL B1 HH XX BB (BB is repeated XX times)
Define Block	Request	LLLL D0 CC TT NNNN AAAA AAAA (repeated)
	Response	LLLL D0 HH
Gather Block	Request	LLLL D1 EEEEEEEE
	Response	LLLL D1 HH EEEEEEEE DD ... DD (repeated)
Write and Gather Blocks	Request	LLLL D2 EEEEEEEE TT AAAA AAAA DD ... DD
	Response	LLLL D2 HH EEEEEEEE DD ... DD (repeated)
Define Record	Request	LLLL D5 CC DD TT NNNN AAAA AAAA (repeated DD times) (repeated up to 32 times)
	Response	LLLL D5 HH
Gather Record	Request	LLLL D6 XX CC (repeated XX times)
	Response	LLLL D6 HH XX CC DD ... DD (repeated) (repeated XX times)
Write and Gather Record	Request	LLLL D7 XX CC TT AAAA AAAA DD ... DD (repeated XX times)
	Response	LLLL D7 HH XX CC DD ... DD (repeated) (repeated XX times)

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Appendix A

PM550 CIM Requirements

A.1 INTRODUCTION

This appendix discusses biasing and terminating the TIWAY I Local Line for network installations containing CIMs in addition to self-biased and switch-biased devices.

A.2 LOCAL LINE LENGTH

The PM550 CIM supports operation over the Local Line at distances up to 10,000 feet and 9600 baud.

Advances in technology have provided line drivers and receivers that support Local Line operation up to 25,000 feet. These new drivers have been incorporated in TIWAY I compatible devices to support the extended operation. However, in networks containing the PM550 CIM, the Local Line length is restricted to 10,000 feet and 9600 baud.

A.3 LOCAL LINE BIAS AND TERMINATION

For TIWAY I networks using the Local Line, some devices are provided with a toggle switch to allow selection of bias or no bias for the Local Line. Other devices have self-biasing built in and therefore have no bias switch. The CIM is provided with a jumper which allows selection of bias or no bias.

The Siemens' Local Line must be properly terminated at both ends of the trunk to prevent a possible impedance mismatch that could result in signal reflections back along the line.

Termination is required regardless of the numbers or types of devices attached to the network.

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NOTE

All Siemens tap housings contain factory-installed termination resistors. If the Tap Housing is not used to terminate the Local Line, the terminating resistors must be removed when the output cable is attached.

A.3.1 Networks with Switch-biased Devices and CIMs

On networks using devices with the bias switch, CIMs, and self-biased devices, a bias must be applied to the line using the switch-biased device as described in the previous section. All CIMs on the network should be positioned somewhere between the two outermost switch-biased devices. (See Chapter 2.)

Terminate the network according to the instructions in Chapter 2.

A.3.2 Networks with Only Self-biasing Devices and CIMs

On networks using devices without the bias switch, bias must be applied to the Local Line by the CIM. To accomplish this, proceed as follows:

1. On networks having only one CIM, place this CIM at one end of the Local Line trunk, and install the jumpers provided with the CIM in accordance with the instructions in the *PM550 CIM User's Manual, Manual Number* PM550–1101154–4. This will apply the correct bias to the Local Line to prevent oscillations of the CIM receivers.

   To terminate the Local Line, replace the existing terminating resistors inside the CIM T-Tap housing. Connect 150-ohm resistors between the LLM+ and the cable shield, and also between LLM– and the cable shield. This resistance value is 150 ohms in each instance, and the connection is made in accordance with instructions inside the tap housing. The combination of termination resistors in the CIM, together with these 150-ohm resistors, provide the correct Local Line termination. Then, terminate the other end of the local line as described in Chapter 2.

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2. If more than one CIM is attached to a Local Line, place CIMs at the extreme ends of the Local Line trunk. Install the jumpers provided with the outermost CIMs in accordance with the instructions in the *PM550 CIM User's Manual*, Manual Number PM550–1101154–4. This will apply the correct bias to the Local Line to prevent oscillations of the CIM receivers.

   To terminate the Local Line, replace the existing terminating resistors inside the outermost CIM tap housings with 150-ohm resistors between the LLM+ and the cable shield, and also between LLM– and the cable shield. This resistance value is 150 ohms in each instance, and the connection is in accordance with instructions inside the tap housing. The combination of termination resistors in the CIM together with these 150-ohm resistors, provides the correct Local Line termination.

The following block diagram Figure A-1 illustrates the proper placement of the CIMs and the termination resistors for networks having CIMs and NIMs *without* the bias switch.

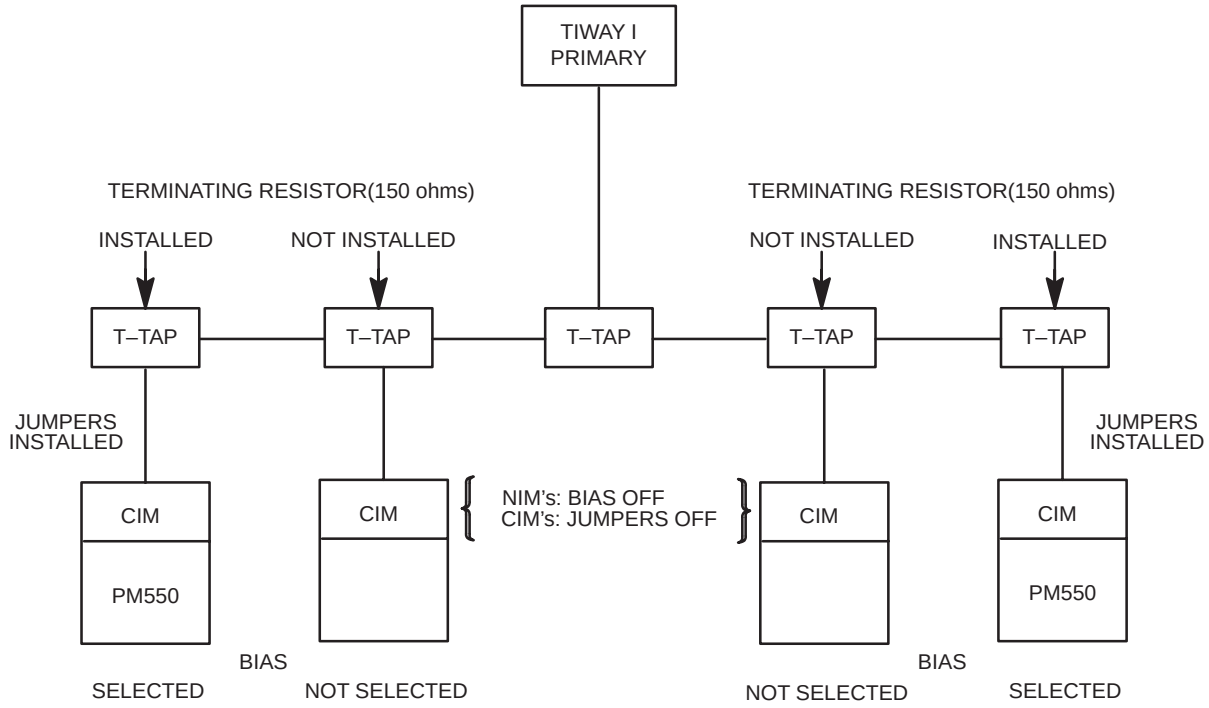


Figure A-1 Local Line Bias and Termination

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Appendix B

Network Congfiguration Data Sheet

Network Name _____ Location _____

Cable Diagram Reference _____

_____

GENERAL SPECIFICATIONS

Media type _____ Network Baud Rate _____

Sync/Asynch _____ Full/Half Duplex _____

Encoding _____ Modem Type _____

_____

NETWORK NODE SPECIFICATIONS

Node Name _____ Network Address _____

Controller Type _____ Serial Number _____ Software Release _____

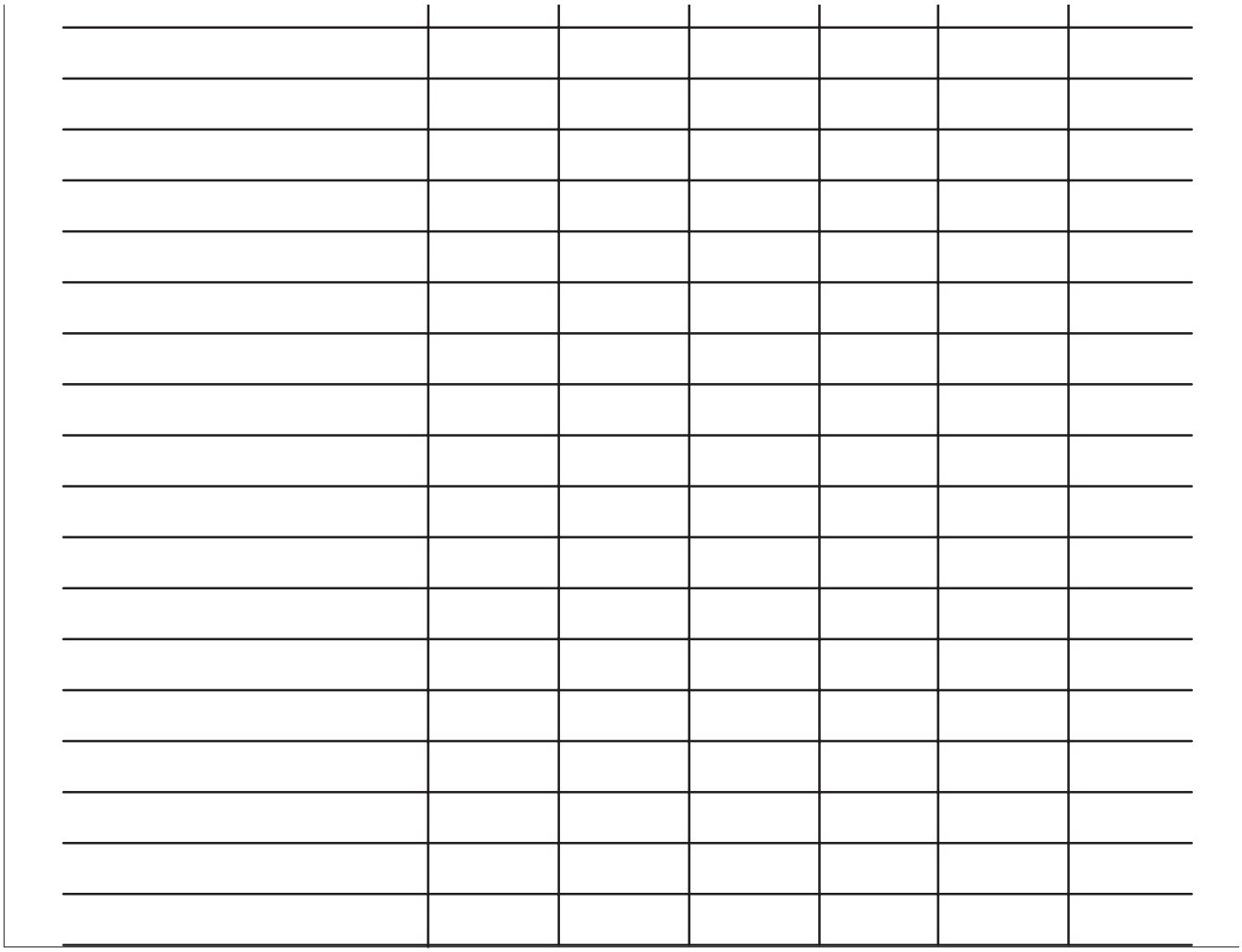
Interface Type _____ Serial Number _____ Software Release _____

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DATA DEFINITION TABLE

Date Name or Identifier	Data Type	Starting Address	Number of Elements	Record Number	Block Number	Length (Bytes)

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Appendix C
Network Evaluation Form

If you would like Seimens Industrial Automation, Inc. to evaluate your network requirements, complete and submit the Network Evaluation Form. Seimens Industrial Automation, Inc.'s, Technical Services group will analyze your requirements and provide you with a network design plan and quote.

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TIWAY I NETWORK EVALUATION FORM

*DATE OF REQUEST: ____/____/____ TI FSE: _____

*CUSTOMER COMPANY: _____

CONTACT NAME: _____

ADDRESS: _____

_____

TELEPHONE: (_____) _____ – _____

*AED CONTACT NAME: _____ PHONE: _____

*ORIGINATOR OF REQUEST: _____

*APPLICATION: _____

_____

*PROPOSED HOST COMPUTER: _____

*PROGRAMMING LANGUAGE: _____

*PLC MODELS	INITIAL PLC QUALITY	NUMBER OF WORDS XFRED
* PM550–		
* TI 520–		
* TI 530–		
* 5TI–		
* TI 560–		
* TI 565–		
*		
*		

*MAXIMUM DISTANCE FROM HOST TO FARTHEST PLC: _____ (FEET)

*LIST ALL OPERATOR INTERFACE REQUIREMENTS FOR THE PLCs: _____

_____

*CAN THE NETWORK SIZE BE REDUCED TO INCREASE PERFORMANCE? _____

*DESCRIBE MAXIMUM RESPONSE TIMES FOR COMMUNICATION: _____

_____

*CONNECTIVITY REQUIREMENTS INTO OTHER NETWORKS OR DEVICES: _____

_____

*WHO WILL BE WRITING THE APPLICATION SOFTWARE? _____

_____

*SPECIAL SAFETY REQUIREMENTS: _____

_____

*LIST ELECTRICAL NOISE PROBLEMS: _____

_____

*OTHER REQUIREMENTS OR NOTES: _____

_____

_____

*WHEN DOES THE NETWORK HAVE TO BE OPERATIONAL? _____

*WHEN DOES THE COMPLETE SYSTEM HAVE TO BE OPERATIONAL? _____

*WHO DEFINES THE PLC CONTROL ENVIRONMENT? _____

*NAME: _____ PHONE: (_____) _____ – _____

*WHO DEFINES THE NETWORK AND SYSTEM REQUIREMENTS?

NAME: _____ PHONE: (_____) _____ – _____

*SEND NPS QUOTE TO:

NAME: _____ PHONE: (_____) _____ – _____

COMPLETE AND RETURN TO THE NETWORK PLANNING SERVICE FOR SITE SURVEY SUPPORT AND A QUOTE FOR A NETWORK DESIGN.

SEND TO: Seimens Industrial Automaion, Inc.
TECHNICAL SERVICES GROUP
MS 3532
P.O. BOX 1255
JOHNSON CITY, TN 37605–1255

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Appendix D
Specifications

Environmental specifications:

Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	–40° to 85° C (–40° to 185° F)
Relative Humidity	5% to 95% noncondensing
Vibration	
Sinusoidal	IEC 68–2–6, Test Fc; 0.15 mm peak–to–peak, 10–57 Hz; 1.0g, 57–150 Hz
Random	NAVMAT P–9492 or IEC 68–2–34, Test Fdc with 0.04g^2/Hz, 80–350 Hz and 3dB/octave rolloff 80–20 Hz and 350–2000 Hz, at 10 minutes/axis
Impact Shock	IEC 68–2–27, Test Ea; Half Sine, 15g, 11ms
Electrostatic Discharge	IEC 801, Part 2, Level 4 (15 kV)
Noise Immunity (Conducted)	IEC 801, Part 4, Level 3 MIL STD 461B, Part 4; CS01, CS02, CS06 IEC 255–4, Appendix E EEC 4517/79 (Com)78 766 Final, Part 4 IEC 472, (2.5 kV)
Noise Immunity (Radiated)	IEC 801, Part 3, Level 3 MIL STD 461B, Part 4; RS01, RS02
Corrosion Protection	All parts are of corrosion resistant material or are plated, or painted, as corrosion protection.

Power requirements:

PPX:505–7339: 8 watts, +5 VDC

PPX:505–7340: 8 watts, +5 VDC;
0.125 watts, –5 VDC

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Communications:

Data Rates	110; 150; 300; 600; 1,200; 2,400; 4,800; 9,600; 19,200; 38,400; 57,600; 115,200 bits per second.
RS–232–C/423 Ports	Configured as Data Terminal Equipment (DTE), synchronous or asynchronous operation, full or half duplex operation, NRZ or NRZI encoding.
Local Line Ports	Local Line Ports default to asynchronous, half duplex, with NRZI encoding.
Data Link Protocol	High Level Data Link (HDLC, ISO 4335) Unbalanced Normal Response Mode, ADCCP (UN,4) class of procedure per Chapter 11 of ANSI Standard X3.66–1979. The Series 505 NIM operates as an HDLC Secondary station on the network.
Network Control Protocol	TIWAY I normally operates with null network layer services; however, the user may optionally select CCITT X.25 protocol in the Permanent Virtual Circuit Mode of operation.
Network Media	Shielded twisted pair cable for Local Line, or appropriate RS-232-C cable for RS-232-C models
Undetected Bit Error Rate	6×10^{-13} (calculated) with cable meeting TIWAY I recommended standards

Certifications and approvals: UL Listed, CSA pending

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Appendix E
Primitive Examples

The following TIWAY I Primitive example reads four words of variable memory from a Series 505 P/C, starting at memory location 100 (hex = 64). The format for the request follows:

Request: LLLL 20 TT NNNN AAAA = 0006 20 01 0004 0064, where:

LLLL (Length) = 0006
Primitive Code = 20
TT (Data Type) = 01 (V, variable memory)
NNNN (Number of locations) = 0004
AAAA (Address, data element location) = 0064

Response: LLLL 20 HH DD ... DD = 000A 20 00 8464 8665 A001 01F4
LLLL (Length) = 000A
Primitive Code = 20
HH (Status) = 00 (unit operational and executing logic)
DDDD ... (values read from V memory)

$V0100 = 8464_{16}$

$V0101 = 8665_{16}$

$V0102 = A001_{16}$

$V0103 = 01F4_{16}$

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In this example, the same task is performed as in the above example, but with extended addressing.

Command: LLLL A0 TT NNNN AAAA AAAA = 0008 A0 01 0004 0000 0064, where:

LLLL (Length) = 0008
Primitive Code = A0 (extended address format for Primitive 20)
TT (Data Type) = 01 (V, variable memory)
NNNN (Number of locations) = 0004
AAAA AAAA (Address) = 0000 0064

Response: LLLL A0 HH DD ... DD = 000A A0 00 8464 8665 A001 01F4

LLLL (Length) = 000A
Primitive Code = A0 (extended address format for Primitive 20)
HH (Status) = 00 (unit operational and executing logic)
DDDD ... (values read from V memory)

$V100 = 8464_{16}$

$V101 = 8665_{16}$

$V102 = A001_{16}$

$V103 = 01F4_{16}$

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Completeness	_____	_____	_____	_____
Overall design	_____	_____	_____	_____
Size	_____	_____	_____	_____
Index	_____	_____	_____	_____

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Manual Assembly Number: 2587871–0053 **Date:** 03/94
Order Number: PPX:TIWAY–8124–2

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