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ProLinX[®]
101M
ProLinX Gateway
IEC 60870-5-101 Master

March 14, 2012

PROTOCOL MANUAL

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101M Protocol Manual

March 14, 2012

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Important Installation Instructions

Power, Input, and Output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods, Article 501-4 (b) of the National Electrical Code, NFPA 70 for installation in the U.S., or as specified in Section 18-1J2 of the Canadian Electrical Code for installations in Canada, and in accordance with the authority having jurisdiction. The following warnings must be heeded:

- A** WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIV. 2;
- B** WARNING - EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE REPLACING OR WIRING MODULES
- C** WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
- D** THIS DEVICE SHALL BE POWERED BY CLASS 2 OUTPUTS ONLY.

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WARNING – EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

AVERTISSEMENT – RISQUE D'EXPLOSION – AVANT DE DÉCONNECTER L'EQUIPMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX.

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- 8 MB file storage for HTML files and associated graphics files (previously limited to 384K)
- 32K maximum HTML page size (previously limited to 16K)

To upgrade a previously purchased Series C model:

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Markings

Electrical Specifications

Label Markings

CL I Div 2 GPs A, B, C, D

II 3 G

Ex nA nL IIC X

-20 °C ≤ Ta ≤ 60 °C

II – Equipment intended for above ground use (not for use in mines).

3 – Category 3 equipment, investigated for normal operation only.

G – Equipment protected against explosive gasses.

Agency Approvals and Certifications

cULus	Class I, Div 2 Groups A, B, C, D T6
	-30 °C ≤ Ta ≤ 60 °C



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1 Introduction

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The ProLinux 101M module works as a master to monitor and control up to 16 slaves using the IEC 60870-5-101 protocol. This protocol is commonly used in substation applications to communicate protection equipments (for example, relays) with a master device. The ProLinux 101M module can periodically poll slaves using Class 1 and Class 2 requests in order to continually update the configured monitor points to the internal database. A monitor point can also be updated through events generated by the slave. Each module supports up to three data sets (referred to as sectors in this manual) per slave address. Each sector is identified by a distinct common ASDU address.

The ProLinux 101M module can also send commands to the controlled slaves. Up to 500 commands are supported by the module. The supported commands are: General Interrogation, Time Synchronization and General Command. When sending a General Command, the control point uses an internal database data as the source value for the command.

Several resources are available to assist with the configuration and support of the ProLinux modules.

Installation, Debug Guides, Protocol Driver documents, and so on are all available for downloading at www.prosoft-technology.com

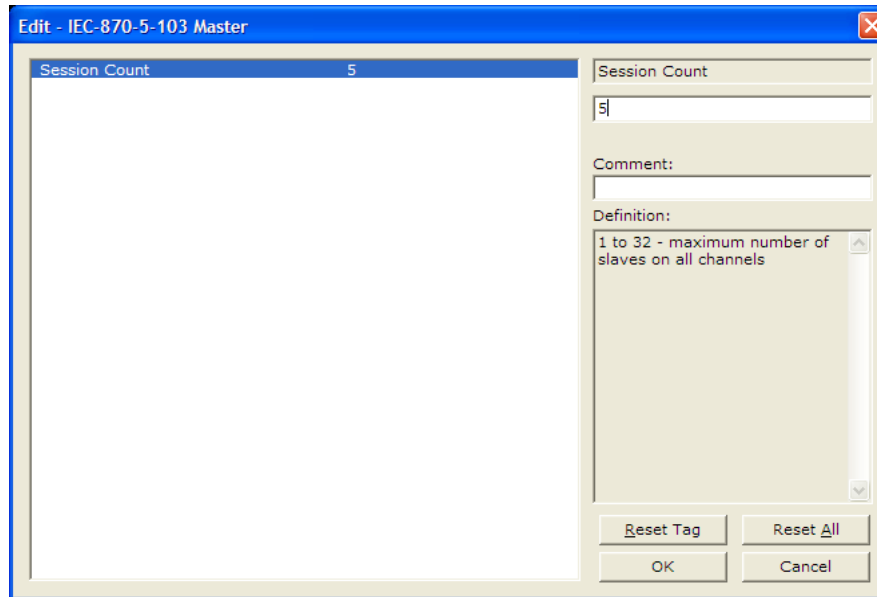
Publication	Title
IEC 60870-5-101	Companion Standard for the informative interface of protection equipment.
IEC 60870-5-101M Annex A	Generic Functions: Examples of constructing a directory.
IEC 60870-5-1	Transmission Frame Formats
IEC 60870-5-2	Link Transmission Procedures
IEC 60870-5-3	General Structure of Application Data
IEC 60870-5-4	Definition and Coding of Application Information Elements
IEC 60870-5-5	Basic Application Functions

1.1 Quick Start

Step 1: Configure the Number of Slaves (Sessions)

The IEC 60870-5-101 protocol is a master-slave protocol where the slaves are typically protection equipments for substations. The 101M module supports a total 16 slaves (sessions) connected to the module's two application ports.

Note: The actual number of available sessions (slaves) will depend on the total number of sessions and sectors (configured). The recommended maximum number of sessions is sixteen.



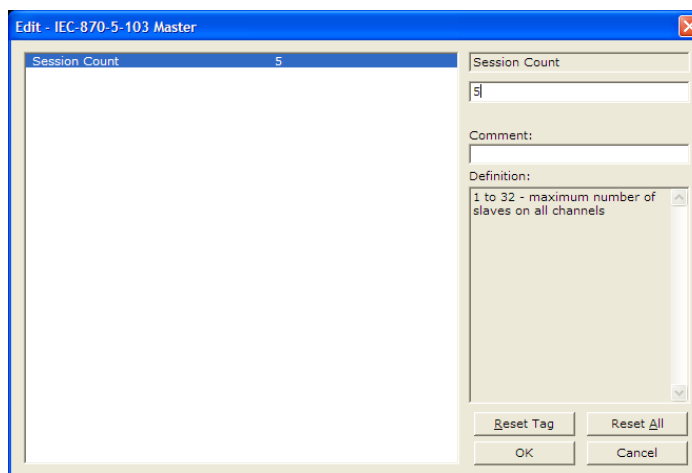
In the example above, the module will only poll sessions 0 to 4. The module would not poll sessions 5 to 31.

In Step 3, you will configure each session as an actual slave in the network.

Step 2: Configure the Port Communication Parameters

The user should configure the port communication parameters in order to enable data transfer between the master and the slave(s). The port communication parameters include baud rate, parity, RTS ON, RTS OFF, and Minimum Delay. The IEC 60870-5-101 protocol uses two baud rates: 19200 or 9600 kb/s and even parity.

Refer to the [IEC-870-5-101 Master Port 0] section in the configuration file in order to configure the communication parameters for the 101M port:



You must also configure the port jumpers to select the correct communication mode: RS-232, RS-422, or RS-485.

Step 3: Configure the Session (Slave) Poll Parameters

According to the IEC 60870-5-101 protocol, the master cyclically polls data from the slaves. The data is classified as Class 1 or Class 2. Events belong to Class 1, and analog data to Class 2. The module can request data through Class 1 or Class 2 requests. Responses to control command and general interrogation commands are also sent as Class 1 data.

Refer to the [IEC-101 Master Session x] section in the configuration file in order to configure how each slave will be polled.

These parameters include the *Data Link Address*, which is the slave address that identifies each piece of protection equipment in the network. There should be a unique number for each slave in the network. There are also certain parameters that pertain to how the Class 1 and Class 2 polls will be used for data transfer.

You must enter the number of sectors for each session using the Sector Count parameter. The module accepts up to five sectors per session.

Note: Actual number of available sectors per session will depend on the total number of sessions and sectors configured. The recommended maximum number of sectors is three.

Parameter	Value
Sector Count	1
Data Link Address	0
Failure Delay	10
Confirm Timeout	1000
Retry Count	2
Response Timeout	20000
C1/C2 Poll Count Pend	5
Class 1 Polls	10
Class 1 Pend delay	0
Class 2 Pend delay	0
Class 1 Poll delay	0
Class 2 Poll delay	0

Configuration Area:

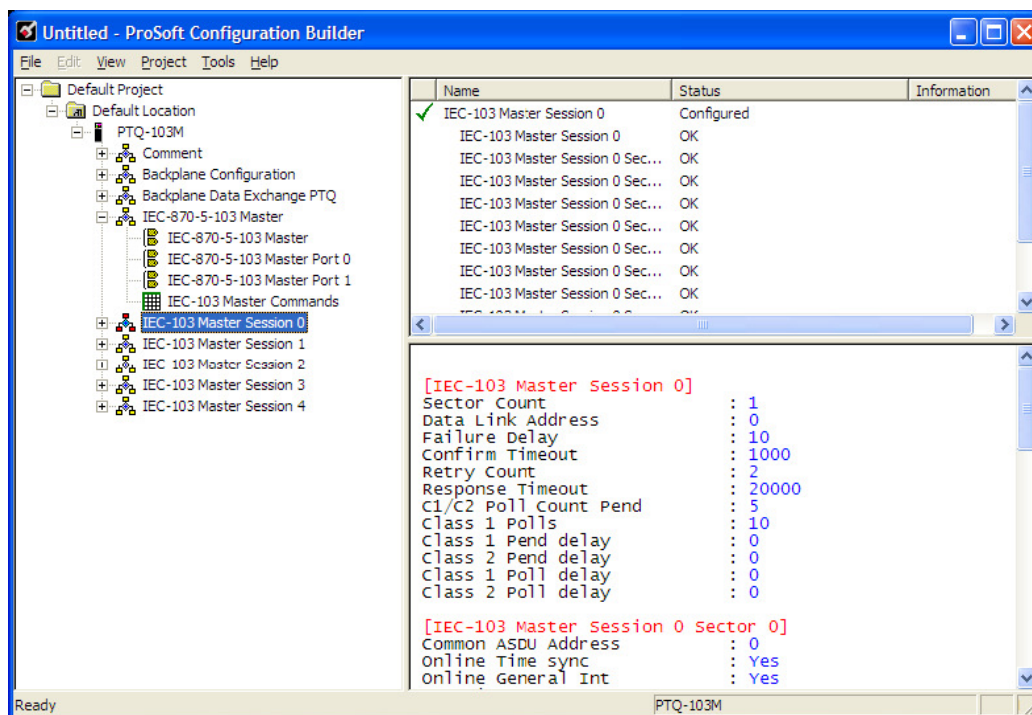
Sector Count: 1

Comment:

Definition: Number of Sectors

Buttons: Reset Tag, Reset All, OK, Cancel

Repeat this step for each session. For example, if you configured 5 sessions during **Step 1**, configure Sessions 0 to 4.



Step 4: Sector (Data Set) Configuration

For each session (slave), you must configure one or more *sectors*. A sector is a data set defined by the vendor. Each sector is identified by the *Common ASDU Address* parameter in the [IEC-101 Master Session x Sector 0] area in the configuration. This area also contains some parameters that will affect the module initialization procedure.

Note: The actual number of available sectors per session will depend on the total number of sessions and sectors configured. The recommended maximum number of sectors is three.

Repeat this step for each sector used by the application. The module will only use the sectors configured in the previous step.

Step 5: Monitor Point Configuration (Monitor Direction)

When a slave receives a Class 1 or Class 2 request from the master, it responds with a message containing data. Each piece of equipment is normally configured to respond with specific points when it is being polled with a Class 2 request. During a Class 2 response, the slave may set a control bit (ACD) to inform the master that there are new events to be transmitted. Then, the master will send a Class 1 poll to read the events from the slave.

The IEC 60870-5-101 protocol states that the data is transferred between the master and slave using an ASDU (Application Service Data Unit) format. Each format is given by:

Type Identification

Variable Structure Qualifier

Cause Of Transmission

Common Address of ASDU

Function Type

Information Number

Data...

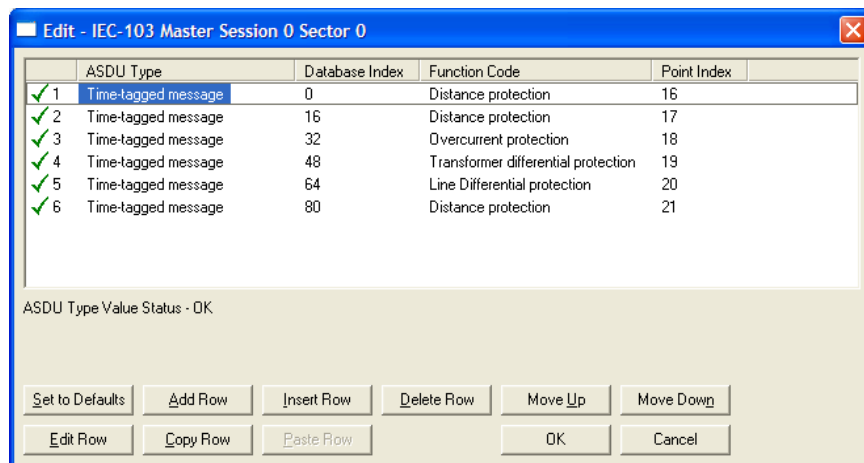
Data...

...

Refer to the protection equipment specification for the following information about each point:

- **Type:** Type of the message
- **Function Type:** Type of protection function
- **Information Number:** Point Identification

This information identifies each point in the configuration. You must configure the points that will be updated in the module database when a Class 2 or Class 1 response containing data is sent from the slave. Refer to **[IEC-101 MASTER SESSION X SECTOR 0]** to configure each point.



For each point, configure the following values.

ASDU Type: ASDU type for the point

Function Type: Function type for the point

Point Index: Information number for the point

Database Index: The module database location where the value will be copied.
The type of addressing will depend on the ASDU type:

ASDU Type	DB Addressing
1	Bit address with each point occupying 2 bits
2	Bit address with each point occupying 2 bits
3	Word address with each point occupying 4 words
4	Double-word address for the single float value
5	Byte address with each point occupying 12 bytes
9	Word address with each point occupying 9 words

For example, to configure the following points,

- Time-tagged message point with information number 17 (teleprotection active) and distance protection function (128). The value will be copied to bits 0 and 1 in word 1 (second word) in the module database.
- Measurands I point with information number 144 (measurands I) and overcurrent protection function (160). The value will be copied to word 50 in the module Database.

use the following configuration.

ASDU Type	Database Index	Function Code	Point Index
✓ 1 Time-tagged message	16	Distance protection	17
✓ 2 Time-tagged message	50	Overcurrent protection	144

ASDU Type Value Status - OK

Set to Defaults Add Row Insert Row Delete Row Move Up Move Down Edit Row Copy Row Paste Row OK Cancel

Every time the module responds with a Class 1 or Class 2 poll with these points, the module will copy the value to the database.

All the points configured in this section are sent from the slave to the master. The protocol specification refers to this data flow as the *Monitor Direction*.

Repeat this step for each sector.

Step 6: Command Configuration (Control Direction)

You can also configure the master to send commands to slaves. The IEC 60870-5-101 protocol specification refers to this data flow as *Control Direction*. The commands include general commands, interrogation requests, and time synchronization requests. In order to configure a command, refer to the [IEC-101 Master Commands] section:

Enable	Database Index	Poll Interval	Session Index	Sector Index	Data type	Function Code
✓ 1 Continuous	0	0	0	0	Time synchronization	Global functi
✓ 2 Continuous	10	0	0	7	Time synchronization	Global functi

Enable Value Status - OK

Set to Defaults Add Row Insert Row Delete Row Move Up Move Down Edit Row Copy Row Paste Row OK Cancel

To send a General Command, you can associate the source data with a register in the module database to be sent to the remote slave. The following example will send 8 commands to the slave configured as Session 0/Sector 0. Use bit addressing to send a General Command.

The screenshot shows a software window titled "Edit - IEC-103 Master Commands". It contains a table with 11 columns: Enable, Database Index, Poll Interval, Session Index, Sector Index, Data type, Function Code, Point Index, Override Flag, and Override Value. There are 8 rows of data, each representing a command for distance protection. The first row is selected, and the "Enable" checkbox is checked. Below the table, there is a status bar that says "Enable Value Status - OK." and a set of buttons for editing the commands.

	Enable	Database Index	Poll Interval	Session Index	Sector Index	Data type	Function Code	Point Index	Override Flag	Override Value
1	☒	Continuous	16000	0	0	General Command	Distance protection	16	0	0
2	☒	Continuous	16016	0	0	General Command	Distance protection	17	0	0
3	☒	Continuous	16032	0	0	General Command	Distance protection	18	0	0
4	☒	Continuous	16048	0	0	General Command	Distance protection	19	0	0
5	☒	Continuous	16064	0	0	General Command	Distance protection	23	0	0
6	☒	Continuous	16080	0	0	General Command	Distance protection	24	0	0
7	☒	Continuous	16096	0	0	General Command	Distance protection	25	0	0
8	☒	Continuous	16112	0	0	General Command	Distance protection	26	0	0

Enable Value Status - OK.

Buttons: Set to Defaults, Add Row, Insert Row, Delete Row, Move Up, Move Down, Edit Row, Copy Row, Paste Row, OK, Cancel.

Refer to the device specification for the Point Index (Information Number) listing available for control direction.

The module can also send a periodic General Interrogation command in order to initialize and refresh the event-updated points in its database. The slave keeps a list of all data subject to General Interrogation.

Step 7: Set the module's Data and Time (optional)

If the module will be sending time synchronization commands to the slave, you must set the *date and time* on the module (page 79).

Step 8: Transfer the Configuration from the Computer to the module.

1.2 Functional Overview

1.2.1 IEC 60870-5-101 Master Protocol Implementation

The following section describes the flow of data between the 101M module and the IEC 60870-5-101 Master unit.

Master Driver

The master driver supported on the application port of the module emulates an IEC 60870-5-101 Master device.

The module communicates with one or more controlled stations on what are referred to as sessions. A session represents a controlled device with a unique data link layer address. Each session (controlled device) contains one data set (sector) that is defined by the vendor of the device.

Note: The IEC 60870-5-101 specification only supports the unbalanced mode. No support is given in the protocol for the balanced mode and the module does not support this mode.

Initialization

According to the IEC 60870-5-101 protocol, the Master should send a Reset FCB (or Reset CU) request to all slaves on the network. The ProLinx 101M module will only send the initialization requests to the Data Link Addresses that are configured as sessions. Once the slave responds to the FCB request with an ACK response, the master starts polling the slave. The master will continuously send the Reset FCB request until it receives the ACK response.

The user may also configure the module to send time synchronization and general interrogation requests once the slave has responded to the reset FGD request. Refer to the configuration file for the initialization parameters.

If the slave is not responding to the initialization request, the user should verify the following items in order to troubleshoot the configuration:

Verify that the slave address (*Data Link Address*) is configured as a session (slave) in the module. For example, if the module has two sessions correctly configured (*Data Link Addresses 1 and 2*), and the slave is configured with a *Data Link address* of 3, the slave will not respond to the initialization request.

- Verify that the communication port parameter matches the network parameters.
- Check cables
- Verify that the communication mode jumpers (RS-232 or RS-485) are set correctly.

Data Transfer in Monitor Direction

The master driver cyclically polls data from the slaves. The data is classified into two classes; Class 1 and Class 2. Events belong to Class 1 and analog data to Class 2. The user may configure the module to set how frequently the master will poll with both classes.

The slave will respond to a Class 2 poll with specific data points. The user can configure these points in the ProLinx module in order to periodically update the database with the point values. The other protocol can access these points using the same database.

Data Transfer in Control Direction

The ProLinx 101M module can be configured to issue commands to the configured slaves (sessions). The General Command can be used to transfer data from the module to each slave. The user may associate a control data point with a register in the internal database using the configuration file. The module may also send a time synchronization request to the device.

The module supports up to 500 commands. Each command is associated with a configured session and server. It is essential that the slave is correctly configured in order to have successful command communication.

1.2.2 101M Data Types

This section describes the databases used by the module to support the IEC 60870-5-101 protocol of the IEC 60870-5-101 data types. Refer to the configuration section for a complete discussion of the configuration file.

The following table summarizes the data types:

Type ID	Description	Data Representation
1	Time-tagged messages with each data point represented by two bits.	Dual-bit status (7.2.6.5 with 00b (0 decimal) = not used. 01b (1 decimal) = Off 10b (2 decimal) = On and 11b (3 decimal) = Not Used
2	Time-tagged messages with relative time with each point represented by two bits.	Dual-bit status (7.2.6.5 with 00b (0 decimal) = not used, 01b (1 decimal) = Off, 10b (2 decimal) = On and 11b (3 decimal) = Not used.
3	Measurands with quality descriptor. The lower three bits of the values represented in the data type contain status information. The upper 13 bits of the value contained a signed, 12-bit number. This data type will return from 1 to 4 values. The number of words received depends on the information object number and the slave device	Measurand with quality descriptor (7.2.6.8) Bit 0: 0=No overflow, 1 = overflow Bit 1: 0=valid, 1 = invalid Bit 2: Reserved Bit 3 to 25: Value from $-1..+1 \cdot 2^{-12}$
4	Time-tagged measurands with relative time with the value in the packet represented by a single floating-point number.	Short floating-point number stored on IEEE STD 754 format (fraction, Exponent, Sign) (7.2.6.20)
5	Identification data composed of 12 characters of data. Each point in defined of this data type should reserve 12 bytes (6-word addresses) in the database for the data received.	Byte data as defined in 7.2.6.2. First 8 bytes are characters 1 to 8 and last 4 bytes are manufacture bytes, either decimal (0 to 255) or as ASCII characters.
9	Measurands with quality descriptor. The lower three bits of the values represented in this data type contain status information. The upper 13 bits of the value contained a signed, 12-bit number. This data type will return from 1 to 9 values (some slaves will return up to 16 values). The number of words received is dependant on the information object number and the slave device	Measurand with quality descriptor (7.2.6.8) Bit 0: 0=No overflow, 1=Overflow Bit 1: 0=Valid, 1=Invalid Bit 2: Reserved Bits 3 to 25: Value from $-1..+1 \cdot 2^{-12}$
20	General command to control a dual-point object. Each command issued by the module uses the values of two adjacent bits in the database or an override value specified by the user command.	Dual-bit status (7.2.6.4 with 00b (0 decimal) = not used 01b (1 decimal) = Off, 10b (2 decimal) = On and 11b (3 decimal) = not used.

2 Port Physical and Protocol Specifications

In This Chapter

- ❖ General Specifications.....24
- ❖ Master Functional Specifications.....25

2.1 General Specifications

The 101M module acts as an input/output module between the IEC 60870-5-101 network and many of the other serial and network protocols, as well as several proprietary interfaces. A 4000-word register space in the module exchanges data between the two protocols.

General specifications include:

- Built in accordance to the approved international specification
- Support for the storage and transfer of up to 4000 registers between protocols
- User-definable module memory usage
- Configuration via a user-generated text file (downloadable to the module)
- Protocol implementation conforms to the IEC 60870-5-101 specification with fully configurable parameters

2.2 Master Functional Specifications

2.2.1 Driver Protocol Specifications

Type	Specifications
General Parameters	
Internal Database	4000 registers (words) available.
IEC 60870-5-101 Master Configurable Parameters	
Status Data	Status data is returned in a block of counter values allowing communications to be effectively debugged.
Conformance Specifications	See Reference chapter for full Object Definition document

3 Configuring the Gateway

3.1 Installing ProSoft Configuration Builder Software

You must install the *ProSoft Configuration Builder (PCB)* software to configure the gateway. You can always get the newest version of *ProSoft Configuration Builder* from the ProSoft Technology website.

Installing ProSoft Configuration Builder from the ProSoft website

- 1 Open your web browser and navigate to <http://www.prosoft-technology.com/pcb>
- 2 Click the **DOWNLOAD HERE** link to download the latest version of *ProSoft Configuration Builder*.
- 3 Choose **SAVE** or **SAVE FILE** when prompted.
- 4 Save the file to your *Windows Desktop*, so that you can find it easily when you have finished downloading.
- 5 When the download is complete, locate and open the file, and then follow the instructions on your screen to install the program.

If you do not have access to the Internet, you can install *ProSoft Configuration Builder* from the *ProSoft Solutions Product CD-ROM*, included in the package with your gateway.

Installing ProSoft Configuration Builder from the Product CD-ROM

- 1 Insert the *ProSoft Solutions Product CD-ROM* into the CD-ROM drive of your PC. Wait for the startup screen to appear.
- 2 On the startup screen, click **PRODUCT DOCUMENTATION**. This action opens a *Windows Explorer* file tree window.
- 3 Click to open the **UTILITIES** folder. This folder contains all of the applications and files you will need to set up and configure your gateway.
- 4 Double-click the **SETUP CONFIGURATION TOOL** folder, double-click the **PCB_*.EXE** file and follow the instructions on your screen to install the software on your PC. The information represented by the "*" character in the file name is the *PCB* version number and, therefore, subject to change as new versions of *PCB* are released.

Note: Many of the configuration and maintenance procedures use files and other utilities on the CD-ROM. You may wish to copy the files from the *Utilities* folder on the CD-ROM to a convenient location on your hard drive.

3.1.1 Using the Online Help

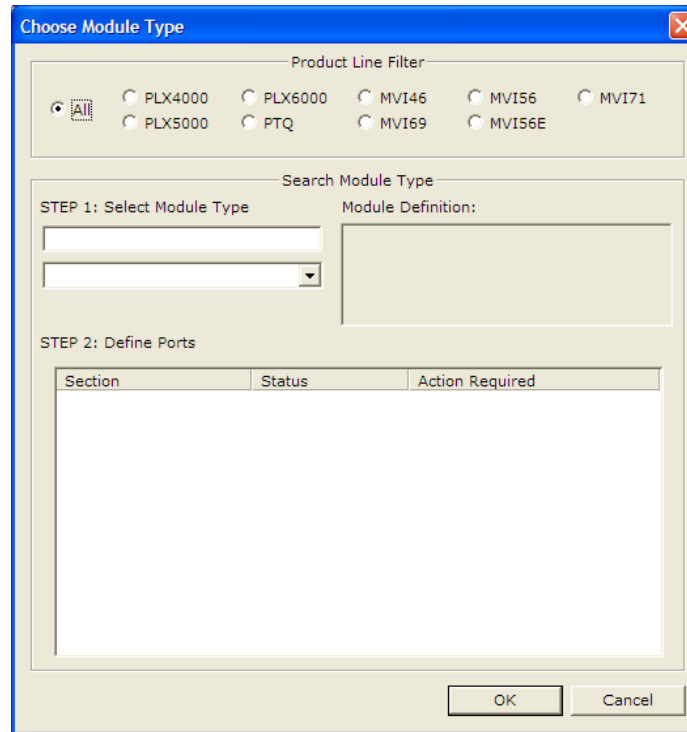
Most of the information needed to help you use ProSoft Configuration Builder is provided in a Help System that is always available whenever you are running ProSoft Configuration Builder. The Help System does not require an Internet connection.

To view the help pages, start ProSoft Configuration Builder, open the **HELP** menu, and then choose **CONTENTS**.

3.2 Adding a Module

Begin the process of creating your custom application configuration by selecting the module type of your ProLinx gateway.

- 1 Double-click the **DEFAULT MODULE** icon to open the *Choose Module Type* dialog box.



- 2 On the *Choose Module Type* dialog box, select the **MODULE** type.

Or

- 1 Open the **PROJECT** menu and choose **LOCATION**.
- 2 On the **LOCATION** menu, choose **ADD MODULE**.

To add a module to a different location

- 1 Right-click the **LOCATION** folder and choose **ADD MODULE**. A new **MODULE** icon appears.

Or

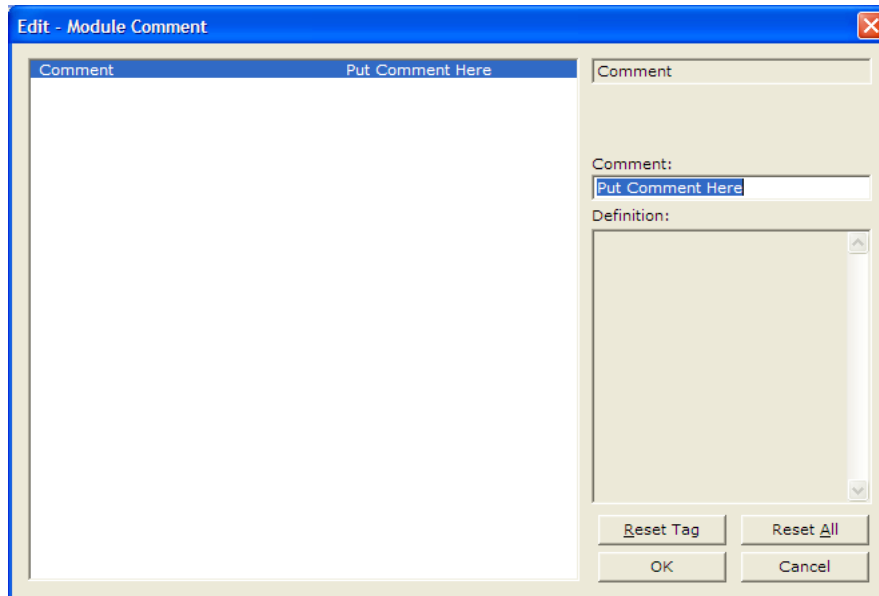
- 1 Select the **LOCATION** icon.
- 2 From the **PROJECT** menu, select **LOCATION**, and then select **ADD MODULE**.

3.3 Configuring Module Parameters

- 1 Click on the **[+]** sign next to the gateway icon to expand gateway information.
- 2 Click on the **[+]** sign next to any  icon to view gateway information and configuration options.
- 3 Double-click any  icon to open an *Edit* dialog box.
- 4 To edit a parameter, select the parameter in the left pane and make your changes in the right pane.
- 5 Click **OK** to save your changes.

3.4 Creating Optional Comment Entries

- 1 Click the **[+]** to the left of the  **Comment** icon to expand the module comments.
- 2 Double-click the  **Module Comment** icon. The *Edit - Module Comment* dialog box appears.



- 3 Enter your comment and click **OK** to save your changes.

3.5 Printing a Configuration File

- 1 Select the gateway icon, and then click the right mouse button to open a shortcut menu.
- 2 On the shortcut menu, choose **VIEW CONFIGURATION**. This action opens the *View Configuration* window.
- 3 In the *View Configuration* window, open the **FILE** menu, and choose **PRINT**. This action opens the *Print* dialog box.
- 4 In the *Print* dialog box, choose the printer to use from the drop-down list, select printing options, and then click **OK**.

3.6 101M Protocol Configuration

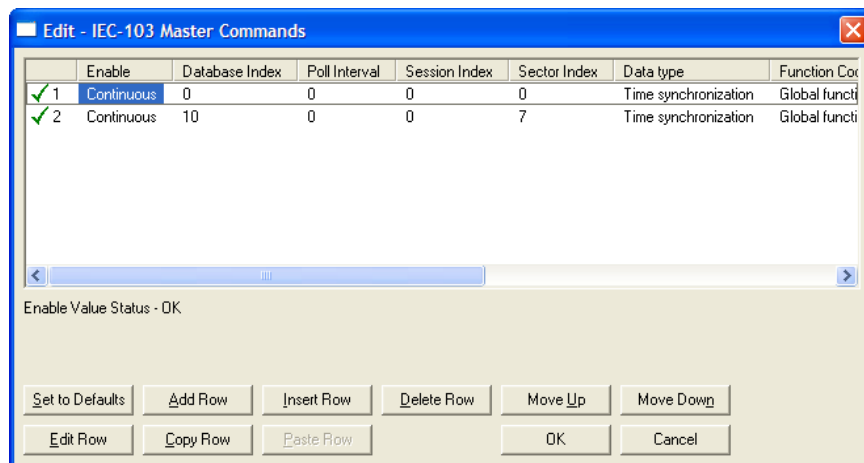
The following is excerpted from a configuration file showing typical examples used for configuration of the 101M driver. A default configuration file for each module application that includes the 101M interface card is available for download from the www.prosoft-technology.com web site. This default configuration can easily form the basis for a working solution. This file can either be downloaded from the ProSoft web site at www.prosoft-technology.com, or transferred from the module.

The configuration file contains the following topics:

[Section]	Description
[IEC-870-5-101 Master]	General configuration for the driver.
[IEC-870-5-101 Master Port n]	Configuration for one of the application ports.
[IEC-101 Master Session x]	Definition of each control unit.
[IEC-101 Master Session x Sector y]	Definition for each sector in the controlled unit.
[IEC-101 Master Commands]	Command list to control slave units.

3.6.1 [IEC-101 Master Commands]

This section can contain up to 1000 user defined commands to be executed by the module and sent to the controlled devices. There is no need to place Class 1 or Class 2 polls in this list for the controlled devices as the master driver for each port will execute these automatically when the port is idle. In order for the port to be idle, make sure that there is idle time available, and that the commands do not constantly utilize the ports.



Enable Code

0 = Disabled

1 = Enabled, will execute using Poll Interval parameter (page 34) (seconds)

2 = Conditional (executed when point in database changes)

This field defines whether the command is to be executed, and under what conditions. To disable the command, set this parameter to 0 (Disabled). You can still execute commands through the processor, using a *Special Function* block.

To enable the command, set this parameter to 1.

- Set the Poll Interval Time to 0 to execute the command during each scan of the command list.
- Set the Poll Interval Time to a value in seconds, to execute the command at the specified interval (page 34).

To execute the command only if the internal data associated with the command changes, set this parameter to 2. This value is valid only for write commands.

Database Index

Database Index is the location in the module's database to use as the source for the data in the command. Refer to *Data Type* for specific information on addressing (page 35).

The data type field determines the meaning of the database index as follows:

Type	Description	DB Index type
6	Clock synchronization	NA
7	General interrogation	NA
20	General Command	Bit address

Poll Interval

This parameter specifies the minimum frequency at which the module should execute the command when the Enable Code is set to one **1**. The value is entered in units of seconds. For example, to execute a command every 10 seconds, enter a value of **10** in the field. A value of **0** for the parameter implies that the command should be executed every scan of the list, as quickly as possible.

Session Index

0 to 31

Session Index represents the session index in the module to associate with the command. This index is set when the session is read in from this file. The range of values for this field is 0 to 31.

Sector Index

0 to 4

Sector Index represents the sector index for the specific session. There are a maximum of five (5) sectors per session.

Data Type

Data type file represents the ASDU type as follows:

Type	Description
6	Clock synchronization
7	General interrogation
20	General Command

Function Code

Code	Definition
128	Distance protection
160	Overcurrent protection
176	Transformer differential protection
192	Line Differential protection
255	Global function type
133	Meter Data for SIEMENS Devices
1	Reset Process
2	Class 2 Polls
x	User-defined

Note: The last item in the *Function Code* dropdown list is user-defined. If you select **USER DEFINED** from the dropdown list, a text box will appear below the list. You may enter any function code in this text box that will be accepted by the destination slave.

Point Index

Point Index specifies the address in the remote slave device of the point to interact with.

Index Value	Description
1	Bit address with each point occupying 2 bits
2	Bit address with each point occupying 2 bits
3	Word address with each point occupying 4 words
4	Double-word address for the single float value
5	Byte address with each point occupying 12 bytes
9	Word address with each point occupying 9 words

Override Flag

0 or 1

Override Flag field is used for general commands to determine the value to be written. If the override flag is clear (0), the value in the database will be utilized. If the override flag is set (1), the value specified in the override value field will be used.

Override Value

If the Override Flag is set to "Yes", you can use this setting to always force a control parameter to a fixed value. Use Enable code **CONDITIONAL** and the database value for the command to determine when the value should be written.

3.6.2 [IEC-870-5-101 Master]

This section establishes the total number of slaves to communicate with through both application serial ports.

[IEC-870-5-101 Master]

Session Count : 1 #1 to 32 - maximum number of slaves on all channels

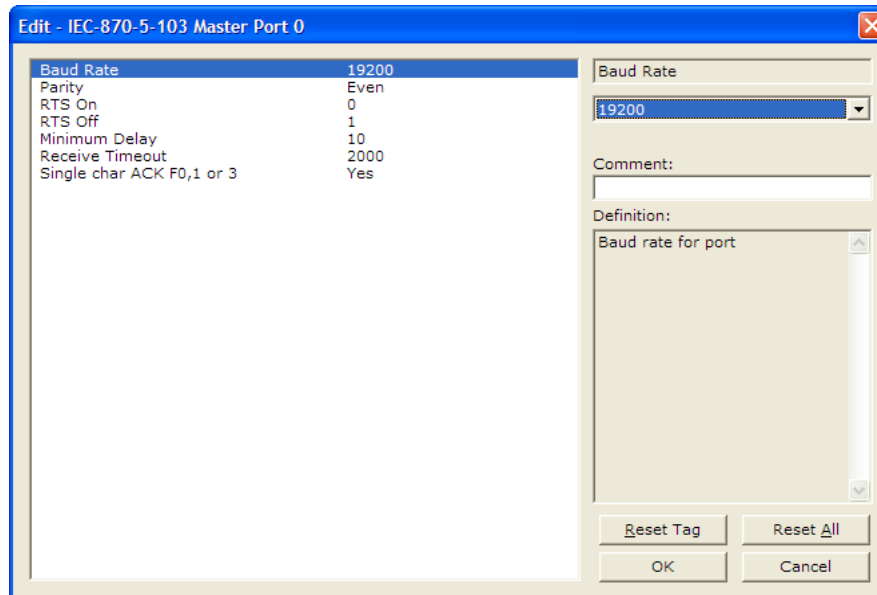
Session Count

1 to 16

This parameter specifies the maximum number of sessions (slaves) to interface with the module's 101M application ports. This value represents the total number of slaves on all ports.

3.6.3 [IEC-870-5-101 Master Port x]

These settings configure the communication parameters for each application port on the module. The following illustration shows typical settings for a Master port.



Baud Rate

Baud Rate Value

This is the baud rate to be used on the port. Enter the baud rate as a value. For example, to select 19K baud, enter 19200. Valid entries for this field include: 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200 (may also enter as 192 or 1920), 28800 (may also enter as 288 or 2880), 38400 (may also enter as 384 or 3840), 57600 (may also enter as 576 or 5760), and 115200 (may also enter as 115, 1152, or 11520).

Parity

N, O, E, M, or S

This parameter sets the parity to be used on the port. The values correspond to the following settings: N=None, O=Odd, E=Even, M=Mark and S=Space.

Note: The 101M specification supports only Even Parity.

RTS On

0 to 65535 milliseconds

This parameter sets the number of milliseconds to delay after *Ready To Send* (RTS) is asserted before data will be transmitted.

RTS Off

0 to 65535 milliseconds

This parameter sets the number of milliseconds to delay after the last byte of data is sent before the RTS modem signal will be set low.

Minimum Delay

1 to 60000 milliseconds

This parameter specifies the minimum number of milliseconds to delay before sending the message (setting RTS high). This can be used when the serial network requires time for units to turn off their transmitters.

Receive Timeout

1 to 65535 milliseconds

This value represents the number of milliseconds to wait on a port from the time the first character is received until the last character in the longest message is received. This parameter will be dependent on the baud rate. A value of 2000 should work with most applications.

Single char ACK F0, 1, or 3

Yes or No

This parameter specifies if the signal *E5* character will be used for *ACK* messages.

3.6.4 [IEC-101 Master Session x]

This section defines Session *y*, which runs on Port *x*. The *Session Count* parameter in the *[IEC-870-5-101 Master]* section of the configuration (page 36) determines the number of sessions (controlled devices) for this port.

The sessions are referenced by a zero-based index value. For example, if the module is configured for four sessions, the configuration file should contain sections for Sessions 0 to 3 (that is, *[IEC-101 Master Session 0]* to *[IEC-101 Master Session 3]*).

The parameters in *[IEC-101 Master Session y]* define the characteristics of the specific controlled device to interface.

Communication Port

0 or 1

This parameter sets the port to which the controlled device is connected. On this module, values of 0 and 1 are permitted.

Sector Count

1 to 3

This parameter sets the number of Sectors (separate databases or *Multiple Application Layer ASDU* addresses) contained in this Session (controlled device). This version of the application supports 1 to 3 sectors for each session.

Data Link Address

0 to 254

This parameter uniquely defines the data link address for this unit on the communication channel. The ranges of values are from 0 to 254. Address 255 is the broadcast address.

Failure Delay

0 to 2000 seconds

This parameter sets the minimum number of seconds to delay before polling this session when it is not online. This parameter is only used in unbalanced mode.

Confirm Timeout

0 to 4,294,967,295 (two raised to the power of 32, minus one) milliseconds

This parameter sets the number of milliseconds to wait for a confirm response from the controlled device.

Retry Count

0 to 255

In balanced mode, this parameter specifies the number of retries (0 to 255) if a response is not received. In unbalanced mode, this parameter is ignored.

C1/C2 Poll Count Pend

0 to 65535

This parameter sets the maximum number of Class 1 and Class 2 polls performed on this session before trying the next session. This parameter prevents a session from monopolizing the communication port.

Class 1 Polls

0 to 100

This parameter sets the maximum number of Class 1 polls performed on this session before switching to another session. This parameter prevents a session from monopolizing the communication port.

Class 1 Pend Delay

0 to 4,294,967,295 (two raised to the power of 32, minus one) milliseconds

This parameter sets the minimum number of milliseconds to delay between Class 1 polls for pending data.

Class 2 Pend Delay

0 to 4,294,967,295 (two raised to the power of 32, minus one) milliseconds

This parameter sets the minimum number of milliseconds to delay between Class 2 polls for pending data.

Class 1 Poll Delay

0 to 4,294,967,295 (two raised to the power of 32, minus one) milliseconds

This parameter sets the minimum number of milliseconds to delay between each Class 1 poll.

Class 2 Poll Delay

0 to 4,294,967,295 (two raised to the power of 32, minus one) milliseconds

This parameter sets the minimum number of milliseconds to delay between each Class 2 poll.

Auto Clock Req Mode

0=Sync Only, 1=Load delay/sync, 2=Acquire delay/load delay/sync

This parameter specifies the method used to perform automatic clock synchronization. 0 performs a synchronization without delay, 1 performs synchronization using the fixed Propagation Delay and 2 computes the delay and use this value when synchronization takes place.

Propagation Delay

0 to 65535

This parameter sets the fixed propagation delay to be utilized if the Auto Clock Req Mode parameter is set to a value of 1.

Response Timeout

0 to 4,294,967,295 milliseconds

This parameter sets the maximum number of milliseconds to wait for a confirmation from the controlled station to a request from this module.

ACTTERM with setpoint

Yes or No

This parameter determines if an *ACTTERM* will be sent. If the parameter is set to Yes, then *setpoint* commands will issue an *ACTTERM* when the command is complete. If the parameter is set to No, *ACTCON* is the last response to a *setpoint* command.

3.6.5 [IEC-101 Master Session x Sector y]

This section defines Sector *z*, which belongs to Session *y*. The *Sector Count* parameter (page 38) in the [IEC-870-5-101 Master Session *y*] section specifies the number of sectors for the session.

Each sector has a corresponding [IEC-101 Master Session *y* Sector *z*] section, where *y* represents the session index and *z* represents the sector index.

The sectors are referenced by a zero-based index value. For example, if Session 0 is configured for four sectors, the configuration file should contain sections for Sectors 0 to 3 (that is, [IEC-101 Master Session 0 Sector 0] to [IEC-101 Master Session 0 Sector 3]).

Edit - IEC-103 Master Session 0 Sector 0	
Common ASDU Address	0
Online Time sync	Yes
Online General Int	Yes
EOI Time sync	Yes
EOI General Int	Yes

Common ASDU Address: 0

Comment:

Definition: Sector address

Reset Tag Reset All OK Cancel

Common ASDU Address

0 to 255

This parameter sets the common *ASDU* address to association with this sector of the specified session. This parameter is usually set the same as the *Data Link Address* when only one sector is used.

Online Time Sync

Yes or No

This parameter specifies if the sector in the controlled device will be sent a time synchronization command when the unit is first recognized as being online. This should only be used for devices that do not send an *EOI* message after initializing.

Online General Int

Yes or No

This parameter specifies if the sector in the controlled device will be sent a general interrogation command when the unit is first recognized as being online. This should only be used for devices that do not send an *EOI* message after initializing.

EOI Time Sync

Yes or No

This parameter specifies if the sector in the controlled device will be sent a time synchronization command after this module received an *EOI* message from the controlled unit.

EOI General Int

Yes or No

This parameter specifies if the sector in the controlled device will be sent a general interrogation command after this module received an *EOI* message from the controlled unit.

ASDU Type

This field contains the *ASDU* type code for the data contained in the message.

- 1 = Time-tagged message (bit addressed with 2 bits/point)
- 2 = Time-tagged message with relative time (bit addressed with 2 bits/point)
- 3 = Measurands I (4 word values using word address using double-word address)
- 4 = Time-tagged measurands with relative time (1 float value)
- 5 = Identification (12 characters using a byte address)
- 9 = Measurands II (9 word values using word address)
- 205 = Siemens meter data

Database Index

Database Index is the location in the module's database to use as the source for the data in the command. Refer to *Data Type* for specific information on addressing (page 35).

The data type field determines the meaning of the database index as follows:

Type	Description	DB Index type
6	Clock synchronization	NA
7	General interrogation	NA
20	General Command	Bit address

Function Code

Code	Definition
128	Distance protection
160	Overcurrent protection
176	Transformer differential protection
192	Line Differential protection
133	For SIEMENS ASDU type 205
255	Global function type
x	User-defined

Note: The last item in the *Function Code* dropdown list is user-defined. If you select **USER DEFINED** from the dropdown list, a text box will appear below the list. You may enter any function code in this text box that will be accepted by the destination slave.

Point Index

Point Index specifies the address in the remote slave device of the point to interact with.

Index Value	Description
1	Bit address with each point occupying 2 bits
2	Bit address with each point occupying 2 bits
3	Word address with each point occupying 4 words
4	Double-word address for the single float value
5	Byte address with each point occupying 12 bytes
9	Word address with each point occupying 9 words

3.6.6 Using the CommonNet Data Map

The *Data Map* section allows you to copy data between areas in the gateway's internal database.

You can copy a maximum of 100 registers per *Data Map* command, and you can configure a maximum of 200 separate copy commands.

You can copy data from the error or status tables in upper memory to internal database registers in the *User Data memory* area.

You can rearrange the byte and/or word order during the copy process. For example, by rearranging byte or word order, you can convert floating-point values to the correct format for a different protocol.

You can also use the *Data Map* to condense widely dispersed data into one contiguous data block, making it easier to access.

	From Address	To Address	Register Count	Swap Code	Delay Preset	Comment
✓ 1	4000	2000	1	No Change	2000	

From Address

0 to highest *Status Data* address

This field specifies the beginning internal database register address for the copy operation. This address can be any valid address in the *User Data Area* or the *Status Data Area* of the gateway.

To Address

0 to **3999**

This parameter specifies the beginning destination register address for the copy operation. This address must always be within the *User Data registers* area. Take care to specify a destination address that will not overwrite data that has been stored in memory by one of the communication protocols running on the gateway.

Register Count

1 to **100**

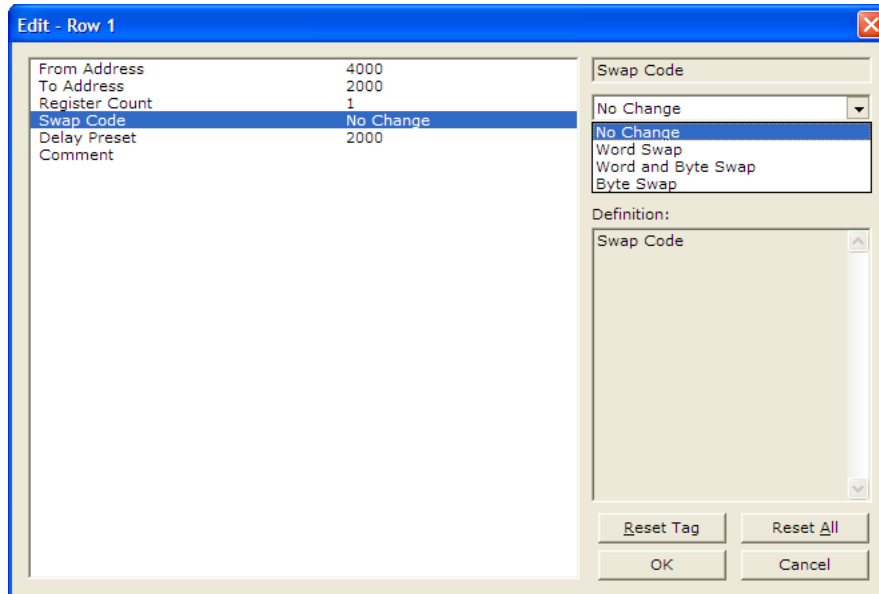
This parameter specifies the number of registers to copy.

Swap Code

NO CHANGE, WORD SWAP, WORD AND BYTE SWAP, BYTE SWAP

You may need to swap the order of the bytes in the registers during the copy process in order to change the alignment of bytes between dissimilar protocols. This parameter is helpful when dealing with floating-point or other multi-register values, as there is no standard method of storage of these data types in slave devices.

The following table defines the values and their associated operations:



Swap Code	Description
No Swap	No change is made in the byte ordering (1234 = 1234)
Word Swap	The words are swapped (1234=3412)
Word and Byte Swap	The words are swapped, then the bytes in each word are swapped (1234=4321)
Bytes	The bytes in each word are swapped (1234=2143)

Delay Preset

This parameter sets an interval for each *Data Map* copy operation. The value you put for the *Delay Preset* is not a fixed amount of time. It is the number of firmware scans that must transpire between copy operations.

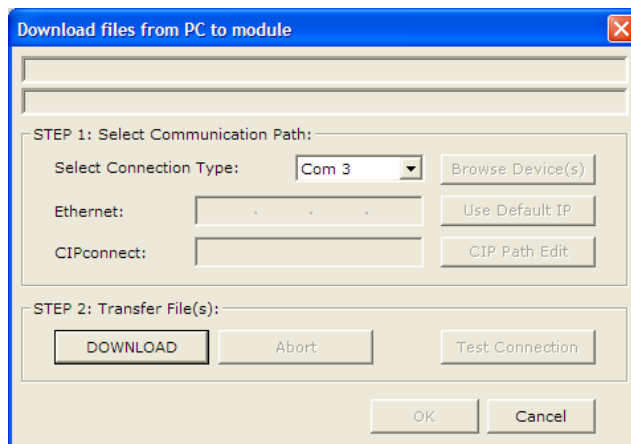
The firmware scan cycle can take a variable amount of time, depending on the level of activity of the protocol drivers running on the ProLinx gateway and the level of activity on the gateway's communication ports. Each firmware scan can take from 1 to several milliseconds to complete. Therefore, *Data Map* copy operations cannot be expected to happen at regular intervals.

If multiple copy operations (several rows in the *Data map* section) happen too frequently or all happen in the same update interval, they could delay the process scan of the gateway protocols, which could result in slow data updates or missed data on communication ports. To avoid these potential problems, you should set the *Delay Preset* to different values for each row in the *Data Map* section and set them to higher, rather than lower, numbers.

For example, *Delay Preset* values below 1000 could begin to cause a noticeable delay in data updates through the communication ports. And you should not set all *Delay Presets* to the same value. Instead, use different values for each row in the Data Map such as 1000, 1001, and 1002 or any other different *Delay Preset* values you like. This will prevent the copies from happening concurrently and prevent possible process scan delays.

3.7 Downloading a File from PC to the Module

- 1 Verify that your PC is connected to the gateway with a null-modem serial cable connected to the serial port on your PC and the serial port on the gateway
- 2 Open the **PROJECT** menu, and then choose **MODULE**.
- 3 On the **MODULE** menu, choose **DOWNLOAD**. Wait while ProSoft Configuration scans for communication ports on your PC. When the scan is complete, the *Download* dialog box opens.



- 4 Select the **PORT** to use for the download.
- 5 Click the **DOWNLOAD** button.

4 LED Indicators

In This Chapter

- ❖ LEDs for Port 0 Serial Port 50

Troubleshooting the operation of the IEC Master port can be performed using several methods.

The first and quickest is to scan the LEDs on the module to determine the existence and possibly the cause of a problem. This section provides insight into the operation of the Serial Port status LEDs. Information on the module's other LEDs can be found in the *ProLinx Reference Guide*.

4.1 LEDs for Port 0 Serial Port

Some ProLinux modules have three extra serial ports. Each of these serial ports has two *LEDs* indicating status.

LED	Color	Description
Port 0 - ACT	Off	No activity on the port.
	Green Flash	The port is either actively transmitting or receiving data
Port 0 - ERR	Off	Normal state. When off and Port Active led is indicating activity, there are no communication errors
	Red On or Flashing	Activity on this led indicates some communication error was detected, either during transmit or receive

5 Debug Information

In This Chapter

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❖ IEC-101 Master Driver Menu.....	54
❖ Data Analyzer.....	58
❖ Data Analyzer Tips	61
❖ IEC-870-Master Command List Menu	63
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The ProLinux Reference Guide provides information on using the *Config/Debug* port and lists various menus that allow users to view module data. The menus listed in the Startup Guide are generic for all modules. The following menus are specific to the ProLinux 101M module. Refer to the ProLinux Reference Guide for information on how to access these menus.

5.1 Main Menu

When you first connect to the module from your computer, your terminal screen will be blank. To activate the main menu, press the **[?]** key on your computer's keyboard. If the module is connected properly, the following menu will appear.

```
DFNT/IEC-870-5-103 MASTER COMMUNICATION MODULE 4201-DFNT-I103M MENU
?=Display Menu
C=Database Configuration
D=Database View
E=Client 0 Command Error Lists
J=Client 0 Command Lists
Q=Port 0 IEC-870-103 Master Driver Menu
S=Transfer Configuration from 4100 Unit to PC
T=Display e-mail setup
U=Reset diagnostic data
V=Version Information
1=Network Status    2=Client 0 Status    7=Client Configurations
8=DFNT Server Status
@=Network Menu      $=Data Map Menu
Esc=Exit Program
```

Caution: Some of the commands available to you from this menu are designed for advanced debugging and system testing only, and can cause the gateway to stop communicating with the processor or with other devices, resulting in potential data loss or other failures. Only use these commands if you are specifically directed to do so by ProSoft Technology Technical Support staff. Some of these command keys are not listed on the menu, but are active nevertheless. Please be careful when pressing keys so that you do not accidentally execute an unwanted command.

5.1.1 Redisplaying the Menu

Press **[?]** to display the current menu. Use this command when you are looking at a screen of data, and want to view the menu choices available to you.

5.1.2 Viewing Module Configuration

Press **[C]** to view the *Module Configuration* screen.

Use this command to display the current configuration and statistics for the gateway.

5.1.3 Opening the Database View Menu

Press **[D]** to open the *Database View* menu.

Use this menu command to view the current contents of the gateway's database. For more information about this submenu, see Database View Menu (page 70).

5.1.4 Opening the Session Configuration Menu

Press **[P]** from the Main Menu Menu to open the *PROFIBUS Slave* menu. Use this command to view *PROFIBUS Slave* configuration information.

The *PROFIBUS Slave Menu* section has more information about the commands on this menu.

5.1.5 Opening the IEC-101 Master Menu

Press **[Q]** from the Main Menu to open the IEC-870-5-101 Master Driver Menu. Use this menu command to view detailed configuration information for the module.

```
IEC-103 MASTER Menu Selected
IEC-870-5-103 MASTER DRIVER MENU
?=Display Menu
A=Data Analyzer
C=General Configuration
I=Command List Menu
P=Port Configuration Menu
Q=Port Status Menu
S=Session Menu
V=Version
Z=Previous Menu
```

For more information about the commands on this menu, refer to IEC-101 Master Driver Menu (page 54).

5.1.6 Sending the Configuration File

Press **[S]** to upload (send) a configuration file from the gateway to your PC.

5.1.7 Viewing Version Information

Press **[V]** to view version information for the gateway.

Use this command to view the current version of the software for the gateway, as well as other important values. You may be asked to provide this information when calling for technical support on the product.

Values at the bottom of the display are important in determining gateway operation. The *Program Scan Counter* value is incremented each time a gateway's program cycle is complete.

Tip: Repeat this command at one-second intervals to determine the frequency of program execution.

5.1.8 Opening the Data Map Menu

Press **[\$]** to open the Data Map menu.

5.1.9 Exiting the Program

Press **[ESC]** to restart the gateway and force all drivers to be loaded. The gateway will use the configuration stored in the gateway's Flash memory to configure the gateway.

5.2 IEC-101 Master Driver Menu

Press **[I]** from the Main Menu to open the IEC-870-5-101 Master Driver Menu. Use this menu command to view detailed configuration information for the module.

5.2.1 Opening the Data Analyzer Menu

Press **[A]** to open the Data Analyzer Menu. Use this command to view all bytes of data transferred on each port. Both the transmitted and received data bytes are displayed. Refer to Data Analyzer (page 58) for more information about this menu.

Important: When in analyzer mode, program execution will slow down. Only use this tool during a troubleshooting session. Before disconnecting from the Config/Debug port, please press **[S]** to stop the data analyzer, and then press **[M]** to return to the main menu. This action will allow the gateway to resume its normal high speed operating mode.

5.2.2 Viewing General Configuration

Press **[C]** from the IEC-101 Master Driver Menu to display the general configuration for the protocol. The following illustration shows an example of the Module Configuration screen:

```

MODULE CONFIGURATION
Max Sessions      = 0 (of maximum 32)
Online States     = 0x00000000 (bit mapped in hex format)
Command Count     = 0 (of maximum 1000)
Current Command   = 0 (IDLE)
MEMORY COUNTERS:
  applRec         = 0
  applTrans       = 0
  anything        = 0
  
```

The Busy/Idle message indicates the current activity state of the module. "Idle" means it is waiting to execute a command. "Busy" means it is executing a command and is waiting for the response to the request. This does not include the normal Class 1 and 2 polls as these are automatically generated.

The counter data displays the number of memory areas allocated for the application layer. When no packets are pending, the counts should all be 0. If messages are waiting to be sent, the applRec count will indicate the number waiting to be sent. If many messages are received at the same time, the applRec count will indicate the number of packets that must be processed. The "anything" count indicates any other buffer area that is allocated and must be processed by the application.

5.2.3 Opening the IEC-870-Master Command List Menu

Press **[I]** from the IEC-101 Master Driver Menu to open the ICE-870 Master Command List menu. Use this command to view the configured command list for the module.

IEC-870-5-103 MASTER COMMAND LIST, COMMANDS 0 TO 9												
ENB	DBIDX	POLLI	SES	SEC	ASDU	FUNC	POINT	LAST_POLL	LERROR	OUR	VALUE	
1	0	10	0	0	20	128	16	7	0	1	2	
0	0	11	0	0	20	128	16	14932	0	1	1	
0	1600	41	0	0	20	128	17	14932	0	0	0	
0	1602	41	0	0	20	128	18	14932	0	0	0	
1	0	5	0	0	7	255	0	4	0			
**** END OF COMMAND LIST REACHED ****												

For more information about the commands on this menu, refer to IEC-870-Master Command List Menu (page 63).

5.2.4 Opening the Port Configuration Menu

Press **[P]** from the IEC-101 Master Driver Menu to open the Port Configuration menu. Use this command to view the port configuration information for each of the application ports.

Port Configuration Menu Selected	
IEC-870-5-103 MASTER CHANNEL 0 CONFIGURATION	
Baudrate	= 19200
Parity	= EVEN
RTS On	= 1
RTS Off	= 0
Minimum Delay	= 30
Receive Timeout	= 2000
Single ACK	= YES
Data Link Length	= 1
Use Balanced Mode	= NO

The *Port Configuration Menu* section has more information about the commands on this menu.

5.2.5 Opening the Port Status Menu

Press **[Q]** from the IEC-101 Master Driver Menu to open the Port Status menu. Use this command to verify the status of the Master commands sent through the port. If the display indicates a communication error, you should compare the generated error code with the command error codes listed in the Appendices of this manual.

```
Port Status Menu Selected
IEC-870-5-103 MASTER PORT 0 STATUS
Commands Executed   = 0
Command Responses   = 0
Command Err Count   = 0
Request Count       = 0
Response Count      = 0
Error Sent Count     = 0
Error Rec Count      = 0
Cfg Error Word       = 0x0000
Current Error Code   = 0
Last Error Code      = 0
```

The *Port Status Menu* section has more information about the commands on this menu.

5.2.6 Opening the Session Configuration Menu

Press **[S]** to open the Session Configuration menu. Use this command to view the session configuration data.

Refer to *Session Configuration Menu* (page 66) for more information about the commands on this menu.

5.2.7 Opening the Sector Menu

Press **[1]** from the IEC-101 Master Driver Menu to open the Sector Configuration menu. Use this command to view the Sector Configuration data.

```
SECTOR CONFIGURATION MENU
?=Display Menu
D=Sector Database Menu
S=Show Again
P=Previous Page
N=Next Page
M=Return to Session Menu
```

The *Sector Configuration Menu* section has more information about the commands on this menu.

5.2.8 Viewing Master Driver Version Information

Press **[V]** from the IEC-101 Master Driver Menu to view the Master driver version information.

```
DRIVER VERSION INFORMATION:

(c) 1999-2003, ProLinux Communication Gateways, Inc.

PRODUCT NAME CODE       : IEC-870-5-103 Master Driver
SOFTWARE REVISION LEVEL : 2.14
SOFTWARE REVISION DATE  : 04/17/2003
FAR CORE LEFT           : 322368
```

5.2.9 Returning to the Main Menu

Press **[M]** to return to the *Main* menu.

5.3.8 Stopping the Data Analyzer

Press **[S]** to stop the data analyzer. Use this option to freeze the display so the data can be analyzed. To restart the analyzer, press **[B]**.

Important: When in analyzer mode, program execution will slow down. Only use this tool during a troubleshooting session. Before disconnecting from the Config/Debug port, please press **[S]** to stop the data analyzer, and then press **[M]** to return to the main menu. This action will allow the module to resume its normal high speed operating mode.

5.3.9 Returning to the Main Menu

Press **[M]** to return to the *Main* menu.

5.4 Data Analyzer Tips

From the main menu, press **[A]** for the "Data Analyzer". You should see the following text appear on the screen:

Data Analyzer Mode Selected

After the "Data Analyzer" mode has been selected, press **[?]** to view the Data Analyzer menu. From this menu, you can select the "Port", the "format", and the "ticks" that you can display the data in.

For most applications, HEX is the best format to view the data, and this does include ASCII based messages (because some characters will not display on HyperTerminal and by capturing the data in HEX, we can figure out what the corresponding ASCII characters are supposed to be).

The Tick value is a timing mark. The module will print a _TT for every xx milliseconds of no data on the line. Usually 10milliseconds is the best value to start with.

To save a capture file of your Diagnostics session

- 1 After you have selected the Port, Format, and Tick, we are now ready to start a capture of this data. Click the Log to File button at the bottom of the Diagnostics window.



Click to capture the Diagnostics session to a log file

- 2 When you have captured the data you want to save, click the Stop Logging button.



Click to stop capturing

You have now captured, and saved the file to your PC. This file can now be used in analyzing the communications traffic on the line, and assist in determining communication errors.

Now you have everything that shows up on the HyperTerminal screen being logged to a file called ProLinxLog.txt. This is the file that you will then be able to email to ProSoft Technical Support to assist with issues on the communications network.

To begin the display of the communications data, you will then want to press **[B]** to tell the module to start printing the communications traffic out on the debug port of the module. After you have pressed **[B]**, you should see something like the following:

```
[03][00][04][00][05][00][06][00][07][00][08][00][09][FB][B7]_TT_TT_<R+><01><02>
<00><00><00><0A><F8><0D><R->_TT_TT_TT_[01][02][02][00][00][B9][B8]_TT_TT_<R+>
<01><03><00><00><00><0A><C5><CD><R->_TT_TT_[01][03][14][00][00][00][01][00]_TT
[02][00][03][00][04][00][05][00][06][00][07][00][08][00][09][CD][51]_TT_TT_<R+>
<01><01><00><00><00><A0><3C><72><R->_TT_TT_[01][01][14][00][00][01][00][02]_TT
[00][03][00][04][00][05][00][06][00][07][00][08][00][09][00][B7][52]_TT_TT_<R+>
<01><04><00><00><00><0A><70><0D><R->_TT_TT_[01][04][14][00][00][00][01][00]_TT
[02][00][03][00][04][00][05][00][06][00][07][00][08][00][09][FB][B7]_TT_TT_<R+>
<01><02><00><00><00><0A><F8><0D><R->_TT_TT_TT_[01][02][02][00][00][B9][B8]_TT
TT_<R+><01><03><00><00><00><0A><C5><CD><R->_TT_TT_[01][03][14][00][00][00][01]
[00]_TT_TT_[02][00][03][00][04][00][05][00][06][00][07][00][08][00][09][CD][51]_TT
TT_<R+><01><01><00><00><00><A0><3C><72><R->_TT_TT_TT_[01][01][14][00][00][01]
[00][02]_TT_TT_[00][03][00][04][00][05][00][06][00][07][00][08][00][09][00][B7][52]
TT_TT_<R+><01><04><00><00><00><0A><70><0D><R->_TT_TT_[01][04][14][00][00][00]
[01][00]_TT_TT_[02][00][03][00][04][00][05][00][06][00][07][00][08][00][09][FB][B7]
TT_TT_<R+><01><02><00><00><00><0A><F8><0D><R->_TT_TT_[01][02][02][00][00][B9]
[B8]_TT_TT_<R+><01><03><00><00><00><0A><C5><CD><R->_TT_TT_[01][03][14][00][00]
[00][01][00]_TT_TT_[02][00][03][00][04][00][05][00][06][00][07][00][08][00][09][CD]
[51]_TT_TT_TT_<R+><01><01><00><00><00><A0><3C><72><R->_TT_TT_TT_[01][01][14][00]
[00][01][00][02]_TT_TT_[00][03][00][04][00][05][00][06][00][07][00][08][00][09][00]
[B7][52]_TT_TT_<R+><01><04><00><00><00><0A><70><0D><R->_TT_TT_[01][04][14][00]
[00][00][01][00]_TT_TT_[02][00][03][00][04][00][05][00][06][00][07][00][08][00][09]
[FB][B7]_TT_TT_<R+><01><02><00><00><00><0A><F8><0D><R->_TT_TT_TT_[01][02][02]
[00][00][B9][B8]_TT_TT_<R+><01><03><00><00><00><0A><C5><CD><R->_TT_TT_
```

The <R+> means that the module is transitioning the communications line to a transmit state.

All characters shown in <> brackets are characters being sent out by the module.

The <R-> shows when the module is done transmitting data, and is now ready to receive information back.

And finally, all characters shown in the [] brackets is information being received from another device by the module.

After taking a minute or two of traffic capture, you will now want to stop the "Data Analyzer". To do so, press the **[S]** key, and you will then see the scrolling of the data stop.

5.5 IEC-870-Master Command List Menu

Press **[I]** from the IEC-101 Master Driver Menu to open the ICE-870 Master Command List menu. Use this command to view the configured command list for the module.

5.5.1 *Redisplaying the Menu*

Press **[?]** to display the current menu. Use this command when you are looking at a screen of data, and want to view the menu choices available to you.

5.5.2 *Redisplaying the Current Page*

Press **[S]** to display the current page of data.

5.5.3 *Moving Back Through 5 Pages of Registers*

Press **[-]** from the *Database View* menu to skip five pages back in the database to see the 100 registers of data starting 500 registers before the currently displayed page.

5.5.4 *Viewing the Previous Page of Registers*

Press **[P]** from the *Database View* menu to display the previous page of data.

5.5.5 *Moving Forward Through 5 Pages of Registers*

Press **[+]** from the *Database View* menu to skip five pages ahead in the database to see 100 registers of data 500 registers ahead of the currently displayed page.

5.5.6 *Viewing the Next Page of Registers*

Press **[N]** from the *Database View* menu to display the next page of data.

5.5.7 *Returning to the Main Menu*

Press **[M]** to return to the *Main* menu.

5.6 Port Configuration Menu

Press **[P]** from the IEC-101 Master Driver Menu to open the Port Configuration menu. Use this command to view the port configuration information for each of the application ports.

5.6.1 *Redisplaying the Menu*

Press **[?]** to display the current menu. Use this command when you are looking at a screen of data, and want to view the menu choices available to you.

5.6.2 *Redisplaying the Current Page*

Press **[S]** to display the current page of data.

5.6.3 *Displaying the Next Page*

Press **[N]** to display the next 100 registers. Use this command to step forward through the data a page at a time.

5.6.4 *Displaying the Previous Page*

Press **[P]** to display the previous 100 registers. Use this command to step backward through the data a page at a time.

5.6.5 *Returning to the Main Menu*

Press **[M]** to return to the *Main* menu.

5.7 Port Status Menu

Press **[Q]** from the IEC-101 Master Driver Menu to open the Port Status menu. Use this command to view the communication status information for each application port.

5.7.1 *Redisplaying the Menu*

Press **[?]** to display the current menu. Use this command when you are looking at a screen of data, and want to view the menu choices available to you.

5.7.2 *Redisplaying the Current Page*

Press **[S]** to display the current page of data.

5.7.3 *Displaying the Previous Page*

Press **[P]** to display the previous 100 registers. Use this command to step backward through the data a page at a time.

5.7.4 *Displaying the Next Page*

Press **[N]** to display the next 100 registers. Use this command to step forward through the data a page at a time.

5.7.5 *Returning to the Main Menu*

Press **[M]** to return to the *Main* menu.

5.8 Session Configuration Menu

Press **[S]** from the IEC-101 Master Driver Menu to open the Session Configuration menu. Use this command to view the session configuration for each controlled device.

5.8.1 Online State

The *Online State* indicator displays 0 if the module is not online, 1 if the module is online.

5.8.2 Session State

The Session State indicator displays 1 if there is a configuration error, or 2 if the module is ready for communication. If the session is not in use, the Session State indicator displays 0.

5.9 Session Configuration Menu

Press **[S]** from the IEC-101 Master Driver Menu to open the Session Configuration menu. Use this command to view the session configuration for each controlled device.

5.9.1 Online State

The *Online State* indicator displays 0 if the module is not online, 1 if the module is online.

5.9.2 Session State

The Session State indicator displays 1 if there is a configuration error, or 2 if the module is ready for communication. If the session is not in use, the Session State indicator displays 0.

5.10 Sector Configuration Menu

Press **[1]** from the IEC-101 Master Driver Menu to open the *Sector Configuration* menu. Use this command to view the contents of the *Sector Configuration Databases* for each session (controlled device). The module supports up to three sectors (databases) per session.

5.10.1 Redisplaying the Menu

Press **[?]** to display the current menu. Use this command when you are looking at a screen of data, and want to view the menu choices available to you.

5.10.2 Opening the Sector Database Menu

Press **[D]** from the Sector Configuration menu to open the Sector Database menu. Use this command to look at the configuration and current value for each point.

The *IEC-870-Master Command List Menu* section has more information about the commands on this menu.

5.10.3 Redisplaying the Current Page

Press **[S]** to display the current page of data.

5.10.4 Displaying the Next Page

Press **[N]** to display the next 100 registers. Use this command to step forward through the data a page at a time.

5.10.5 Displaying the Previous Page

Press **[P]** to display the previous 100 registers. Use this command to step backward through the data a page at a time.

5.10.6 Returning to the Main Menu

Press **[M]** to return to the *Main* menu.

5.11 Sector Database Menu

Press **[D]** from the *Sector Configuration* menu to open the *Sector Database* menu. Use this command to display the sector database values. Each session (controlled device) contains one or more data sets (sectors) that are defined by the vendor of the device.

5.11.1 Redisplaying the Menu

Press **[?]** to display the current menu. Use this command when you are looking at a screen of data, and want to view the menu choices available to you.

5.11.2 Viewing ASDU n Data

Press keys **[0]** (zero) through **[4]** to display *ASDU* (*Application Data Service Unit*) data for each of the supported data types. Refer to *[IEC-101 Master Session x Sector x]* for a list of *ASDU* types.

5.11.3 Listing ASDU point counts

Press **[5]** to display the *ASDU* point counts for each *ASDU* type.

SESSION 0	SECTOR 0	DATABASE SIZES:
ASDU	COUNT	
1&2	10	
3	0	
4	0	
5	0	
9	0	

5.11.4 Returning to the Main Menu

Press **[M]** to return to the *Main* menu.

5.12 Database View Menu

Press **[D]** from the *Main* menu to open the *Database View* menu. Use this menu command to view the current contents of the gateway database. Press **[?]** to view a list of commands available on this menu.

```
DB Menu Selected

DATABASE VIEW MENU
?=Display Menu
0-9=Display 0-9000
S=Show Again
-=Back 5 Pages
P=Previous Page
+=Skip 5 Pages
N=Next Page
D=Decimal Display
H=Hexadecimal Display
F=Float Display
A=ASCII Display
M=Main Menu
```

5.12.1 Viewing Register Pages

To view sets of register pages, use the keys described below:

Command	Description
[0]	Display registers 0 to 99
[1]	Display registers 1000 to 1099
[2]	Display registers 2000 to 2099

And so on. The total number of register pages available to view depends on your gateway's configuration.

5.12.2 Displaying the Current Page of Registers Again

Press **[S]** from the *Database View* menu to show the current page of registers again.

DATABASE DISPLAY 0 TO 99 <DECIMAL>									
100	101	102	4	5	6	7	8	9	10
11	12	13	14	15	16	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

This screen displays the current page of 100 registers in the database.

5.12.3 Moving Back Through 5 Pages of Registers

Press **[-]** from the *Database View* menu to skip five pages back in the database to see the 100 registers of data starting 500 registers before the currently displayed page.

5.12.4 Moving Forward (Skipping) Through 5 Pages of Registers

Press **[+]** from the *Database View* menu to skip five pages ahead in the database to see the 100 registers of data starting 500 registers after the currently displayed page.

5.12.5 Viewing the Previous Page of Registers

Press **[P]** from the *Database View* menu to display the previous page of data.

5.12.6 Viewing the Next Page of Registers

Press **[N]** from the *Database View* menu to display the next page of data.

5.12.7 Viewing Data in Decimal Format

Press **[D]** from the *Database View* menu to display the data on the current page in decimal format.

5.12.8 Viewing Data in Hexadecimal Format

Press **[H]** from the *Database View* menu to display the data on the current page in hexadecimal format.

5.12.9 Viewing Data in Floating-Point Format

Press **[F]** from the *Database View* menu to display the data on the current page in floating-point format. The program assumes that the values are aligned on even register boundaries. If floating-point values are not aligned as such, they are not displayed properly.

5.12.10 Viewing Data in ASCII (Text) Format

Press **[A]** from the *Database View* menu to display the data on the current page in ASCII format. This is useful for regions of the database that contain ASCII data.

5.12.11 Returning to the Main Menu

Press **[M]** to return to the *Main* menu.

5.13 Data Map Menu

Press [**\$**] from the *Main* Menu to open the *Data Map* menu. The *Data Map* Menu shows a list of data addresses and their contents.

5.13.1 Redisplaying the Current Page

Press [**S**] to display the current page of data.

5.13.2 Displaying the Next Page

Press [**N**] to display the next 100 registers. Use this command to step forward through the data a page at a time.

5.13.3 Displaying the Previous Page

Press [**P**] to display the previous 100 registers. Use this command to step backward through the data a page at a time.

5.13.4 Returning to the Main Menu

Press [**M**] to return to the *Main* menu.

6 Reference

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6.1 101M Driver Error and Status Data

The second and most thorough troubleshooting method for debugging the operation of the 101M driver (and the module in general) is the powerful Debug port on the module which provides much more complete access to the internal operation and status of the module. Accessing the Debug capabilities of the module can be accomplished by connecting a PC to the Debug port using HyperTerminal or some other terminal emulation program.

6.1.1 Slave Error and Status

The 101M Driver Error and Status Data areas are discussed in this section. This data represents a collection of status, diagnostic and troubleshooting registers which may prove helpful in troubleshooting the 101M network and port operation. The data map functionality of the module must be utilized in order to map this data into the normal module database region (0 to 3999). All or any portion of the data can be moved using this facility.

The data area is initialized with zeros whenever the module is initialized. This occurs during a cold-start (power-on), reset (reset push-button pressed) or a warm-boot operation (commanded or loading of new configuration).

In order to read the sector area into the module database, refer to the Remap section in the configuration file in order to remap the sector area from address 14000 to any address in the database.

Note: All commands should be mapped separately and not grouped together

Offset	Name	Description
14000	Session Count	This word contains the number of sessions configured in the module.
14001	Current Cmd	This word contains the index of the current command being executed in the command list.
14002	Cmd Busy Flag	This word is set to zero if no command is currently being executed and waiting on a response.
14003	Cmd Count	This word contains the count of the number of commands configured for the module.
14004	Cmd Delay	This word contains the command delay counter preset. There is a fixed delay between each command to permit the module to perform class polls on controlled stations.
14005	Cmd Queue	This word is set to zero if the command executing is from the command list. If the executing command is from the command queue, the word will be set to 1.
14006	Cmd Queue Count	This word contains the number of active commands in the command queue for the module. Up to 100 commands can be buffered in this queue. These commands are transferred from the processor to the module using special command blocks.

Offset	Name	Description
14007 to 14008	Online Status	This double word value contains a bit for each of the 16 potential sessions in the module. If the bit is set for a session in the double word, the station is online. If the bit is clear, the station is offline. Use this value to determine if commands sent from the processor will have a chance of succeeding.
14009	Reserved	Not used at this time

Port 0 Status

Offset	Name	Description
14010	State	This word contains the state machine value for the channel.
14011	Cmd Req	This word contains the number of commands transferred out the channel.
14012	Cmd Resp	This word contains the number of command response messages received on the channel.
14013	Cmd Err	This word contains the number of command errors recognized on the channel.
14014	Requests	This word contains the total number of messages transmitted on the channel.
14015	Responses	This word contains the total number of messages received on the channel.
14016	Err Sent	This word contains the number of error messages sent on the channel.
14017	Err Received	This word contains the number of error messages received on the channel.
14018	Cfg Error	This bit-mapped word recognizes any configuration errors for the channel. Refer to the configuration error word table for a definition of each bit.
14019	Current Error	This word contains the error code for the current command executing on the channel.
14020	Last Error	This word contains the error code for the last error recognized on the channel.
14021 to 14029	Reserved	Not used at this time

The following table defines the contents of the configuration error word. Each bit in the word corresponds to an error condition recognized when the module is configured. There is a separate word for each application port. This data is reported in the status data area previously defined.

Configuration Error Word

Bit	Code	Description
0	0x0001	Invalid baud rate selected
1	0x0002	Invalid parity selected
2	0x0004	Received timeout set to 0
3	0x0008	Invalid port selected for a session
4	0x0010	Invalid sector count for session
5	0x0020	Could not allocate memory for sector of a session
6	0x0040	
7	0x0080	Invalid failure delay or confirm timeout for session
8	0x0100	
9	0x0200	
10	0x0400	
11	0x0800	
12	0x1000	
13	0x2000	
14	0x4000	
15	0x8000	

Master Communication Module Error Codes

Error	Description
51	Physical Layer Error: Error transmitting message.
52	Physical Layer Error: Intercharacter timeout occurred before message fully received
53	Physical Layer Error: Frame not entirely received before timeout condition
54	Physical Layer Error: Invalid Frame Length
101	Link Layer Error: Invalid checksum received
102	Link Layer Error: Address unknown to module
103	Link Layer Error: Link established
104	Link Layer Error: Link failed
105	Link Layer Error: Received Primary
106	Link Layer Error: FCB error discard
107	Link Layer Error: FCB error repeat
108	Link Layer Error: Invalid start character received
109	Link Layer Error: Invalid second character received
110	Link Layer Error: Invalid ending character received
111	Link Layer Error: Length mismatch error
112	Link Layer Error: Illegal function
113	Link Layer Error: No confirmation received
114	Link Layer Error: No ACK received
115	Link Layer Error: Sequence unknown
116	Link Layer Error: Out of sequence
117	Link Layer Error: Remote close
118	Link Layer Error: Unexpected ACK
119	Link Layer Error: Request cancelled
201	Application Layer Error: Length mismatch
202	Application Layer Error: Address unknown
203	Application Layer Error: Response late
251	RBE Error: Clock event buffer overflow
252	RBE Error: Event buffer overflow
271	Data Error: Address unknown
281	Control Error: Illegal operation
282	Control Error: Illegal value
283	Control Error: Not selected
301	Initialization Error: Database
302	Initialization Error: Out of Memory
401	Channel open error
501	Session Error: Database
502	Session Error: Configuration
601	No memory to receive message
602	Session not reserved
603	Illegal session
604	Session is reserved
605	Session is not available
701	No memory to transmit message
702	ASDU not supported
703	Duplicate request

Error	Description
704	Illegal sector
705	Control mode is illegal
801	Partial stop request
802	Stop request failed
902	Negative COT in response
903	Session is offline
904	Session is disabled
905	Select confirmation received, waiting to execute
906	Execute confirmation has not been received.

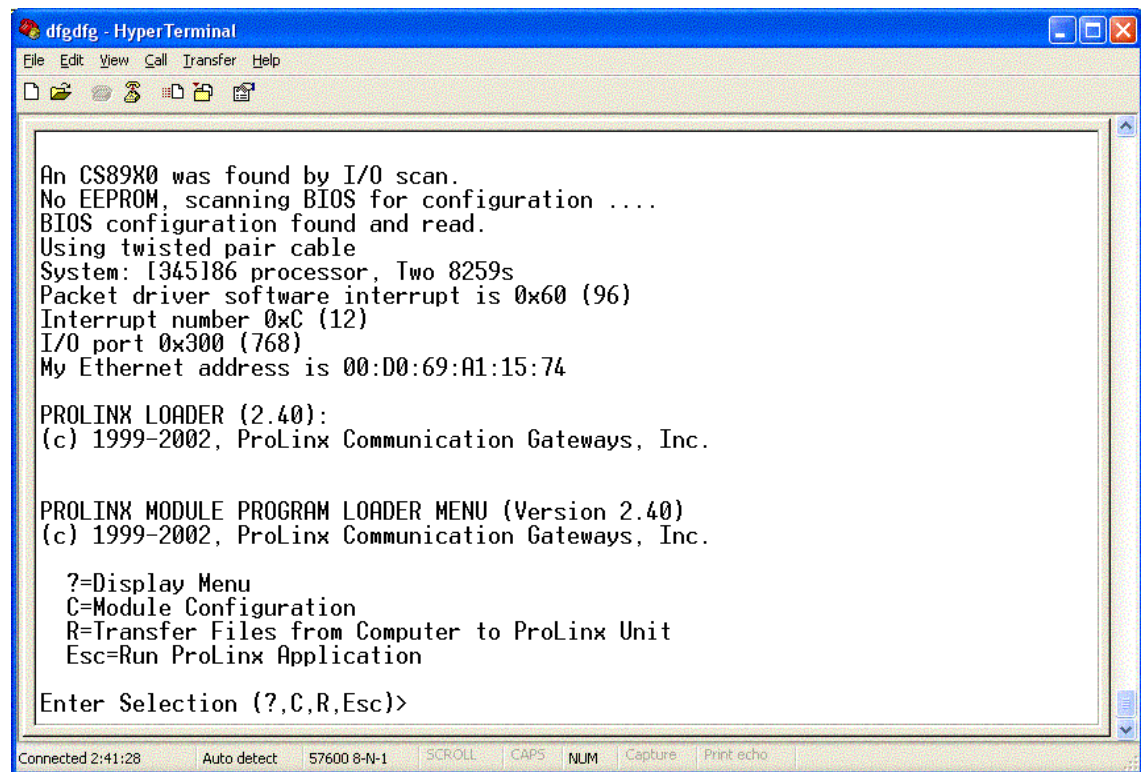
6.2 Setting the Module's Date and Time

This section describes how to set the module's date and time. The module does not support a dynamic date and time configuration, therefore, date and time information must be entered manually.

The protocol uses time and date information to exchange events. The Master may also send periodic time synchronization requests to the slave. It is important to ensure that the Master is using the correct date and time information.

Assuming that the Debug port is connected to an ASCII terminal, perform the following steps to set the module's date and time:

- 1 Press the **RESET** button located on the front of the ProLinX module.
- 2 While the module is loading, press and hold down the **[L]** key.



The screenshot shows a HyperTerminal window titled 'dfgdfg - HyperTerminal'. The window contains the following text:

```
An CS89X0 was found by I/O scan.  
No EEPROM, scanning BIOS for configuration ....  
BIOS configuration found and read.  
Using twisted pair cable  
System: I345186 processor, Two 8259s  
Packet driver software interrupt is 0x60 (96)  
Interrupt number 0xC (12)  
I/O port 0x300 (768)  
My Ethernet address is 00:D0:69:A1:15:74  
  
PROLINX LOADER (2.40):  
(c) 1999-2002, ProLinX Communication Gateways, Inc.  
  
PROLINX MODULE PROGRAM LOADER MENU (Version 2.40)  
(c) 1999-2002, ProLinX Communication Gateways, Inc.  
  
  ?=Display Menu  
  C=Module Configuration  
  R=Transfer Files from Computer to ProLinX Unit  
  Esc=Run ProLinX Application  
  
Enter Selection (?,C,R,Esc)>
```

The status bar at the bottom of the window shows: Connected 2:41:28, Auto detect, 57600 8-N-1, SCROLL, CAPS, NUM, Capture, Print echo.

- 3 Enter the following three keys in order: [~], [Esc], [~]. The following DOS screen appears:

```
Enter Selection (?,C,R,Esc)>
Press 'Y' key to confirm program exit!

Program exit aborted

PROLIX MODULE PROGRAM LOADER MENU (Version 2.40)
(c) 1999-2002, ProLinux Communication Gateways, Inc.

?=Display Menu
C=Module Configuration
R=Transfer Files from Computer to ProLinux Unit
Esc=Run ProLinux Application

Enter Selection (?,C,R,Esc)>
Press 'Y' key to confirm program exit!
Confirmation timedout!

Press 'Y' key to confirm program exit!

Exit Program....Please wait....and go to DOS

A:\>_
```

- 4 At the DOS prompt, type `time`.
- 5 The screen shows the current time and asks for the new time. Enter a value using the following format:
- 6 HOUR:MINUTE:SECOND:MILISEC
- 7 Press Enter.

```
My Ethernet address is 00:D0:69:A1:15:74

PROLIX LOADER (2.40):
(c) 1999-2002, ProLinux Communication Gateways, Inc.

PROLIX MODULE PROGRAM LOADER MENU (Version 2.40)
(c) 1999-2002, ProLinux Communication Gateways, Inc.

?=Display Menu
C=Module Configuration
R=Transfer Files from Computer to ProLinux Unit
Esc=Run ProLinux Application

Enter Selection (?,C,R,Esc)>
Press 'Y' key to confirm program exit!

Exit Program....Please wait....and go to DOS

A:\>time
Current time is 22:1:17.38
Enter new time: 08:07:55.100
```

- 8 At the DOS prompt, type `date`.

```
PROLINX LOADER (2.40):  
(c) 1999-2002, ProLinx Communication Gateways, Inc.  
  
PROLINX MODULE PROGRAM LOADER MENU (Version 2.40)  
(c) 1999-2002, ProLinx Communication Gateways, Inc.  
  
  ?=Display Menu  
  C=Module Configuration  
  R=Transfer Files from Computer to ProLinx Unit  
  Esc=Run ProLinx Application  
  
Enter Selection (?,C,R,Esc)>  
Press 'Y' key to confirm program exit!  
  
Exit Program....Please wait....and go to DOS  
  
A:\>time  
Current time is 22:1:17.38  
Enter new time: 08:07:55.100  
  
A:\>date  
Current date is Tue 7-15-2003  
Enter new date (mm-dd-yy):
```

- 9 Enter the new date information using the format MONTH-DAY-YEAR, and then press **[ENTER]**.

```
PROLINX MODULE PROGRAM LOADER MENU (Version 2.40)  
(c) 1999-2002, ProLinx Communication Gateways, Inc.  
  
  ?=Display Menu  
  C=Module Configuration  
  R=Transfer Files from Computer to ProLinx Unit  
  Esc=Run ProLinx Application  
  
Enter Selection (?,C,R,Esc)>  
Press 'Y' key to confirm program exit!  
  
Exit Program....Please wait....and go to DOS  
  
A:\>time  
Current time is 22:1:17.38  
Enter new time: 08:07:55.100  
  
A:\>date  
Current date is Tue 7-15-2003  
Enter new date (mm-dd-yy): 03-30-2003  
  
A:\>_
```

- 10 Reboot the module by pressing the **RESET** button on the front of the module.
The module now contains the new date and time information.

6.3 101M Protocol Support

This section describes the portions of IEC 60870-5-101 protocol that are supported by the module.

Note: Shaded areas are not supported by the module.

6.3.1 List of Type Identification Codes

In Monitor Direction

Type	Description
1	time-tagged message
2	time-tagged message with relative time
3	measurands I
4	time-tagged measurands with relative time
5	identification
6	time synchronization
8	general interrogation termination
9	measurands II
10	generic data
11	generic identification
23	list of recorded disturbances
26	ready for transmission of disturbance data
27	ready for transmission of channel
28	ready for transmission of tags
29	transmission of tags
30	transmission of disturbance values
31	end of transmission

In Control Direction

Type	Description
6	time synchronization
7	general interrogation
10	generic data
20	general command
21	generic command
24	order for disturbance data transmission
25	ack for disturbance data transmission

6.3.2 List of Cause of Transmission Codes

In Monitor Direction

COT	Description
1	spontaneous
2	cyclic
3	reset frame count bit (FCB)
4	reset communication unit (CU)
5	start/restart
6	power on
7	test mode
8	time synchronization
9	general interrogation
10	termination of general interrogation
11	local operation
12	remote operation
20	positive ack of command
21	negative ack of command
31	transmission of disturbance data
40	positive ack of generic write command
41	negative ack of generic write command
42	valid data response to generic read command
43	invalid data response to generic read command
44	generic write confirmation

In Control Direction

COT	Description
8	time synchronization
9	initiation of general interrogation
20	general command
31	transmission of disturbance data
40	generic write command
42	generic read command

6.3.3 List of Function Types

Fun	Description	Symbol
128	Distance protection	t(z)
160	Overcurrent protection	I>>
176	Transformer differential protection	ΔI_T
192	Line differential protection	ΔI_L
254	Generic function type	GEN
255	Global function type	GLB

6.3.4 Information Numbers Used in Monitor Direction

System functions

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
0	end of general interrogation		8						X
0	time synchronization		6						X
2	reset FCB		5						*
3	reset CU		5						*
4	start/restart		5						*
5	power on		5						*
* - According to main function									

Status Indications

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
16	auto-recloser active	X	1	X	X		X		
17	teleprotection active	X	1	X	X				
18	protection active	X	1	X	X	X	X		
19	LED reset		1	X	X	X	X		
20	monitor direction blocked	X	1	X	X	X	X		
21	test mode	X	1	X	X	X	X		
22	local parameter setting	X	1	X	X	X	X		
23	characteristic 1	X	1	X					
24	characteristic 2	X	1	X					
25	characteristic 3	X	1	X					
26	characteristic 4	X	1	X					
27	auxiliary input 1	X	1	X	X	X	X		
28	auxiliary input 2	X	1	X	X	X	X		
29	auxiliary input 3	X	1	X	X	X	X		
30	auxiliary input 4	X	1	X	X	X	X		

Supervision indications

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
32	measured supervision I	X	1	X	X				
33	measured supervision V	X	1	X	X				
35	phase sequence supervision	X	1	X	X				
36	trip circuit supervision	X	1	X	X	X	X		
37	I>>back-up operation	X	1	X					
38	VT fuse failure	X	1	X	X				
39	teleprotection disturbed	X	1	X	X		X		
46	group warning	X	1	X	X	X	X		
47	group alarm	X	1	X	X	X	X		

Earth fault indications

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
48	earth fault L ₁	X	1	X	X				
49	earth fault L ₂	X	1	X	X				
50	earth fault L ₃	X	1	X	X				
51	earth fault forward (that is, line)	X	1	X	X				
52	earth fault reverse (that is, busbar)	X	1	X	X				

Fault indications

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
64	start/pick-up L ₁	X	2	X	X		X		
65	start/pick-up L ₂	X	2	X	X		X		
66	start/pick-up L ₃	X	2	X	X		X		
67	start/pick-up N	X	2	X	X		X		
68	general trip		2	X	X	X	X		
69	trip L ₁		2	X	X	X	X		
70	trip L ₂		2	X	X	X	X		
71	trip L ₃		2	X	X	X	X		
72	trip I>> (back-up operation)		4	X					
73	fault location X in ohms		2	X	X				
74	fault forward/line		2	X	X				
75	fault reverse/busbar		2	X	X				
76	teleprotection signal transmitted		2	X	X				
77	teleprotection signal received		2	X	X				
78	zone 1		2	X					
79	zone 2		2	X					
80	zone 3		2	X					
81	zone 4		2	X					
82	zone 5		2	X					
83	zone 6		2	X					
84	general start/pick-up	X	2	X	X	X	X		
85	breaker failure		2	X	X				
86	trip measuring system L ₁		2			X			
87	trip measuring system L ₂		2			X			
88	trip measuring system L ₃		2			X			
89	trip measuring system E		2			X			
90	trip I>		2		X				
91	trip I>>		2		X				
92	trip IN>		2		X				
93	trip IN>>		2		X				

Auto-reclosure indications

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
128	CB 'on' by AR		1	X	X		X		
129	CB 'on' by long-time AR		1	X	X		X		
130	AR blocked	X	1	X	X		X		

Measurands

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
144	measurand I		3.1	X	X				
145	measurands I, V		3.2	X	X				
146	measurands I, V, P, Q		3.3	X					
147	measurands I_N , V_{EN}		3.4	X	X				
148	measurands $I_{L1,2,3}$, $V_{L1,2,3}$, P, Q, f		9	X					

Generic functions

Inf	Description	GI	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
240	read headings of all defined groups		10					X	
241	read values or attributes of all entries of one group		10					X	
243	read directory of a single entry		11					X	
244	read value or attribute of a single entry	(x)	10					X	
245	end of general interrogation of generic data		10					X	
249	write entry with confirmation		10					X	
250	write entry with execution		10					X	
251	write entry aborted		10					X	

6.3.5 Information Numbers used in Control Direction

System functions

Inf	Description	Type	Fun					
			128	160	176	192	254	255
			t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
0	initiation of general interrogation	7						X
0	time synchronization	6						X

General commands

Inf	Description	Com	Type	Fun					
				128	160	176	192	254	255
				t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
16	auto-recloser on/off	On/Off	20	X	X		X		
17	teleprotection on/off	On/Off	20	X	X				
18	protection on/off	On/Off	20	X	X	X	X		
19	LED reset	On	20	X	X	X	X		
23	activate characteristic 1	On	20	X					
24	activate characteristic 2	On	20	X					
25	activate characteristic 3	On	20	X					
26	activate characteristic 4	On	20	X					

Generic functions

Inf	Description	Type	Fun					
			128	160	176	192	254	255
			t(z)	I>>	ΔI_T	ΔI_L	GEN	GLB
240	read headings of all defined groups	21					X	
241	read values or attributes of all entries of one group	21					X	
243	read directory of a single entry	21					X	
244	read value or attribute of a single entry	21					X	
245	general interrogation of generic data	21					X	
248	write entry	10					X	
249	write entry with confirmation	10					X	
250	write entry with execution	10					X	
251	write entry abort	10					X	

6.3.6 Definition and Presentation of ASDUs In Monitor Direction

TYPE 1: Time-tagged

Bytes	Description	Spec
1	Value of 1	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
1	DPI (0 to 3)	7.2.6.5
4	4-octet binary time	7.2.6.28
1	SIN	7.2.6.23

TYPE 2: Time-tagged with relative time

Bytes	Description	Spec
1	Value of 2	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
1	DPI (0 to 3)	7.2.6.5
2	RET (relative time)	7.2.6.15
2	FAN (fault number)	7.2.6.6
4	4-octet binary time	7.2.6.28
1	SIN	7.2.6.23

TYPE 3: Measurands I

Bytes	Description	Spec
1	Value of 3	
1	i = value of 1, 2 or 4	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
2	Current L_2	7.2.6.8
2	Voltage L_1 - L_2	7.2.6.8
2	Active power P	7.2.6.8
2	Reactive power Q	7.2.6.8
	ASD U3.1: i=1	
	ASDU 3.2: i=2	
	ASDU 3.3: i=4	
	ASDU 3.4: i=2 val1= I_N and val2= V_{EN}	

TYPE 4: Time-tagged measurands with relative time

Bytes	Description	Spec
1	Value of 4	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
4	SCL (short-circuit location (real))	7.2.6.20
2	RET (relative time)	7.2.6.15
2	FAN (fault number)	7.2.6.6
4	4-octet binary time	7.2.6.28

TYPE 5: Identification

Bytes	Description	Spec
1	Value of 5	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
1	COL (compatibility level 2 or 3)	7.2.6.3
1	Char 1	7.2.6.2
1	Char 2	7.2.6.2
1	Char 3	7.2.6.2
1	Char 4	7.2.6.2
1	Char 5	7.2.6.2
1	Char 6	7.2.6.2
1	Char 7	7.2.6.2
1	Char 8	7.2.6.2
1	Manufacture byte	Free assignment
1	Manufacture byte	Free assignment
1	Manufacture byte	Free assignment
1	Manufacture byte	Free assignment

TYPE 6: Time synchronization

Bytes	Description	Spec
1	Value of 6	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
7	7-Octet binary time	7.2.6.29

TYPE 8: Termination of general interrogation

Bytes	Description	Spec
1	Value of 8	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
1	SCN (scan number 0 to 255)	7.2.6.21

TYPE 9: Measurands II

Bytes	Description	Spec
1	Value of 9	
1	I = 1 to 9 for number of values	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
2	Current L ₁	7.2.6.8
2	Current L ₂	7.2.6.8
2	Current L ₃	7.2.6.8
2	Voltage L _{1-E}	7.2.6.8
2	Voltage L _{2-E}	7.2.6.8
2	Voltage L _{3-E}	7.2.6.8
2	Active power P	7.2.6.8
2	Reactive power Q	7.2.6.8
2	Frequency f	7.2.6.8
Value of I determines number of parameters passed in the message with a range of 1 to 9 but always starts with the L ₁ value.		

6.3.7 Definition and Presentation of ASDUs in Control Direction

TYPE 6: Time synchronization

Bytes	Description	Spec
1	Value of 6	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type = GLB (255)	
1	Information number	
7	7-Octet binary time	7.2.6.29

TYPE 7: Initiation of general interrogation

Bytes	Description	Spec
1	Value of 7	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type = GLB (255)	
1	Information number	
1	SCN (scan number 0 to 255)	7.2.6.21

TYPE 20: General command

Bytes	Description	Spec
1	Value of 20	
1	0x81	
1	COT	
1	Common address of ASDU	
1	Function Type	
1	Information number	
1	DCO (1=Off, 2=On)	7.2.6.4
1	Rll	7.2.6.19
Rll is not to be processed within the protection equipment, but to be used as a SIN of the return message.		

6.4 IEC 60870-5-101 Master Protocol Interoperability Documentation

This companion standard presents sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the COMMON ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers it is necessary that all partners agree on the selected parameters.

Note: In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows:

☐	Function or ASDU is not used
☒	Function or ASDU is used as standardized (default)
R	Function or ASDU is used in reverse mode
B	Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

The pages in this section have been extracted from the 60870-5-101 © IEC:1997, pages 159 to 171.

6.4.1 Electrical Interface

☒	EIA RS-485
☒	Number of loads 32. For one protection equipment

NOTE - EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line. For detailed information refer to clause 3 of EIA RS-485 standard.

6.4.2 Optical Interface

☐	Glass fiber
☐	Plastic fiber
☐	F-SMA type connector
☐	BFOC/2,5 type connector

6.4.3 Transmission speed

☒	9 600 bit/s
☒	19 200 bit/s

6.4.4 Link Layer

There are no choices for the link layer.

6.4.5 Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

6.4.6 Common Address of ASDU

☒	One Common Address of ASDU (identical with station address)
☒	More than one Common Address of ASDU

6.4.7 Selection of standard information numbers in monitor direction

6.4.8 System functions in monitor direction

	INF	Semantics
☒	<0>	End of general interrogation
☒	<0>	Time synchronization
☒	<2>	Reset FCB
☒	<3>	Reset CU
☒	<4>	Start/restart
☒	<5>	Power on

6.4.9 Status indications in monitor direction

	INF	Semantics
☒	<16>	Auto-recloser active
☒	<17>	Teleprotection active
☒	<18>	Protection active
☒	<19>	LED reset
☒	<20>	Monitor direction blocked
☒	<21>	Test mode
☒	<22>	Local parameter setting
☒	<23>	Characteristic 1
☒	<24>	Characteristic 2
☒	<25>	Characteristic 3
☒	<26>	Characteristic 4
☒	<27>	Auxiliary input 1
☒	<28>	Auxiliary input 2
☒	<29>	Auxiliary input 3
☒	<30>	Auxiliary input 4

6.4.10 Supervision indications in monitor direction

	INF	Semantics
☒	<32>	Measurand supervision I
☒	<33>	Measurand supervision V
☒	<35>	Phase sequence supervision
☒	<36>	Trip circuit supervision
☒	<37>	I>> back-up operation
☒	<38>	VT fuse failure
☒	<39>	Teleprotection disturbed
☒	<46>	Group warning
☒	<47>	Group alarm

6.4.11 Earth fault indications in monitor direction

	INF	Semantics
☒	<48>	Earth fault L ₁
☒	<49>	Earth fault L ₂
☒	<50>	Earth fault L ₃
☒	<51>	Earth fault forward, that is, line
☒	<52>	Earth fault reverse, that is, busbar

6.4.12 Fault indications in monitor direction

	INF	Semantics
--	-----	-----------

	INF	Semantics
☒	<64>	Start /pick-up L ₁
☒	<65>	Start /pick-up L ₂
☒	<66>	Start /pick-up L ₃
☒	<67>	Start /pick-up N
☒	<68>	General trip
☒	<69>	Trip L ₁
☒	<70>	Trip L ₂
☒	<71>	Trip L ₃
☒	<72>	Trip I>> (back-up operation)
☒	<73>	Fault location X in ohms
☒	<74>	Fault forward/line
☒	<75>	Fault reverse/busbar
☒	<76>	Teleprotection signal transmitted
☒	<77>	Teleprotection signal received
☒	<78>	Zone 1
☒	<79>	Zone 2
☒	<80>	Zone 3
☒	<81>	Zone 4
☒	<82>	Zone 5
☒	<83>	Zone 6
☒	<84>	General start/pick-up
☒	<85>	Breaker failure
☒	<86>	Trip measuring system L ₁
☒	<87>	Trip measuring system L ₂
☒	<88>	Trip measuring system L ₃
☒	<89>	Trip measuring system E
☒	<90>	Trip I>
☒	<91>	Trip I>>
☒	<92>	Trip IN>
☒	<93>	Trip IN>>

6.4.13 Auto-reclosure indications in monitor direction

	INF	Semantics
☒	<128>	CB "on" by AR
☒	<129>	CB "on" by long-time AR
☒	<130>	AR blocked

6.4.14 Measurands in monitor direction

	INF	Semantics
☒	<144>	Measurand I

	INF	Semantics
☒	<145>	Measurands I, V
☒	<146>	Measurands I, V, P, Q
☒	<147>	Measurands I _N , V _{EN}
☒	<148>	Measurands I _{L1,2,3} , V _{L1,2,3} , P, Q, f

6.4.15 Generic functions in monitor direction

	INF	Semantics
☐	<240>	Read headings of all defined groups
☐	<241>	Read values or attributes of all entries of one group
☐	<243>	Read directory of a single entry
☐	<244>	Read value or attribute of a single entry
☐	<245>	End of general interrogation of generic data
☐	<249>	Write entry with confirmation
☐	<250>	Write entry with execution
☐	<251>	Write entry aborted

6.4.16 System functions in control direction

	INF	Semantics
☒	<0>	Initiation of general interrogation
☒	<0>	Time synchronization

6.4.17 General commands in control direction

	INF	Semantics
☒	<16>	Auto-recloser on/off
☒	<17>	Teleprotection on/off
☒	<18>	Protection on/off
☒	<19>	LED reset
☒	<23>	Activate characteristic 1
☒	<24>	Activate characteristic 2
☒	<25>	Activate characteristic 3
☒	<26>	Activate characteristic 4

6.4.18 Generic functions in control direction

	INF	Semantics
☐	<240>	Read headings of all defined groups
☐	<241>	Read values or attributes of all entries in one group
☐	<243>	Read directory of a single entry
☐	<244>	Read value or attribute of a single entry
☐	<245>	General interrogation of generic data
☐	<248>	Write entry
☐	<249>	Write entry with confirmation
☐	<250>	Write entry with execution
☐	<251>	Write entry abort

6.4.19 Basic application functions

☒	Test mode
☒	Blocking of monitor direction
☐	Disturbance data
☐	Generic services
☒	Private data (if ASDU type is supported by module)

6.4.20 Miscellaneous

Measurands are transmitted with ASDU 3 as well as with ASDU 9. As defined in 7.2.6.8, the maximum MVAL can either be 1,2 or 2,4 times the rated value. No different rating shall be used in ASDU 3 and ASDU 9, that is, for each measurand there is only one choice.

Measurand Max. MVAL = rated value times

	1,2	or	2,4
Current L ₁	☒		☒
Current L ₂	☒		☒
Current L ₃	☒		☒
Voltage L _{1-E}	☒		☒
Voltage L _{2-E}	☒		☒
Voltage L _{3-E}	☒		☒
Active power P	☒		☒
Reactive power Q	☒		☒
Frequency f	☒		☒
Voltage L ₁ - L ₂	☒		☒

[illegible]

6.6 Frequently Asked Questions

This section provides answers frequently asked questions about the ProLinx 101M module.

6.6.1 Why is the module not communicating with the slave?

First, ensure that the slave Data Link Address is configured as a slave (session) in the configuration file. The module will only try to initialize slaves identified by Data Link Addresses that are currently configured as sessions. Refer to technical specification for your protection equipment for its Data Link Address. You should also check to see if the common ASDU address is configured as a sector in the module. Make sure all port communication parameters match the slave parameters (baud rate, parity, and so on). Finally, look at the cables and ensure that the correct communication mode is set (RS-232 or RS-495).

6.6.2 The slave is responding but I cannot see the monitor data in the Module database.

Ensure that the monitor points are correctly configured. Refer to your protection equipment's documentation for the correct ASDU type, Function Code, and Information Number. These values must match the parameters that are entered for every monitor point in the [IEC-101 Master Session 0] section of the configuration file.

The addressing type in the module database depends on the point ASDU type. The Database Index parameter can be interpreted as bit, byte, word, or double-word address. For more details, refer to Data Types and Mapping.

6.6.3 How can I confirm if the configuration was received by the module?

You can verify this using the Debug menu. Refer to Diagnostics and Troubleshooting in this manual for information on using the Debug menu.

7 Support, Service & Warranty

In This Chapter

- ❖ Contacting Technical Support 103
- ❖ Return Material Authorization (RMA) Policies and Conditions..... 105
- ❖ LIMITED WARRANTY 107

Contacting Technical Support

ProSoft Technology, Inc. (ProSoft) is committed to providing the most efficient and effective support possible. Before calling, please gather the following information to assist in expediting this process:

- 1 Product Version Number
- 2 System architecture
- 3 Network details

If the issue is hardware related, we will also need information regarding:

- 1 Module configuration and associated ladder files, if any
- 2 Module operation and any unusual behavior
- 3 Configuration/Debug status information
- 4 LED patterns
- 5 Details about the serial, Ethernet or fieldbus devices interfaced to the module, if any.

Note: For technical support calls within the United States, an after-hours answering system allows 24-hour/7-days-a-week pager access to one of our qualified Technical and/or Application Support Engineers. Detailed contact information for all our worldwide locations is available on the following page.

Internet	Web Site: www.prosoft-technology.com/support E-mail address: support@prosoft-technology.com
Asia Pacific (location in Malaysia)	Tel: +603.7724.2080, E-mail: asiapc@prosoft-technology.com Languages spoken include: Chinese, English
Asia Pacific (location in China)	Tel: +86.21.5187.7337 x888, E-mail: asiapc@prosoft-technology.com Languages spoken include: Chinese, English
Europe (location in Toulouse, France)	Tel: +33 (0) 5.34.36.87.20, E-mail: support.EMEA@prosoft-technology.com Languages spoken include: French, English
Europe (location in Dubai, UAE)	Tel: +971-4-214-6911, E-mail: mea@prosoft-technology.com Languages spoken include: English, Hindi
North America (location in California)	Tel: +1.661.716.5100, E-mail: support@prosoft-technology.com Languages spoken include: English, Spanish
Latin America (Oficina Regional)	Tel: +1-281-2989109, E-Mail: latinam@prosoft-technology.com Languages spoken include: Spanish, English
Latin America (location in Puebla, Mexico)	Tel: +52-222-3-99-6565, E-mail: soporte@prosoft-technology.com Languages spoken include: Spanish
Brasil (location in Sao Paulo)	Tel: +55-11-5083-3776, E-mail: brasil@prosoft-technology.com Languages spoken include: Portuguese, English

7.1 Return Material Authorization (RMA) Policies and Conditions

The following Return Material Authorization (RMA) Policies and Conditions (collectively, "RMA Policies") apply to any returned product. These RMA Policies are subject to change by ProSoft Technology, Inc., without notice. For warranty information, see Limited Warranty (page 107). In the event of any inconsistency between the RMA Policies and the Warranty, the Warranty shall govern.

7.1.1 Returning Any Product

- a) In order to return a Product for repair, exchange, or otherwise, the Customer must obtain a Return Material Authorization (RMA) number from ProSoft Technology and comply with ProSoft Technology shipping instructions.
- b) In the event that the Customer experiences a problem with the Product for any reason, Customer should contact ProSoft Technical Support at one of the telephone numbers listed above (page 103). A Technical Support Engineer will request that you perform several tests in an attempt to isolate the problem. If after completing these tests, the Product is found to be the source of the problem, we will issue an RMA.
- c) All returned Products must be shipped freight prepaid, in the original shipping container or equivalent, to the location specified by ProSoft Technology, and be accompanied by proof of purchase and receipt date. The RMA number is to be prominently marked on the outside of the shipping box. Customer agrees to insure the Product or assume the risk of loss or damage in transit. Products shipped to ProSoft Technology using a shipment method other than that specified by ProSoft Technology, or shipped without an RMA number will be returned to the Customer, freight collect. Contact ProSoft Technical Support for further information.
- d) A 10% restocking fee applies to all warranty credit returns, whereby a Customer has an application change, ordered too many, does not need, etc. Returns for credit require that all accessory parts included in the original box (i.e.; antennas, cables) be returned. Failure to return these items will result in a deduction from the total credit due for each missing item.

7.1.2 Returning Units Under Warranty

A Technical Support Engineer must approve the return of Product under ProSoft Technology's Warranty:

- a) A replacement module will be shipped and invoiced. A purchase order will be required.
- b) Credit for a product under warranty will be issued upon receipt of authorized product by ProSoft Technology at designated location referenced on the Return Material Authorization
 - i. If a defect is found and is determined to be customer generated, or if the defect is otherwise not covered by ProSoft Technology's warranty, there will be no credit given. Customer will be contacted and can request module be returned at their expense;
 - ii. If defect is customer generated and is repairable, customer can authorize ProSoft Technology to repair the unit by providing a purchase order for 30% of the current list price plus freight charges, duties and taxes as applicable.

7.1.3 Returning Units Out of Warranty

- a) Customer sends unit in for evaluation to location specified by ProSoft Technology, freight prepaid.
- b) If no defect is found, Customer will be charged the equivalent of \$100 USD, plus freight charges, duties and taxes as applicable. A new purchase order will be required.
- c) If unit is repaired, charge to Customer will be 30% of current list price (USD) plus freight charges, duties and taxes as applicable. A new purchase order will be required or authorization to use the purchase order submitted for evaluation fee.

The following is a list of non-repairable units:

- 3150 - All
- 3750
- 3600 - All
- 3700
- 3170 - All
- 3250
- 1560 - Can be repaired, only if defect is the power supply
- 1550 - Can be repaired, only if defect is the power supply
- 3350
- 3300
- 1500 - All

7.2 LIMITED WARRANTY

This Limited Warranty ("Warranty") governs all sales of hardware, software, and other products (collectively, "Product") manufactured and/or offered for sale by ProSoft Technology, Incorporated (ProSoft), and all related services provided by ProSoft, including maintenance, repair, warranty exchange, and service programs (collectively, "Services"). By purchasing or using the Product or Services, the individual or entity purchasing or using the Product or Services ("Customer") agrees to all of the terms and provisions (collectively, the "Terms") of this Limited Warranty. All sales of software or other intellectual property are, in addition, subject to any license agreement accompanying such software or other intellectual property.

7.2.1 What Is Covered By This Warranty

- a) *Warranty On New Products:* ProSoft warrants, to the original purchaser, that the Product that is the subject of the sale will (1) conform to and perform in accordance with published specifications prepared, approved and issued by ProSoft, and (2) will be free from defects in material or workmanship; provided these warranties only cover Product that is sold as new. This Warranty expires three (3) years from the date of shipment for Product purchased **on or after** January 1st, 2008, or one (1) year from the date of shipment for Product purchased **before** January 1st, 2008 (the "Warranty Period"). If the Customer discovers within the Warranty Period a failure of the Product to conform to specifications, or a defect in material or workmanship of the Product, the Customer must promptly notify ProSoft by fax, email or telephone. In no event may that notification be received by ProSoft later than 39 months from date of original shipment. Within a reasonable time after notification, ProSoft will correct any failure of the Product to conform to specifications or any defect in material or workmanship of the Product, with either new or remanufactured replacement parts. ProSoft reserves the right, and at its sole discretion, may replace unrepairable units with new or remanufactured equipment. All replacement units will be covered under warranty for the 3 year period commencing from the date of original equipment purchase, not the date of shipment of the replacement unit. Such repair, including both parts and labor, will be performed at ProSoft's expense. All warranty service will be performed at service centers designated by ProSoft.
- b) *Warranty On Services:* Materials and labor performed by ProSoft to repair a verified malfunction or defect are warranted in the terms specified above for new Product, provided said warranty will be for the period remaining on the original new equipment warranty or, if the original warranty is no longer in effect, for a period of 90 days from the date of repair.

7.2.2 What Is Not Covered By This Warranty

- a) ProSoft makes no representation or warranty, expressed or implied, that the operation of software purchased from ProSoft will be uninterrupted or error free or that the functions contained in the software will meet or satisfy the purchaser's intended use or requirements; the Customer assumes complete responsibility for decisions made or actions taken based on information obtained using ProSoft software.
- b) This Warranty does not cover the failure of the Product to perform specified functions, or any other non-conformance, defects, losses or damages caused by or attributable to any of the following: (i) shipping; (ii) improper installation or other failure of Customer to adhere to ProSoft's specifications or instructions; (iii) unauthorized repair or maintenance; (iv) attachments, equipment, options, parts, software, or user-created programming (including, but not limited to, programs developed with any IEC 61131-3, "C" or any variant of "C" programming languages) not furnished by ProSoft; (v) use of the Product for purposes other than those for which it was designed; (vi) any other abuse, misapplication, neglect or misuse by the Customer; (vii) accident, improper testing or causes external to the Product such as, but not limited to, exposure to extremes of temperature or humidity, power failure or power surges; or (viii) disasters such as fire, flood, earthquake, wind and lightning.
- c) The information in this Agreement is subject to change without notice. ProSoft shall not be liable for technical or editorial errors or omissions made herein; nor for incidental or consequential damages resulting from the furnishing, performance or use of this material. The user guide included with your original product purchase from ProSoft contains information protected by copyright. No part of the guide may be duplicated or reproduced in any form without prior written consent from ProSoft.

7.2.3 Disclaimer Regarding High Risk Activities

Product manufactured or supplied by ProSoft is not fault tolerant and is not designed, manufactured or intended for use in hazardous environments requiring fail-safe performance including and without limitation: the operation of nuclear facilities, aircraft navigation or communication systems, air traffic control, direct life support machines or weapons systems in which the failure of the product could lead directly or indirectly to death, personal injury or severe physical or environmental damage (collectively, "high risk activities"). ProSoft specifically disclaims any express or implied warranty of fitness for high risk activities.

7.2.4 Intellectual Property Indemnity

Buyer shall indemnify and hold harmless ProSoft and its employees from and against all liabilities, losses, claims, costs and expenses (including attorney's fees and expenses) related to any claim, investigation, litigation or proceeding (whether or not ProSoft is a party) which arises or is alleged to arise from Buyer's acts or omissions under these Terms or in any way with respect to the Products. Without limiting the foregoing, Buyer (at its own expense) shall indemnify and hold harmless ProSoft and defend or settle any action brought against such Companies to the extent based on a claim that any Product made to Buyer specifications infringed intellectual property rights of another party. ProSoft makes no warranty that the product is or will be delivered free of any person's claiming of patent, trademark, or similar infringement. The Buyer assumes all risks (including the risk of suit) that the product or any use of the product will infringe existing or subsequently issued patents, trademarks, or copyrights.

- a) Any documentation included with Product purchased from ProSoft is protected by copyright and may not be duplicated or reproduced in any form without prior written consent from ProSoft.
- b) ProSoft's technical specifications and documentation that are included with the Product are subject to editing and modification without notice.
- c) Transfer of title shall not operate to convey to Customer any right to make, or have made, any Product supplied by ProSoft.
- d) Customer is granted no right or license to use any software or other intellectual property in any manner or for any purpose not expressly permitted by any license agreement accompanying such software or other intellectual property.
- e) Customer agrees that it shall not, and shall not authorize others to, copy software provided by ProSoft (except as expressly permitted in any license agreement accompanying such software); transfer software to a third party separately from the Product; modify, alter, translate, decode, decompile, disassemble, reverse-engineer or otherwise attempt to derive the source code of the software or create derivative works based on the software; export the software or underlying technology in contravention of applicable US and international export laws and regulations; or use the software other than as authorized in connection with use of Product.
- f) **Additional Restrictions Relating To Software And Other Intellectual Property**

In addition to compliance with the Terms of this Warranty, Customers purchasing software or other intellectual property shall comply with any license agreement accompanying such software or other intellectual property. Failure to do so may void this Warranty with respect to such software and/or other intellectual property.

7.2.5 Disclaimer of all Other Warranties

The Warranty set forth in What Is Covered By This Warranty (page 107) are in lieu of all other warranties, express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose.

7.2.6 Limitation of Remedies **

In no event will ProSoft or its Dealer be liable for any special, incidental or consequential damages based on breach of warranty, breach of contract, negligence, strict tort or any other legal theory. Damages that ProSoft or its Dealer will not be responsible for include, but are not limited to: Loss of profits; loss of savings or revenue; loss of use of the product or any associated equipment; loss of data; cost of capital; cost of any substitute equipment, facilities, or services; downtime; the claims of third parties including, customers of the Purchaser; and, injury to property.

** Some areas do not allow time limitations on an implied warranty, or allow the exclusion or limitation of incidental or consequential damages. In such areas, the above limitations may not apply. This Warranty gives you specific legal rights, and you may also have other rights which vary from place to place.

7.2.7 Time Limit for Bringing Suit

Any action for breach of warranty must be commenced within 39 months following shipment of the Product.

7.2.8 No Other Warranties

Unless modified in writing and signed by both parties, this Warranty is understood to be the complete and exclusive agreement between the parties, suspending all oral or written prior agreements and all other communications between the parties relating to the subject matter of this Warranty, including statements made by salesperson. No employee of ProSoft or any other party is authorized to make any warranty in addition to those made in this Warranty. The Customer is warned, therefore, to check this Warranty carefully to see that it correctly reflects those terms that are important to the Customer.

7.2.9 Allocation of Risks

This Warranty allocates the risk of product failure between ProSoft and the Customer. This allocation is recognized by both parties and is reflected in the price of the goods. The Customer acknowledges that it has read this Warranty, understands it, and is bound by its Terms.

7.2.10 Controlling Law and Severability

This Warranty shall be governed by and construed in accordance with the laws of the United States and the domestic laws of the State of California, without reference to its conflicts of law provisions. If for any reason a court of competent jurisdiction finds any provisions of this Warranty, or a portion thereof, to be unenforceable, that provision shall be enforced to the maximum extent permissible and the remainder of this Warranty shall remain in full force and effect. Any cause of action with respect to the Product or Services must be instituted in a court of competent jurisdiction in the State of California.

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