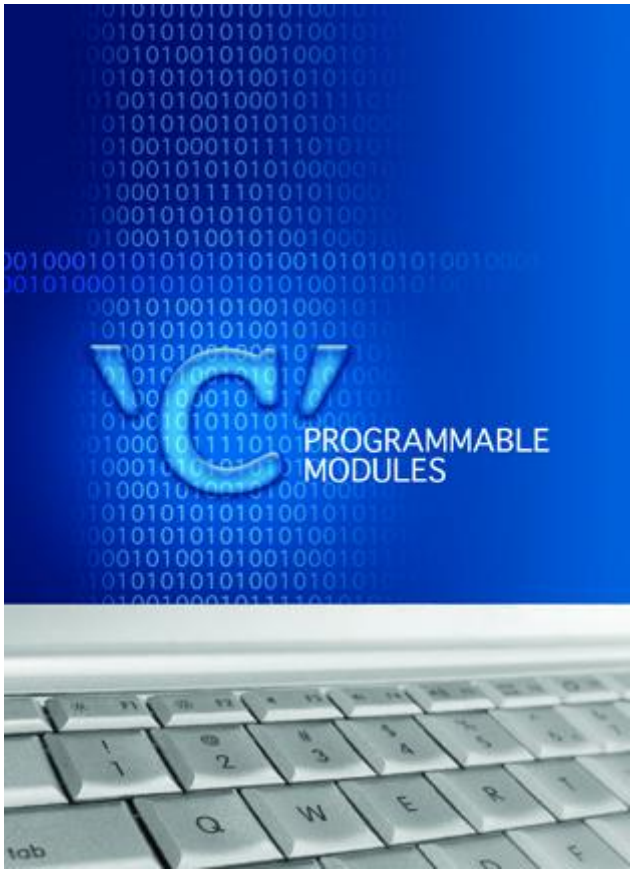
ProSoft® TECHNOLOGY

Where Automation Connects.



ProLinx®

MCM4-ADM4

ProLinx Standalone

'C' Programmable Modbus Communication Module

February 20, 2013

DEVELOPER'S GUIDE

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 NONHAZARDOUS.
D THIS DEVICE SHALL BE POWERED BY CLASS 2 OUTPUTS ONLY.

All ProLinx® Products

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.

Markings

UL/cUL	ISA 12.12.01 Class I, Div 2 Groups A, B, C, D
cUL	C22.2 No. 213-M1987

243333 183151

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

Temp Code T5

II 3 G

Ex nA nL IIC T5 X

0° 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.

Your Feedback Please

We always want you to feel that you made the right decision to use our products. If you have suggestions, comments, compliments or complaints about the product, documentation, or support, please write or call us.

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MCM4-ADM4 Developer's Guide

February 20, 2013

In an effort to conserve paper, ProSoft Technology no longer includes printed manuals with our product shipments. User Manuals, Datasheets, Sample Ladder Files, and Configuration Files are provided on the enclosed CD-ROM, and are available at no charge from our web site: www.prosoft-technology.com.

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Printed documentation is available for purchase. Contact ProSoft Technology for pricing and availability.

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Contents

1 Introduction

In This Chapter

This document provides information needed for development of application programs for the MCM4-ADM4 Serial Communication Module.

The modules are programmable to accommodate devices with unique serial protocols.

Included in this document is information about the available software API libraries and tools, module configuration and programming information, and example code for the module.

1.1 Operating System

The module includes General Software Embedded DOS 6-XL. This operating system provides DOS compatibility along with real-time multitasking functionality. The operating system is stored in Flash ROM and is loaded by the BIOS when the module boots.

DOS compatibility allows user applications to be developed using standard DOS tools, such as Borland compilers.

Note: DOS programs that try to access the video or keyboard hardware directly will not function correctly on the PLX module. Only programs that use the standard DOS and BIOS functions to perform console I/O are compatible.

Refer to the General Software Embedded DOS 6-XL Developer's Guide (page 117) on the MCM4-ADM4 CD-ROM for more information.

2 Preparing the PLX-MCM4 Module

In This Chapter

2.1 Package Contents

The following components are included with your MCM4-ADM4 gateway, and are all required for installation and configuration.

Important: Before beginning the installation, please verify that all of the following items are present.

Qty.	Part Name	Part Number	Part Description
1	MCM4-ADM4 gateway	PLX-####	ProLinx communication gateway gateway
1	Cable	Cable #15, RS232 Null Modem	For RS232 Connection from a PC to the CFG Port of the gateway
Varies	Cable	Cable #9, Mini-DIN8 to DB9 Male Adapter	For DB9 Connection to gateway's Port. One DIN to DB-9M cable included per configurable serial port, plus one for gateway configuration
Varies	Adapter	1454-9F	Adapters, DB9 Female to Screw Terminal. For RS422 or RS485 Connections to each serial application port of the gateway
1	ProSoft Solutions CD		Contains sample programs, utilities and documentation for the MCM4-ADM4 gateway.

If any of these components are missing, please contact ProSoft Technology Support for replacements.

2.2 Setting Port 0 Configuration Jumpers

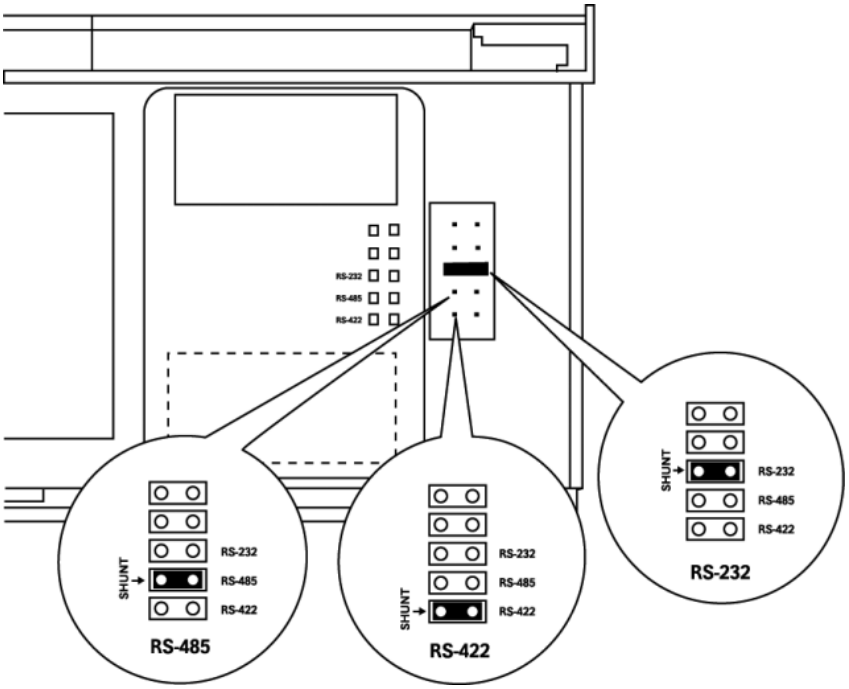
Before installing the module on the DIN-rail, you must set the jumpers for the Port 0 application port.

Note: Ethernet-only ProLinx modules do not use the serial port jumper settings. The serial configuration jumper settings on an Ethernet-only module have no effect.
Note: The presence of Port 0 depends on the specific combination of protocols in your ProLinx module. If your module does not have a Port 0, the following jumper settings do not apply.

Port 0 is preconfigured for RS-232. You can move the port configuration jumper on the back of the module to select RS-485 or RS-422.

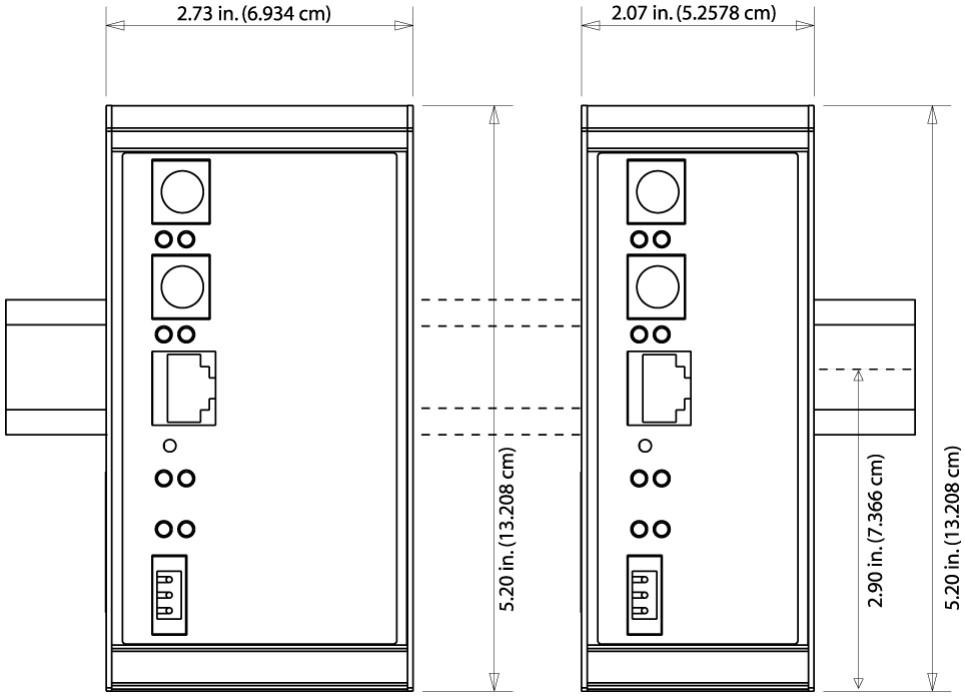
Note: Some ProLinx modules do not correctly report the position of the port 0 jumper to the Port Configuration page on the Config/Debug menu. In cases where the reported configuration differs from the known jumper configuration, the physical configuration of the jumper is correct.

The following illustration shows the jumper positions for Port 0:



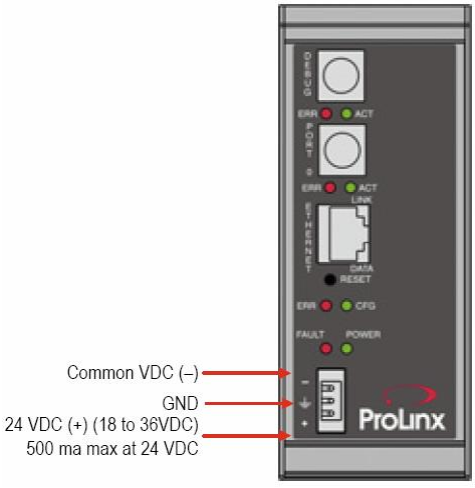
ProLinx 5000/6000 Series Module

2.3 Mounting the gateway on the DIN-rail



ProLinx 5000/6000 Series gateway

2.4 Connecting Power to the Unit



WARNING: Ensure that you do not reverse polarity when applying power to the gateway. This will cause damage to the gateway's power supply.

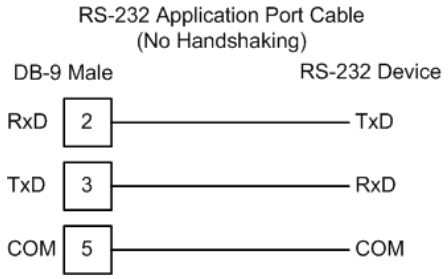
2.5 Cable Connections

The application ports on the MCM4-ADM4 module support RS-232, RS-422, and RS-485 interfaces. Please inspect the module to ensure that the jumpers are set correctly to correspond with the type of interface you are using.

Note: When using RS-232 with radio modem applications, some radios or modems require hardware handshaking (control and monitoring of modem signal lines). Enable this in the configuration of the module by setting the UseCTS parameter to 1.

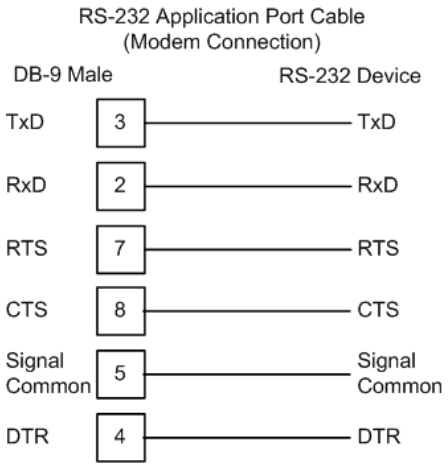
2.5.1 RS-232

When the RS-232 interface is selected, the use of hardware handshaking (control and monitoring of modem signal lines) is user definable. If no hardware handshaking will be used, the cable to connect to the port is as shown below:



RS-232: Modem Connection

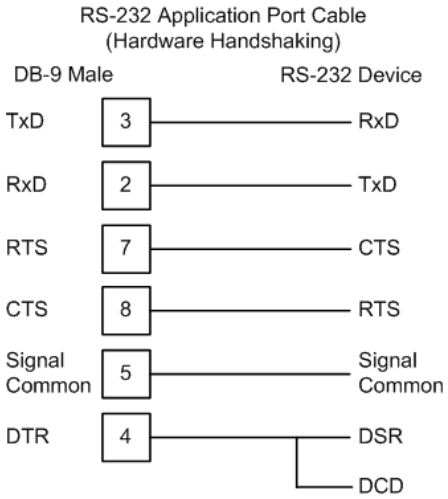
This type of connection is required between the module and a modem or other communication device.



The "Use CTS Line" parameter for the port configuration should be set to 'Y' for most modem applications.

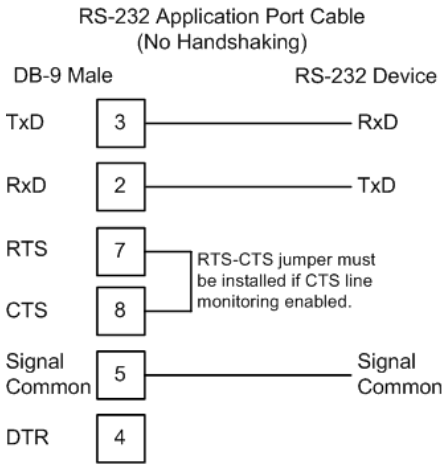
RS-232: Null Modem Connection (Hardware Handshaking)

This type of connection is used when the device connected to the module requires hardware handshaking (control and monitoring of modem signal lines).



RS-232: Null Modem Connection (No Hardware Handshaking)

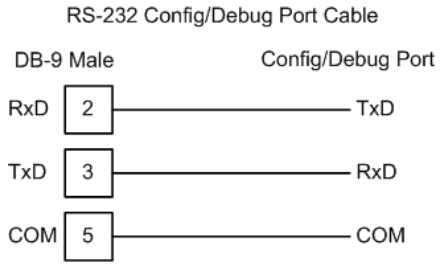
This type of connection can be used to connect the module to a computer or field device communication port.



Note: If the port is configured with the "Use CTS Line" set to 'Y', then a jumper is required between the RTS and the CTS line on the module connection.

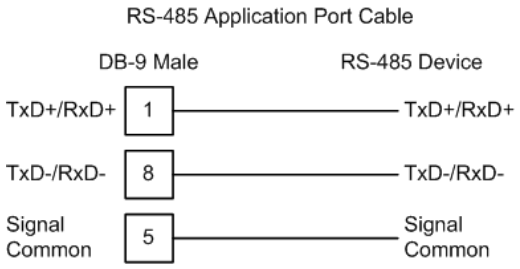
2.5.2 RS-232 Configuration/Debug Port

This port is physically a Mini-DIN connection. A Mini-DIN to DB-9 adapter cable is included with the module. This port permits a PC based terminal emulation program to view configuration and status data in the module and to control the module. The cable for communications on this port is shown in the following diagram:



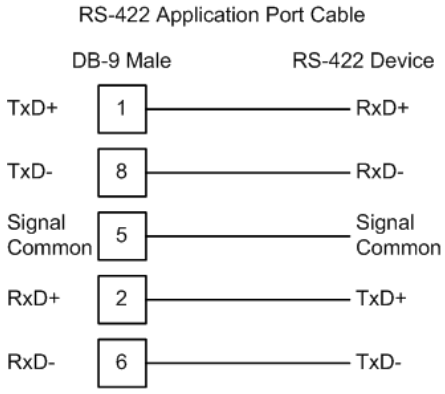
2.5.3 RS-485

The RS-485 interface requires a single two or three wire cable. The Common connection is optional and dependent on the RS-485 network. The cable required for this interface is shown below:



Note: Terminating resistors are generally not required on the RS-485 network, unless you are experiencing communication problems that can be attributed to signal echoes or reflections. In this case, install a 120-ohm terminating resistor on the RS-485 line.

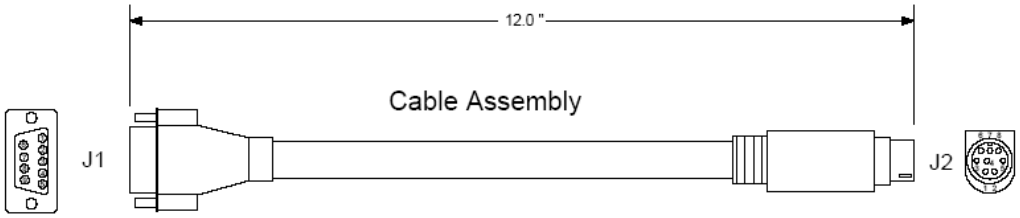
2.5.4 RS-422

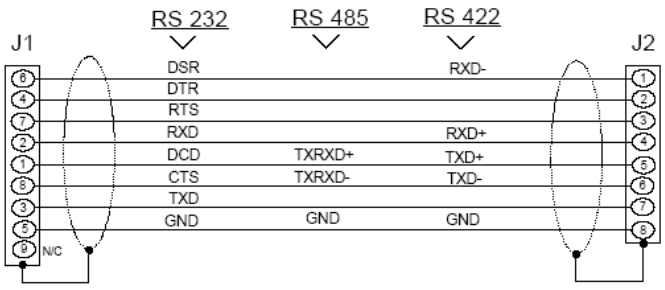


RS-485 and RS-422 Tip

If communication in the RS-422/RS-485 mode does not work at first, despite all attempts, try switching termination polarities. Some manufacturers interpret +/- and A/B polarities differently.

2.5.5 DB9 to Mini-DIN Adaptor (Cable 09)





Wiring Diagram

3 Setting Up Your Development Environment

In This Chapter

3.1 Setting Up Your Compiler

There are some important compiler settings that must be set in order to successfully compile an application for the ProLinx platforms. The following topics describe the setup procedures for each of the supported compilers.

3.1.1 Configuring Digital Mars C++ 8.49

The following procedure allows you to successfully build the sample ADM code supplied by ProSoft Technology using Digital Mars C++ 8.49. After verifying that the sample code can be successfully compiled and built, you can modify the sample code to work with your application.

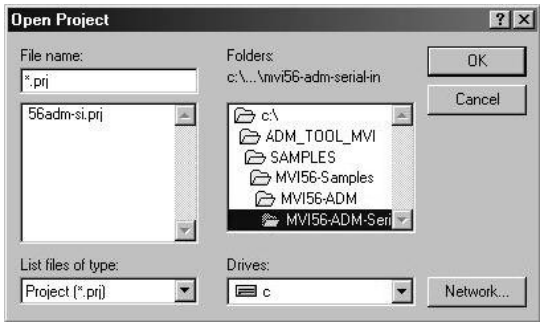
Note: This procedure assumes that you have successfully installed Digital Mars C++ 8.49 on your workstation.

Downloading the Sample Program

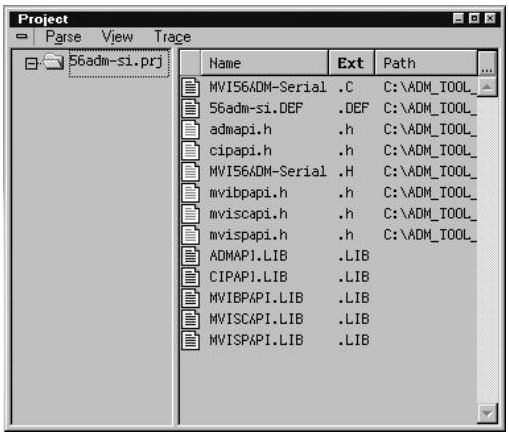
The sample code files are located in the ADM_MCM_TOOL_PLX.ZIP file. This zip file is available from the CD-ROM shipped with your system or from the www.prosoft-technology.com web site. When you unzip the file, you will find the sample code files in \ADM_MCM_TOOL_PLX\SAMPLES\.

Building an Existing Digital Mars C++ 8.49 ADM Project

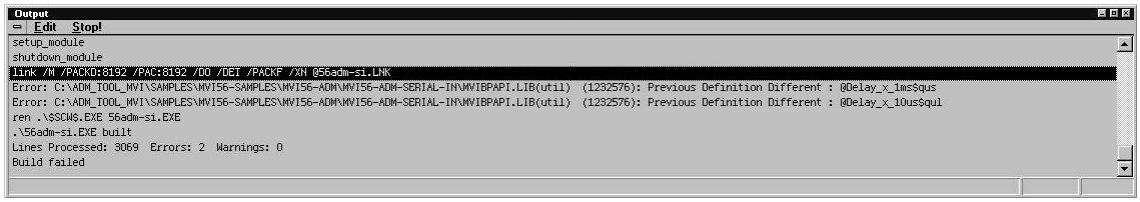
1 Start Digital Mars C++ 8.49, and then click **Project** → **Open** from the *Main Menu*.



2 From the *Folders* field, navigate to the folder that contains the project (C:\ADM_MCM_TOOL_PLX\SAMPLES\…).
3 In the *File Name* field, click on the project name (56adm-si.prj).
4 Click **OK**. The *Project* window appears:

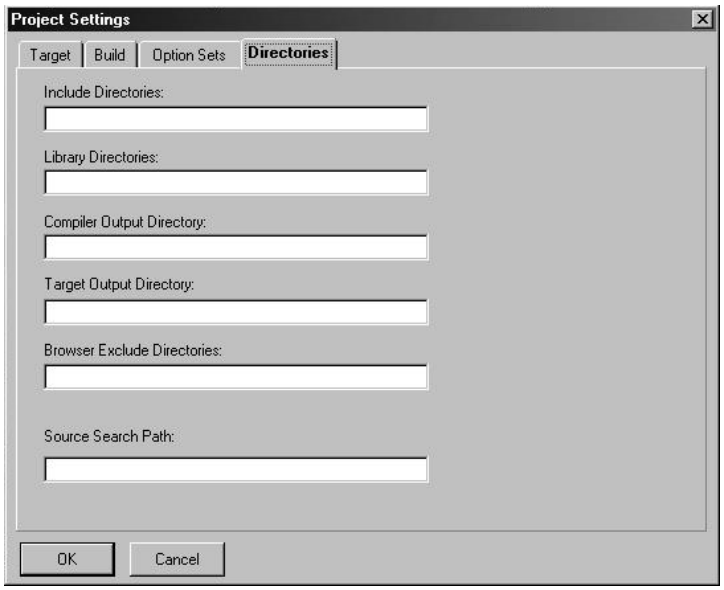


5 Click **Project** → **Rebuild All** from the *Main Menu* to create the .exe file. The status of the build will appear in the Output window:



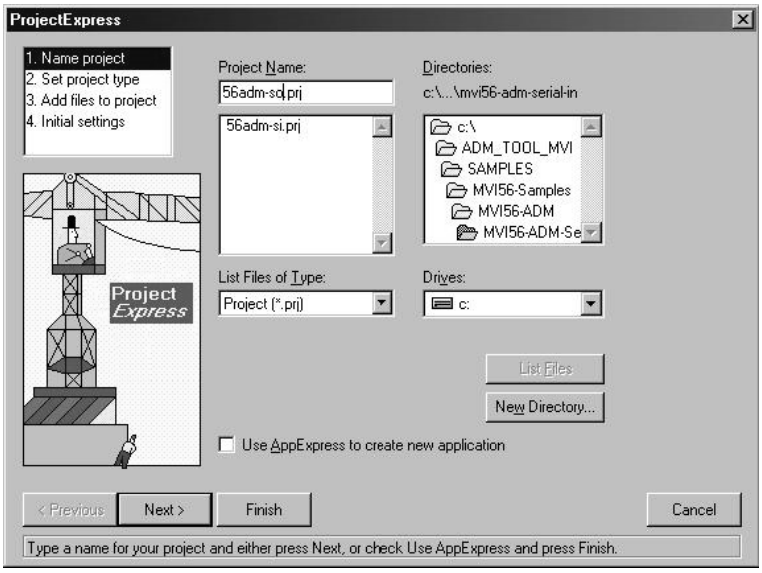
Porting Notes: *The Digital Mars compiler classifies duplicate library names as Level 1 Errors rather than warnings. These errors will manifest themselves as "Previous Definition Different: function name". Level 1 errors are non-fatal and the executable will build and run. The architecture of the ADM libraries will cause two or more of these errors to appear when the executable is built. This is a normal occurrence. If you are building existing code written for a different compiler you may have to replace calls to run-time functions with the Digital Mars equivalent. Refer to the Digital Mars documentation on the Run-time Library for the functions available.*

6 The executable file will be located in the directory listed in the Compiler Output Directory field. If it is blank then the executable file will be located in the same folder as the project file. The *Project Settings* window can be accessed by clicking **Project** → **Settings** from the *Main Menu*.



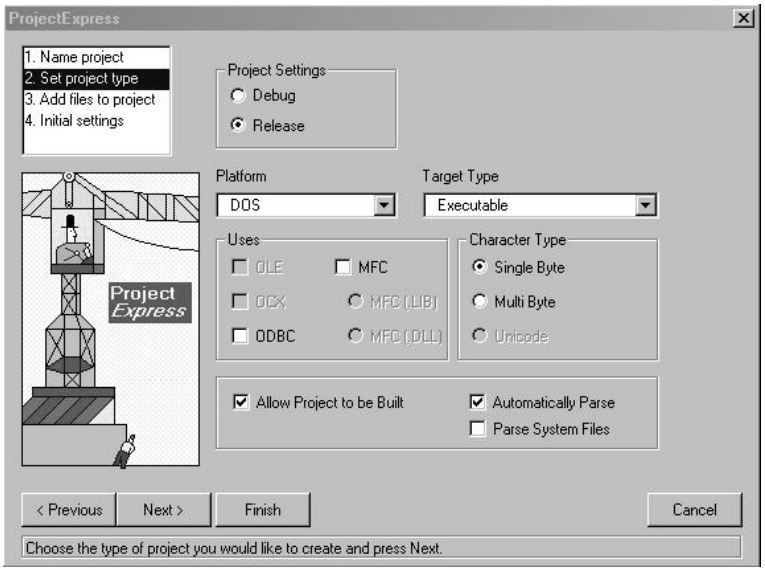
Creating a New Digital Mars C++ 8.49 ADM Project

1 Start Digital Mars C++ 8.49, and then click **Project** → **New** from the *Main Menu*.

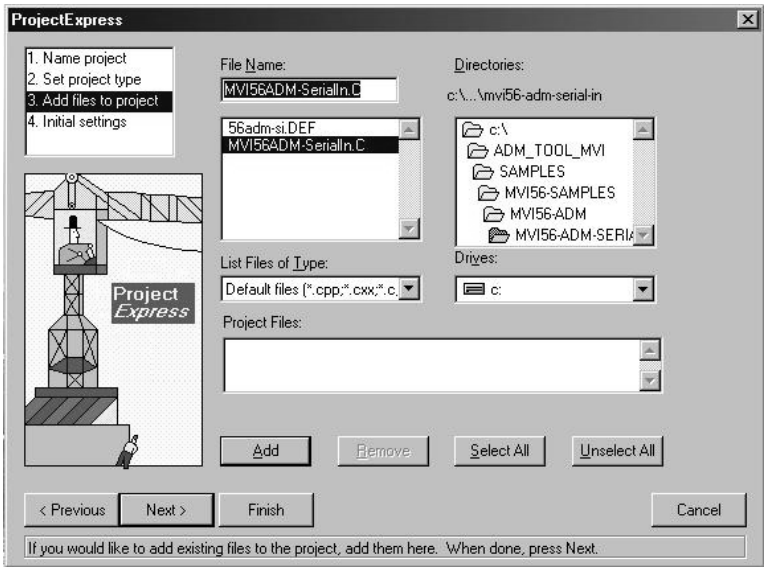


2 Select the path and type in the **Project Name**.

3 Click Next.

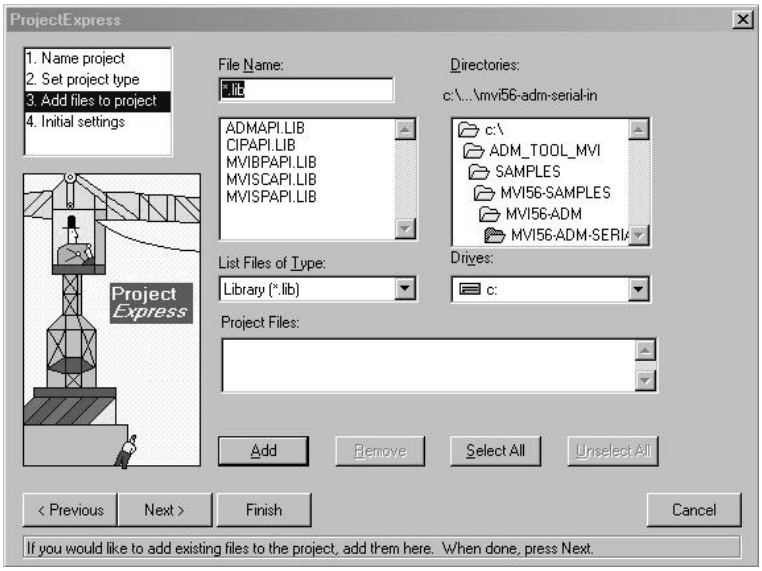


4 In the *Platform* field, choose **DOS**.
5 In the Project Settings choose Release if you do not want debug information included in your build.
6 Click Next.

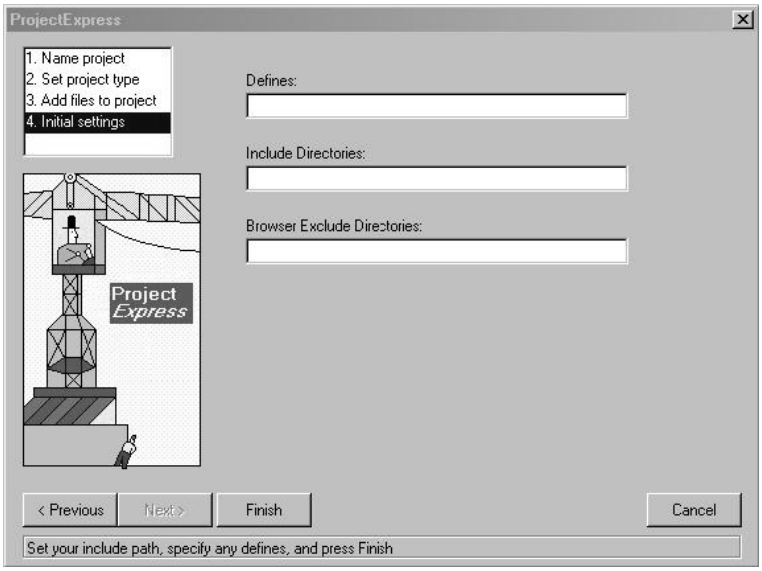


7 Select the first source file necessary for the project.
8 Click Add.
9 Repeat this step for all source files needed for the project.
10 Repeat the same procedure for all library files (.lib) needed for the project.

11 Choose Libraries (*.lib) from the *List Files of Type* field to view all library files:

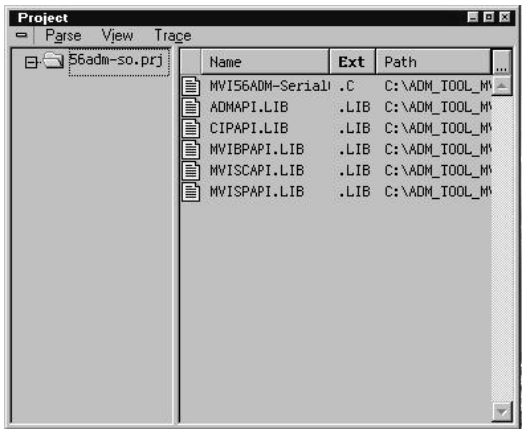


12 Click Next.

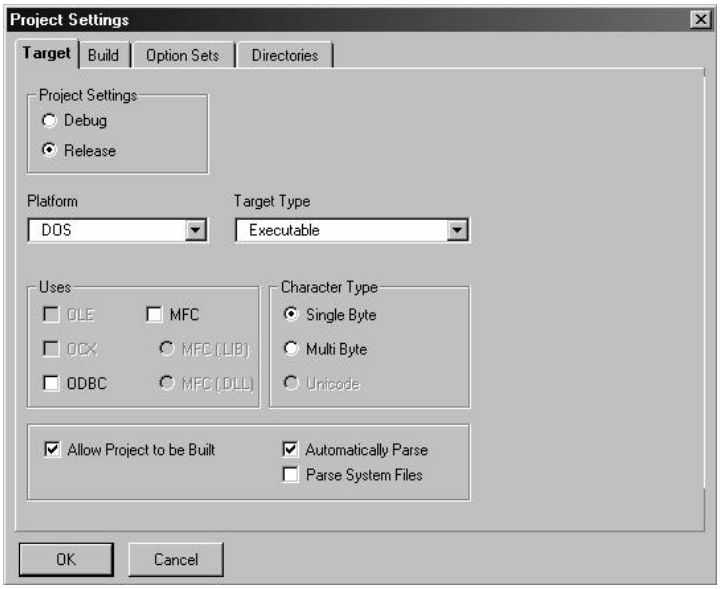


13 Add any defines or include directories desired.
14 Click **Finish**.

15 The *Project* window should now contain all the necessary source and library files as shown in the following window:

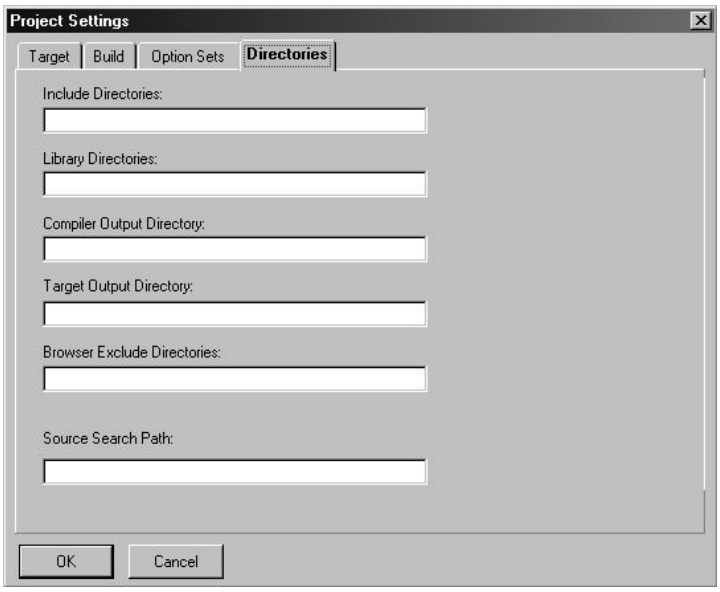


16 Click **Project** → **Settings** from the *Main Menu*.



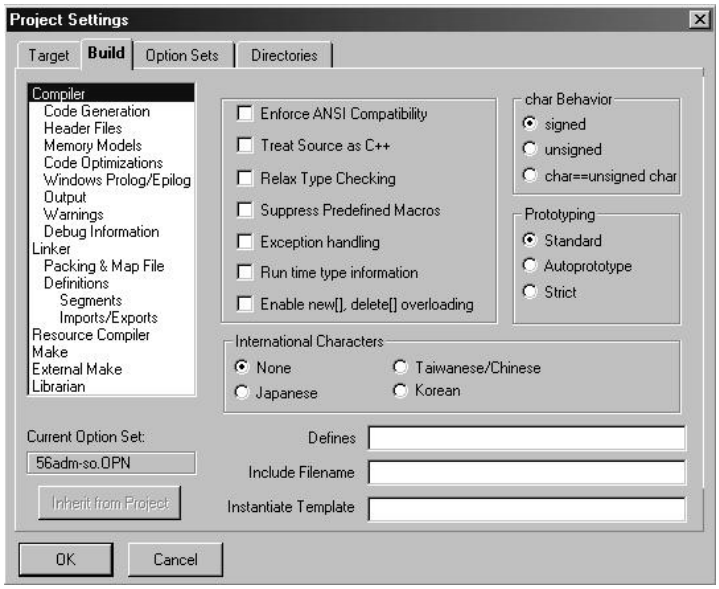
17 These settings were set when the project was created. No changes are required. The executable must be built as a DOS executable in order to run on the PLX platform.

18 Click the **Directories** tab and fill in directory information as required by your project's directory structure.

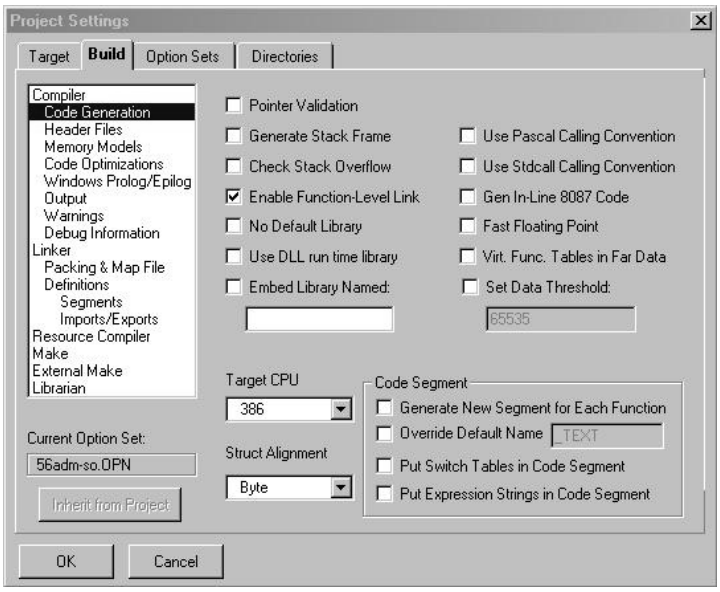


19 If the fields are left blank then it is assumed that all of the files are in the same directory as the project file. The output files will be placed in this directory as well.

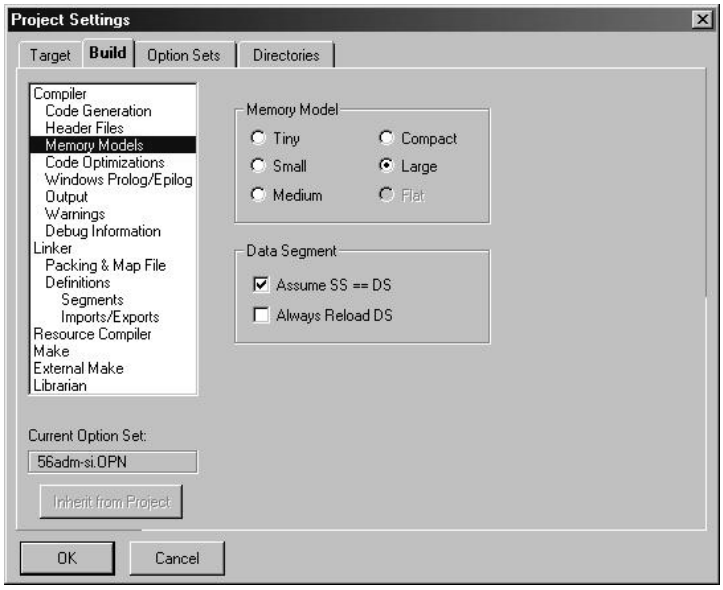
20 Click on the **Build** tab, and choose the **Compiler** selection. Confirm that the settings match those shown in the following screen:



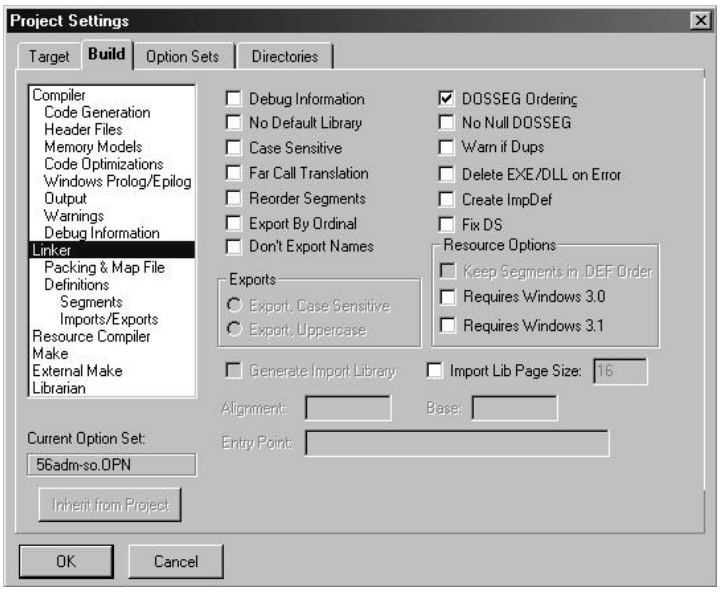
21 Click **Code Generation from** the *Topics* field and ensure that the options match those shown in the following screen:



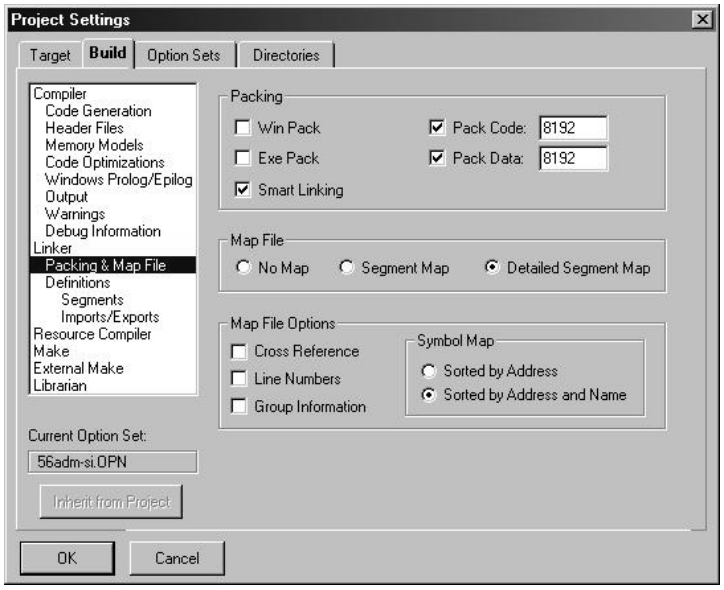
22 Click **Memory Models from** the *Topics* field and ensure that the options match those shown in the following screen:



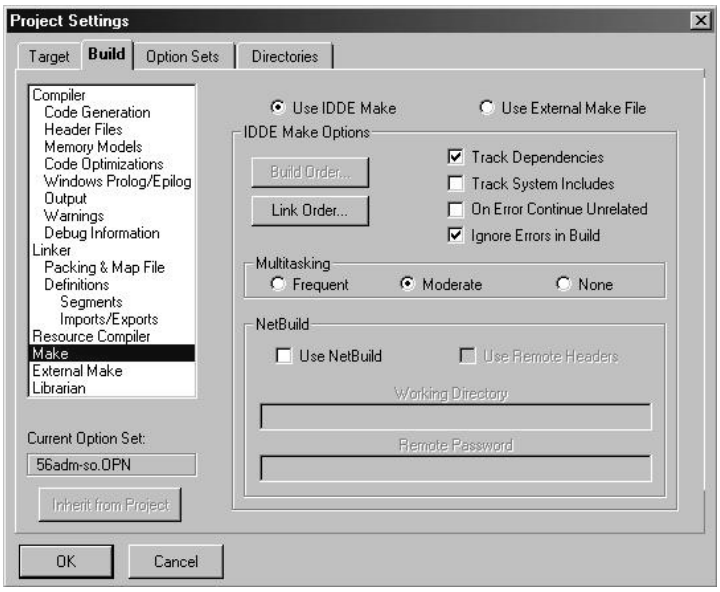
23 Click **Linker from** the *Topics* field and ensure that the options match those shown in the following screen:



24 Click **Packing & Map File from** the *Topics* field and ensure that the options match those shown in the following screen:



25 Click **Make from** the *Topics* field and ensure that the options match those shown in the following screen:

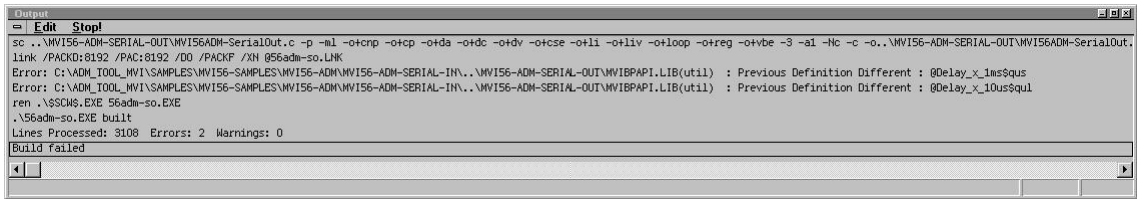


26 Click **OK**.

27 Click **Parse** → **Update All** from the Project Window *Menu*. The new settings may not take effect unless the project is updated and reparsed.

28 Click **Project** → **Build All** from the Main Menu.

29 When complete, the build results will appear in the Output window:



The executable file will be located in the directory listed in the Compiler Output Directory box of the Directories tab (that is, C:\ADM_MCM_TOOL_PLX\SAMPLES\…). The *Project Settings* window can be accessed by clicking **Project** → **Settings** from the *Main Menu.*

Porting Notes: *The Digital Mars compiler classifies duplicate library names as Level 1 Errors rather than warnings. These errors will manifest themselves as "Previous Definition Different: function name". Level 1 errors are non-fatal and the executable will build and run. The architecture of the ADM libraries will cause two or more of these errors to appear when the executable is built. This is a normal occurrence. If you are building existing code written for a different compiler you may have to replace calls to run-time functions with the Digital Mars equivalent. Refer to the Digital Mars documentation on the Run-time Library for the functions available.*

3.1.2 Configuring Borland C++5.02

The following procedure allows you to successfully build the sample ADM code supplied by ProSoft Technology. using Borland C++ 5.02. After verifying that the sample code can be successfully compiled and built, you can modify the sample code to work with your application.

Note: This procedure assumes that you have successfully installed Borland C++ 5.02 on your workstation.

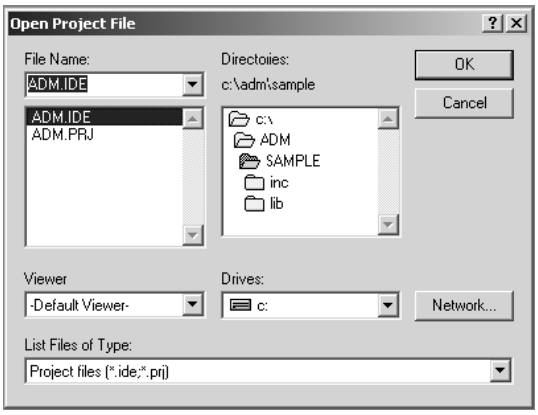
Downloading the Sample Program

The sample code files are located in the MCM4ADM.zip file. This zip file is available from the CD-ROM shipped with your system or from the www.prosoft-technology.com web site. One the file is unzipped, you can find the sample code files in \MCM4ADM\Sample.

Note: ProSoft recommends using the project file MCMADM.IDE as a starting point for your project. You can then modify this file for your particular needs.

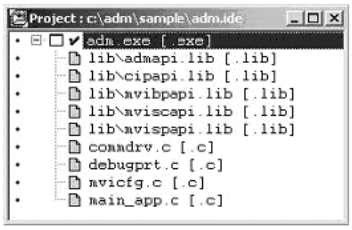
Building an Existing Borland C++ 5.02 ADM Project

1 Start Borland C++ 5.02, then click **Project → Open Project** from the *Main Menu*.

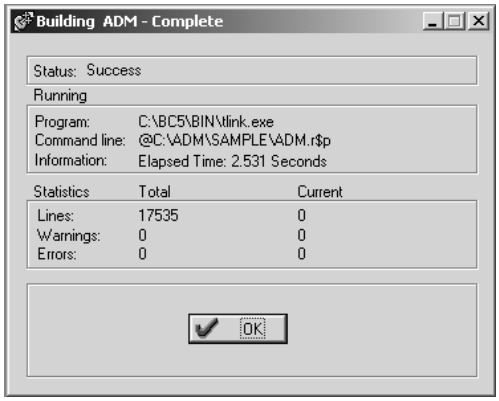


2 From the *Directories* field, navigate to the directory that contains the project (C:\adm\sample).
3 In the *File Name* field, click on the project name (adm.ide).

4 Click **OK**. The *Project* window appears:

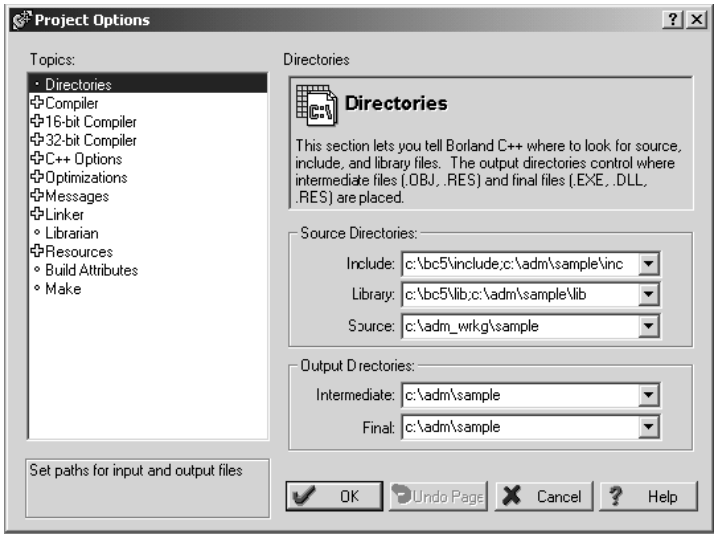


5 Click **Project → Build All** from the *Main Menu* to create the .exe file. The *Building ADM* window appears when complete:



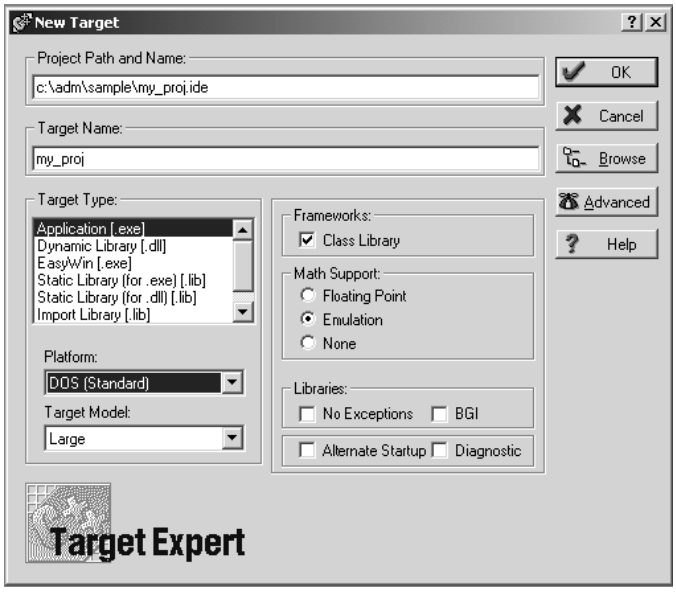
6 When Success appears in the *Status* field, click **OK**.

The executable file will be located in the directory listed in the *Final* field of the Output Directories (that is, C:\adm\sample). The *Project Options* window can be accessed by clicking **Options → Project Menu** from the *Main Menu*.

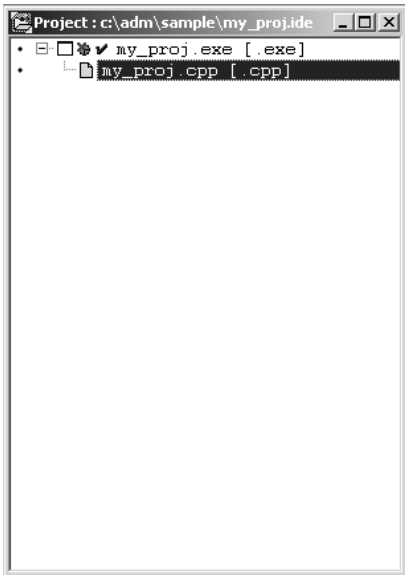


Creating a New Borland C++ 5.02 ADM Project

1 Start Borland C++ 5.02, and then click **File** → **Project** from the *Main Menu*.

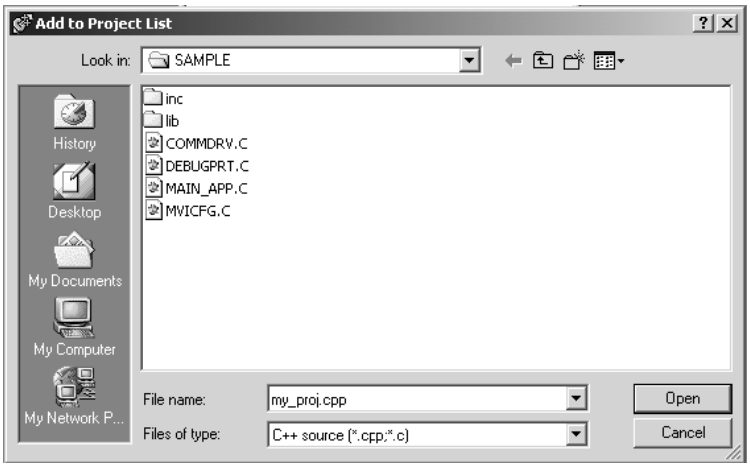


2 Type in the **Project Path and Name**. The Target Name is created automatically.
3 In the *Target Type* field, choose **Application (.exe)**.
4 In the *Platform* field, choose **DOS (Standard)**.
5 In the *Target Model* field, choose **Large**.
6 Ensure that **Emulation** is checked in the *Math Support* field.
7 Click **OK**. A Project window appears:



8 Click on the .cpp file created and press the **Delete** key. Click **Yes** to delete the .cpp file.

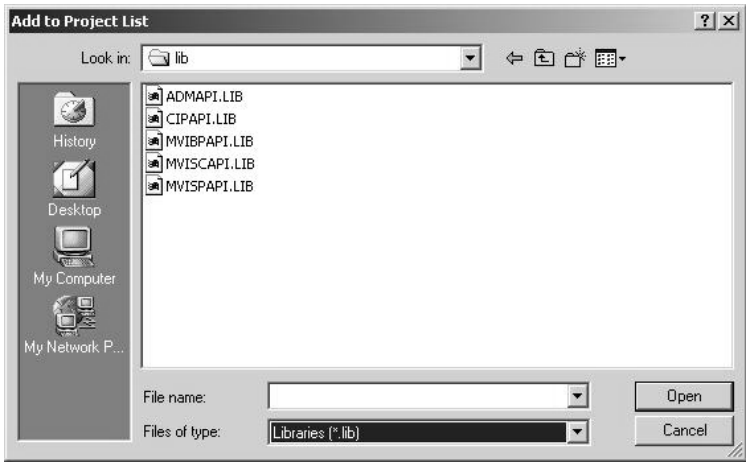
9 Right click on the .exe file listed in the *Project* window and choose the *Add Node* menu selection. The following window appears:



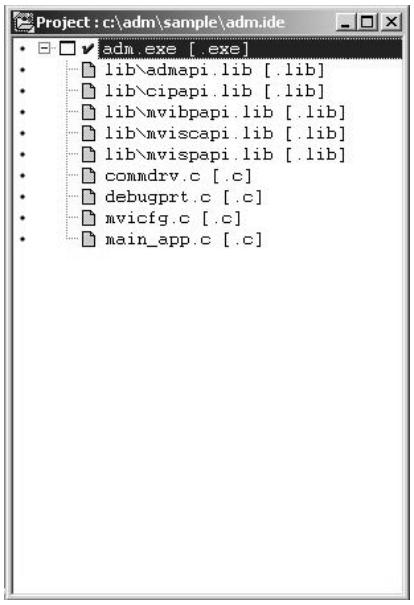
10 Click source file, then click **Open** to add source file to the project. Repeat this step for all source files needed for the project.

11 Repeat the same procedure for all library files (.lib) needed for the project.

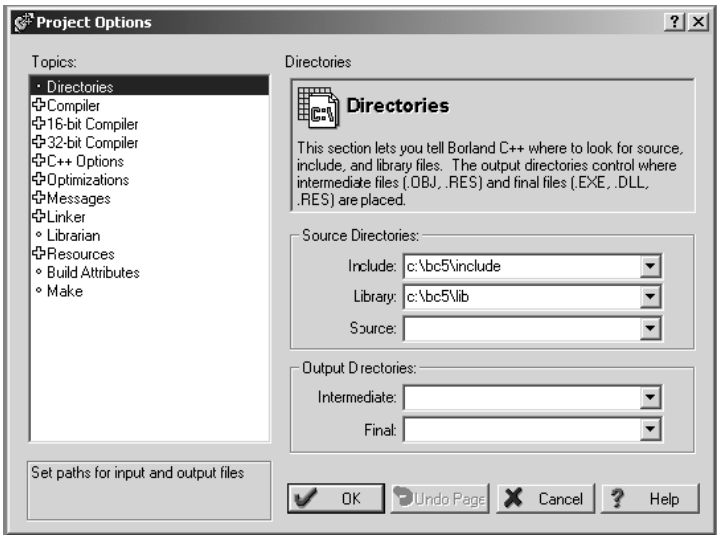
12 Choose Libraries (*.lib) from the *Files of Type* field to view all library files:



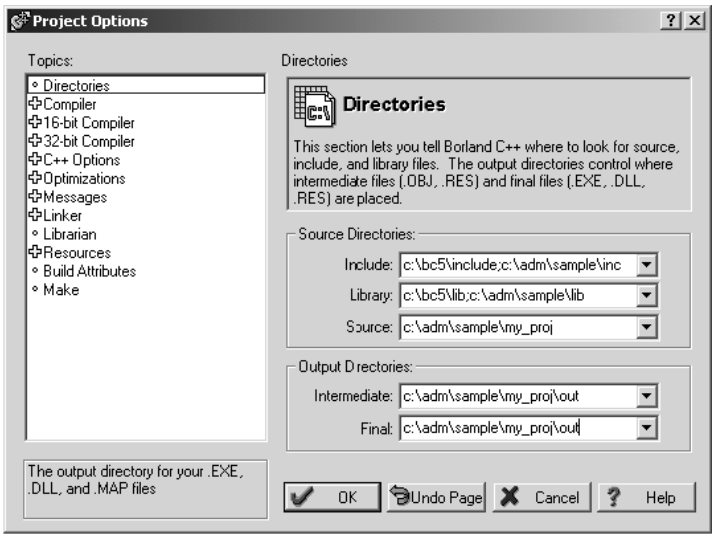
13 The *Project* window should now contain all the necessary source and library files as shown in the following window:



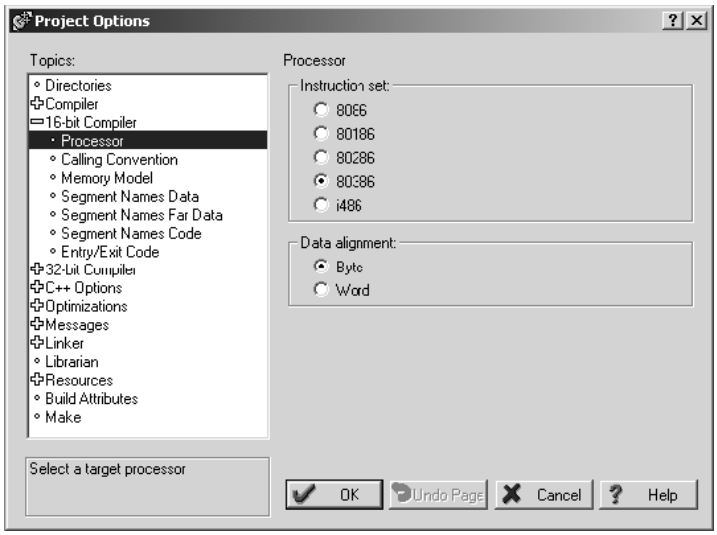
14 Click **Options** → **Project** from the *Main Menu*.



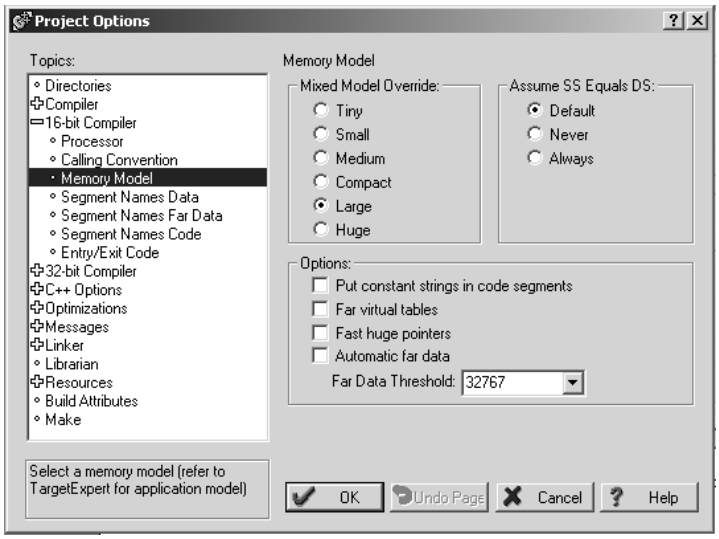
15 Click **Directories** from the *Topics* field and fill in directory information as required by your project's directory structure.



16 Double-click on the **Compiler** header in the *Topics* field, and choose the **Processor** selection. Confirm that the settings match those shown in the following screen:



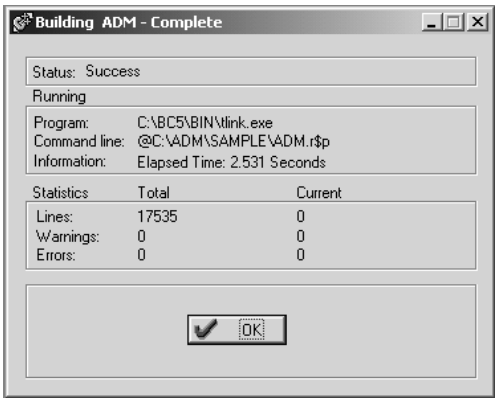
17 Click **Memory Model** from the *Topics* field and ensure that the options match those shown in the following screen:



18 Click **OK**.

19 Click **Project** → **Build All** from the *Main Menu*.

20 When complete, the *Success* window appears:



21 Click **OK**. The executable file will be located in the directory listed in the Final box of the Output Directories (that is, C:\adm\sample). The *Project Options* window can be accessed by clicking **Options** → **Project** from the *Main Menu.*

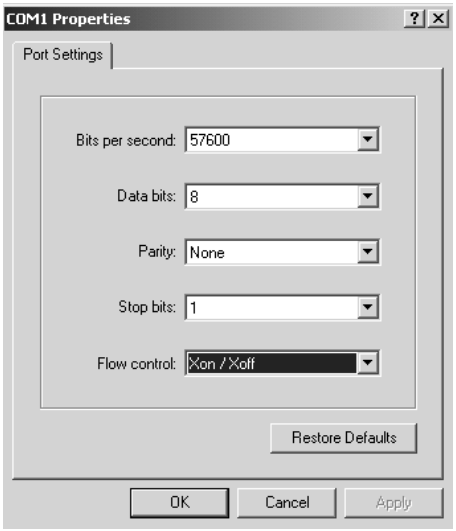
3.1.3 Downloading Files to the Module

1 Connect your PC's COM port to the ProLinx Configuration/Debug port using the Null Modem cable and ProLinx Adapter cable.

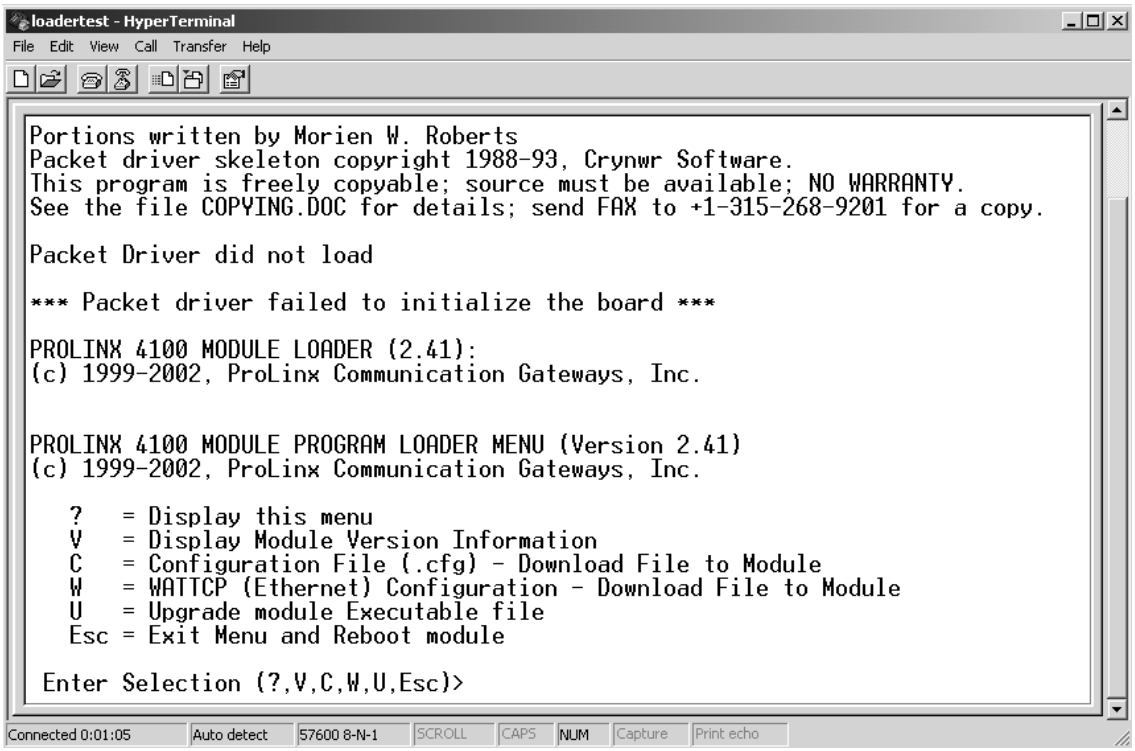
2 From the Start Menu on your PC, select **Programs** → **Accessories** → **Communications** → **HyperTerminal**. The *New Connection* Screen appears:

3 Enter a name and choose **OK**. The *Connect To* window appears:

4 Choose the COM port that your ProLinx module is connected to and choose **OK**. The COM1 Properties window appears.

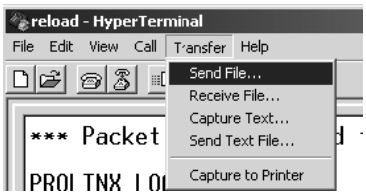


5 Ensure that the settings shown on this screen match those on your PC.
6 Click **OK**. The HyperTerminal window appears with a DOS prompt and blinking cursor.
7 Apply power to the ProLinx module and hold down the **[L]** key. The screen displays information and ultimately displays the Loader menu:

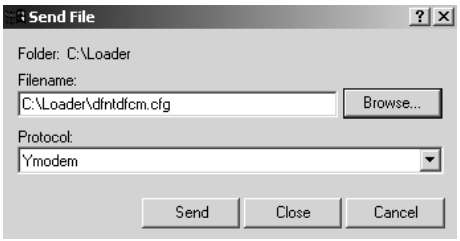


This menu provides options that allow you to download a configuration file **[C]**, a WATTCP file **[W]**, or a new executable file **[U]**. You can also press **[V]** to view module version information.

1. Type **[U]** at the prompt to transfer executable files from the computer to the ProLinx unit.
2. Type **[Y]** when the program asks if you want to load an .exe file.
3. From the HyperTerminal menu, select **Transfer** → **Send**.



4. When the *Send To* screen appears, browse for the executable file to send to the module. Be sure to select **Y Modem** in the Protocol field.



5. Click **Send**. The program loads the new executable file to the ProLinx module. When the download is complete, the program returns to the Loader menu.

   If you want to load a new configuration file or a WATTCP file, select the appropriate option and perform the same steps to download these files.

6. Press **[Esc]**, then **[Y]** to confirm module reboot.

4 Programming the Module

In This Chapter

This section describes how to get your application running on the ProLinx module. Once an application has been developed using the serial API, it must be downloaded to the ProLinx module in order to run. The application may then be run manually from the console command line, or automatically on boot from the AUTOEXEC.BAT or CONFIG.SYS files.

4.1 Debugging Strategies

For simple debugging, printf's may be inserted into the module application to display debugging information on the console connected to the Debug port.

4.2 RS-485 Programming Note

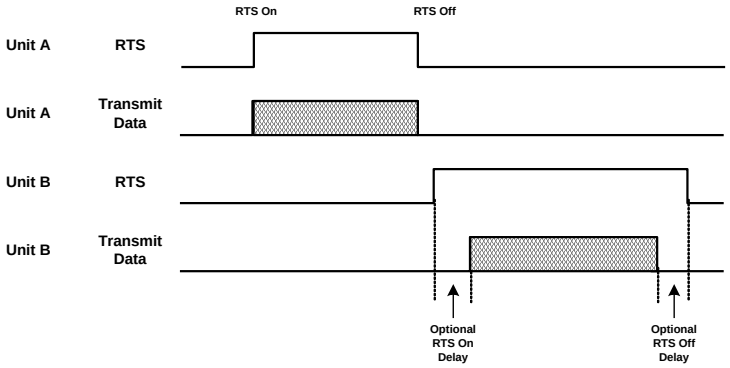
4.2.1 Hardware

The serial port has two driver chips, one for RS-232 and one for RS-422/485. The Request To Send (RTS) line is used for hardware handshaking in RS-232 and to control the transmitter in RS-422/485.

In RS-485, only one node can transmit at a time. All nodes should default to listening (RTS off) unless transmitting. If a node has its RTS line asserted, then all other communication is blocked. An analogy for this is a 2-way radio system where only one person can speak at a time. If someone holds the talk button, then they cannot hear others transmitting.

In order to have orderly communication, a node must make sure no other nodes are transmitting before beginning a transmission. The node needing to transmit will assert the RTS line then transmit the message. The RTS line must be de-asserted as soon as the last character is transmitted. Turning RTS on late or off early will cause the beginning or end of the message to be clipped resulting in a communication error. In some applications it may be necessary to delay between RTS transitions and the message. In this case RTS would be asserted, wait for delay time, transmit message, wait for delay time, and de-assert RTS.

RS-485 Transmit / Receive



4.2.2 Software

The following is a code sample designed to illustrate the steps required to transmit in RS-485. Depending on the application, it may be necessary to handle other processes during this transmit sequence and to not block. This is simplified to demonstrate the steps required.

```
int length = 10; // send 10 characters
int CharsLeft;
BYTE buffer[10];
// Set RTS on
MVIsp_SetRTS(COM2, ON);
// Optional delay here (depends on application)
// Transmit message
MVIsp_PutData(COM2, buffer, &length, TIMEOUT_ASAP);
// Check to see that message is done
MVIsp_GetCountUnsent(COM2, &CharsLeft);
// Keep checking until all characters sent
while(CharsLeft)
{
MVIsp_GetCountUnsent(COM2, &CharsLeft);
}
// Optional delay here (depends on application)
// Set RTS off
MVIsp_SetRTS(COM2, OFF);
```

5 Understanding the ADM API

In This Chapter

The ADM API Suite allows software developers to access the serial ports without needing detailed knowledge of the module's hardware design. The API provides for Modbus Master/Slave and generic serial ports.

Applications for the MCM4-ADM4 module may be developed using industry-standard DOS programming tools and the appropriate API components.

This section provides general information pertaining to application development for the MCM4-ADM4 module.

5.1 API Libraries

Each API provides a library of function calls. The library supports any programming language that is compatible with the Pascal calling convention.

Each API library is a static object code library that must be linked with the application to create the executable program. It is distributed as a 16-bit large model OMF library, compatible with Digital Mars C++ or Borland development tools.

Note: The following compiler versions are intended to be compatible with the PLX module API:
- Digital Mars C++ 8.49
- Borland C++ V5.02

More compilers will be added to the list as the API is tested for compatibility with them.

5.1.1 Calling Convention

The API library functions are specified using the 'C' programming language syntax. To allow applications to be developed in other industry-standard programming languages, the standard Pascal calling convention is used for all application interface functions.

5.1.2 Header File

A header file is provided along with each library. This header file contains API function declarations, data structure definitions, and miscellaneous constant definitions. The header file is in standard 'C' format.

5.1.3 Sample Code

A sample application is provided to illustrate the usage of the API functions. Full source for the sample application is provided. The sample application may be compiled using Borland C++.

5.1.4 Multithreading Considerations

The DOS 6-XL operating system supports the development of multi-threaded applications.

Note: The multi-threading library *kernel.lib* in the DOS folder on the distribution CD-ROM is compiler-specific to Borland C++ 5.02. It is *not* compatible with Digital Mars C++ 8.49. ProSoft Technology, Inc. does not support multi-threading with Digital Mars C++ 8.49.

Note: The ADM DOS 6-XL operating system has a system tick of 5 milliseconds. Therefore, thread scheduling and timer servicing occur at 5ms intervals. Refer to the *DOS 6-XL Developer's Guide* on the distribution CD-ROM for more information.

Multi-threading is also supported by the API.

- *DOS* libraries have been tested and are thread-safe for use in multi-threaded applications.
- *MVIsp* libraries are safe to use in multi-threaded applications with the following precautions: If you call the same *MVIsp* function from multiple threads, you will need to protect it, to prevent task switches during the function's execution. The same is true for different *MVIsp* functions that share the same resources (for example, two different functions that access the same read or write buffer).

WARNING: *ADM* and *ADMNET* libraries are *not* thread-safe. ProSoft Technology, Inc. does not support the use of *ADM* and *ADMNET* libraries in multi-threaded applications.

5.2 Development Tools

An application that is developed for the MCM4-ADM4 module must be stored on the module's Flash ROM disk to be executed. A loader program is provided with the module, to download an executable, configuration file or wattcp.cfg file via module port 0, as needed.

5.3 Theory of Operation

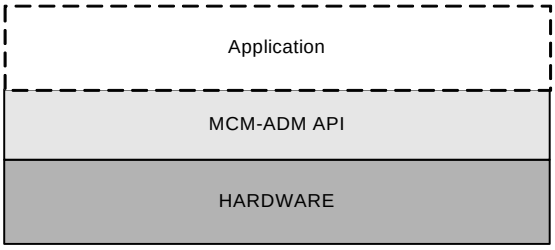
5.3.1 ADM API

The ADM API is one component of the ADM API Suite. The ADM API provides a simple module level interface that is portable between members of the ProLinx Family. This is useful when developing an application that implements a serial protocol for a particular device, such as a scale or bar code reader. After an application has been developed, it can be used on any of the ProLinx family modules.

5.3.2 ADM API Architecture

The ADM API is composed of a statically-linked library (called the ADM library). Applications using the ADM API must be linked with the ADM library. The ADM API encapsulates the hardware making it possible to design ProLinx applications that can be run on any of the ProLinx family of modules.

The following illustration shows the relationship between the API components.



5.4 ADM Functional Blocks

5.4.1 Debug / Status Port

The Configuration/Debug Port allows you to transmit or receive configuration data, view database information in the module and view configuration data. Use of this port can aid in locating problems that may exist in the user configuration and attached devices. Refer to Diagnostics and Troubleshooting for information on using the Config/Debug port.

5.4.2 Serial Communications

The developer must provide the serial communication driver code. The serial API has many useful functions to facilitate writing a driver. A sample communication driver is included in the example program provided.

5.4.3 Database

The database functions of the ADM API allow the creation of a database in memory to store data to be accessed via the application ports. The database consists of word registers that can be accessed as bits, bytes, words, longs, floats or doubles. Functions are provided for reading and writing the data in the various data types. The database serves as a holding area for exchanging data with foreign devices attached to the application ports.

5.4.4 MCM4_ADM.C

The application starts by opening the MCMADM API. The console for the Debug port and the database is installed. A protocol driver for each port is registered. Two protocol drivers are available, Modbus (MCM) and user developed (ADM). When registering ADM protocol drivers the name of the user written functions must be passed to the registration function.

The startup function is then called, initializing the application and protocol drivers.

The application enters the run loop that calls the run functions of the protocol drivers.

When an ESC key is received on the Debug port the loop exits and the shutdown function is called, shutting down the application and the protocol drivers.

5.4.5 MCMADM.H

This header file contains definitions and function declarations for the MCMADM library.

5.4.6 adm_prot.c

This file contains sample ADM protocol driver functions. There are startup, run and shutdown functions for each of the ADM ports.

The ADM driver on Port 0 is an ASCII talker. On 1 second intervals a count value is retrieved from the database, incremented, and saved back to the database. This counter value is then sent out of the serial port.

The ADM driver on Port 1 is an ASCII listener. This driver receives a two byte ASCII value from the serial port (sent from Port 0), swaps the byte order and saves the value to the database.

5.4.7 adm_prot.h

This header file contains definitions and function declarations for the ADM protocol driver.

5.5 ADM API Files

Table 1 lists the supplied API file names. These files should be copied to a convenient directory on the computer where the application is to be developed. These files need not be present on the module when executing the application.

File Name	Description
mcmadm.h	Include file
mcmadm.lib	Library (16-bit OMF format)

6 Application Development Function Library - ADM API

In This Chapter

6.1 ADM API Functions

This section provides detailed programming information for each of the ADM API library functions. The calling convention for each API function is shown in 'C' format.

API library routines are categorized according to functionality.

Function Category	Function Name	Description
Core Functions	MCM_Open	Opens the API and enables the other functions to be used
	MCM_RegisterProtocol	Registers a Modbus driver on a particular port
	ADM_RegisterProtocol	Registers a ADM driver on a particular port
	ADM_RegisterUserFunc	Registers a user process in the application
	MCM_InstallDatabase	Creates the database area for the protocols to pass data to one another
	MCM_InstallConsole	Installs the console on the Debug port
	MCM_Startup	Performs the module startup process
	MCM_Run	Performs the module run process
	MCM_Shutdown	Performs the module shutdown process
Database Functions	MCM_DBGetBit	Get bit value
	MCM_DBSetBit	Set bit
	MCM_DBClearBit	Clear bit
	MCM_DBGetByte	Get byte value
	MCM_DBSetByte	Set byte value
	MCM_DBGetWord	Get 16-bit word value
	MCM_DBSetWord	Set 16-bit word value
	MCM_DBGetLong	Get 32-bit long word value
	MCM_DBSetLong	Set 32-bit long word value

Function Category	Function Name	Description
	MCM_DBGetFloat	Get 32-bit float value
	MCM_DBSetFloat	Set 32-bit float value
	MCM_DBGetDFloat	Get 64-bit double float value
	MCM_DBSetDFloat	Set 64-bit double float value
	MCM_DBGetBytes	Get multiple bytes
	MCM_DBSetBytes	Set multiple bytes
	MCM_DBGetWords	Get multiple 16-bit words
	MCM_DBSetWords	Set multiple 16-bit words
	MCM_DBGetString	Get ASCII string
	MCM_DBSetString	Set ASCII string
	MCM_DBGetIntPtr	Get a pointer to a word location
	MCM_DBBitChanged	Test for bit changed
	MCM_DBByteChanged	Test for byte changed
	MCM_DBChanged	Test for 16-bit word changed
	MCM_DBLongChanged	Test for 32-bit long word changed
	MCM_DBFloatChanged	Test for 32-bit float changed
	MCM_DBDoubleChanged	Test for 64-bit double float changed
Clock Functions	MCM_ClockGetHandle	Gets access to a timer
	MCM_ClockStart	Starts timer
	MCM_ClockCheck	Check for timeout
	MCM_ClockGetValue	Gets value of timer
Console Port Functions	MCM_Send	Send characters to the console
	MCM_GetKey	Get a key from the console
LED Functions	MCM_LED_Set	Activate/deactivate LEDs
Serial Port Functions	MCM_SendBytes	Send bytes to the serial port using the built-in driver
	MCM_SendBytesDirect	Send bytes directly to the serial port
	MCM_SetRTS	Set the RTS level
	MCM_SetDTR	Set the DTR level
	MCM_GetCTS	Get the CTS level
	MCM_GetByte	Get character from receive buffer
	MCM_GetAsciiString	Get an ASCII string from the receive buffer
	MCM_GetDataString	Get a multiple bytes from the receive buffer
	MCM_BytesInTransmitBuffer	Get the number of bytes in the transmit buffer still to be sent
	MCM_BytesInReceiveBuffer	Get the number of bytes in the receive buffer
	MCM_FlushTransmitBuffer	Clear characters from the transmit buffer
	MCM_FlushReceiveBuffer	Clear characters from the receive buffer

6.2 Core Functions

MCM_Open

Syntax

```
ADMAPIENTRY  MCM_Open(void);
```

Parameters

None

Description

This function opens the MCMADM API. This function must be called before any of the other API functions can be used.

Important: After the API has been opened, MCM_Shutdown should always be called before exiting the application.

Return Value

ADM_SUCCESS	API was opened successfully
ADM_ERR_REOPEN	API is already open
ADM_ERR_NOACCESS	API cannot run on this hardware

Note: ADM_ERR_NOACCESS will be returned if the hardware is not from ProSoft Technology.

Example

```
/* open MCMADM API */
if(MCM_Open() != ADM_SUCCESS)
{
  printf("\nFailed to open MCMADM API... exiting program\n");
  exit(1);
}
```

MCM_RegisterProtocol

Syntax

```
ADMAPIENTRYW  MCM_RegisterProtocol(int port);
```

Parameters

port	Com port to use (0 to 3)

Description

This function registers and installs an MCM driver on the Com port. This function must be called in order to use the MCM protocol driver.

Return Value

ADM_SUCCESS	MCM driver was installed successfully
ADM_ERR_REOPEN	MCM driver is already installed
ADM_ERR_NOACCESS	API is not open
ADM_ERR_BADPARAM	Com port specified is out of range

Example

```
MCM_RegisterProtocol(0);   // Register MCM driver on port 0
```

ADM_RegisterProtocol

Syntax

```
ADMAPIENTRYW  ADM_RegisterProtocol(int port, void (*startup_func)(), void
(*run_func)(), void (*shutdown_func)());
```

Parameters

port	Com port to use (0 to 3)
startup_func	Pointer to user startup function
run_func	Pointer to user run function
shutdown	Pointer to user shutdown function

Description

This function registers and installs an ADM driver on the Com port. This function must be called in order to use the ADM port driver. A pointer to a startup, run and shutdown function must be provided. These functions will be called by the system at various times. The startup function will be called once during the boot process. When the module enters the run loop the run function will be called once per loop. When shutdown of the module is requested the shutdown function will be called once.

Note: The run function should be written to be non-blocking to ensure timely processing of all the drivers.

Return Value

ADM_SUCCESS	ADM driver was installed successfully
ADM_ERR_REOPEN	ADM driver is already installed
ADM_ERR_NOACCESS	API is not open
ADM_ERR_BADPARAM	Com port specified is out of range

Example

```
/* Set port 0 as an ADM port */
ADM_RegisterProtocol(0,
ADM_Protocol_Startup0,
ADM_Protocol_Run_Talker,
ADM_Protocol_Shutdown0);
/* startup function for port 0 */
void ADM_Protocol_Startup0(void)
{
  printf("ADM Startup0\n");
  MCM_FlushTransmitBuffer(0);
  // if clock handle does not exist get handle
  if(CountTimer == -1)
   CountTimer = MCM_ClockGetHandle();
  /* start 1 second timer */
  MCM_ClockStart(CountTimer, 1000000L);
}
```

```
/* run function for port 0 */
void ADM_Protocol_Run_Talker(void)
{
  /* check timer */
  if(MCM_ClockCheck(CountTimer) == TRUE)
   return;
  /* re-start clock, 1 second */
  MCM_ClockStart(CountTimer, 1000000L);
  /* get counter from database */
  Counter = MCM_DBGetWord(COUNTER_OFFSET);
  /* increment count */
 Counter++;
 /* save new count to database */
  MCM_DBSetWord(COUNTER_OFFSET, Counter);
  /* get count from database and swap bytes */
  TxBuff[1] = MCM_DBGetByte(COUNTER_OFFSET*2);
  TxBuff[0] = MCM_DBGetByte((COUNTER_OFFSET*2)+1);
 /* send count message out of port */
 MCM_SendBytes(0, TxBuff, 2);
}
/* shutdown function for port 0 */
void ADM_Protocol_Shutdown0(void)
{
  printf("ADM Shutdown0\n");
}
```

Note: The pointers to the user functions are the names of the functions.

ADM_RegisterUserFunc

Syntax

```
ADMAPIENTRYW ADM_RegisterUserFunc(void (*startup_func)(), void (*run_func)(),
void(*shutdown_func)() , int (*debug_func)());
```

Parameters

startup_func	Pointer to user startup function
run_func	Pointer to user run function
shutdown	Pointer to user shutdown function
debug_func	Pointer to user debug function

Description

This function registers and installs a user process. This function is useful for adding a user-defined process to the application. A pointer to a startup, run and shutdown function must be provided. These functions will be called by the system at various times. The startup function will be called once during the boot process. When the module enters the run loop the run function will be called once per loop. When shutdown of the module is requested the shutdown function will be called once.

Note: The run function should be written to be non-blocking to ensure timely processing of all the drivers.

ADM_SUCCESS	ADM driver was installed successfully
ADM_ERR_NOACCESS	API is not open

Example

```
void ADM_Protocol_Startup(void)
{
   /* initialize user function */
   ...
}
void ADM_Protocol_Run(void)
{
   /* run user function */
   ...
}
void ADM_Protocol_Shutdown(void)
{
   /* close user function */
...
}
int ADM_Protocol_Debug(void)
{
   /* print out debugging information */
...
}
```

```
...
ADM_RegisterUserFunc(
   ADM_Protocol_Startup,
   ADM_Protocol_Run,
   ADM_Protocol_Shutdown,
   ADM_Protocol_Debug);
```

MCM_InstallDatabase

Syntax

```
ADMAPIENTRYW  MCM_InstallDatabase(unsigned int size);
```

Parameters

size	Size of database in 16-bit registers

Description

Return Value

ADM_SUCCESS	Database was installed successfully
ADM_ERR_DB_MAX_SIZE	Database maximum size exceeded
ADM_ERR_MEMORY	Insufficient memory for database
ADM_ERR_REOPEN	Database is already installed
ADM_ERR_NOACCESS	API is not open
ADM_ERR_BADPARAM	Size is less than 1000 or greater than 10000

Example

```
MCM_InstallDatabase(4000);  // Install database of 4000 registers
```

MCM_InstallConsole

Syntax

```
ADMAPIENTRYW  MCM_InstallConsole(void);
```

Parameters

None

Description

This function installs the console on the Debug port. This allows access to the module through a terminal emulation program such as Hyper Term.

Return Value

ADM_SUCCESS	Console was installed successfully
ADM_ERR_NOACCESS	API is not open

Example

```
/* initialize console */
MCM_InstallConsole();
```

MCM_Startup

Syntax

```
ADMAPIENTRYW  MCM_Startup(void);
```

Parameters

None

Description

This function performs the module initialization. The protocol drivers must be registered before the initialization is performed. During the initialization the protocol drivers will be initialized and the database will be cleared.

Return Value

ADM_SUCCESS	Initialization was performed
ADM_ERR_NOACCESS	API is not open

Example

```
/* Initialize processes */
MCM_Startup();
```

MCM_Run

Syntax

```
ADMAPIENTRYW  MCM_Run(void);
```

Parameters

None

Description

This function calls startup for all of the processes. The user startup function will be called by this function. Once startup is complete, the processes will be run. The user run function will be called repeatedly while the function is running. When an ESC key is received over the Debug port, the processes will be shutdown. The user shutdown function will be called at this time. The function will then exit.

Return Value

ADM_SUCCESS	Run was performed
ADM_ERR_NOACCESS	API is not open

Example

```
/* Run protocol drivers */
MCM_Run();
```

MCM_Shutdown

Syntax

```
ADMAPIENTRYW  MCM_Shutdown(void);
```

Parameters

None

Description

This function removes the protocol drivers and closes the database.

Return Value

ADM_SUCCESS	Shutdown was performed

Example

```
MCM_Shutdown();
exit(0);
```

6.3 Database Functions

MCM_DBGetBit

Syntax

```
ADMAPIENTRY  MCM_DBGetBit(unsigned short offset);
```

Parameters

offset	Bit offset into database

Description

This function is used to read a bit from the database at a specified bit offset.

Return Value

Requested bit

ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
/* test bit at offset 16 */
offset = 16;
if(MCM_DBGetBit(offset))
printf("bit is set");
else
printf("bit is clear");
```

MCM_DBSetBit

Syntax

```
ADMAPIENTRY  MCM_DBSetBit(unsigned short offset);
```

Parameters

offset	Bit offset into database

Description

This function is used to set a bit to a 1 in the database at a specified bit offset.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
/* set bit at offset 16 to 1 */
offset = 16;
MCM_DBSetBit(offset);
```

MCM_DBClearBit

Syntax

```
ADMAPIENTRY  MCM_DBClearBit(unsigned short offset);
```

Parameters

offset	Bit offset into database

Description

This function is used to clear a bit to a 0 in the database at a specified bit offset.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
/* clear bit at offset 16 to 0 */
offset = 16;
MCM_DBClearBit(offset);
```

MCM_DBGetByte

Syntax

```
ADMAPIENTRYC  MCM_DBGetByte(unsigned short offset);
```

Parameters

offset	Byte offset into database

Description

This function is used to read a byte from the database at a specified byte offset.

Return Value

Requested byte

Example

```
unsigned short offset;
char c;
/* get byte value at byte offset 1000 (register 500) */
offset = 1000;
c = MCM_DBGetByte(offset);
```

MCM_DBSetByte

Syntax

```
ADMAPIENTRY  MCM_DBSetByte(unsigned short offset, const char val);
```

Parameters

offset	Byte offset into database
val	Value to be written to the database

Description

This function is used to write a byte to the database at a specified byte offset.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
const char val;
/* write 25 to byte 1000 (register 500) */
offset = 1000;
val = 25;
MCM_DBSetByte(offset, val);
```

MCM_DBGetWord

Syntax

```
ADMAPIENTRY  MCM_DBGetWord(unsigned short offset);
```

Parameters

offset	Word offset into database

Description

This function is used to read a word from the database at a specified word offset.

Return Value

Requested word

Example

```
unsigned short offset;
int i;
i = MCM_DBGetWord(offset);
```

MCM_DBSetWord

Syntax

```
ADMAPIENTRY  MCM_DBSetWord(unsigned short offset, const short val);
```

Parameters

offset	Word offset into database
val	Value to be written to the database

Description

This function is used to write a word to the database at a specified word offset.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
const short val;
/* write 300 to register 1000 */
offset = 1000;
val = 300;
MCM_DBSetWord(offset, val);
```

MCM_DBGetLong

Syntax

```
ADMAPIENTRYL  MCM_DBGetLong(unsigned short offset);
```

Parameters

offset	Long int offset into database

Description

This function is used to read a long int from the database at a specified offset.

Return Value

Requested long int

Example

```
unsigned short offset;
long l;
/* get long value at long register offset 1000 (register 2000) */
offset = 2000;
l = MCM_DBGetLong(offset);
```

MCM_DBSetLong

Syntax

```
ADMAPIENTRY  MCM_DBSetLong(unsigned short offset, const long val);
```

Parameters

offset	Long int offset into database
val	Value to be written to the database

Description

This function is used to write a long int to the database at a specified offset.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
const long val;
/* write 100000 to long register 1000 (register 2000) */
offset = 2000;
val = 100000L;
MCM_DBSetLong(offset, val);
```

MCM_DBGetFloat

Syntax

```
ADMAPIENTRYF  MCM_DBGetFloat(unsigned short offset);
```

Parameters

offset	float offset into database

Description

This function is used to read a floating-point number from the database at a specified float offset.

Return Value

Requested floating-point number.

Example

```
unsigned short offset;
float f;
/* read float from float register 1000 (register 2000) */
offset = 2000;
f = MCM_DBGetFloat(offset);
```

MCM_DBSetFloat

Syntax

```
ADMAPIENTRY  MCM_DBSetFloat(unsigned short offset, const float val);
```

Parameters

offset	float offset into database
val	Value to be written to the database

Description

This function is used to write a floating-point number to the database at a specified float offset.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
const float val;
/* write 25.3 to float register 200 (register 400) */
offset = 400;
val = 25.3;
MCM_DBSetFloat(offset, val);
```

MCM_DBGetDFloat

Syntax

```
ADMAPIENTRYD  MCM_DBGetDFloat(unsigned short offset);
```

Parameters

offset	double float offset into database

Description

This function is used to read a double floating-point number from the database at a specified double float offset.

Return Value

Requested double floating-point number

Example

```
unsigned short offset;
double d;
/* get double value at double offset 1000 (register 2000) */
offset = 2000;
d = MCM_DBGetDFloat(offset);
```

MCM_DBSetDFloat

Syntax

```
ADMAPIENTRY  MCM_DBSetDFloat(unsigned short offset, const double val);
```

Parameters

offset	double float offset into database
val	Value to be written to the database

Description

This function is used to write a double floating-point number to the database at a specified double float offset.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
const double val;
/* write 300.8 to double offset 100 (register 200) */
offset = 200;
val = 300.8;
MCM_DBSetDFloat(offset, val);
```

MCM_DBGetBytes

Syntax

```
ADMAPIENTRY  MCM_DBGetBytes(unsigned short offset, const unsigned short count,
char* pBytes);
```

Parameters

offset	Character offset into database where the buffer starts
count	Number of characters to retrieve
pBytes	String buffer to receive characters

Description

This function is used to copy a number of characters in the database to a character buffer.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range
ADM_ERR_MEMORY	Insufficient memory for database

Example

```
unsigned short offset;
const unsigned short char_count;
char *string_buff;
/* get 20 bytes from byte offset 200 (register 100) */
offset = 100;
char_count = 20;
MCM_DBGetBytes(offset, char_count, string_buff);
```

MCM_DBSetBytes

Syntax

```
ADMAPIENTRY  MCM_DBSetBytes(unsigned short offset, const unsigned short count,
const char* pBytes);
```

Parameters

offset	Character offset into database where the buffer starts
count	Number of characters to write
pBytes	String buffer to copy characters from

Description

This function is used to copy a buffer of characters to the database.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short offset;
char *string_buff[] = {1,2,3,4,5};
/* set 5 bytes at byte offset 200 (register 100) */
offset = 100;
MCM_DBSetBytes(offset, 5, string_buff);
```

MCM_DBGetWords

Syntax

```
ADMAPIENTRY  MCM_DBGetWords(unsigned short offset, const unsigned short count,
unsigned short* pWords);
```

Parameters

offset	Character offset into database where the buffer starts
count	Number of integers to retrieve
pWords	Register buffer to receive integers

Description

This function is used to copy a buffer of registers in the database to a register buffer.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range
ADM_ERR_MEMORY	Insufficient memory for database

Example

```
unsigned short reg_buff[20];
/* get 20 registers from offset 200 */
MCM_DBGetWords(200, 20, reg_buff);
```

MCM_DBSetWords

Syntax

```
ADMAPIENTRY  MCM_DBSetWords(unsigned short offset, const unsigned short count,
const unsigned short* pWords);
```

Parameters

offset	Character offset into database where the buffer starts
count	Number of integers to retrieve
pWords	Register buffer to receive integers

Description

This function is used to copy a buffer of registers to the database.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range

Example

```
unsigned short reg_buff[] = {1,2,3,4,5};
/* set 5 registers at offset 200 */
MCM_DBSetWords(200, 5, reg_buff);
```

MCM_DBGetString

Syntax

```
ADMAPIENTRY  MCM_DBGetString(unsigned short offset, const unsigned short
maxcount, char* str);
```

Parameters

offset	Character offset into database where the buffer starts
maxcount	Maximum number of characters to retrieve
str	String buffer to receive characters

Description

This function is used to copy a string from the database to a string buffer.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range
ADM_ERR_MEMORY	Insufficient memory for database
ADM_ERR_DB_MAX_SIZE	maxcount is larger than database size

Example

```
char string_buff[20];
/* get max of 20 bytes from offset 200 (register 100) */
MCM_DBGetString(100, 20, string_buff);
```

MCM_DBSetString

Syntax

```
ADMAPIENTRY  MCM_DBSetString(unsigned short offset, const char* str);
```

Parameters

offset	Character offset into database where the buffer starts
str	String buffer to receive characters

Description

This function is used to copy a string to the database from a string buffer.

Return Value

ADM_SUCCESS	No errors were encountered
ADM_ERR_NOT_OPEN	Database is not open
ADM_ERR_REG_RANGE	Database register is out of range
ADM_ERR_MEMORY	Insufficient memory for database

Example

```
char string_buff[] = {"abc"};
/* set bytes to offset 200 (register 100) */
MCM_DBSetString(100, string_buff);
```

MCM_DBGetIntPtr

Syntax

```
ADMAPIENTRYIP  MCM_DBGetIntPtr(int offset);
```

Parameters

offset	Word offset into database

Description

This function is used to obtain a pointer to int corresponding to the database + offset location.

Return Value

Returns NULL if not successful.

Returns pointer to int if successful.

Example

```
int i;
/* get the value from offset 100 using a pointer to the location */
i = *(MCM_DBGetIntPtr(100));
```

MCM_DBBitChanged

Syntax

```
ADMAPIENTRY  MCM_DBBitChanged(int offset);
```

Parameters

offset	Bit offset into database

Description

This function is used to check to see if a bit has changed since the last call to MCM_DBBitChanged.

Return Value

0	No change
1	Bit has changed

Example

```
if(MCM_DBBitChanged(offset))
printf("Bit has changed");
else
printf("Bit is unchanged");
```

MCM_DBByteChanged

Syntax

```
ADMAPIENTRY  MCM_DBByteChanged(unsigned short offset);
```

Parameters

offset	Byte offset into database

Description

This function is used to check to see if a byte has changed since the last call to MCM_DBByteChanged.

Return Value

0 No change

1 Byte has changed

Example

```
if(MCM_DBByteChanged(offset))
printf("Byte has changed");
else
printf("Byte is unchanged");
```

MCM_DBChanged

Syntax

```
ADMAPIENTRY  MCM_DBChanged(unsigned short offset);
```

Parameters

offset	Word offset into database

Description

This function is used to check to see if a register has changed since the last call to

MCM_DBChanged.

Return Value

0	No change
1	Register has changed

Example

```
/* test register 100 for change */
if(MCM_DBChanged(100))
printf("Data has changed");
else
printf("Data is unchanged");
```

MCM_DBLongChanged

Syntax

```
ADMAPIENTRY  MCM_DBLongChanged(unsigned short offset);
```

Parameters

offset	long offset into database

Description

This function is used to check to see if a long int has changed since the last call to

MCM_DBLongChanged.

Return Value

0	No change
1	long int has changed

Example

```
/* test long int 100 for change */
if(MCM_DBLongChanged(200))
printf("Data has changed");
else
printf("Data is unchanged");
```

MCM_DBFloatChanged

Syntax

```
ADMAPIENTRY  MCM_DBFloatChanged(unsigned short offset);
```

Parameters

offset	float offset into database

Description

This function is used to check to see if a float has changed since the last call to MCM_DBFloatChanged.

Return Value

0	No change
1	float has changed

Example

```
/* test float 100 for change */
if(MCM_DBFloatChanged(200))
printf("Data has changed");
else
printf("Data is unchanged");
```

MCM_DBDoubleChanged

Syntax

```
ADMAPIENTRY  MCM_DBDoubleChanged(unsigned short offset);
```

Parameters

offset	double offset into database

Description

This function is used to check to see if a double has changed since the last call to

MCM_DBDoubleChanged.

Return Value

0	No change
1	double has changed

Example

```
/* test double 100 for change */
if(MCM_DBDoubleChanged(200))
printf("Data has changed");
else
printf("Data is unchanged");
```

6.4 Clock Functions

MCM_ClockGetHandle

Syntax

```
ADMAPIENTRY  MCM_ClockGetHandle(void);
```

Parameters

None

Description

This function gets access to a clock. There approximately 300 clocks available to the user. This number depends on the number of MCM drivers and the system processes used.

Return Value

ClockHandle	Handle for accessing clock
ADM_ERR_NOACCESS	There are no clocks available.

Example

```
int handle;
handle = MCM_ClockGetHandle();   // Get clock handle
```

MCM_ClockStart

Syntax

```
ADMAPIENTRY  MCM_ClockStart(int ClockHandle, long MicroSecondCount);
```

Parameters

ClockHandle	The handle to the clock returned by MCM_ClockGetHandle
MicroSecondCount	The number of microseconds to run

Description

This function starts the clock timing for the period of MicroSecondCount.

Return Value

ClockHandle	L

Example

```
ClockStart(ClockHandle, 1000L);  // Start clock timing for 1 millisecond
```

MCM_ClockCheck

Syntax

```
ADMAPIENTRY  MCM_ClockCheck(int ClockHandle);  // returns true if clock running
```

Parameters

ClockHandle	The handle to the clock returned by MCM_ClockGetHandle

Description

This function checks the clock to see if it has expired.

Return Value

true	Clock is running.	
false	Clock has timed out.	L

Example

```
If(MCM_ClockCheck(ClockHandle) == false)
{
  printf("Clock timed out\n");
}
```

MCM_ClockGetValue

Syntax

```
ADMAPIENTRYL  MCM_ClockGetValue(int ClockHandle);
```

Parameters

ClockHandle	The handle to the clock returned by MCM_ClockGetHandle

Description

This function gets the current microsecond value of the clock.

Return Value

The current long word	microsecond value of the clock.

Example

```
long ClockValue;
ClockValue = MCM_ClockGetValue(ClockHandle);
```

6.5 Console Port Functions

MCM_Send

Syntax

```
ADMAPIENTRY  MCM_Send(const char*p_Data);
```

Parameters

p_Data	Pointer to text string to send

Description

This function sends a string of text to the console (Debug port).

Return Value

Returns number of characters placed in the console buffer.

Example

```
char text[] = "hello";
MCM_Send(text);
```

MCM_GetKey

Syntax

```
ADMAPIENTRY  MCM_GetKey(char *Char);
```

Parameters

Char	pointer to char to hold key from console port

Description

This function will get a key from the console port if a key is waiting. If no key is waiting the function will exit without waiting for a key.

Return Value

0	if no valid keypress
1	if valid keypress

Example

```
char z = 0;
/* check for key press from console */
if(MCM_GetKey(&z) == 1)
{
  /* print out key received */
  printf("key: %c\n", z);
}
```

6.6 LED Functions

MCM_LED_Set

Syntax

```
ADMAPIENTRY  MCM_LED_Set(unsigned short LED, int On);
```

Parameters

LED	The LED to be controlled
MCM_LED_OFF	Fault, CFG, APP ERR, Port 0 ERR LED OFF
MCM_LED_FLT	Fault LED
MCM_LED_CFG	CFG LED
MCM_LED_APP	APP ERR LED
MCM_LED_P0	Port 0 ERR LED
MCM_LED_P1	Port 1 ERR LED
MCM_LED_P2	Port 2 ERR LED
MCM_LED_P3	Port 3 ERR LED
MCM_LED_POFF	Port 1 to 3 ERR LED OFF
On	On=ON, Off=OFF

Description

This function sets an LED to the desired on/off state.

Return Value

ADM_SUCCESS	LED was set to desired state
ADM_ERR_BADPARAM	Invalid LED designation

Example

```
MCM_LED_Set(MCM_LED_FLT, ON);  // Set the Fault LED on
```

6.7 Serial Port Functions

MCM_SendBytes

Syntax

```
ADMAPIENTRY  MCM_SendBytes(int port, unsigned char *data, int len);
```

Parameters

port	port to use to send bytes (0 to 3)
data	pointer to buffer holding bytes to send
len	number of bytes to send

Description

MCM_SendBytes puts bytes in the serial port state machine to be sent out of the port. The state machine handles hardware handshaking and the internal data analyzer for the port.

Return Value

Number of bytes sent

ADM_ERR_NOACCESS	port value is out of range

Example

```
unsigned char TxBuff[] = {1,2,3,4,5};
MCM_SendBytes(0, TxBuff, 5);
```

MCM_SendBytesDirect

Syntax

```
ADMAPIENTRY  MCM_SendBytesDirect(int port, unsigned char *data, int len);
```

Parameters

port	port to use to send bytes (0 to 3)
data	pointer to buffer holding bytes to send
len	number of bytes to send

Description

MCM_SendBytesDirect sends a number of bytes out of the port without using the serial port state machine. Hardware handshaking has to be handled by the application.

Return Value

Number of bytes sent

ADM_ERR_NOACCESS	port value is out of range

Example

```
unsigned char TxBuff[] = {1,2,3,4,5};
MCM_SendBytesDirect(0, TxBuff, 5);
```

MCM_SetRTS

Syntax

```
ADMAPIENTRY  MCM_SetRTS(int port, int state);
```

Parameters

port	port for which RTS is to be changed (0 to 3)
state	desired RTS state

Description

This functions allows the state of the RTS signal to be controlled. state specifies desired state of the RTS signal. Valid values for state are ON and OFF.

Return Value

ADM_SUCCESS	RTS was set to desired state
ADM_ERR_NOACCESS	port value is out of range

Example

```
int rc;
rc = MCM_SetRTS(COM1, ON);
if (rc != ADM_SUCCESS)
printf("SetRTS failed\n ");
```

MCM_SetDTR

Syntax

```
ADMAPIENTRY  MCM_SetDTR(int port, int state);
```

Parameters

port	port for which DTR is to be changed (0 to 3)
state	desired RTS state

Description

This function allows the state of the DTR signal to be controlled. state is the desired state of the DTR signal. Valid values for state are ON and OFF.

Return Value

ADM_SUCCESS	RTS was set to desired state
ADM_ERR_NOACCESS	port value is out of range

Example

```
int rc;
rc = MCM_SetDTR(COM1, ON);
if (rc != ADM_SUCCESS)
printf("SetDTR failed\n ");
```

MCM_GetCTS

Syntax

```
ADMAPIENTRY  MCM_GetCTS(int port);
```

Parameters

port	port for which CTS is requested (0 to 3)

Description

This function allows the state of the CTS signal to be determined.

Return Value

The state of CTS line

ADM_ERR_NOACCESS	port value is out of range

Example

```
int state;
state = MCM_GetCTS(0);
if(state == ON)
printf("CTS is ON\n");
else
printf("CTS is OFF\n");
```

MCM_GetByte

Syntax

```
ADMAPIENTRY  MCM_GetByte(int port);
```

Parameters

port	port from which data is to be received

Description

This function is used to receive a single character from a serial port.

All data received from a port is queued after reception from the serial port. Therefore, some delay may occur between the time a character is received across the serial line and the time the character is returned by MCM_GetByte.

Return Value

Byte from receive buffer of serial port

ADM_ERR_NOACCESS	port value is out of range

Example

```
int ch;
ch = MCM_GetByte(0);
```

MCM_GetAsciiString

Syntax

```
ADMAPIENTRY  MCM_GetAsciiString(int port, unsigned char *buffer, char endChar,
int *count);
```

Parameters

port	port from which data is to be received
buffer	buffer to hold string
endChar	character marking the end of the string (ex. LF)
count	max number of bytes to get

Description

This function is used to get a string terminated by endChar from a serial port.

All data received from a port is queued after reception from the serial port. Therefore, some delay may occur between the time a character is received across the serial line and the time the character is returned by MCM_GetAsciiString.

Return Value

Number of bytes in string

ADM_ERR_NOACCESS	port value is out of range

Example

```
#define LF 0x0A
unsigned char RxBuff[21];
MCM_GetAsciiString(0, RxBuff, LF, 20);
```

MCM_GetDataString

Syntax

```
ADMAPIENTRY  MCM_GetDataString(int port, unsigned char *buffer, int count);
```

Parameters

port	port from which data is to be received
buffer	buffer to hold string
count	max number of bytes to get

Description

This function is used to receive an array of bytes from a serial port.

All data received from a port is queued after reception from the serial port. Therefore, some delay may occur between the time a character is received across the serial line and the time the character is returned by MCM_GetDataString.

Return Value

Number of bytes in string

ADM_ERR_NOACCESS	port value is out of range

Example

```
unsigned char RxBuff[21];
MCM_GetDataString(0, RxBuff, 20);
```

MCM_BytesInTransmitBuffer

Syntax

```
ADMAPIENTRY  MCM_BytesInTransmitBuffer(int port);
```

Parameters

port	port whose transmit buffer is to be queried

Description

MCM_BytesInTransmitBuffer returns the number of characters in the transmit queue that are waiting to be sent. Since data sent to a port is queued before transmission across a serial port, the application may need to determine if all characters have been transmitted or how many characters remain to be transmitted.

Return Value

Returns number of bytes in buffer

ADM_ERR_NOACCESS	port value is out of range

Example

```
int count;
count = MCM_BytesInTransmitBuffer(COM2)
if(count == 0)
printf("All chars read\n");
else
printf("%d characters remaining\n",count);
```

MCM_BytesInReceiveBuffer

Syntax

```
ADMAPIENTRY  MCM_BytesInReceiveBuffer(int port);
```

Parameters

port	port whose receive buffer is to be queried

Description

MCM_BytesInReceiveBuffer returns the number of characters in the receive queue that are waiting to be read. Since data received from a port is queued after reception from a serial port, the application may need to determine if all characters have been read or how many characters remain to be read.

Return Value

Returns number of bytes in buffer

ADM_ERR_NOACCESS	port value is out of range

Example

```
int count;
count = MCM_BytesInReceiveBuffer(COM2)
if(count == 0)
printf("All chars read\n");
else
printf("%d characters remaining\n",count);
```

MCM_FlushTransmitBuffer

Syntax

```
ADMAPIENTRY  MCM_FlushTransmitBuffer(int port);
```

Parameters

port	port whose transmit data is to be purged

Description

MCM_FlushTransmitBuffer deletes all data waiting in the transmit queue. The data is discarded and is not transmitted.

Return Value

ADM_SUCCESS	the data was purged successfully
ADM_ERR_BADPARAM	Com port specified is out of range
ADM_ERR_NOACCESS	the comport has not been opened

Example

```
if (MCM_FlushTransmitBuffer (COM1) == ADM_SUCCESS)
printf("Transmit Data purged.\n");
```

MCM_FlushReceiveBuffer

Syntax

```
ADMAPIENTRY MCM_FlushReceiveBuffer(int port)
```

Parameters

port	The port whose receive data is to be purged.

Description

MCM_FlushReceiveBuffer deletes all data waiting in the receive queue. The data is discarded and is no longer available for reading.

Return Value

ADM_SUCCESS	the data was purged successfully
ADM_ERR_BADPARAM	Com port specified is out of range
ADM_ERR_NOACCESS	the comport has not been opened

Example

```
if (MCM_FlushReceiveBuffer (COM1) == ADM_SUCCESS)
printf("Receive Data purged.\n");
```

7 Reference

In This Chapter

7.1 Product Specifications

7.1.1 General Specifications

The MCM4-ADM4 module acts as an input/output module between the ADM4 network and the user protocol. The data transfer from the user protocol is asynchronous from the actions on the MODBUS network. A 1000 to 10,000-word register space in the module exchanges data between the user protocol and the MODBUS network.

Some of the general specifications include:

- Support for the storage and transfer of up to 10,000 registers
- Module memory usage that is completely user definable
- Four ports to emulate any combination of MODBUS master or slave device and user protocol
- Configurable MCM port parameters include:

Parameter	Value
Protocol	RTU or ASCII
Baud Rate	110 to 115,200 (up to 38,400 on Port 0)
Parity	None, Odd and Even
Data Bits	5 to 8
Stop Bits	1 or 2
RTS On and Off Timing	0 to 65535 milliseconds
Minimum Response Delay	0 to 65535 milliseconds
Use of CTS Modem Line	Yes or No
Floating-Point Support	

Slave Functional Specifications

The MCM4-ADM4 module accepts MODBUS commands from an attached MODBUS master unit. A port configured as a virtual MODBUS slave permits a remote master to interact with all data contained in the module. This data can be derived from other MODBUS slave devices on the network through a master port or from the user protocol.

Master Functional Specifications

A port configured as a virtual MODBUS master device on the MCM4-ADM4 module will actively issue MODBUS commands to other nodes on the MODBUS network. One hundred commands are supported on each port. Additionally, the master ports have an optimized polling characteristic that will poll slaves with communication problems less frequently.

7.1.2 Hardware Specifications and Equipment Ratings

Type	Specifications
Serial Ports	
Serial Port Cable (DB-9M Connector)	A mini-DIN to DB-9M cable is included with the unit
Debug	RS-232/422/485 - jumper selectable DB-9M connector No hardware handshaking
Serial Port Isolation	2500V RMS port-to-port isolation per UL 1577. 3000V DC min. port to ground and port to logic power isolation.
Serial Port Protection	RS-485/422 port interface lines TVS diode protected at +/- 27V standoff voltage. RS-232 port interface lines fault protected to +/- 36V power on, +/- 40V power off.
General Signal Connections	For highest EMI/RFI immunity, signal connections shall use the interconnect cable as specified by the protocol in use. Interconnect cable shields shall be connected to earth ground.
Example Interconnect Cable Types	Rockwell Automation RIO and DH+ protocols use Belden 9463 type shielded cable or equivalent. Schneider Electric Modbus Plus protocol uses Belden 9841 type shielded cable or equivalent.
Power	
External Power	Supply Voltage: 24 VDC nominal, 18 to 32 VDC allowed Supply Current: 500 mA (max. at 24 VDC) Center terminal shall be connected to earth ground.
Power Connector	+/-/GND screw connectors, rated for 24 AWG to 14 AWG tinned copper, stranded, insulated wire. Use 2.5 mm screwdriver blade.
Environmental	
Operating Temperature	-20 to 60° C (-4 to 140° F)
Storage Temperature	-40 to 85° C (-40 to 185° F)

Type	Specifications
Relative Humidity	5% to 95% (non-condensing)
Shock (Unpackaged)	Operational - Pending testing
	Non-operational - Pending testing
Vibration (Unpackaged)	Pending testing
Dimensions	3.71H x 6.06 W x 4.70 D inches 94.2 H x 153.9 W x 119.3 D mm
Weight (max.)	Pending
Altitude	Shipping and storage: up to 3000 m (9843 Feet). Operation: up to 2000 m (6562 Feet).
Corrosion Immunity	Rated in accordance with IEC 68.
Pollution Degree	Rated to pollution degree 2. Equipment may be exposed to non-conductive pollution. Occasional conductivity due to condensation may occur. Equipment may not function properly until condensation evaporates.
Overvoltage Category	Rated to over voltage category I. Reverse polarity, improper lead connection, and/or voltages outside of the range of 18 VDC to 36 VDC applied to the power connector may damage the equipment.

7.1.3 Ports

Serial (Mini DIN 8)

The ProLinx module serial ports are capable of supporting several protocols as either Master or Slave on up to four ports. Each port is individually configurable, thereby providing a great deal of flexibility.

When configured as a Master port, the serial ports can be used to continuously interface with slave devices over a serial Communication Interface (RS-232, RS-422, or RS-485). Each Master port supports 100 user-defined commands that determine the read/write commands issued to each slave attached to the port.

In addition, the module may be configured to place slave devices that are not responding to commands at a lower priority. If the module recognizes that a slave device has failed to respond to a message after the user-defined retry count, it marks the slave as "in communication failure" and sets the error delay counter to the user-specified value.

Alternatively, the serial port can be configured to emulate a slave device.

Every gateway module is shipped with one Mini DIN 8 to DB-9 conversion cable per configurable port on the module.

7.2 MCM Database Definition

This section contains a listing of the internal database of the MCM4-ADM4 module. This information can be used to interface other devices to the data contained in the module.

Content	Offset from top of user data
MCM Port 0 Status	0
MCM Port 1 Status	10
MCM Port 2 Status	20
MCM Port 3 Status	30
MCM Port 0 Configuration	40
MCM Port 1 Configuration	70
MCM Port 2 Configuration	100
MCM Port 3 Configuration	130
MCM Port 0 Commands	160
MCM Port 1 Commands	960
MCM Port 2 Commands	1760
MCM Port 3 Commands	2560

The User Data area holds data collected from other nodes on the network (master read commands) or data received from the processor (write blocks).

Detailed definition of the miscellaneous status data area can be found in Misc. Status.

Definition of the configuration data areas can be found in the data definition section of this document and in Configuration Data Definition.

7.3 Configuration Data

This section contains listings of the MCM4-ADM4 module's database that are related to the module's configuration. This data is available to any node on the network and is read from the config file when the module first initializes. Additionally, this section contains the miscellaneous status data and command control database layout.

7.3.1 MCM Port x Configuration

Offset	Content	Description
0	Enable	This parameter defines if this MODBUS port will be used. If the parameter is set to 0, the port is disabled. A value of 1 enables the port.
1	Type	This parameter specifies if the port will emulate a MODBUS master device (0), a MODBUS slave device without pass-through (1), or a MODBUS slave device with unformatted pass-through (2), or a MODBUS slave device with formatted pass-through and data swapping (3).

Offset	Content	Description
2	Float Flag	This flag specifies if the floating-point data access functionality is to be implemented. If the float flag is set to 1, MODBUS functions 3, 6, and 16 will interpret floating-point values for registers as specified by the two following parameters.
3	Float Start	This parameter defines the first register of floating-point data. All requests with register values greater than or equal to this value will be considered floating-point data requests. This parameter is only used if the Float Flag is enabled.
4	Float Offset	This parameter defines the start register for floating-point data in the internal database. This parameter is only used if the Float Flag is enabled.
5	Protocol	This parameter specifies the MODBUS protocol to be used on the port. Valid protocols are: 0 = MODBUS RTU and 1 = MODBUS ASCII.
6	Baud Rate	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 are 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 28800, 38400, 576, and 115.
7	Parity	This is the parity code to be used for the port. Values are None, Odd, Even.
8	Data Bits	This parameter sets the number of data bits for each word used by the protocol. Valid entries for this field are 5 through 8.
9	Stop Bits	This parameter sets the number of stop bits to be used with each data value sent. Valid entries are 1 and 2.
10	RTS On	This parameter sets the number of milliseconds to delay after RTS is asserted before the data will be transmitted. Valid values are in the range of 0 to 65535 milliseconds.
11	RTS Off	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. Valid values are in the range of 0 to 65535.
12	Minimum Response Time	This parameter specifies the minimum number of milliseconds to delay before responding to a request message. This pre-send delay is applied before the RTS on time. This may be required when communicating with slow devices.
13	Use CTS Line	This parameter specifies if the CTS modem control line is to be used. If the parameter is set to 0, the CTS line will not be monitored. If the parameter is set to 1, the CTS line will be monitored and must be high before the module will send data. This parameter is normally only required when half-duplex modems are used for communication (2-wire).
14	Slave ID	This parameter defines the virtual MODBUS slave address for the internal database. All requests received by the port with this address are processed by the module. Verify that each device has a unique address on a network. Valid range for this parameter is 1 to 255 (247 on some networks).
15	Bit in Offset	This parameter specifies the offset address in the internal MODBUS database to use with network requests for MODBUS Function 2 commands. For example, if the value is set to 150, an address request of 0 will return the value at register 150 in the database.

Offset	Content	Description
16	Word in Offset	This parameter specifies the offset address in the internal MODBUS database to use with network request for MODBUS function 4 commands. For example, if the value is set to 150, an address request of 0 will return the value at register 150 in the database.
17	Out in Offset	This parameter specifies the offset address in the internal MODBUS database to use with network requests for MODBUS function 1,5, or 15 commands. For example, if the value is set to 100, an address request of 0 will correspond to register 100 in the database.
18	Holding Reg Offset	This parameter specifies the offset address in the internal MODBUS database to use with network requests for MODBUS function 3, 6, or 16 commands. For example, if a value of 50 is entered, a request for address 0 will correspond to the register 50 in the database.
19	Command Count	This parameter specifies the number of commands to be processed by the MODBUS master port.
20	Minimum Command Delay	This parameter specifies the number of milliseconds to wait between issuing each command. This delay value is not applied to retries.
21	Command Error Pointer	This parameter sets the address in the internal MODBUS database where the command error will be placed. If the value is set to -1, the data will not be transferred to the database. The valid range of values for this parameter is -1 to 4999.
22	Response Timeout	This parameter represents the message response timeout period in 1-millisecond increments. This is the time that a port configured as a master will wait before re-transmitting a command if no response is received from the addressed slave. The value is set depending upon the communication network used and the expected response time of the slowest device on the network.
23	Retry Count	This parameter specifies the number of times a command will be retried if it fails. If the master port does not receive a response after the last retry, the slave devices communication will be suspended on the port for Error Delay Counter scans.
24	Error Delay Counter	This parameter specifies the number of polls to skip on the slave before trying to re-establish communications. After the slave fails to respond, the master will skip commands to be sent to the slave the number of times entered in this parameter.
25	Spare	
26	Spare	
27	Spare	
28	Spare	
29	Spare	

7.3.2 MCM Port x Commands

Offset	Content	Description
0 to 7	Command #1	This set of registers contains the parameters for the first command in the master command list. Refer to the data object section of the documentation.
8 to 15	Command #2	Command #2 data set
-	-	-
782 to 789	Command #100	Command #100 data set

7.4 Modbus Error and Status Data Area Addresses

Modbus error and status data are stored in registers based on port number. Starting register addresses are shown in the following table.

Modbus Port	Starting Address
0	4400
1	4800
2	5200
3	5600

Note: None of the addresses are available in the Modbus address range. In order to view them via a Modbus request, they must be moved into the 0 to 3999 address range using the Data Map section of the configuration file. For additional information on how to move data within the gateway's internal database, see Moving Data.

7.4.1 Modbus Ports: Error and Status

The serial port (Modbus Master/Slave) Error and Status Data areas are discussed in this section.

The data area is initialized with zeros whenever the gateway is restarted. This occurs during a cold-start (power-on), reset (reset push-button pressed) or a warm-boot operation (commanded from a debug menu or after downloading a new configuration). The addresses listed are for Port 0 only; but the format is the same for each port. The start address for each port is given in the previous section, Modbus Error and Status Data Area Addresses (page 109).

Example Internal Database Address	Offset	Description
4400	0	Number of Command Requests
4401	1	Number of Command Responses
4402	2	Number of Command Errors
4403	3	Number of Requests
4404	4	Number of Responses
4405	5	Number of Errors Sent
4406	6	Number of Errors Received
4407	7	Configuration Error Code
4408	8	Current Error/Index
4409	9	Last Error/Index

Refer to the following Error Codes (page 112) section to interpret the status/error codes present in the data area.

7.4.2 Master Port: Command List Errors

The individual command errors for each Master port are returned to the address locations specified in the following table. Each port can have up to 100 commands configured. Each configured command will use one word of these data areas to store a value representing the execution status from the most recent command execution attempt.

Modbus Port	Address Range
0	4410 to 4509
1	4810 to 4909
2	5210 to 5309
3	5610 to 5709

The first word in the defined register location contains the status/error code for the first command in the port's *Command List*. Successive words in the *Command Error List* are associated with corresponding commands in the list.

Refer to Error Codes (page 112) to interpret the status/error codes present in this data area.

Port 0 Command Error List Layout

The addresses listed are for Port 0 only; but the format is the same for each port. The start address for each port is given in the previous section, Master Port: Command List Errors (page 110).

Internal Database Address (Example)	Offset	Description
4410	0	Command #0 Error Status
4411	1	Command #1 Error Status
4412	2	Command #2 Error Status
4413	3	Command #3 Error Status
4414	4	Command #4 Error Status
...	...	...
...	...	...
...	...	...
4507	97	Command #97 Error Status
4508	98	Command #98 Error Status
4509	99	Command #99 Error Status

Note that the values in the *Command Error List* tables are initialized to zero (0) at power-up, cold boot, and warm boot. If a command executes successfully, the value in the associated register will remain at zero (0), indicating no command error was detected. Any non-zero value in this table indicates the corresponding command experienced an error. The Error Code (page 112) shown will provide valuable troubleshooting information.

The data in this table is dynamic. It is updated each time a command is executed. Therefore, if the command fails once and succeeds on the next attempt, the Error Code from the previously failed attempt will be replace with zero and lost. Error Codes are not archived in the gateway's database. To see if the port has experienced an error since the most recent restart and what the most recently occurring error was, if any, you can check the Last Error/Index (page 109).

7.4.3 Master Port: Modbus Slave List Status

The slave status list contains the current poll status of each slave device on a Master port. Slaves attached to a Master port can have one of three states.

0	The slave has not defined in the command list for the Master port and will not be polled from the Command List.
1	The slave is configured to be polled by the Master port and the most recent communication attempt was successful.
2	The Master port has failed to communicate with the slave device. Communication with the slave is suspended for a user defined period based on the scanning of the command list.

Slaves are defined to the system when the gateway loads the Master Command List during start-up and initialization. Each slave defined will be set to a state value of 1 in this initial step. If the Master port fails to communicate with a slave device (timeout expired on a command, retries failed), the Master will set the state of the slave to a value of 2 in this status table. This suspends communication with the slave device for a user-specified Error Delay Count.

When the Master first suspends polling of a particular slave, it creates a Error Delay Counter for this slave address and set the value in that counter equal to the Error Delay Counter parameter in the configuration file. Then, each time a command in the list is scanned that has the address of a suspended slave, the delay counter value for that slave will be decremented. When the value reaches zero, the slave state will be set to 1. This will re-enable polling of the slave.

The first word in the defined register locations contains the status code for slave node address 1. Each successive word in the list is associated with the next node in sequence, up to slave node address 255.

The individual Slave List Status for each Modbus port are returned to the address locations specified in the following table.

Modbus Port	Address Range
0	4510 to 4764
1	4910 to 5164
2	5310 to 5564
3	5710 to 5965=4

Port 0 Slave List Status Layout

The addresses listed are for Port 0 only; but the format is the same for each port. The start address for each port is given in the previous section, Master Port: Modbus Slave List Status. (page 111)

Internal Database Address (Example)	Offset	Description
4510	0	Slave #1 Status
4511	1	Slave #2 Status
4512	2	Slave #3 Status
4513	3	Slave #4 Status
4514	4	Slave #5 Status
	.	.
	.	.
	.	.

Note that the values in the Slave List Status tables are initialized to zero (0) at power-up, cold boot and during warm boot.

7.5 Error Codes

These are error codes that are part of the Modbus protocol or are extended codes unique to this gateway.

7.5.1 Modbus Error Codes

These error codes are generated or returned on both the Master and slave ports. These codes are the standard Modbus errors.

Code	Description
1	Illegal Function
2	Illegal Data Address
3	Illegal Data Value
4	Failure in Associated Device
5	Acknowledge
6	Busy, Rejected Message

7.5.2 gateway Communication Error Codes

These gateway-specific error codes are also returned from the command polling process and stored in the Command Error List memory area.

Code	Description
-1	CTS modem control line not set before transmit
-2	Timeout while transmitting message
-11	Timeout waiting for response after request
253	Incorrect slave address in response
254	Incorrect function code in response
255	Invalid CRC/LRC value in response

7.5.3 Command List Error Codes

These command-specific error codes are detected during initial command list loading at power-up or gateway reset and are stored in the *Command Error List* memory region.

CODE	Description
-41	Invalid enable code
-42	Internal address > maximum address
-43	Invalid node address (<0 or > 255)
-44	Count parameter set to 0
-45	Invalid function code
-46	All parameters set to 0
-47	All parameters set to -1

7.5.4 Modbus Configuration Error Word

Modbus Configuration Error Word errors are stored in protocol-specific registers. The following table lists the Port/Register address configuration.

Modbus Port	Configuration Error Word Register
0	4407
1	4807
2	5207
3	5607

A register containing a code indicates a problem with the configuration. The following table lists the codes, a description of the problem, and parameters to correct the error condition within the configuration file.

Bit	Code	Description
0	0x0001	Invalid Enabled parameter (Yes or No)
1	0x0002	Invalid RS-Interface parameter (0 to 2)
2	0x0004	Invalid Type (Master or Slave)
3	0x0008	Invalid Protocol (RTU or ASCII)
4	0x0010	Invalid Baud Rate
5	0x0020	Invalid Parity (None, Odd, Even)
6	0x0040	Invalid Data Bits (7 or 8 bits)
7	0x0080	Invalid Stop Bits (1 or 2)
8	0x0100	Invalid Use CTS Line (Yes or No)
9	0x0200	Retry Count Invalid (0 to 10)
10	0x0400	Invalid Floating Point Data: Float Flag not Yes or No Float Start less than 0 or Float Offset is Invalid
11	0x0800	Invalid Internal Slave ID (1 to 255) (Slave Only)

Bit	Code	Description
12	0x1000	Invalid Entry for Register Offset Data (Slave Only)
13	0x2000	Reserved
14	0x4000	Reserved
15	0x8000	Reserved

7.6 LED Indicators

LED indicators provide a means of monitoring the operation of the system and individual ports. There are extremely useful for troubleshooting. The gateway provides LEDs to help monitor each port. In addition, system configuration errors, application errors, and fault indications are all indicated by LEDs, providing alerts to possible problems.

7.6.1 Common gateway LEDs

LED	State	Description
Power	Off	Power is not connected to the power terminals or source is insufficient to properly power the gateway (800mA at 24vdc minimum required)
	Green Solid	Power is connected to the power terminals. Verify that the other LEDs for operational and functional status come on briefly after power-up (check for burned-out LEDs).
Fault	Off	Normal operation.
	Red Solid	A critical error has occurred. Program executable has failed or has been user-terminated and is no longer running. Press Reset p/b or cycle power to clear error. If not, use the Debug procedures described later in this manual.
Cfg	Off	Normal operation.
	Amber Solid	The unit is in configuration mode. The configuration file is currently being downloaded or, after power-up, is being read, the unit is implementing the configuration values, and initializing the hardware. This will occur during power cycle, or after pressing the reset button. It also occurs after a cold/warm boot command is received.
Err	Off	Normal operation.
	Flashing	An error condition has been detected and is occurring on one of the application serial ports. Check configuration and troubleshoot for communication errors.
	Solid Red	This error flag is cleared at the start of each command attempt (master/client) or on each receipt of data (slave/adapter/server); so, if this condition exists, it indicates a large number of errors are occurring in the application (due to bad configuration) or on one or more ports (network communication failures).

7.6.2 LEDs for Serial Ports

ProLinx gateways may have as many as five (5) serial ports. Each of these serial ports has two LEDs indicating status.

LED	Color	Description
Debug - ACT	Off	No activity on the port.
Port 0 - ACT	Green	The port is actively transmitting or receiving data
Port 1 - ACT	Flash	
Port 2 - ACT		
Port 3 - ACT		
Debug - ERR	Off	Normal state. When off and Port Active led is indicating activity, there are no communication errors
Port 0 - ERR		
Port 1 - ERR	RED	Activity on this LED indicates communication errors areoccurring. To determine the exact error, connect the Debug terminal to the Debug port and use the built-in Diagnostic Menus.
Port 2 - ERR	On Solid or Flashing	
Port 3 - ERR		

8 DOS 6 XL Reference Manual

The DOS 6 XL Reference Manual makes reference to compilers other than Digital Mars C++ or Borland Compilers. The PLX-ADM and ADMNET modules only support Digital Mars C++ and Borland C/C++ Compiler Version 5.02. References to other compilers should be ignored.

9 Glossary of Terms

A

API

Application Program Interface

B

Backplane

Refers to the electrical interface, or bus, to which modules connect when inserted into the rack. The module communicates with the control processor(s) through the processor backplane.

BIOS

Basic Input Output System. The BIOS firmware initializes the module at power up, performs self-diagnostics, and provides a DOS-compatible interface to the console and Flashes the ROM disk.

Byte

8-bit value

C

CIP

Control and Information Protocol. This is the messaging protocol used for communications over the ControlLogix backplane. Refer to the ControlNet Specification for information.

Connection

A logical binding between two objects. A connection allows more efficient use of bandwidth, because the message path is not included after the connection is established.

Consumer

A destination for data.

Controller

The PLC or other controlling processor that communicates with the module directly over the backplane or via a network or remote I/O adapter.

D

DLL

Dynamic Linked Library

E

Embedded I/O

Refers to any I/O which may reside on a CAM board.

ExplicitMsg

An asynchronous message sent for information purposes to a node from the scanner.

H

HSC

High Speed Counter

I

Input Image

Refers to a contiguous block of data that is written by the module application and read by the controller. The input image is read by the controller once each scan. Also referred to as the input file.

L

Library

Refers to the library file containing the API functions. The library must be linked with the developer's application code to create the final executable program.

Linked Library

Dynamically Linked Library. See Library.

Local I/O

Refers to any I/O contained on the CPC base unit or mezzanine board.

Long

32-bit value.

M

Module

Refers to a module attached to the backplane.

Mutex

A system object which is used to provide mutually-exclusive access to a resource.

MVI Suite

The MVI suite consists of line products for the following platforms:

- Flex I/O
- ControlLogix
- SLC
- PLC
- CompactLogix

MVI46

MVI46 is sold by ProSoft Technology under the MVI46-ADM product name.

MVI56

MVI56 is sold by ProSoft Technology under the MVI56-ADM product name.

MVI69

MVI69 is sold by ProSoft Technology under the MVI69-ADM product name.

MVI71

MVI71 is sold by ProSoft Technology under the MVI71-ADM product name.

MVI94

MVI94 and MVI94AV are the same modules. The MVI94AV is now sold by ProSoft Technology under the MVI94-ADM product name

O

Originator

A client that establishes a connection path to a target.

Output Image

Table of output data sent to nodes on the network.

P

Producer

A source of data.

PTO

Pulse Train Output

PTQ Suite

The PTQ suite consists of line products for Schneider Electronics platforms:

Quantum (ProTalk)

S

Scanner

A DeviceNet node that scans nodes on the network to update outputs and inputs.

Side-connect

Refers to the electronic interface or connector on the side of the PLC-5, to which modules connect directly through the PLC using a connector that provides a fast communication path between the - module and the PLC-5.

T

Target

The end-node to which a connection is established by an originator.

Thread

Code that is executed within a process. A process may contain multiple threads.

W

Word

16-bit value

10 Support, Service & Warranty

In This Chapter

10.1 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

10.2 Warranty Information

Complete details regarding ProSoft Technology's TERMS AND CONDITIONS OF SALE, WARRANTY, SUPPORT, SERVICE AND RETURN MATERIAL AUTHORIZATION INSTRUCTIONS can be found at www.prosoft-technology.com/warranty.

Documentation is subject to change without notice.

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