COMM-TROLLER™

USERS MANUAL
REVISION 2.2

June 28, 1989

COPYRIGHT ©1989

MARC

MIILLE APPLIED RESEARCH CO., INC. HOUSTON, TEXAS

PROPRIETARY NOTICE

Proprietary rights of MIILLE APPLIED RESEARCH CO., INC. are involved in this subject matter and all manufacturing, reproduction, use and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner or to any person except to meet the purpose for which it was delivered.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

TABLE OF CONTENTS

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

TABLE OF CONTENTS (CONT)

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

LIST OF FIGURES

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC
HOUSTON, TEXAS

USING THIS MANUAL

1.1 OVERVIEW

The MARC Communications Controller (Comm-Troller) provides enhanced communication capabilities for a wide variety of applications. The Allen-Bradley Comm-Troller (MARC PN 127-005-0) described in this manual permits standard off-the-shelf Allen Bradley Programmable Controllers to be used as a Remote Terminal Unit (RTU) in existing SCADA systems. The Comm-Troller translates between the SCADA host protocol on one side and one or more Allen Bradley PLCs on the other side.

1.2 MANUAL'S PURPOSE

This manual tells how to install and operate the Comm-Troller. The manual covers the following areas:

- **Hardware Specifications**
- **Installation of the Comm-Troller**
- **Functional Operation**
- **Configuration Information**

The Comm-Troller is a programmable device. Through custom programming it is capable of supporting a wide variety of communication protocols. Several standard host protocols have already been implemented with others currently under development.

1.3 AUDIENCE

In order to properly utilize this manual, the reader should first be familiar with the set-up and operation of the Allen-Bradley Programmable Logic Controller (PLC) system to be used with the Comm-Troller

COPYRIGHT © 1988 MILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

INTRODUCING THE COMM-TROLLER

2.1 OBJECTIVES

This section discusses the functions and features of the Comm-Troller. After finishing this section the reader should:

- **Understand and be able to identify the hardware components of the Comm-Troller.**
- **Understand the basic features and functions of the Comm-Troller.**

2.2 GENERAL FEATURES

The 127-005 Comm-Troller is a module which plugs into a standard Allen-Bradley 1771 I/O chassis. The Comm-Troller draws only power from the PLC backplane. The Comm-Troller communicates with the PLC by means of an RS232 serial communication cable connected between the Comm-Troller and another module in the PLC. Up to eight (8) PLC's may be connected to the Comm-Troller at a site

The Comm-Troller continuously communicates with and collects data from the local PLC's. The data collected is defined by tables in the master PLC. These tables can be defined and changed easily with PLC logic. The data gathered from the PLC's is held in the Comm-Troller's memory and is ready to be sent to a SCADA master host upon demand.

The Comm-Troller may communicate with remotely located host computers using either asynchronous or synchronous protocols. The host computers standard communications protocol is emulated by the Comm-Troller's unique microprocessor controlled hardware. Since the Comm-Troller exactly imitates the host's protocol it appears as a standard remote terminal unit. When interrogated, the Comm-Troller responds with data which has been previously collected and saved in its memory. This technique allows the local PLC's to function completely independently from the host SCADA system. The Comm-Troller resolves all timing problems and allows the PLC's to perform the functions of sequencing and control with no custom modifications.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

2.3 HARDWARE FEATURES

The principal hardware components of the Comm-Troller are shown in Figure 1. They are:

- **Two MC6809 Microprocessors**
- **Two RS232 Asynchronous Serial Ports**
- **One Universal Serial Port, programmable to a wide variety of synchronous or asynchronous communication formats**
- **Three 8 Kbyte Memory Chip Sites Per Microprocessor, usable for RAM, EPROM, or EEPROM**
- **4 Kbytes of Shared Ram.**

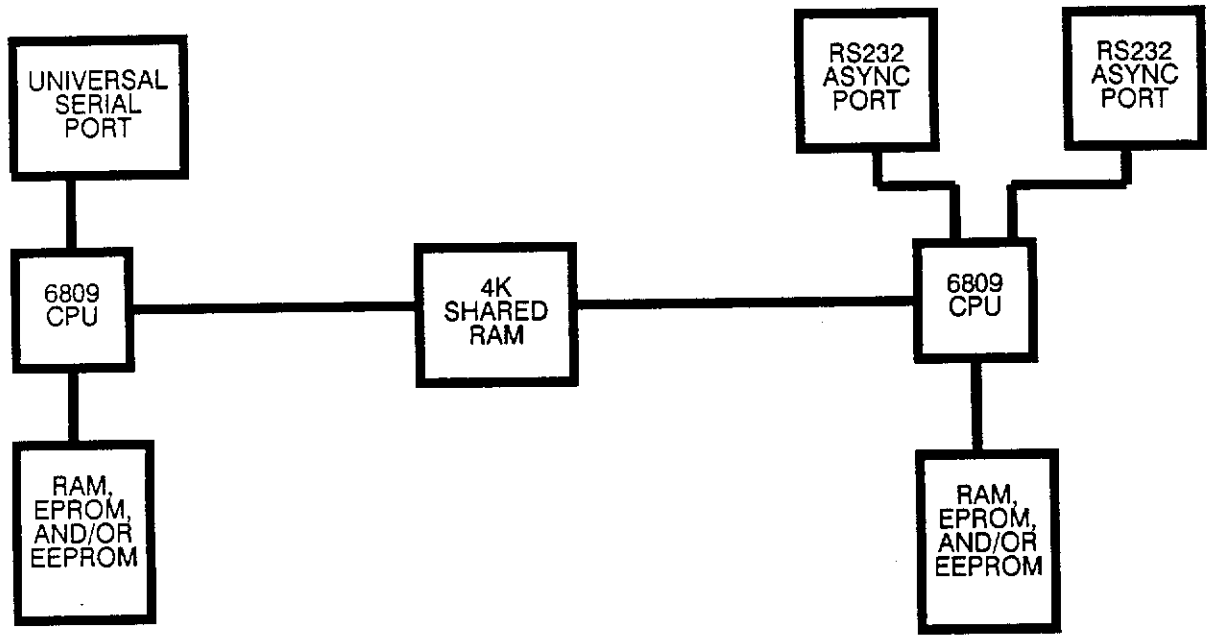


Figure 1 Comm-Troller Block Diagram

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

2.4 SOFTWARE FUNCTIONALITY

The software in the Comm-Troller is implemented in two parts which run asynchronously to each other. One part, the PLC side, communicates to one or more Allen-Bradley PLC's in Allen-Bradley protocol. The other part, the HOST side, communicates with a host SCADA master in another communication format. Data is passed between the two parts by means of a common data base located in the shared RAM memory.

2.5 SPECIFICATIONS

Physical:

- **Requires one module slot in an Allen-Bradley 1771 I/O chassis**
- **1.1" W X 10" H X 5.75" D (Standard Allen-Bradley Module Size)**
- **2 pounds 5 ounces**

Microprocessors:

- **2 6809 Microprocessors**

I/O Ports:

- **2 Asynchronous Serial Data Ports**
- **1 Universal Serial Data Port (asynchronous Or Synchronous)**
- **RS232 Signal Levels**
- **Modem Control Lines**

Port Connections:

- **3 15 pin "D" type connectors (DE15S)**

Communication baud rates:

- **300, 600, 1200, 2400, 4800, 7200, 9600 bits/sec**

Backplane Power Supply Load:

- **1.5 A from 5 Vdc**

Memory Capacity:

- **Six 8-Kbyte Universal Memory Sites**
- **4-Kbyte Dual Ported RAM**

Operating Environment:

- **0 to 60 degrees C**
- **Relative Humidity 0% to 90% (non-condensing)**

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

2.6 SYSTEM CONFIGURATIONS

The Comm-Troller can be used with a single PLC or with a network of up to eight PLC's connected on an Allen-Bradley data highway.

2.6.1 Single PLC Configuration

When the Comm-Troller is used with a single PLC, the system is configured as shown in Figure 2. This configuration uses an Allen-Bradley 1771-KG module tied directly to the single Allen-Bradley PLC to allow a gateway for asynchronous communication in Allen-Bradley protocol. The Comm-Troller serves as the interface between the communication protocol on the communication line and the 1771-KG module gateway. In a PLC-5 system an Allen-Bradley 1785-KE module is used to provide the Comm-Troller interface.

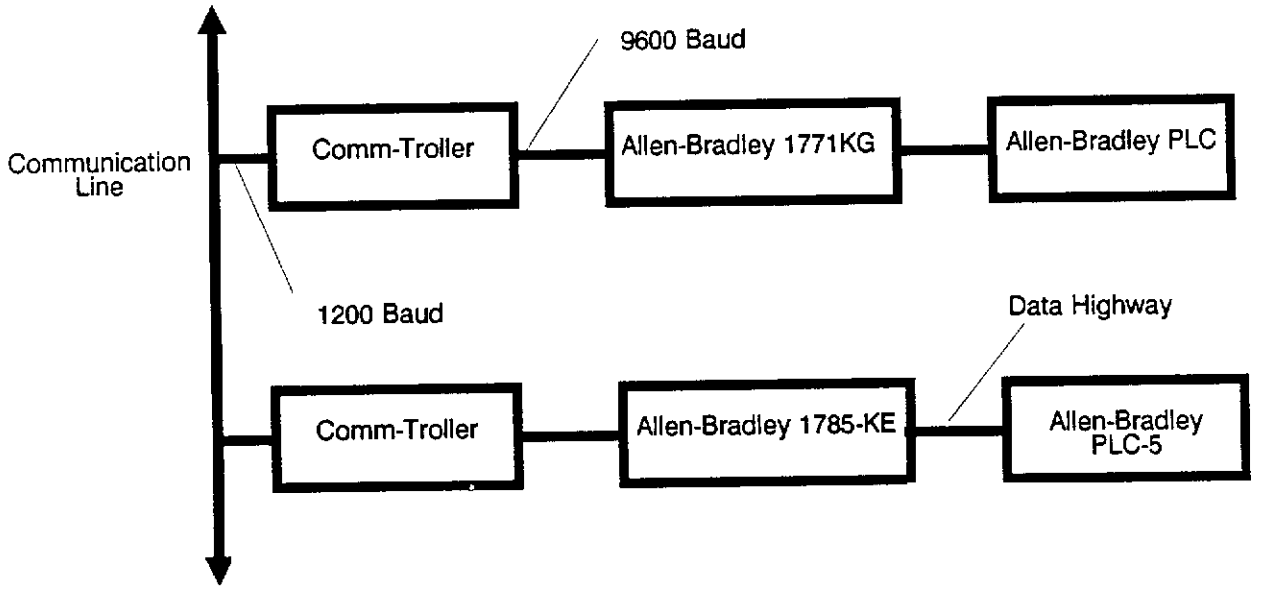


Figure 2 Single PLC Configuration

COPYRIGHT © 1988 MILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

2.6.2 Multiple PLC Configuration

The Comm-Troller can be used as an interface between a serial communication line and up to eight Allen-Bradley PLC's at one site. This configuration is shown in Figure 3. The PLC's are tied together on an Allen-Bradley data highway, a 57.6 Kb local area network that provides peer-to-peer communication with a floating master. An Allen-Bradley 1771-KF module is connected to the data highway to serve as a gateway for asynchronous communication using Allen-Bradley protocol. The Comm-Troller serves as the interface between the protocol on the communication line and the 1771-KF module gateway.

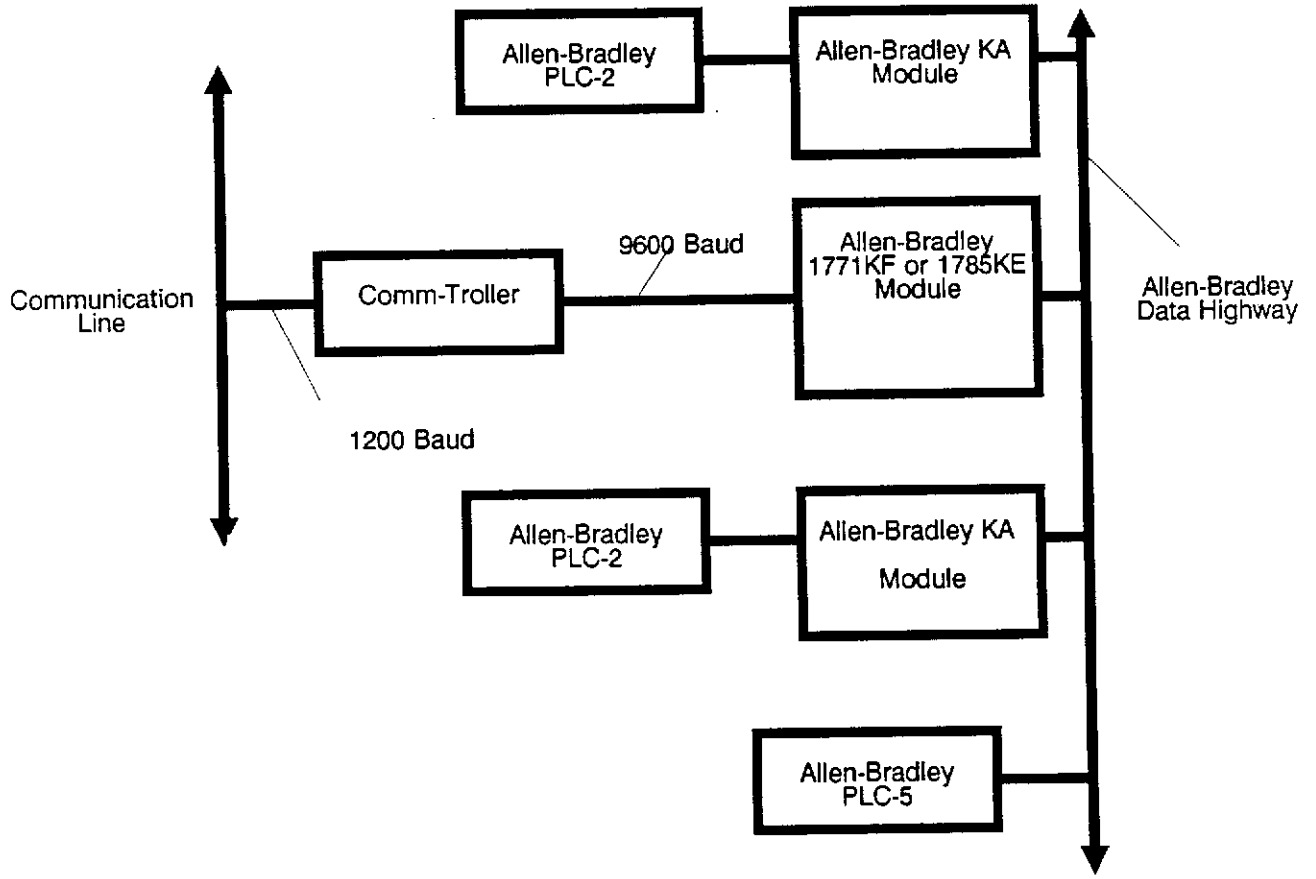


Figure 3 Multiple PLC Configuration

COPYRIGHT © 1988 MILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

INSTALLING THE COMM-TROLLER

3.1 OBJECTIVES

This section tells how to install the Comm-Troller into a 1771 I/O Rack. It also provides information on connecting the Comm-Troller to the host SCADA system and the local PLC(s). After finishing this section the reader should be able to:

- **Configure the options on the Comm-Troller**
- **Insert the Comm-Troller into a 1771 I/O backplane**
- **Connect the Allen-Bradley protocol cable**
- **Connect the host communication line cable**
- **Understand Comm-Troller status indicators**
- **Install additional RAM, EPROM and EEPROM chips**

3.2 INSTALLATION OF THE COMM-TROLLER

Before installing the comm-troller in the 1771 I/O chassis the following steps should be taken:

- **Insure that adequate power is available on the I/O chassis backplane. (Section 3.2.1)**
- **Determine the location of the Comm-Troller in the I/O chassis. (Section 3.2.2)**
- **Configure the options on the Comm-Troller. (Section 3.2.4)**

3.2.1 Power Requirements

The Comm-Troller receives its power through the 1771 I/O chassis backplane from the chassis power supply. It does not require any other external power to function. It is important to calculate the total power required by all modules plugged into the I/O chassis and insure that it is within the power supply specifications. The Comm-Troller requires 1.5 amps at +5V DC.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

3.2.2 Comm-Troller Location in the I/O Chassis

The Comm-Troller can be placed in any slot in the 1771 I/O chassis that is not reserved for another module.

3.2.3 Module Keying

No module keying is required. The Comm-Troller can be installed in any slot of the Allen-Bradley 1771 I/O Chassis.

3.2.4 Hardware Strapping Options

The Comm-Troller is an extremely versatile module which can be configured in many different ways to allow it to be used in numerous applications. The hardware strapping configurations are application dependent and are explicitly defined in the appendix for each protocol application. The following paragraphs detail the functions of each of the hardware jumper options.

J1 ____ A three position jumper which is used to allow connector P3 pin 1 to function as either an input to the host side VIA signal CB1 or as a buffered output from CB1.

J2 ____ A three position jumper which is used to select the size of EPROM or RAM chips installed in socket U13. A jumper will be connected from 1-2 for 4K or 8K devices. The jumper should be connected from 2-3 for 16K or 32K devices.

J3 ____ A three position jumper which is used to select the size of EPROM or RAM chip installed in socket U16. It will be installed as described for jumper J2.

J4 ____ A two position jumper which is used to invert the signal on Connector P4 Pin 15. This line is normally used for an external Transmit Clock (TxC). If J4 is installed, the clock signal will be inverted; if not installed, the clock signal will not be inverted.

J5 ____ A two position jumper which is used to invert the signal on Connector P4 Pin 14. This line is normally used for an external Receive Clock (RxC). If J5 is installed the clock signal will be inverted; if not installed, the clock signal will not be inverted.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

J6 ___ A three position jumper which is used for selection of the type of device to be used in socket U13. If the memory device is an 8K EPROM or RAM, then J6 will be connected from 1-2. If it is a 32K RAM, then it will be connected from 2-3.

J7 ___ A three position jumper which is used to select the size of memory device to be installed in socket U23. It is connected as described for jumper J2.

J8 ___ A three position jumper which is used to select the type of device to be used in socket U16. It is connected as described for jumper J6.

J9 ___ A three position jumper which is used to select the size of memory device to be installed in socket U20. It is connected as described for jumper J2.

J10 ___ A dual row, 5 position jumper which is used for configuration of the PLC side VIA chip (U29). Almost any connection required can be accomplished by interwiring pins on jumper J10. The application program will determine the connections required.

J11 ___ A three position jumper which is used to select the size of memory device to be installed in socket U30. It is connected as described for jumper J2.

J12 ___ A three position jumper which is used to select the type of device to be used in socket U23. It is connected as described for jumper J6.

J13 ___ A three position jumper which is used to select the type of device to be used in socket U20. It is connected as described for jumper J6.

J14 ___ A three position jumper which is used to select the size of memory device to be installed in socket U27. It is connected as described for jumper J2.

J15 ___ A three position jumper which is used to select the type of device to be used in socket U30. It is connected as described for jumper J6.

J16 ___ A three position jumper which is used to select the type of device to be used in socket U27. It is connected as described for jumper J6.

J17 ___ A three position jumper which is used to select the type of interrupt which will be generated when the host side processor signals the PLC side processor. Connection of the jumper from 1-2 will select an NMI interrupt. Connection from 2-3 will select an IRQ interrupt. The application software will determine the type of interrupt required.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC
HOUSTON, TEXAS

3.2.5 Comm-Troller Installation

The following paragraphs provide the user with suggested inspection, preparatory procedures, considerations, and background information needed prior to using the Comm-Troller.

3.2.5.1 Unpacking and Inspection

Carefully remove the Comm-Troller card from the anti-static protection bag. Since many of the components of the Comm-Troller are subject to damage by static discharge, the bag should be saved for card storage or future return, if necessary. Closely inspect the card for signs of shipment related damages such as loose socketed components or bent and broken pins. Should evidence of damage be found, notify the carrier and the manufacturer at once.

3.2.5.2 Installing Comm-Troller in I/O Chassis

The Comm-Troller can be installed in any empty mounting position in an Allen-Bradley 1771 I/O Rack.

CAUTION: Always remove power from the I/O Rack prior to inserting or removing the Comm-Troller. Failure to remove power can result in severe damage to the Comm-Troller or the I/O chassis.

Push the card retainer latch to the right and rotate the card retainer upward to gain access to the selected mounting slot. Carefully align the Comm-Troller card with the card guides and push the card into the I/O chassis until fully installed. Rotate the card retainer back into position. The retainer latch will click into position when the card has been locked into place. Connect serial I/O cables to the Comm-Troller as described in the appendix for the protocol application and apply power. The Comm-Troller will initialize itself upon the application of power and will be ready for operation.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

3.3 USING THE COMMUNICATION PORTS

The Comm-Troller has three (3) ports for communication with other devices. Two of the ports are standard asynchronous ports and one is a "Universal Serial Port" which can be

PIN	SIGNAL NAME
1	GND Signal Ground
2	TXD Transmit Data (output)
3	RXD Receive Data (input)
4	RTS Request To Send (output)
5	CTS Clear To Send (input)
6	DSR Data Set Ready (input)
7	GND Signal Ground
8	DCD Data Carrier Detect (input)
11	DTR Data Terminal Ready (output)

Figure 4 Connector P1 Pinouts

PIN	SIGNAL NAME
1	GND Signal Ground
2	TXD Transmit Data (output)
3	RXD Receive Data (input)
4	RTS Request To Send (output)
5	CTS Clear To Send (input)
6	DSR Data Set Ready (input)
7	GND Signal Ground
8	DCD Data Carrier Detect (input)
11	DTR Data Terminal Ready (output)

Figure 5 Connector P2 Pinouts

PIN	SIGNAL NAME
1	GND Signal Ground
2	TXD Transmit Data (output)
3	RXD Receive Data (input)
4	RTS Request To Send (output)
5	CTS Clear To Send (input)
7	GND Signal Ground
8	DCD Data Carrier Detect (input
11	DTR Data Terminal Ready (output)
14	RXC Receive Data Clock (input)

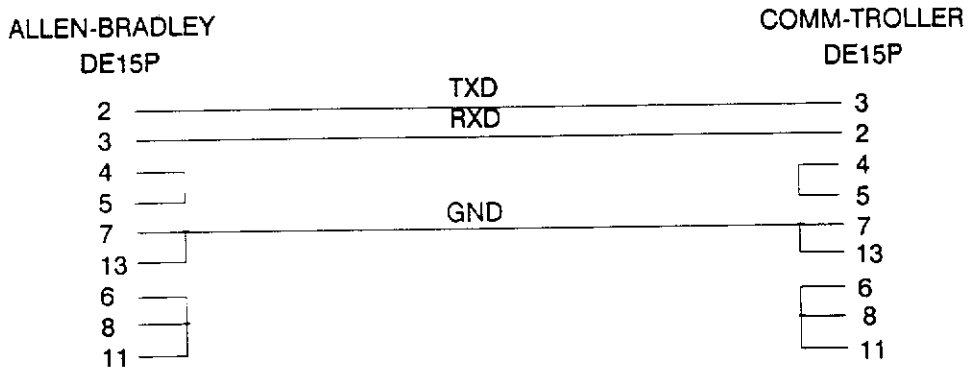
Figure 6 Connector P3 Pinouts

programmed for any type of serial communication. The ports are numbered P1, P2, and P3. P1 is located at the top of the Comm-Troller card when it is installed, P3 is at the bottom. A 15 pin "D" type connector is used for termination of the serial interface cables. The mating connector for the Comm-Troller serial interface ports is a TRW/Cinch DE15P or equivalent. Ports P1 and P2 are asynchronous ports controlled by the master side microprocessor; Port P3 is the Universal Serial Port and is controlled by the slave microprocessor. All lines are buffered by RS232 drivers and receivers. Figures 4, 5 and 6 detail the pinouts for each of the serial interface connectors.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

3.3.1 Connecting the Allen-Bradley Protocol Port

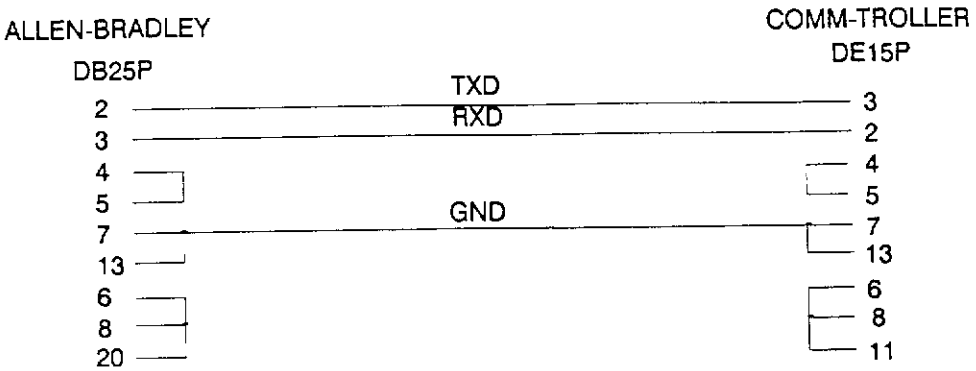
Port P2 (center connector) is used to communicate with the Allen-Bradley 1771 KF or KG module. The cable connections and protocol are identical for both types of modules. The communication rate, data format, and parity selections are fixed by the Comm-Troller firmware. It automatically selects a rate of 9600 baud, 8 data bits, 1 stop bit, and no parity. The interface signals are at RS232 voltage levels. Figure 7 details the cable connections.



Part # 127-052-12

Figure 7 KG or KE Cable

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

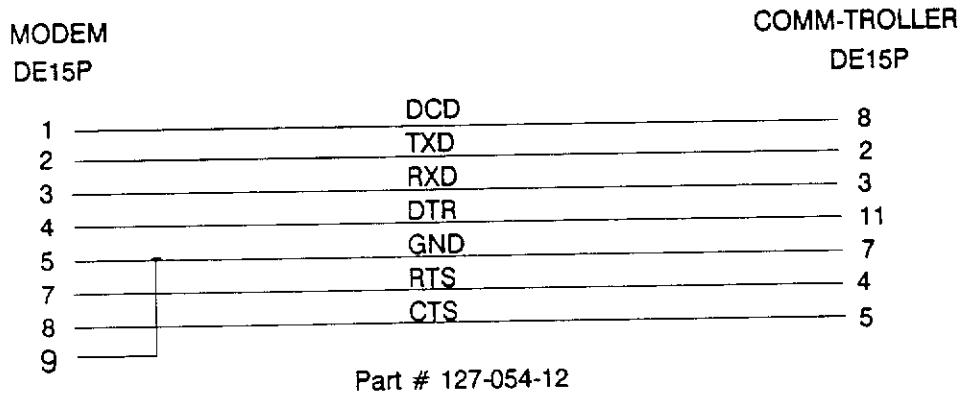


Part # 127-053-96

Figure 8 KF-2 Cable

3.3.2 Connecting the SCADA Protocol Port

The connections to the remaining ports of the Comm-Troller are dependent on the type of equipment and protocol requirements. Details for connection to these ports can be found in the appendix for the specific protocol. A modem may be used in many applications for communication to the host computer. The following figure details the cable connections required for connecting to a MARC 137-001 Modem module.



Part # 127-054-12

Figure 9 Modem Cable Connections

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

3.4 COMM-TROLLER STATUS INDICATORS

The Comm-Troller has seven (7) LED indicators located near the top of the module and visible through a slot in the module housing. These indicators provide status information for each of the serial interface ports. The LED's are numbered DS1 through DS7 starting from the top. Figure 10 defines the function for each of the LED indicators.

LED #	FUNCTION
DS1	Port P1 Receive Data
DS2	Port P1 Transmit Data
DS3	Port P2 Receive Data
DS4	Port P2 Transmit Data
DS5	Port P3 Receive Data
DS6	Port P3 Transmit Data
DS7	Slave Processor Active

Figure 10 LED Indicators

3.5 INSTALLING PROGRAM CHIPS

The Comm-Troller is a completely programmable device. The operation of each of the two microprocessors is controlled by programs stored in EPROM memory chips. Variable information for each processor is stored in Random Access Memory (RAM) chips. The type, size, and number of program chips is dependent on the application. The appendix for a specific protocol or application will contain the chip part numbers and jumper option selections.

Each microprocessor has three (3) "Universal" memory sites. Each site can be used for RAM or EPROM type memory of various sizes depending on the jumper option selection. Locations U13, U23, and U30 are associated with the host side processor. Locations U16, U20, and U27 are connected with the PLC side processor. A seventh memory site (U37) is connected to both processors. Normally, sites U27 and U30 will be used with 8K x 8 RAM chips, and U13, U16, U20, and U23 will be used with 8K x 8 EPROM chips. Site U37 will always be used with a 8K x 8 RAM chip.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

3.6 Allen-Bradley Interface Module Configuration

The Allen-Bradley Interface module must be configured for the type of communication network on which it will be used. The following table shows an example of the module switch selections for use with the Comm-Troller.

1785-KE	1785-KE Series B	1771-KF	1771-KG
SW1-1 OFF	SW1-1 OFF	SW1-1 OFF	SW1-1 OFF
SW1-2 ON	SW1-2 ON	SW1-2 ON	SW1-2 ON
SW1-3 ON	SW1-3 ON	SW1-3 ON	SW1-3 ON
SW1-4 OFF	SW1-4 ON	SW1-4 OFF	
SW1-5 ON	SW1-5 ON	SW1-5 ON	SW2-1 OFF
	SW1-6 ON		SW2-2 ON
SW2-2 OFF		SW2-1 OFF	SW2-3 ON
SW2-3 OFF	SW2-1 ON	SW2-2 OFF	SW2-4 ON
	SW2-2 ON		SW2-5 ON
SW3-1 OFF	SW2-3 ON	SW3-1 OFF	
SW3-2 OFF	SW2-4 ON	SW3-2 OFF	SW3-1 OFF
SW3-3 ON	SW2-5 OFF	SW3-3 ON	SW3-2 OFF
	SW2-6 ON		
SW4-1 OFF	SW2-7 ON	SW4-1 OFF	SW4-1 OFF
SW4-2 OFF	SW2-8 OFF	SW4-2 OFF	SW4-2 OFF
SW4-3 ON		SW4-3 ON	SW4-3 ON
	SW3-1 ON		
SW5-1 ON	SW3-2 ON	SW5-1 ON	SW5-1 OFF
SW5-2 ON	SW3-3 OFF	SW5-2 ON	SW5-2 ON
	SW3-4 ON		SW5-3 OFF
SW6-1 OFF	SW3-5 ON	SW6-1 OFF	
SW6-2 ON	SW3-6 ON	SW6-2 ON	
SW6-3 ON		SW6-3 ON	
SW6-4 OFF	SW4-1 ON	SW6-4 OFF	
	SW4-2 ON		
	SW4-3 ON	SW7-1 ON	
	SW4-4 ON	SW7-2 OFF	

Figure 11 Interface Module Switches

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

3.7 CONFIGURATION TABLE START ADDRESS SELECTION

The starting address of the configuration table is read by the Comm-Troller at initialization . The address within the PLC which is read is defined by setting 3 rotary hex switches on the Comm-Troller. The switches are accessible thru a slot in the cover of the module as shown in the figure below.

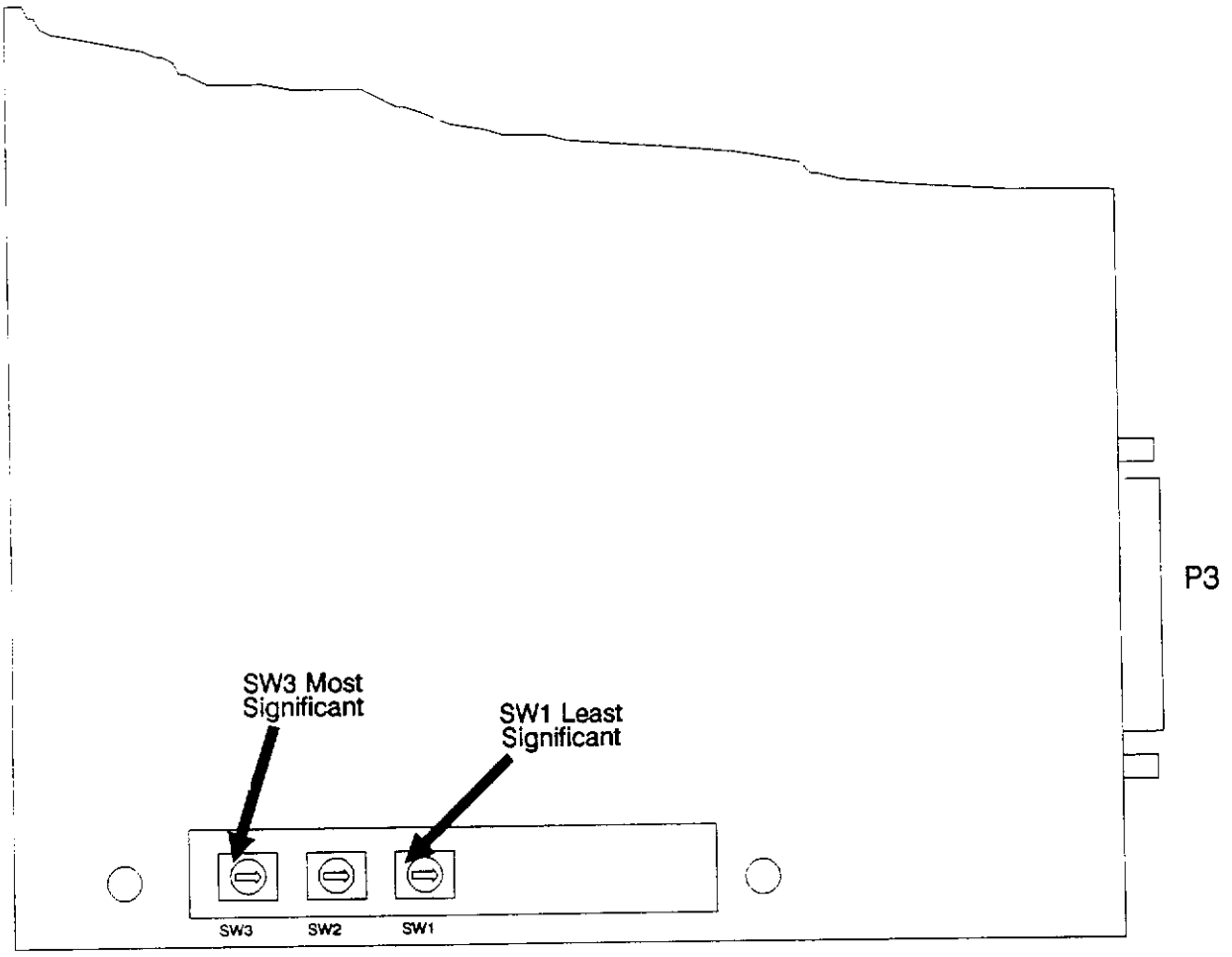


Figure 12 Address Selection Switches

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

OPERATING FUNCTIONS OF THE COMM-TROLLER

4.1 OBJECTIVES

This section describes the operating functions of the Comm-Troller and the methods used to accomplish the functions. Through custom programming by the manufacturer the Comm-Troller is able to support many different host protocols. The descriptions in this section apply to any host protocol. Specific information on currently implemented host protocols is supplied in the appendix.

4.2 GENERAL INFORMATION

The purpose of the Comm-Troller as depicted in Figure 13 is to allow a host to communicate to an Allen-Bradley PLC in a telemetry protocol other than Allen-Bradley protocol. The primary purpose of the communications is to read the field inputs to the PLC and change the field outputs from the PLC. In order to accomplish this function the Comm-Troller communicates to the host in the host protocol and to the PLC in Allen-Bradley protocol.

Figure 14 illustrates the primary functional software components of the Comm-Troller and the associated Allen-Bradley PLC. These components fall into the following three categories:

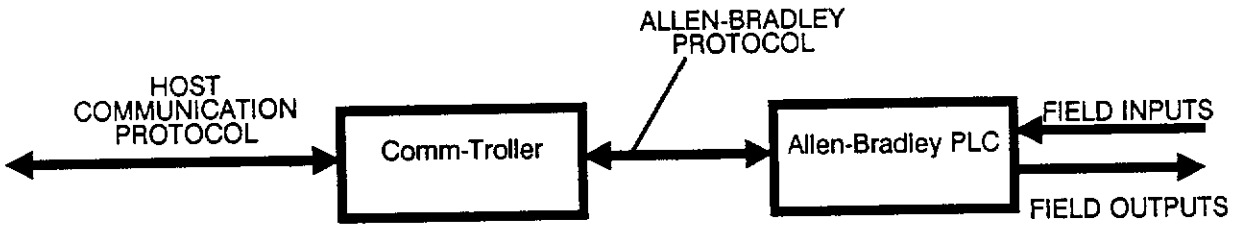


Figure 13 Functional Block Diagram

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

OPERATING FUNCTIONS OF THE COMM-TROLLER

- Data storage sections of memory
- Software programs
- Data flow paths.

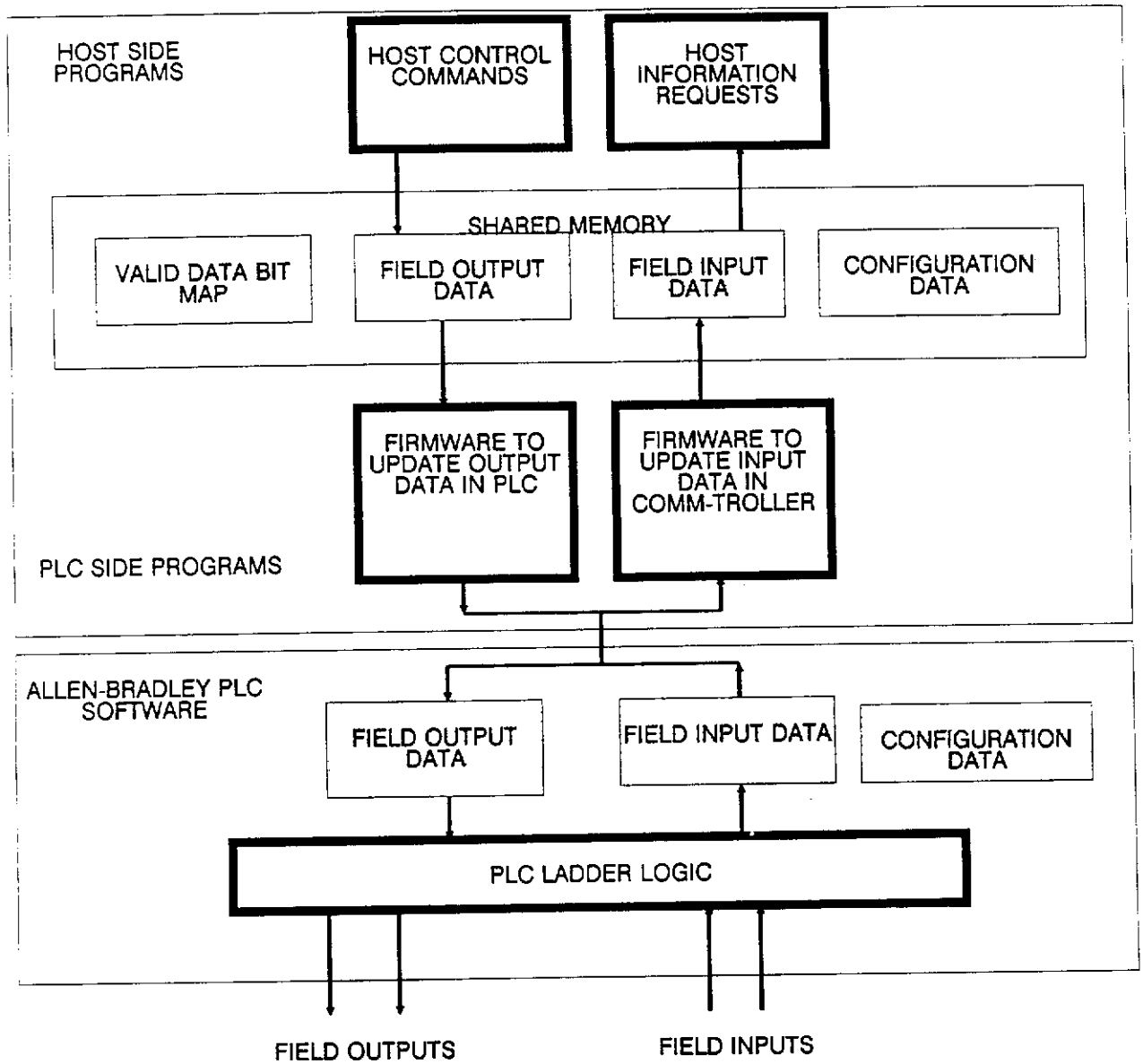


Figure 14 Software BLock Diagram

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

The functional software components contained in the PLC consist of the following items:

- **A configuration data section defining parameters such as the number of PLC's in the local cluster the host communication line baud rate and the location and size of the input/output data sections in the PLC.**
- **An input/output data section in each PLC in the local cluster containing the actual field data in the format required by the host communication protocol.**
- **Ladder logic programs to move data in and out of the input/output data sections.**

The functional software components of the Comm-Troller can be broken down into three areas:

- **A data section containing the same configuration and input/output data as the PLC.**
- **A set of programs referred to as the "PLC side" which communicate with the PLC to keep the data in the Comm-Troller up to date with the data in the PLC.**
- **A set of programs referred to as the "host side" which respond to messages from the host by accessing the data in the Comm-Troller memory.**

An important function of the Comm-Troller is to speed up the response to messages from the host. Having the PLC data constantly updated in the shared memory area of the Comm-Troller allows the Comm-Troller to respond to the host within a few milliseconds after receipt of a message. The PLC requires much more time to formulate a response to a message.

The remainder of this section describes each of the data sections and programs.

4.3 PLC SOFTWARE

The PLC software is supplied by the user. An understanding of it is necessary to appreciate the operation of the Comm-Troller.

4.3.1 PLC Data Structures

The Comm-Troller communicates with the programs in the PLC by reading data from and writing data into designated memory areas in the PLC. The PLC data structures are divided into two categories: configuration data and input/output data.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

4.3.1.1 PLC Configuration Data

A configuration data section in the PLC defines the addresses and parameters necessary for the Comm-Troller to communicate with the host. The format of the configuration section allows one or several PLC's to communicate with a single Comm-Troller. The start address of the configuration data section is always contained in the master PLC configured for Allen-Bradley data highway address hex A.

The exact format of the configuration section depends on the host protocol being used. A typical configuration data section is shown in Figures 18 and 19 (Chapter 5). This configuration section consists of two parts: a header which defines data common to all of the PLC's in the local cluster and one data definition section per PLC which defines the size and starting address of each type of input/output data.

4.3.1.2 PLC Input/Output Data

Each PLC in the local cluster contains an input/output data section with the various kinds of data required by the host protocol in the format required by the host. The data will normally consist of inputs such as discretes and analogs as well as discrete and/or analog outputs.

4.3.2 PLC Ladder Logic

Ladder logic in each PLC is necessary to write the data obtained from the PLC input cards into the data section and to send appropriate commands to the PLC output cards based on output data written into the output data section by the Comm-Troller.

4.4 COMM-TROLLER SOFTWARE

The Comm-Troller software is comprised of a data section, a set of programs which communicate with the PLC, a set of programs which communicate with the host and a set of programs used to initialize the Comm-Troller.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC
HOUSTON, TEXAS

4.4.1 Comm-Troller Data Structures

A set of data structures exist in the Comm-Troller that are very similar to the data sections in the PLC. There are several advantages to this approach including:

- **The Comm-Troller is able to respond to messages from the host within a few milliseconds whereas the PLC requires much longer to respond.**
- **Consolidation of the input/output data in the Comm-Troller simplifies the task of having multiple PLC's appear to the host as a single device.**
- **The data structures provide the software interface between the programs which communicate to the PLC and the programs which communicate to the host thus eliminating timing problems.**
- **The use of the data structures in the Comm-Troller as the interface between the PLC and the host protocols simplifies the implementation of new host protocols by the manufacturer.**

4.4.1.1 Comm-Troller Configuration Data

The configuration section in the Comm-Troller is identical to the configuration section in the master PLC configured for Allen- Bradley data highway address hex A.

4.4.1.2 Comm-Troller Input/Output Data

The input/output data section in the Comm-Troller is identical in content to the data sections in the PLC but slightly different in format. As shown in Figure 15 the Comm-Troller memory contains continuous blocks of data by type rather than by PLC. This structure allows the host to communicate to the Comm-Troller as one large remote device rather than several smaller ones.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

4.4.1.3 Comm-Troller Valid Data Bit Map

The Comm-Troller contains one data structure which is not present in the PLC. This structure contains a bit for every input (or card) in the PLC cluster. The bits are used to indicate that the PLC is not responding to data requests from the Comm-Troller and thus the data is not valid.

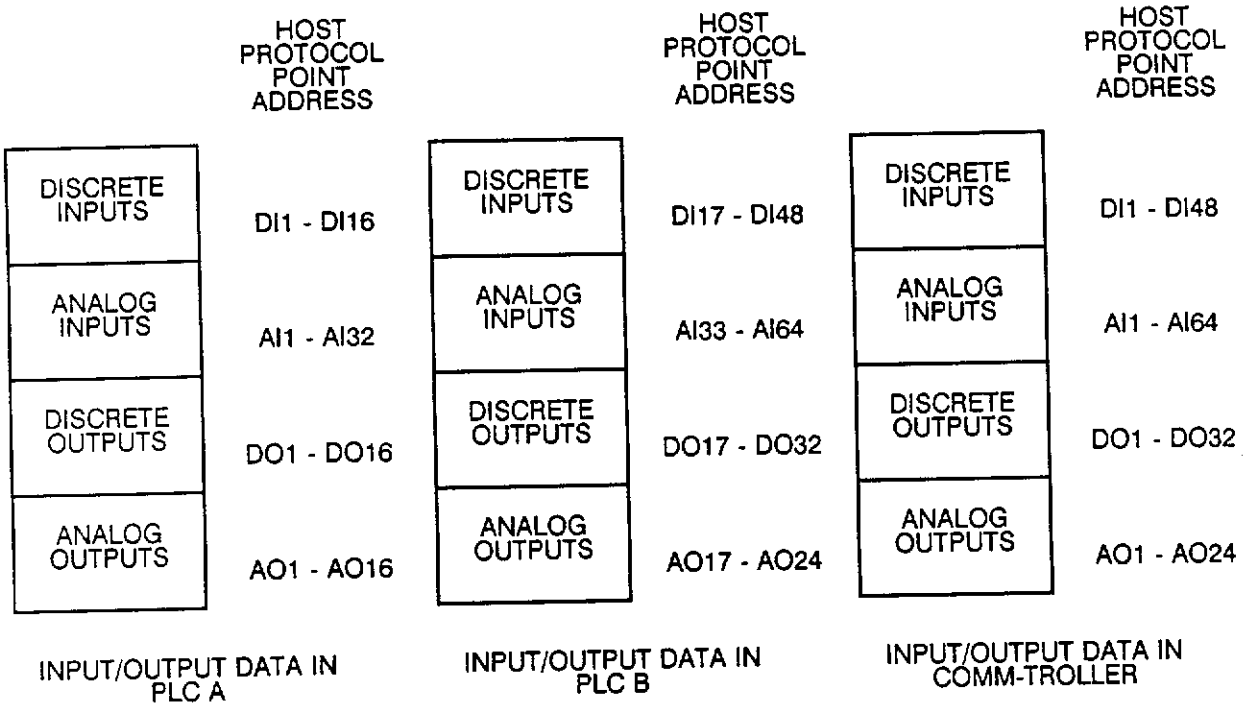


Figure 15 Input/Output Data Section Concepts

4.4.2 PLC Side Programs

The PLC side programs provide all communication with the PLC's in the local cluster including polling requests and control commands. All messages between the PLC and the Comm-Troller are initiated by the PLC side of the Comm-Troller

Polling requests are issued in a periodic circular fashion. PLC's in the local cluster are polled in the order that they are defined in the configuration section.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

Returned messages are error checked for validity. Invalid messages are discarded. Messages with communication errors are retried one time.

Valid responses are processed by moving the data for each data type into the appropriate data sections. The data from the first data type in the first PLC defined in the configuration section is placed at the beginning of the Comm-Troller data section. The data from the same data type in the second PLC is placed at the end of the data from the first PLC and so on. The total number of data bytes per data type must always be even. The appropriate valid data bits are set when data is moved into the data section. The valid data bits are reset for all the data values expected in a response when no valid response is received.

Control commands are asynchronously passed from the host side software to the PLC side software as they are processed by the host side (see Section 4.4.3). These commands trigger a task on the PLC side. This task waits until the current poll message exchange is complete then issues the control command to the appropriate PLC. Success or failure of the control message to the PLC is not reported to the host side software. There are no retries for controls.

4.4.3 Host Side Programs

The host side software provides for all communications with the host computer. Most host protocols require all communications between the host and a remote station to be initiated by the host. In this mode the host side software constantly listens for messages from the host and formulates responses.

All received messages are interpreted by the host side software. Messages directed to another Comm-Troller are ignored. Invalid or erroneous messages are handled as defined by the host protocol.

Responses to valid data requests are built by the host side software from the data in the Comm-Troller input/output data sections. If the valid data bit indicates non-updated data the host will be notified as provided for in the host protocol.

Valid control commands are processed by the host side software as shown in Figure 16.

COPYRIGHT © 1988 MILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

4.4.4 Comm-Troller Initialization

Upon power-up the PLC side of the Comm-Troller will issue an unprotected block read to the master PLC at address hex A on the Allen-Bradley highway. The read will be for 2 bytes starting at a byte address specified by switches SW1 thru SW3 on the Comm-Troller. The switches are set to specify the hex address times 10_{hex} of the memory location to read from. The bytes read must contain the starting byte address of

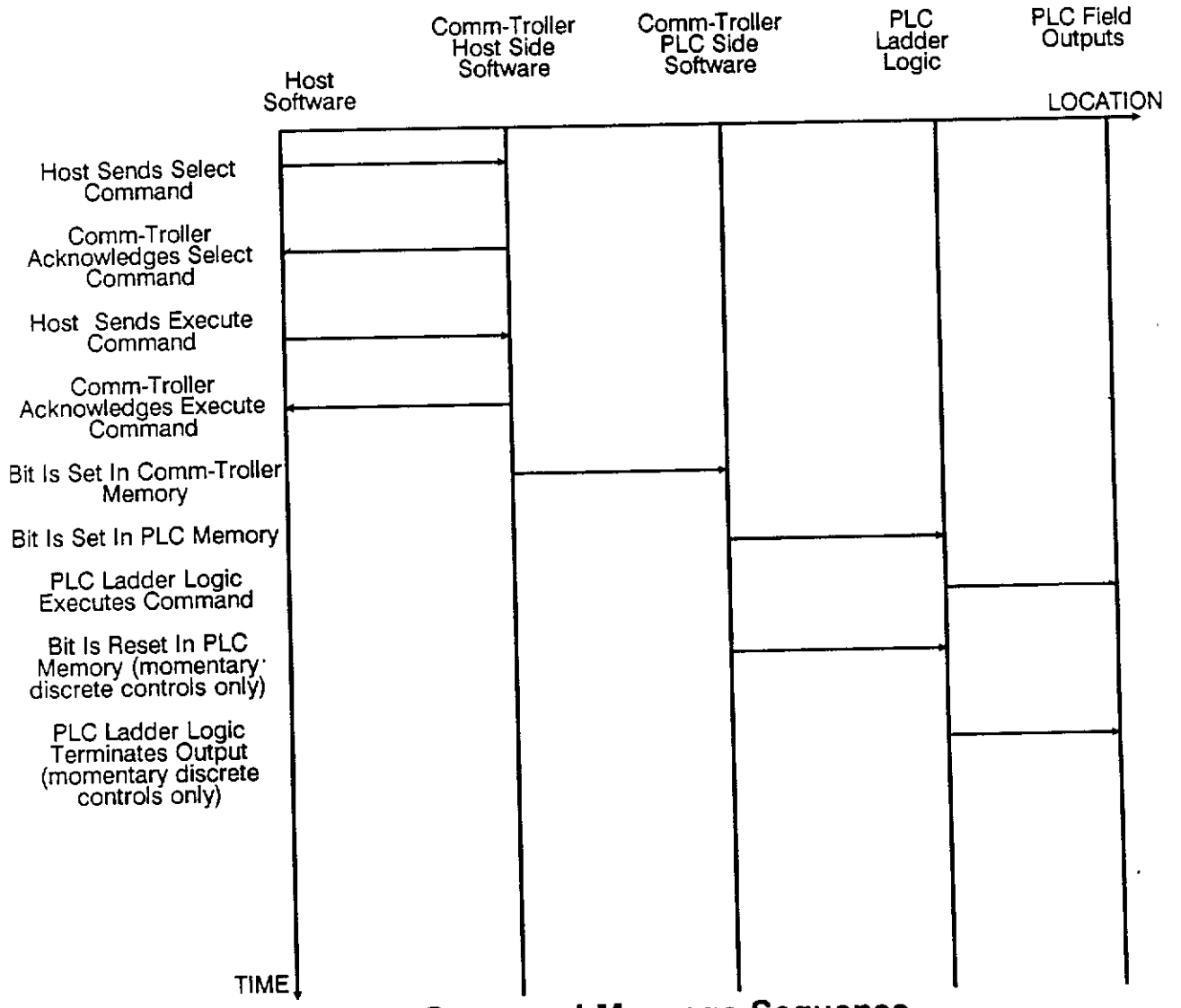


Figure 16 Command Message Sequence

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

the configuration data section in PLC memory. A block read for 50 bytes starting at the configuration section start address will then be issued. This will read the fixed length portion of the configuration section including the number of PLC's defined. Based on this number a block read for the remainder of the configuration section will be issued. The sizes of each of the data structures will be computed. These data structures will be established in memory as well as their corresponding bit maps.

If the PLC side of the Comm-Troller does not receive valid responses to the requests for configuration data it will continuously retry the request. This cycle will be repeated until a valid response is received. If the configuration table does not contain valid data an error word will be written to the PLC at address A_{hex}. The error word will be stored in the word immediately following the starting address word. For example if the switches on the Comm-Troller module are set at 012 then the configuration table start address will be read from location 0120_{hex} and the error word stored at location 1022_{hex}. The high byte of the error word will be a copy of the STS field in the message returned from the PLC (or RS-232 Interface Module). The low byte will contain error information originating within the Comm-Troller itself. Figure 17 details the error byte bit definitions.

Upon successful completion of initialization the PLC side of the Comm-Troller will begin its normal operation. After one full poll cycle is complete the PLC side will set a flag indicating initialization and first pass completed. This will trigger the host side software to begin its normal operation. The host side software will not respond to or take action on any host request until this flag has been set.

ERROR	DESCRIPTION
00000000	No Errors Found
00000001	Indexing Error in Xmit/RCV Handlers
00000010	Error In a Table
00000100	Receive Buffer Overrun
00001000	Master/Backup PLC's Swapped
00010000	Illegal PLC Address In Receive Message
00100000	Error In Configuration Information
01000000	Insufficient Data Returned From Poll
10000000	Illegal Write to Protected Memory in PLC

Figure 17 PLC Error Word

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

4.5 ALLEN-BRADLEY PROTOCOL

4.5.1 General Description

Communications between the Comm-Troller and the Allen-Bradley interface module use the Allen-Bradley master/slave full-duplex polled protocol with non-embedded responses. The 1771-KF, 1771-KG and 1785-KE modules all use the same protocol, are addressed the same by the Comm-Troller and respond the same to poll requests. This protocol operates at a fixed I/O configuration of 9600 baud 8 data bits 1 stop bit and no parity.

In using the Allen-Bradley protocol the Comm-Troller is the master and the PLC's on the data highway are the slaves. All communications exchanges are initiated by the Comm-Troller. All messages between the master/slave use a CRC-16 bit protection code.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

PLC CONFIGURATION TABLE

5.1 OBJECTIVES

This section describes the data structure in the Allen-Bradley PLC which defines the various data types and number of points. This description is general in nature and applies to all Comm-Troller models. Specific information and example configuration table for each protocol can be found in the appropriate appendix.

5.2 DATA STRUCTURES

The Comm-Troller transfers data in and out of data structures which reside within the PLC(s). In multi-PLC configurations each PLC contains a data area which is accessed by the Comm-Troller. In addition to the data areas there is a configuration area which resides in only one of the PLC's (the master PLC configured to address hex A) regardless of the number of PLC's in the cluster.

5.2.1 Configuration Section

The configuration section contains information defining the environment of each local PLC cluster. This section contains such information as the RTU address for the Comm-Troller, the number of PLC's in the local cluster parity and stop bit information, etc. A block of memory is defined for each PLC in the local cluster. This block defines the address of each PLC on the Allen-Bradley data highway. It includes four (4) bytes for each data section describing the number of bytes per data type, the number of points in the data section and the starting address of the data section within the PLC's memory.

The exact format of the configuration section will differ depending on the communication protocol used on the host side of the Comm-Troller, however general guidelines apply to all configuration tables.

- **All configuration table <u>Data</u> must be in Hexadecimal**
- **The Data Table Area for each PLC must be <u>contiguous</u>**
- **Unused or undefined data types should be set to zero**
- **The configuration table only resides in one PLC on the data highway. This PLC must have its station address set to A_{hex} or 12_{Octal}**

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

The configuration section resides in only one PLC regardless of the number of PLC's in the local cluster. The master PLC containing the configuration section is always at address hex A on the Allen-Bradley data highway. The configuration section start address is not fixed and must be defined for each application. The starting address of the configuration table is defined by three (3) rotary HEX switches on the Comm-Troller. The switches are set to reference a PLC Data Table BYTE address which contains the Address of the beginning of the Configuration Section. The address switches are used to select the most significant three (3) digits of the configuration table address pointer The least significant digit is always 0.

5.2.2 PLC Addressing

Before a configuration table can be built for any application it is necessary to understand how the hex byte addressing used by the Comm-Troller switch settings, and also used in the configuration table addressing, relate to PLC addressing. This relationship differs between the PLC-2 and PLC-5 families of Allen-Bradley processors.

5.2.2.1 PLC-2 Addressing

The PLC-2 Processors all have one data storage area called the Data Table. The size of this area is defined by the user based on his requirements. Portions of the Data Table in PLC-2 Processors are dedicated and cannot be used for the configuration table or data storage. The Allen-Bradley Programming Manual for the particular processor in use should be consulted for further details on the processor memory organization. In general the Comm-Troller configuration table and data storage area should reside below any portion of the Data Table used for application programming. Additional space should be allotted when assigning the Data Table addresses to allow for future expansion. The PLC-2 family uses **OCTAL** word addressing for the Data Table. A conversion to **HEX BYTE** addressing is therefore required. As an example, if the Comm-Troller switches are set to 123(0-implied) the configuration table start address will be read from location 4430_8

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

5.2.2.2 PLC-5 Addressing

The PLC-5 processors utilize a file structure for the Data Memory organization. The first nine data files have a default type designation which cannot be modified. The file type and size for the remaining data area is user defined. The file numbers can range from 9-999. Each file can be from 1 to 1000 elements. The PLC-5 manual has further details concerning file number assignments, sizing and use. The Comm-Troller can only access one file in the PLC-5 Data Memory. The file which is accessed is determined by the Station Address Switches on the RS-232 Interface module. Normally this module address is set to 11_8. Since the file numbers are in decimal the Comm-Troller will be accessing file 9 ($11_8 = 9_D$). An additional conversion must also be made since the word addressing within the file is zero based decimal and the Comm-Troller addresses are in Hex bytes. For example, if the Comm-Troller switches are set to 023 it will attempt to read the starting address of the configuration table from file #9 word 280.

5.2.3 Input and Output Data Sections

The format of the data sections within each PLC differs depending on the communication protocol utilized on the host side communication line. A separate data section exists for each data type utilized in the host communication protocol. Some typical data types are the following:

- **Discrete inputs**
- **Discrete outputs**
- **Analog inputs**
- **Analog outputs**
- **Accumulator inputs**
- **Calculated integers**
- **Integer parameters**
- **Calculated floating points**
- **Floating point parameters.**

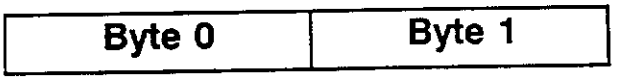
COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

5.3 TYPICAL CONFIGURATION SECTION

BYTE	DESCRIPTION
0	RTU Address
1	Number of PLC's
2,3	Radio Delay Timer
4	Baud Rate *
5	Parity **
6	Number of Stop Bits (1 or 2)
7,8	Control De-selectTime (10 ms inc.)
9-14	Reserved for Protocol Specific Applications
15	Master/Backup Swap Flag (0 = no,1 = yes)
16- 49	Reserved for Protocol Specific Applications

* Baud Rate Code: 4 = 300, 5 = 600, 6 = 1200, 7 = 1050, 8 = 2400, 9 = 4800, 10 = 7200, 11 = 9600
** Parity Code: 0 = None 1 = Odd 2 = Even

Figure 18 Typical Header



PLC WORD

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC
HOUSTON, TEXAS

BYTE	FUNCTION
0	PLC Address
1	# Bytes per Data Type 0
2	# Data Type 0
3,4	Start Address Data Type 0
5	# Bytes per Data Type 1
6	# Data Type 1
7,8	Start Address Data Type 1
9	# Bytes per Data Type 2
10	# Data Type 2
11,12	Start Address Data Type 2
13	# Bytes per Data Type 3
14	# Data Type 3
15,16	Start Address Data Type 3
17	# Bytes per Data Type 4
18	# Data Type 4
19,20	Start Address Data Type 4
21	# Bytes per Data Type 5
22	# Data Type 5
23,24	Start Address Data Type 5
25	# Bytes per Data Type 6
26	# Data Type 6
27,28	Start Address Data Type 6
29	# Bytes per Data Type 7
30	# Data Type 7
31,32	Start Address Data Type 7

BYTE	FUNCTION
33	# Bytes per Data Type 8
34	# Data Type 8
35,36	Start Address Data Type 8
37	# Bytes per Data Type 9
38	# Data Type 9
39,40	Start Address Data Type 9
41	# Bytes per Data Type 10
42	# Data Type 10
43,44	Start Address Data Type 10
45	# Bytes per Data Type 11
46	# Data Type 11
47,48	Start Address Data Type 11
49	# Bytes per Data Type 12
50	# Data Type 12
51,52	Start Address Data Type 12
53	# Bytes per Data Type 13
54	# Data Type 13
55,56	Start Address Data Type 13

Figure 19 Typical PLC Data Configuration Section

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

IMPLEMENTATION OF RTU PROTOCOLS

The Comm-Troller uses software routines stored in EPROM to emulate different communication protocols. The routines may be executed in either the host side processor or the PLC side processor depending on the particular requirements of the protocol. Data is collected by the Allen-Bradley communication routines running on the PLC side processor. The PLC is continuously scanned for data based on information read from the PLC configuration tables during initialization. Refer to Section 4.0 for more details on communication with the PLC. The data collected is placed into a dual-ported memory area where it is available to either processor. When a request for information is received from one of the serial ports the data is retrieved from the dual-ported memory formatted in accordance with the protocol being emulated and then transmitted out the requesting port. The appendix to this manual contains specific information concerning the PLC configuration EPROM part numbers and other information necessary for each protocol supplied.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

MAINTENANCE AND TROUBLESHOOTING

7.1 GENERAL

The Comm-Troller is constructed using modern integrated circuits soldered onto a printed circuit board. These components can be destroyed by improper soldering and handling procedures. Therefore maintenance and troubleshooting of the Comm-Troller module should be limited to verification of proper option selection, proper EPROM program installation, correct PLC configuration table entries and cable connectors. The Comm-Troller does not include any user-accessible troubleshooting and diagnostic aids other than the LED's described in Section 3.4 and below. If the Comm-Troller fails to function please contact a manufacturer's service representative for help.

7.2 STATUS LEDs

A good deal of information can be obtained by close observation of the flashing LEDs located on the front of the Comm-Troller. In normal operation the port 2 LEDs (DS3 and DS4) will blink in a very regular manner. DS4, the transmit LED will be on when the Comm-Troller is requesting a block of data from the PLC; DS3 will be on when the PLC responds with the requested data. During normal operation the Comm-Troller continuously polls each PLC for its data resulting in a very regular "cadence" of the blinking LEDs. If an error occurs, the Comm-Troller will attempt to write an error word back to the PLC resulting in discernable blip in the normal cadence. If communications fail entirely, the Comm-Troller will fall back to a mode where it will only attempt to communicate to the PLC once every minute. This mode ("dead PLC") will be indicated by the LEDs flashing briefly only once each minute as the Comm-Troller attempts to regain communication. A common error condition which occures when the Comm-Troller is first installed is an error in the configuration table information. When this occures, the Comm-Troller can never get to its normal scanning mode of operation and the regular cadence will not be observed. When power is cycled, the Comm-Troller attempts to read the configuration information from PLC A_{hex}. The transmit and receive LEDs will blink for each block of configuration data read. The first block read is the starting address of the configuration table as defined by the address selection switches on the Comm-Troller (see section 3.7 and in the appropriate Appendix for the communication protocol being implemented). Next the Comm-Troller will read the configuration table header, followed by the configuration table data. If an error is detected anywhere in this operation the initialization process is aborted and an error word will be written back to the PLC. After the error word is sent, the Comm-Troller immediately returns to the start of the initialization sequence and starts over again. This results in a very rapid blinking of the transmit and receive LEDs on the front of the Comm-Troller.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS

LED 1 or 5 will blink whenever information is received from the Host computer. If the incomming message is valid and contains the PLCs RTU address (as defined in the configuration table), the Comm-Troller will respond blinking LED 2 or 6 depending on the type of host protocol installed.

7.3 MAINTENANCE MANUAL

For advanced users, a complete maintenance manual is available which includes a complete description of the Comm-Troller hardware, Parts Lists and Schematics. Contact the manufactgurer for details on the Comm-Troller Maintenance Manual.

COPYRIGHT © 1988 MIILLE APPLIED RESEARCH CO., INC.
HOUSTON, TEXAS