ALLEN-BRADLEY

Users' Manual

PROVOX System Interface Module

(Cat. No. 1771-KX1)

Important User Information

Because of the variety of uses for this equipment and because of the differences between this solid state equipment and electromechanical equipment, the user of and those responsible for applying this equipment must satisfy themselves as to the acceptability of each application and use of the equipment. In no event will Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The illustrations, charts and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Allen-Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

No patent liability is assumed by Allen-Bradley Company with respect to use of information, circuits, equipment or software described in this text.

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Introduction

1.0 General

This manual describes the installation and operation of the PROVOX® System Interface Module (cat. no. 1771-KX1). This module, known as the KX1 module, provides an interface between the Allen-Bradley Data Highway and Fisher Controls' PROVOX system. This manual describes the KX1 module from the perspective of the Allen-Bradley Data Highway, where the KX1 interacts with other communication modules and programmable controllers.

1.1 Data Highway

The Allen-Bradley Data Highway is a multipoint communication network that provides a data transfer path for programmable controller (PC) processors and/or computers. The data highway trunkline may be up to 10,000 cable feet in length, with the communicating stations distributed anywhere along its length. This allows for flexible configuration and ease of expansion, where new stations may be added at the end of an existing trunkline or between existing stations.

The KX1 module can communicate with from 1 to 8 PC stations on the data highway. In effect, the KX1 module acts as a communication gateway between the PROVOX system and the Allen-Bradley Data Highway. It enables the PROVOX system to access certain memory locations within the PC stations. The KX1 module is a directional gateway because it enables the PROVOX system to send command messages to the Allen-Bradley Data Highway, but the data highway stations cannot send commands to the PROVOX system. Figure 1.1 shows a representative configuration of one KX1 module and eight PCs interfaced to the data highway.

The communicating stations are connected to the data highway by droplines, which may be up to 100 cable feet (30 meters) in length each. The trunkline and droplines are low cost, shielded twinaxial (one twisted pair) cable.

> **CAUTION:** Do not program any PC-to-PC communications on the Allen-Bradley Data Highway. Such data highway communications can cause timeouts and loss of data in communication on the KX1-to-PROVOX link.

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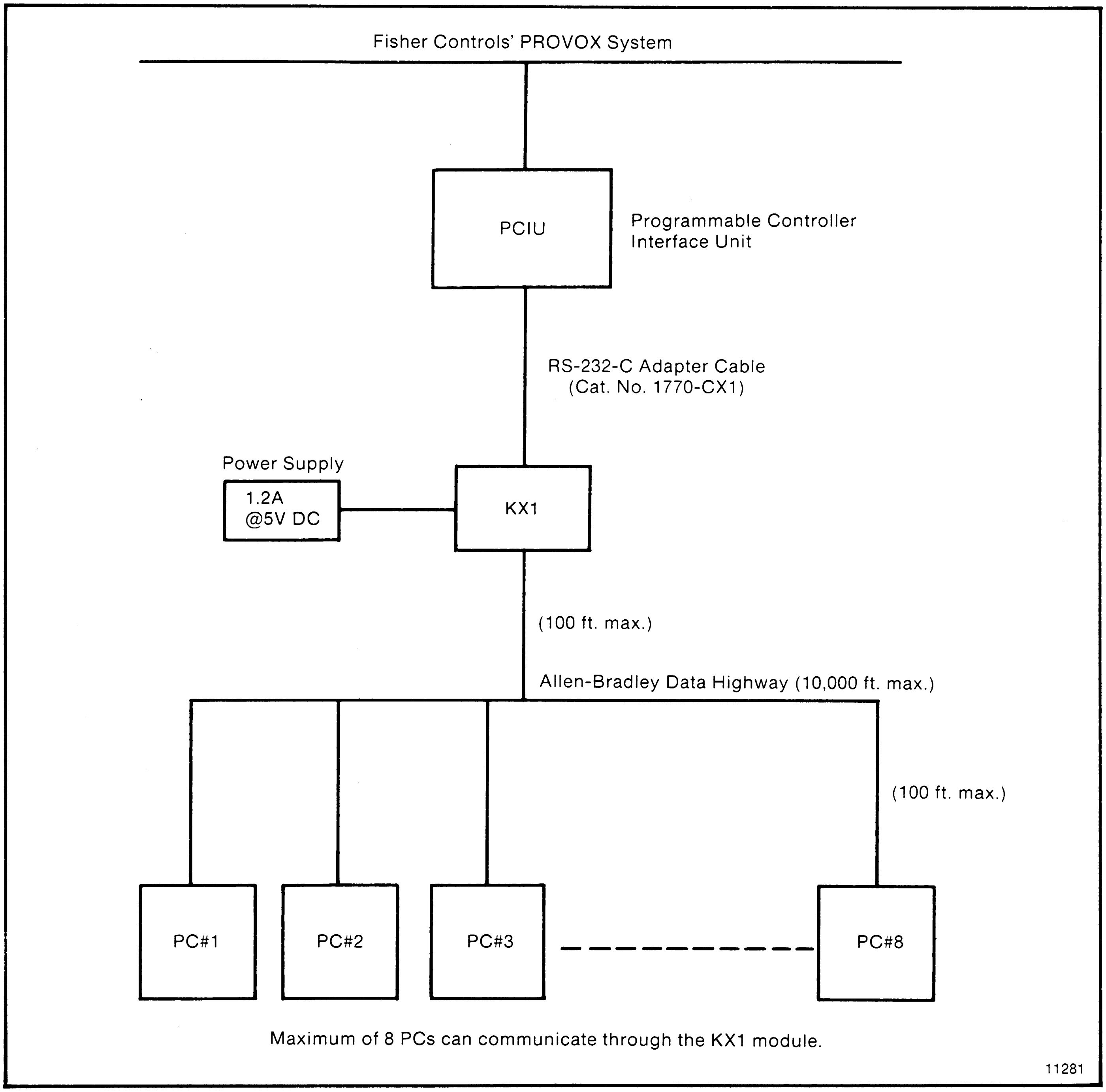


Figure 1.1 — Example Data Highway Configuration with KX1 Module

1.2 Communication Interface Modules

A data highway station consists of the appropriate communication module coupled to the PC processor device it is interfacing to the data highway. Some PCs can be linked to the data highway through modems. Each type of station device requires a particular communication interface module. For example:

Device	Interface Module
PLC-2 Family of PCs	Communication Adapter Module (cat. no. 1771-KA)
PLC Programmable Controller	Communication Adapter Module (cat. no. 1774-KA)

The KX1 module links the Allen-Bradley Data Highway to the PROVOX system manufactured by Fisher Controls. The comparable interface module in the PROVOX system is the Type DH6005 Programmable Controller Interface Unit (known as PCIU). The PCIU and the KX1 module can be combined to form either a single link (Figure 1.1) or a backup link (Figure 1.2) between the two data highway systems.

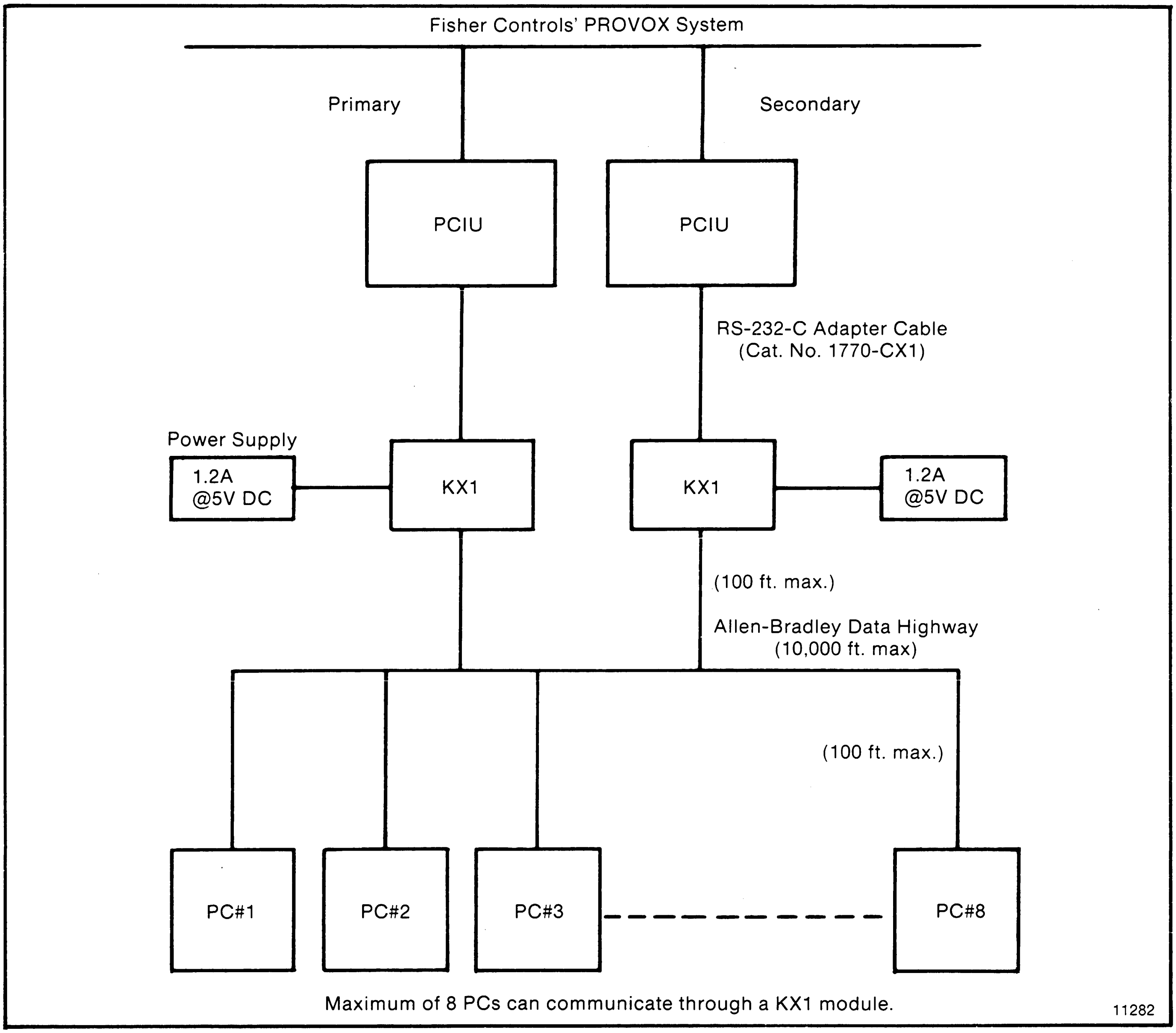


Figure 1.2 — Example of Backup Communication Link

1.3 Capabilities

The KX1 module enables the PCIU to access particular data highway stations to perform the following functions:

- Read up to 64 words of data from the data table memory of the PC stations
- Write a word of data into the data table memory of a PC station
- Modify an individual bit in the data table memory of a PC station

1.4 Module Specifications

Following are the specifications for the KX1 module.

Function

- Interfaces Allen-Bradley Data Highway with PCIU of Fisher Controls' PROVOX system

Location

- Standalone

Communication Channels

- To PCIU: RS-232-C
- To data highway: 15-pin

Communication Rate

- To PCIU: switch selectable, 110 to 19,200 bits per second
- To data highway: 57,600 bits per second (recommended)

Maximum Cable Length

- To PCIU: 50 feet (15 meters)
- To data highway: 100 feet (30 meters)
- Data highway trunkline: 10,000 feet (3048 meters)

Cable Type

- To PCIU: RS-232-C Adapter Cable (cat. no. 1770-CX1) or equivalent
- Data highway trunkline and dropline: Belden 9463 or equivalent cable and Dropline Connector Kit (cat. no. 1770-XG)

Power Requirement

- 1.2A @ 5V DC

Power Source

- User supplied (can be Allen-Bradley power supply, such as 1771-P2)

Enable Signal (User Power Supply)

- High: +3 to +5V DC
- Low: -0.2 to +0.6V DC

Ambient Temperature Rating

- Operating: 0° C to 60° C (32° F to 140° F)
- Storage: -40° C to 85° C (-40° F To 185° F)

Ambient Humidity Rating

- 5 to 95% without condensation

1.5 Related Publications

The following is a list of other publications related to the data highway.

Publication	Title and Catalog Number
1770-810	Data Highway Cable Assembly and Installation Manual.
1771-801	Communication Adapter Module Cat. No. 1771-KA User's Manual (for PLC-2 Family Processor).
1771-802	Communication Controller Module Cat. No. 1771-KC/KD User's Manual (for computers).
1771-811	PLC-2 Family/RS-232-C Interface Module Cat. No. 1771-KG User's Manual (for PLC-2 Family Processor).
1774-819	Communication Adapter Module Cat. No. 1774-KA User's Manual (for PLC Processor).

Chapter

2

Operation

2.0 General

All messages sent from the PCIU for transmission on the data highway must conform to the communication protocol detailed in Chapter 5 of this manual. Only messages conforming to that format will be acknowledged by the KX1 module.

Once a message transmitted from the PCIU is accepted by the KX1 module, the module buffers the message until it receives mastership and is able to transmit it on the data highway. The module also buffers reply messages from the PC stations on the data highway for transmission to the PCIU.

As with other Allen-Bradley communication interface modules, the KX1 module has the following features for transmission on the data highway.

- Retries of unacknowledged messages
- Acknowledgment of received messages
- Error checking of received messages
- Automatic disconnect of faulted station without disabling the remaining stations on the data highway

2.1 Data Highway Messages

There are two types of messages that are transmitted over the data highway, as follows.

- Command messages
- Reply messages

2.1.1 Command Messages

Command messages are used to request execution of a particular function by the message destination station. Commands issued by a PCIU can access only specified areas in the data table memory of the PC processors on the data highway; there are no PCIU commands that have access to PC program memory.

The commands that the PCIU may send to the KX1 module are:

- Word Read - reads 1 to 64 words of data from PC data table memory and a status word from the PC processor
- Word Write - writes one word of data into PC data table memory
- Bit Write - modifies the state of a single bit in PC data table memory

CAUTION: Do not program PC-to-PC communications on a data highway that is linked to a PCIU through a KX1 module. In such cases, PC-to-PC communications can cause delays in transmitting data to or from the PCIU.

2.1.2 Reply Messages

For most commands issued by the PCIU, the KX1 module will wait for a reply message from the destination PC station. There are two types of reply messages:

- Normal replies
- Exception replies

A normal reply indicates that the command has been executed successfully, while an exception reply returns an error code that indicates why the command failed.

2.1.3 Message Priority Level

Command messages are ranked according to their transmission priority, as follows:

- Priority
- Normal

All priority messages are transmitted and processed before normal messages.

Switch settings on the KX1 module determine whether the module will transmit normal or priority commands to the data highway (refer to section 3.3.1). A reply message is automatically given the same priority ranking as its corresponding command.

NOTE: For communication between the KX1 module and the PCIU, normal command messages are recommended.

2.1.4 Command Access Level

Commands sent from the PCIU to the KX1 module can access different areas of PC memory, depending on the type of command sent. The word-read command is called an unprotected command because it can access any area of PC data table memory. The word-write and bit-write commands are called protected commands because they can access only limited areas of PC data table memory defined by memory access rungs in the PC program. For an explanation of how to use memory access rungs, refer to the appropriate Communication Adapter Module User's Manual (publication 1771-801 or 1774-819).

2.2 Floating Master

The KX1 module shares control of the data highway with the other communication modules. It does this through the floating master feature, whereby each station bids for mastership based on its need to send messages. The transfer of mastership among stations is done in an orderly polling process.

The polling process and transfer of mastership is conducted automatically by the communication modules and is transparent to the user. It may, however, be helpful to understand the general procedure. When a station acquires mastership and, therefore, becomes the current master, it sends all command and reply messages stored in its output buffer. User-determined priority messages are sent first. After the current master station has sent 16 messages (or all of its messages, if fewer than 16), it conducts a polling sequence to determine which station will be the next data highway master.

If the current master receives a response to its polling sequence, it transfers mastership to the responding station. If the current master does not receive a response to its poll, it continues to transmit another 16 messages followed again by the polling sequence.

The most important point to remember here is that a PC station must acquire mastership of the data highway before it can transmit its reply to a PCIU command. Therefore, you should not program any PC-to-PC communication because such communication could slow transfer of mastership when a station needs to reply to a PCIU command.

2.2.1 Priority Message Polling

The first poll of the polling sequence executed by the current master is a priority poll, conducted to identify a station that is ready to transmit a priority command or reply message. The priority poll is directed to all other stations and is responded to by any station with a priority message to send. If a response is received by the current master, the master uses a descending binary search (which reduces the polled group size by half) to locate the station with a priority message ready, and transfers mastership to that station.

If no response is received from the first priority poll, the current master begins a normal poll by locating any station with normal messages to transmit.

2.2.2 Normal Message Polling

In normal message polling, the current master station first polls only the next higher station address. If a station with that address responds, mastership is transferred to it. If there is no response from that address, the current master conducts an ascending binary search. In this method the next 3 higher addresses are polled, then the next 7 addresses, then the next 15, then the next 31, and finally all addresses in a global poll.

When a response is received during any polling sequence, the current master performs a descending binary search on the last group polled. This is done by dividing the polled group in half until the responding station is located.

When more than one station responds to one of the polls in the sequence, the current master detects only one response and will proceed as described above. Because of the way in which addresses are grouped during the descending binary search, the responding station with the lowest station address greater than the current master's will be selected as the next master.

If no response is received during the entire polling sequence, the current master will conduct repeated global polls, where all addresses are polled until a response is received. This is done after a priority poll and after no response is received to the normal ascending poll.

2.3 Faulted Master Disconnect

The interface module monitors all transmissions on the data highway in order to detect a faulted current master station that is preventing normal floating master operation. If a faulted operation is detected, the module momentarily de-energizes a reed relay on board and disconnects itself from the data highway to check its transmitting circuitry. If it has faulted, the module will remain disconnected from the data highway; if it has not faulted, the module will energize its reed relay and reconnect with the data highway and resume normal communications.

If the current master becomes disconnected from the data highway for any reason, timers in the other communication modules are enabled. The first station to time-out will become the new master. Because the preset for these timers is calculated in part using the station address, the station with the lowest address will time-out first.

The faulted or disconnected communication module will be identified through message error detection when an attempt is made to transmit a message to or from the faulted station.

2.4 Message Error Detection

To help assure transmission integrity, the KX1 module performs error checks on all messages it receives, both from the PCIU and from another data highway station.

On the data highway, messages with errors are automatically retransmitted by the initiating station. If retries are unsuccessful in completing communications, a fault flag bit is set to indicate why the error occurred. The status of the fault bits is contained in the reply message and, therefore, may be easily monitored by the processing unit to signal the faulted condition.

On the PCIU link, error detection is handled as described in Chapter 5.

2.5 Backup Configurations

Only one KX1 module is needed to interface a PCIU with 8 PCs on the data highway. However, in some applications, it might be desirable to provide backup communication channels between the PROVOX system and the Allen-Bradley Data Highway, as shown in Figure 1.2.

Module option switches (section 3.3.1) designate one of the KX1 modules as primary and the other as secondary. During normal operation, the secondary KX1 module remains dormant. If the primary KX1 module becomes disabled for any reason, the secondary module can be used as a substitute.

Station numbers for the primary and secondary KX1 modules must be set as described in section 3.3.2. In addition, the PROVOX system must be programmed to function properly in backup configurations.

Chapter 3

Description

3.0 General

The KX1 interface module is the intermediary for all command and reply messages transmitted between the data highway and the PROVOX system. In that capacity it operates through two different communication channels: one to the PCIU and one to the data highway. (Refer to Figure 3.1.)

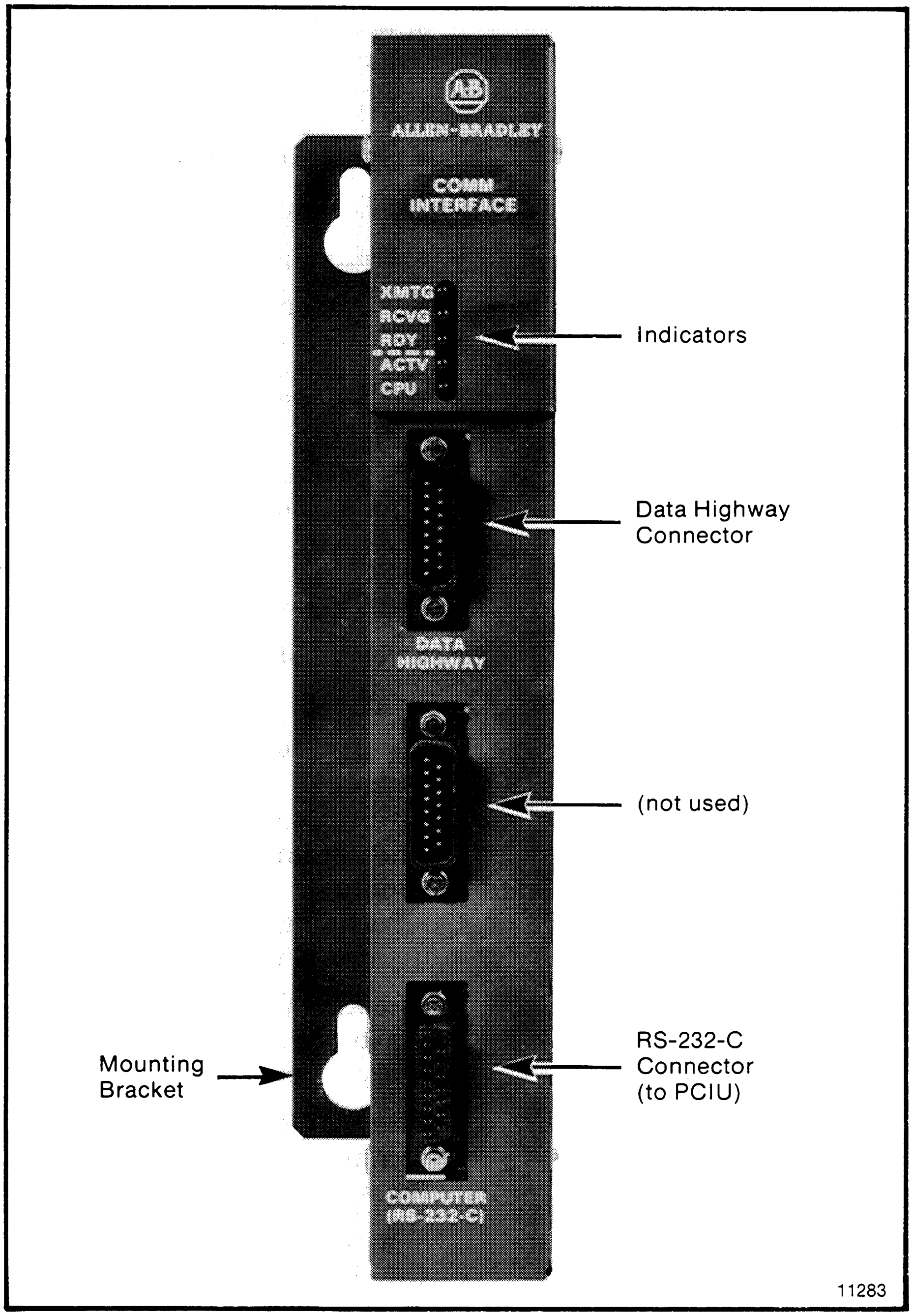


Figure 3.1 — Front View of KX1 Module

3.1 Communication Channels

The transmission channel between the KX1 module and the PCIU is RS-232-C compatible. This link has the following features.

- Differential, isolated (optoelectronic coupled) transmission
- Asynchronous serial data transmission
- Switch-selectable baud rate
- Full duplex
- Byte-oriented protocol

Transmissions between the module and other data highway stations take place over the data highway's single twinaxial cable. This link has the following features.

- Differential, transformer-isolated transmission
- Synchronous serial data transmission
- 57,600 baud rate
- Half-duplex
- Bit-oriented protocol

3.2 Indicators

Refer to Figure 3.1. The KX1 module has five LED status indicators located on its top front edge. The indicators are designed to aid the user in diagnosing transmission faults or errors. These indicators are as follows.

- XMTG - Transmitting
- RCVG - Receiving
- RDY - Message ready
- ACTV - PCIU link active
- CPU - PCIU communication error

3.2.1 Data Highway Link Indicators

The top three LED's (Figure 3.1) are normally off. An on condition, for any one of them, signals that the indicated situation exists for transmissions with the data highway, as defined below.

The XMTG light on indicates that this station is the current master of the data highway and is transmitting a command or reply message over the data highway.

The RCVG light on indicates that this station is receiving a command or reply message from the current data highway master.

When the XMTG and RCVG lights are both on, this station is the current master and is in the process of polling the other stations in order to transfer mastership as needed.

The RDY light on indicates that the module has one or more messages stored in its memory and is ready to accept mastership to transmit them.

3.2.2 PCIU Link Indicators

The bottom two LED indicators (Figure 3.1) give the status of the communication link to the PCIU.

The ACTV light is normally on (and there is a negative DC voltage on pin 3, received-data pin of PCIU socket on front panel), indicating that the cable between the KX1 module and the PCIU is properly connected and able to transmit messages. When this light flickers it indicates the cable is properly connected and transmission across the link is in progress.

The CPU light is normally off. It will blink once every 0.5 second whenever one of the following error conditions exists:

- All of the switches in switch group SW-4 are off.
- The station number switches (SW-2 and SW-3) are set to an invalid station number. Valid station numbers are 010 to 360 for a primary KX1 module and 010 to 350 for a backup KX1 module.

The CPU light will remain on at power-up if the power enable signal switches are not set correctly (see section 4.2.2).

3.3 Switches

Refer to Figure 3.2. The KX1 module has a number of options which are user-selected by setting rocker switches on the module circuit board. The switches are divided into five groups to select one of the following.

- Communication options (SW-1)
- Station number (SW-2 and SW-3)
- Number of PC stations (SW-4)
- Data highway baud rate (SW-5)
- PCIU link baud rate and parity (SW-6)

The option switches are easily accessed through the small, switch cover plate on the side of the module.

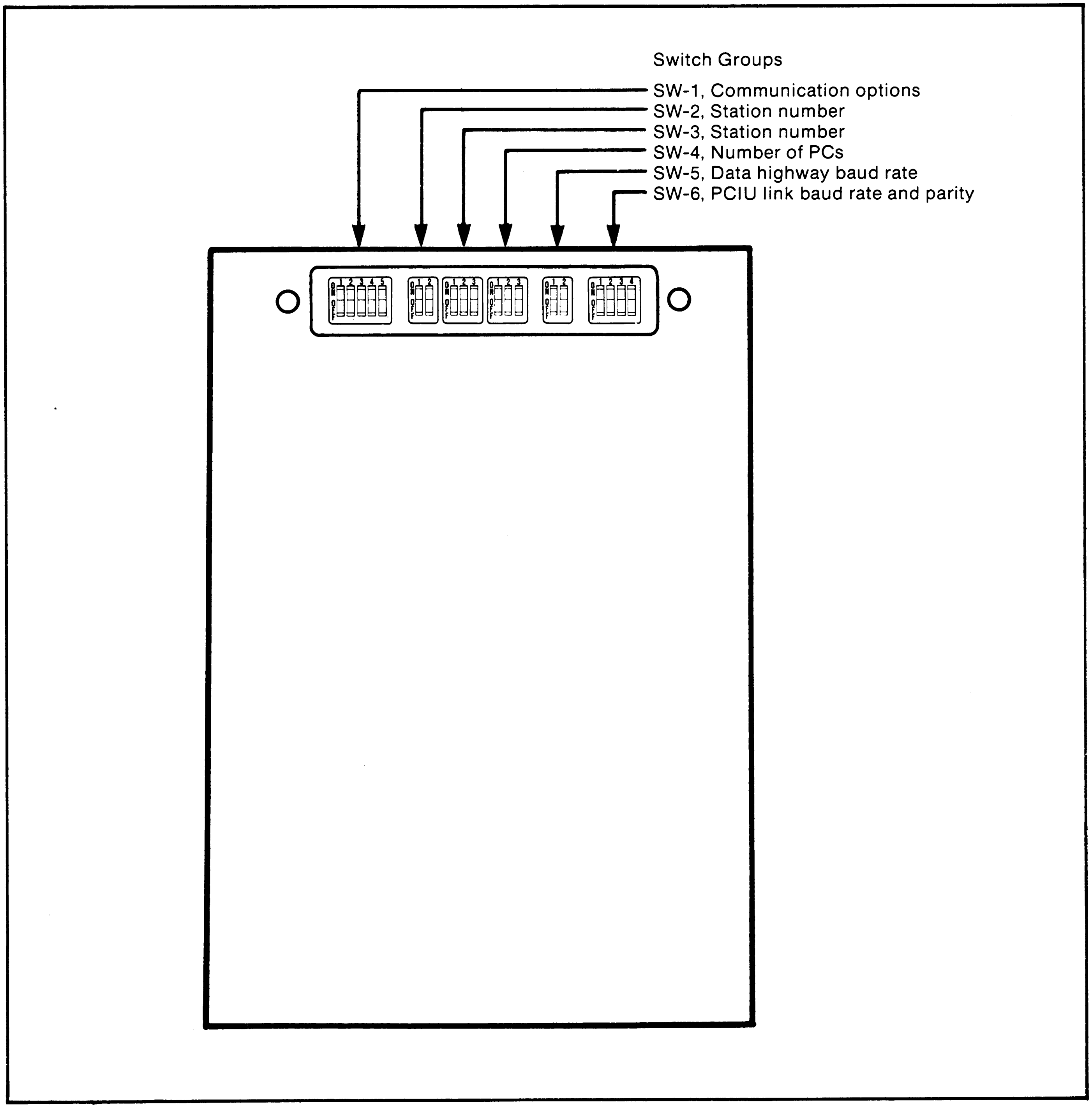


Figure 3.2 — Option Switches

NOTE: The depressed side of a rocker switch indicates its on-off state, as shown in Figure 3.3.

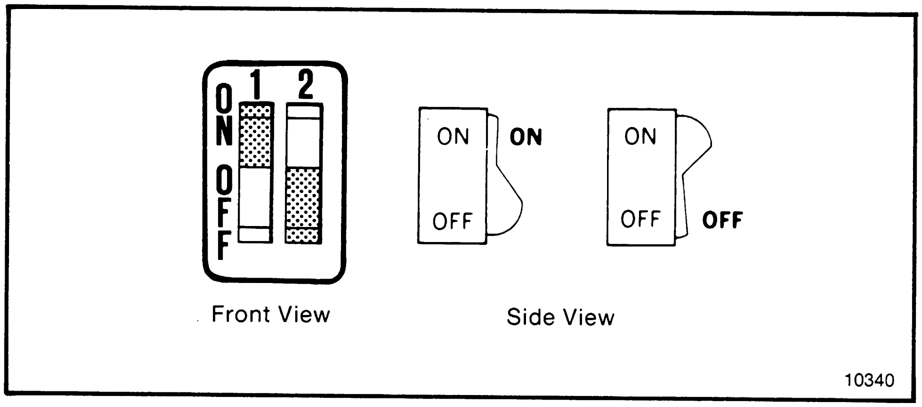


Figure 3.3 — Rocker Switch On/Off Setting

3.3.1 Communication Options

Refer to Figure 3.4. The switch assembly labeled SW-1 on the module circuit board allows the user to select several options for transmission to and from the module. The switches are numbered left to right as follows.

1. Not used, but must be off
2. Not used, but must be off
3. Priority message
4. Backup interface
5. Not used, but must be off

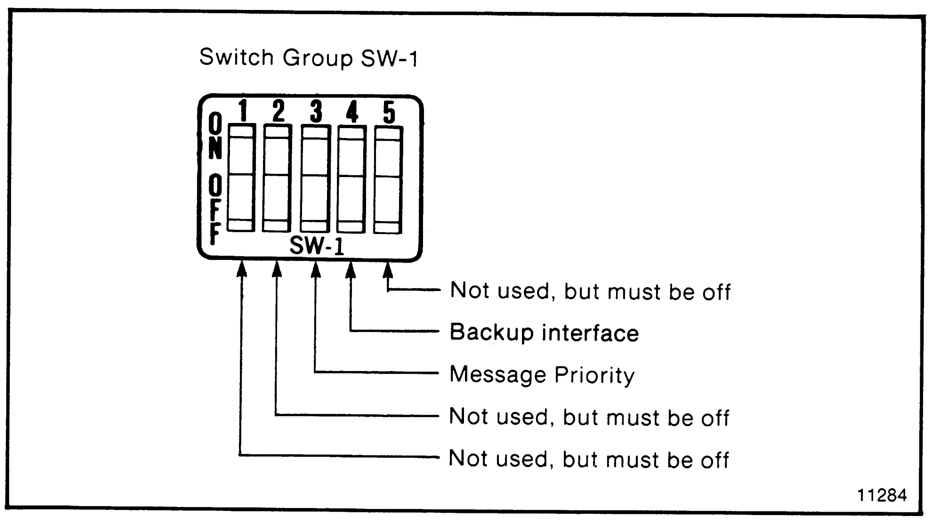


Figure 3.4 — Communication Options Switches

Switch 3 selects the priority ranking for all commands sent from the PCIU to the data highway stations (refer to section 2.1.3). If switch 3 is on, all PCIU commands will be transmitted as priority messages; if this switch is off, the commands will be transmitted as normal messages. For PCIU communications, it is recommended that switch 3 always be off.

Switch 4 applies to backup configurations (refer to section 2.5). If switch 4 is on, the KX1 module serves as a secondary interface; if the switch is off, the KX1 module is the primary interface to the PROVOX system.

3.3.2 Station Number

Two switch groups, SW-2 and SW-3, are used to select the station identification number that the KX1 module will have on the data highway. The station number is used in data highway protocol to identify the source and destination station for messages, and in the polling sequence for floating master transfer.

The station number is a 3-digit binary coded octal number. Switches SW-2 set the first (most significant, or left-most) digit of the station number, and SW-3 sets the second digit. The last (least significant, or right-most) digit of the KX1 station number is always 0 (zero). Figure 3.5 shows an example of how to set the KX1 station number to 150 octal.

Valid station numbers for the KX1 module are 010 to 360 octal, in increments of 10 octal. Thus, valid KX1 station numbers are 010, 020, 030, etc.

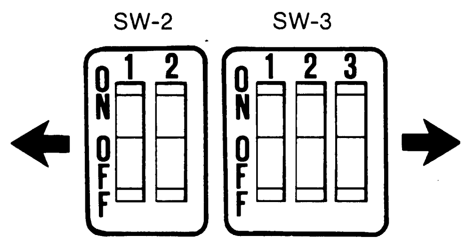
Commands from the PCIU to the KX1 module can address a maximum of 8 PC stations on the data highway. These stations must have station numbers set according to a particular pattern, which is as follows: the PC stations must be numbered in sequence, beginning with the KX1 station number as the base. For example, if the KX1 station number is set to 150 octal, then the PC station numbers must be set to 151, 152, 153, and so on, up to 160 octal if 8 PC stations are included in the communication link. Stations with other numbers may exist on this same data highway, but this KX1 module could not communicate with them.

In a backup configuration, the secondary KX1 module must be set to a station number that is 10 (octal) lower than the station number of the primary KX1. Thus, a backup KX1 module in the above example would have to have its station number set to 140 octal.

For information on how the station numbers are used in the polling process, refer to section 2.2. For information on how to set the station numbers for PC interface modules, refer to the appropriate user's manuals for those modules (publication 1771-801 or 1774-819).

Switch Setting		Digit
No. 1	No. 2	
OFF	OFF	0
OFF	ON	1
ON	OFF	2
ON	ON	3

First digit of station number



Switch Setting			Digit
No. 1	No. 2	No. 3	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON	ON	OFF	6
ON	ON	OFF	7

Second digit of station number

Example: Setting station number 150 (octal) for KX1 module

Switch Group	SW-2		SW-3			none
Station Number Digits	1		5			0
Switch Number	1	2	1	2	3	Always 0 (zero) for KX1 module
Switch Setting	OFF	ON	ON	OFF	ON	

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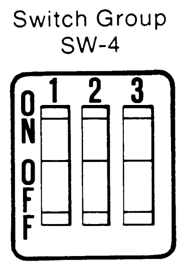
Figure 3.5 — Station Number Switch Settings

3.3.3 Number of PCs

For communication between the PROVOX system and the data highway, the PCIU can send commands to as many as 8 PC stations through the KX1 module. Switch group SW-4 indicates the number of PC stations communicating through the KX1 module. Figure 3.6 shows how to set these switches.



Switch Setting			Number of PCs on Data Highway
1	2	3	
OFF	OFF	OFF	illegal
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	4
ON	OFF	OFF	8
ON	OFF	ON	not used
ON	ON	OFF	not used
ON	ON	ON	not used

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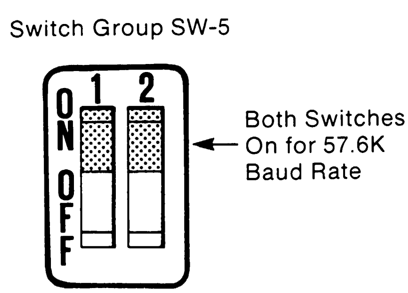
Figure 3.6 — Switch Settings for Number of PC Stations on Data Highway

3.3.4 Data Highway Baud Rate

Switch assembly SW-5 allows the user to select the rate of transmission across the data highway. Figure 3.7 shows the switch settings for the recommended rate of 57,600 baud.

NOTE: At this time 57,600 baud is the only recommended rate.

All communication modules must be set to the same data highway baud rate. Usually, the modules are shipped from the factory with the switches set for 57,600 baud. The user should verify that the switches are set for this rate.



Baud Rate	Switch Number	
	1	2
38,400	OFF	ON
57,600 [1]	ON	ON
76,800	ON	OFF
115,200	OFF	OFF

[1] Recommended

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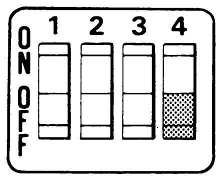
Figure 3.7 — Data Highway Baud Rate Switch Settings

3.3.5 PCIU Link Options

Switch group SW-6 sets communication options for the link between the PCIU and the KX1 module. Switches 1, 2, and 3 of this group set the communication rate for the PCIU link. Figure 3.8 shows the settings for these switches.

NOTE: Switch 4 of this group must always be set to the off position.

Switch Group SW-6



RS-232-C Port (PCIU Link) Baud Rate

Baud Rate	Switch Setting		
	1	2	3
110	OFF	OFF	OFF
300	ON	OFF	OFF
600	OFF	ON	OFF
1,200	ON	ON	OFF
2,400	OFF	OFF	ON
4,800	ON	OFF	ON
9,600	OFF	ON	ON
19,200	ON	ON	ON

RS-232-C Port (PCIU Link) Parity

Parity	Switch Setting for Switch 4
even	ON
no	OFF

NOTE: For the current implementation of the KX1 module, switch 4 should always be OFF.

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Figure 3.8 — Switch Settings for PCIU Link Baud and Parity

Chapter

4

Installation

4.0 General

The installation instructions given in this section assume prior construction of the data highway trunkline and station droplines according to the instructions given in publication 1770-810, Data Highway Cable Assembly and Installation Manual. Also, the module's option switches should be set, as desired, according to the information given in section 3.3 of this manual.

After the above procedures have been completed, installing the KX1 module and connecting it to the data highway consists of three steps, as follows.

1. Selecting module location
2. Connecting data highway dropline to module
3. Connecting module to PCIU

Refer to Table 4.A for a list of cables and cabling parts. Items on this list are not included with the module and must be ordered separately.

Table 4.A
Cabling and Connectors

Product	Allen-Bradley Catalog Number	Components	Manufacturer	Manufacturer Part Number
Twinaxial Cable	1770-CD	Trunkline and dropline cable	Belden 1	9463
Connector Kit	1770-XG	Tee connector Jack connector Plug connector 15-pin female connector and hood	Trompeter 2 Trompeter 2 Trompeter 2 Cannon 3	BN73 BJ79-9 PL75-9 DA-15S DA-51211-1
Terminator Set (one set per data highway)	1770-XF	Jack terminator Plug terminator	Trompeter 2 Trompeter 2	3005-0404-1-150 TNGI-1-150
RS-232-C Adapter Cable	1770-CX1	Null modem cable (16.5 feet long), connects to PCIU	Allen-Bradley	

1 Belden Corporation
P.O. Box 1331
Richmond, Indiana
47374

2 Trompeter Electronics
8936 Comanche Avenue
Chatsworth, California
91311

3 ITT Canon Electric
A Division of International
Telephone and Telegraph
666 East Dyer Road
Santa Ana, California 92702

4.1 Location

The KX1 module must be located within 50 feet of the RS-232-C port of the PCIU. The module has a bracket attached to its rear edge to allow for user-selected mounting in any appropriate industrial enclosure (NEMA type 12, or similar). Mounting dimensions are given in Figure 4.1.

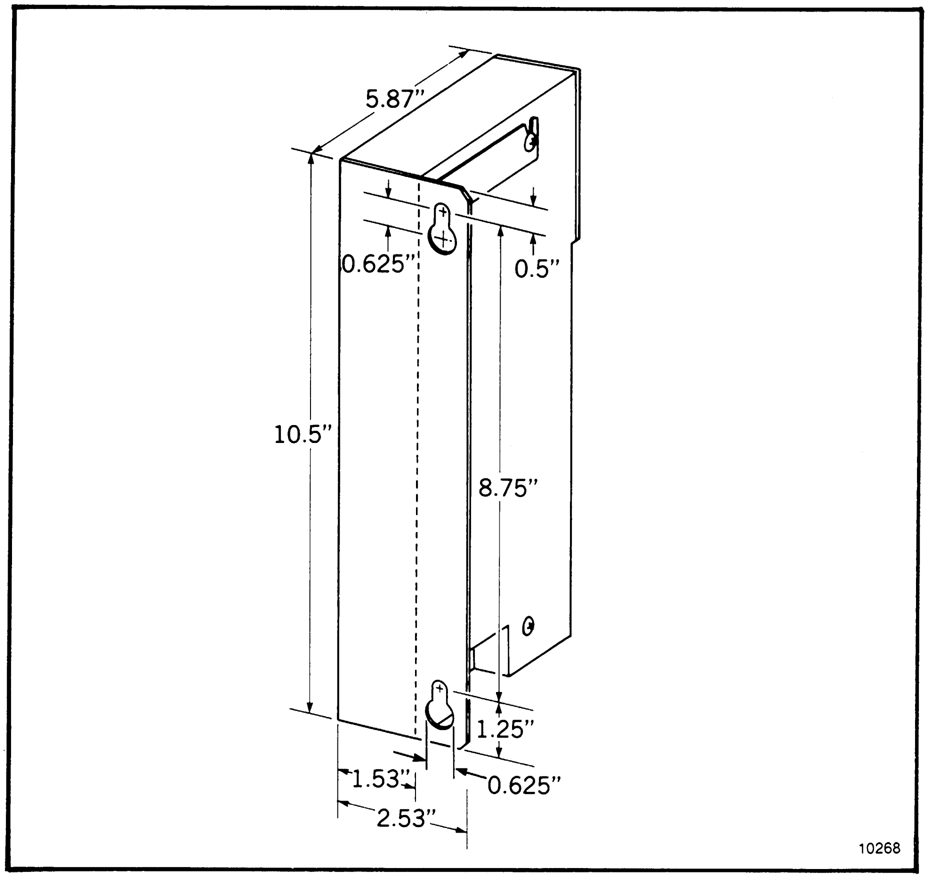


Figure 4.1 — Module Mounting Dimensions

4.2 Power Supply Connection

You must provide the +5V DC power necessary to drive the KX1 module. This can be an Allen-Bradley power supply, such as the cat. no. 1771-P2, or other. The electrical connections are made to an easily accessible terminal strip on the side of the module. (Refer to Figure 4.2.) Allen-Bradley Module Power Cable (cat. no. 1770-CF) can be used for this purpose.

The 0-Volt lead of the power supply must be connected to the first terminal from the left on the module (Figure 4.2). (On some power supplies the 0-volt lead is called ground.) The +5V DC lead of the power supply must be connected to the third terminal from the left on the module.

The right-most terminal on the module is for earth ground. A connection should be made from the terminal either directly to an earth ground or, if the module's enclosure is already connected to earth ground, through a ground bus to the enclosure.

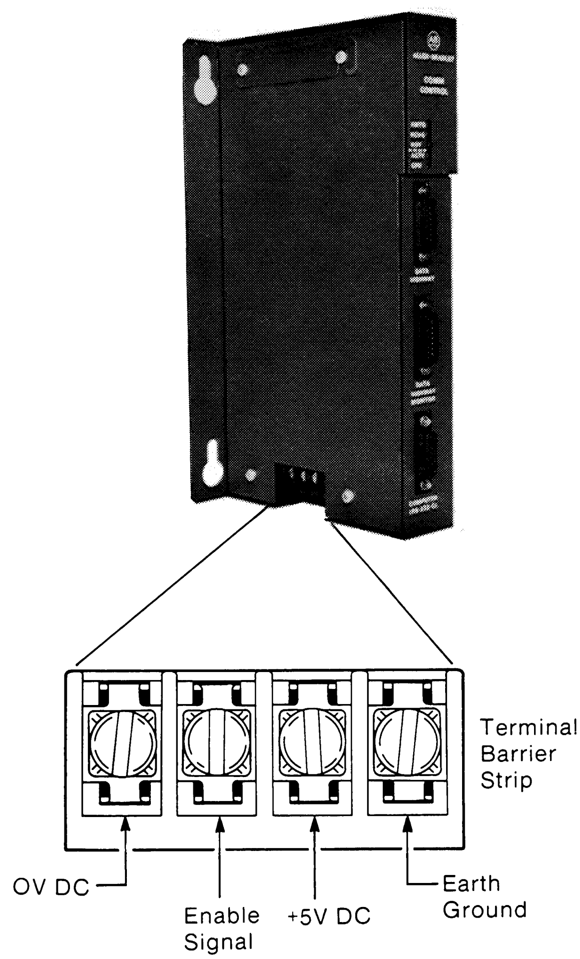


Figure 4.2 — Power Supply Connection

4.2.1 Enable Signal Connection

The second terminal from the left on the module barrier strip is for connection to an enable signal line (see Figure 4.2.). Some DC power supplies generate an enable signal that can be used to detect changes in the state of the output power. If the power supply connected to the KX1 module has a lead for such an enable signal, the user should connect this lead to the second terminal from the left on the terminal strip of the module.

Some power supplies, including most Allen-Bradley power supplies (Table 4.B), use a low-true enable signal to indicate when output power is enabled. Other types of power supplies use a high-true enable signal for this function. In order for the module to interpret this signal properly, a special switch assembly, called the power supply enable signal switch assembly, is provided on the module circuit board (Figure 4.3).

Table 4.B

Allen-Bradley Power Supplies Suitable for Use with KX1 Module

Allen-Bradley Catalog No.	Enable Signal Lo True	Enable Signal Hi True
1771-P1	X	
1771-P2	X	
1772-P1	X	
1774-P1	X	
1777-P2	X	
1778-P2		X

This switch assembly contains two switches. If the enable signal from the power supply is the high-true type (that is, if the signal goes high when output power from the supply is enabled), then the user must set switch number 1 of this switch assembly to the OFF position and set switch number 2 to the ON position. If the enable signal from the power supply is the low-true type (that is, if the signal goes low when output power from the supply is enabled), then the user must set switch number 1 of this switch assembly to the ON position and switch number 2 to the OFF position (refer to Figure 4.3).

If the power supply has no facility for generating an enable signal or if the user does not want to use the enable signal, then both switches of the power supply enable signal switch assembly should be set to the OFF position. In this case, no connection will be made to the second terminal from the left on the terminal strip of the module.

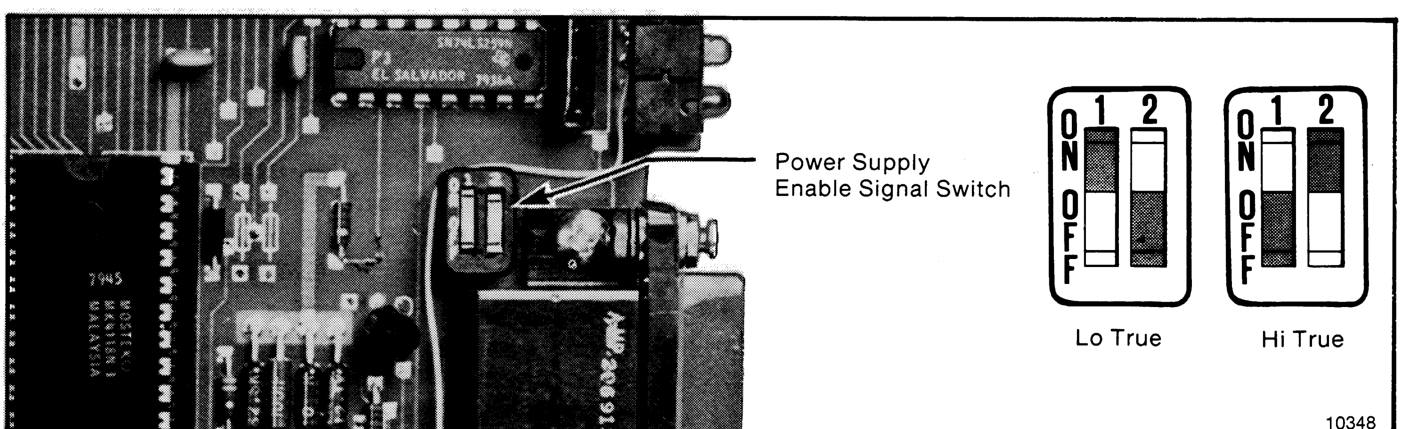


Figure 4.3 — Power Supply Enable Signal Switch

4.2.2 Setting Enable Signal Switches

If necessary, the setting of the power supply enable switches can be modified as follows. The user should verify proper setting of these switches.

Step 1 — Refer to Figure 4.4 and lay the module down so the metal cover plate containing the white identification sticker is face down and the front edge of the module is to the user's right as he faces the module.

Step 2 — Remove the four phillips screws from the corners of the metal cover plate that is now facing up.

Step 3 — Carefully lift the metal cover plate off the module in order to expose the printed circuit board.

Step 4 — Locate the power supply enable signal switch assembly on the module circuit board. This switch assembly is situated on the right side of the circuit board, between the indicator LED's and the DATA HIGHWAY connector.

Step 5 — Set the switches on this switch assembly to the desired positions.

> **CAUTION:** Never set switches 1 and 2 both on. Doing so will disable the interface module.

Step 6 — After setting the switches, replace the metal cover plate.

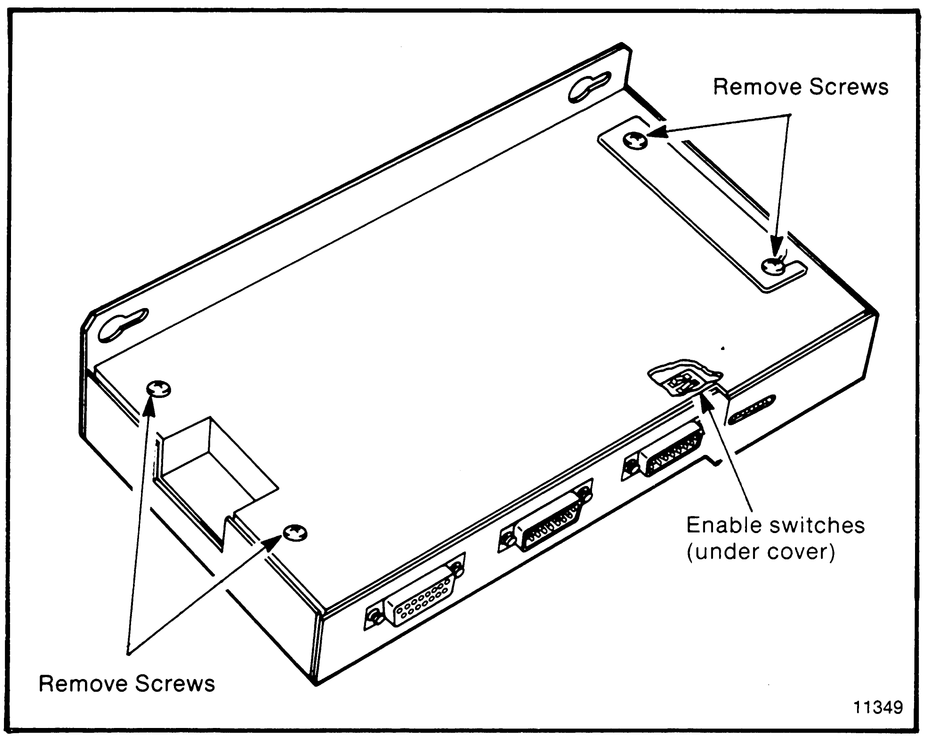


Figure 4.4 — Removing Module Cover

4.3 Dropline

The user-assembled station dropline may be up to 100 cable feet in length (50 feet minimum). One end of the dropline should be connected to the data highway trunkline through a tee-connector as detailed in publication 1770-810. The other end of the dropline has a 15-pin connector, which should be inserted into the DATA HIGHWAY connector on the module (Figure 4.5). Connector Kit 1770-XG provides the proper connectors for constructing the dropline.

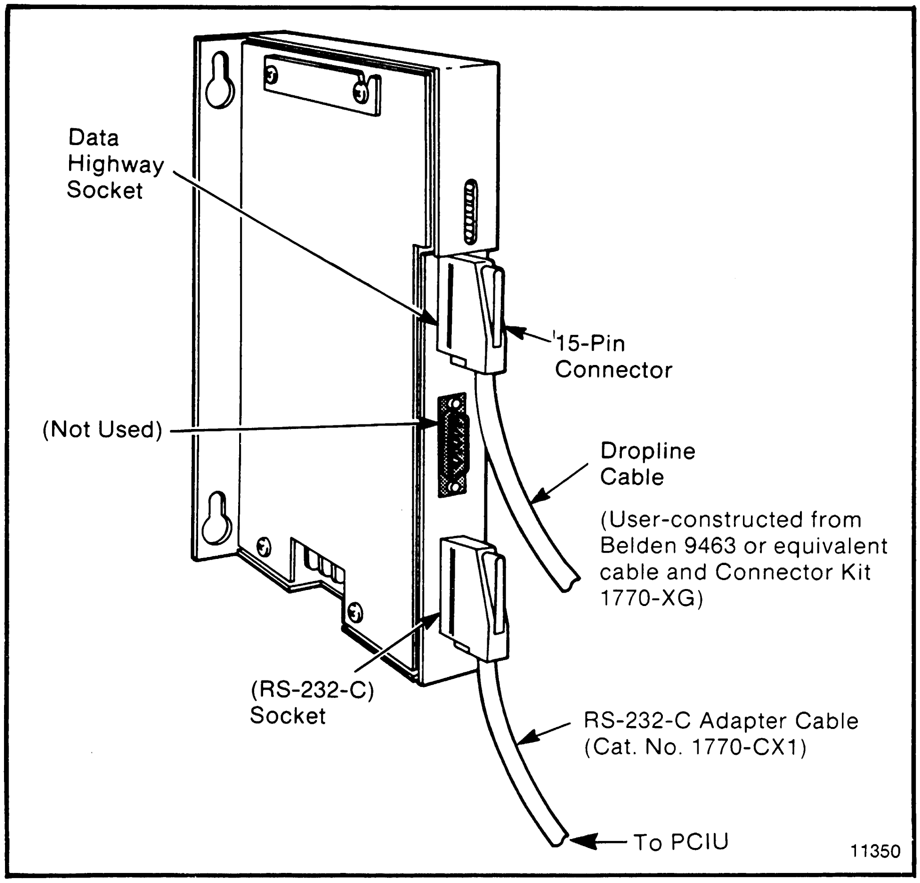


Figure 4.5 — Cable Connections

4.4 RS-232-C Adapter Cable

The RS-232-C Adapter Cable (cat. no. 1770-CX1) is 16.5 feet long, with a 15-pin male connector at one end and an RS-232-C compatible 25-pin connector at the other end. This null modem cable is configured to accommodate an RS-232-C device. The 15-pin connector of the cable should be inserted into the RS-232-C connector (Figure 4.5) on the module. The 25-pin connector should be connected to the RS-232-C interface of the PCIU. Figure 4.6 shows the wiring the adapter cable.

NOTE: The middle connector on the front of the module is presently reserved for future product use. Connections should not be made at this connector.

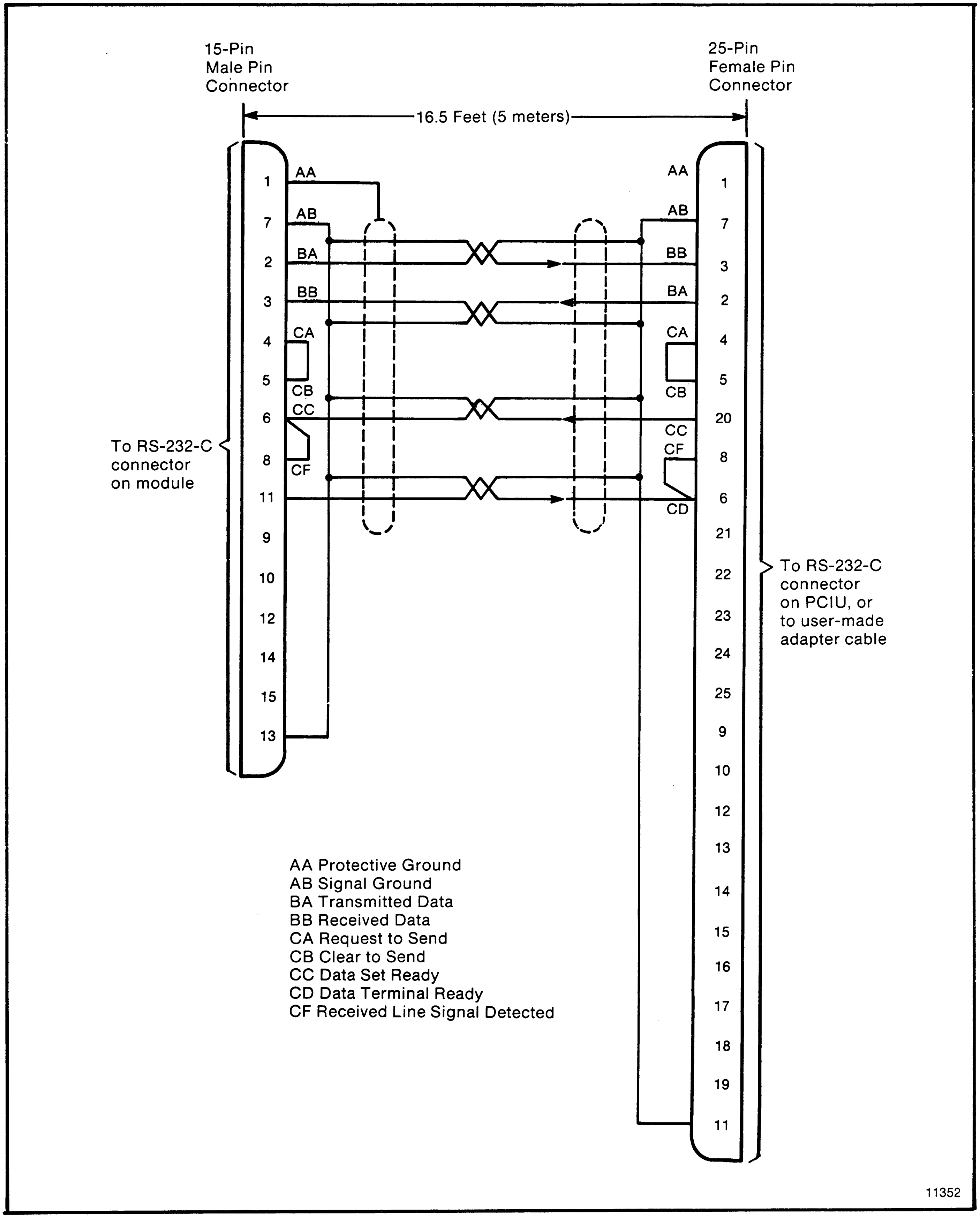


Figure 4.6 — RS-232-C Adapter Cable (Cat. No. 1770-CX1)

Chapter

5

Communication Protocol

5.0 General

As an interface module, the KX1 receives command messages from the PCIU and translates these messages into a format compatible with Allen-Bradley Data Highway communication. This section describes the communications protocol and message formats for transmissions between the PCIU and the KX1 module.

The PCIU link is a serial transmission link following RS-232-C conventions. Some characteristics of the PCIU protocol include:

- Serial processing of messages
- RTU mode of data transmission
- Error checking of messages received
- Exception responses

5.1 Message Transmission

The relationship between the PCIU and the data highway is always a master-slave relationship, whereby the PCIU is always the master unit that initiates a command message and the KX1 module—as the gateway to the data highway — is a slave unit that provides responses to the PCIU commands. The KX1 module never initiates a command to the PCIU.

The complete communication cycle between KX1 and PCIU consists of a command message and its corresponding response message. There is no acknowledgment (ACK or NAK) of messages on this KX1-to-PCIU link.

The command/response sequence on the KX1-to-PCIU link takes place as an integral cycle in serial fashion. This means that once a PCIU sends a command, it waits for up to a pre-determined time to get a response before attempting to send another command. The PCIU times out if it fails to get a response. This sequence is known as a transaction cycle on the KX1-to-PCIU link.

For its part, the KX1 module begins the transaction cycle upon receiving a valid command from the PCIU and terminates the cycle when it forwards a reply to the PCIU or when it performs a timeout of an expected reply from a data highway PC station. The KX1 module accepts commands from the PCIU only when a previous transaction cycle has completed; that is, when no response to a previous command is pending.

There is one situation where a complete command/response cycle does not apply. It involves a transmission error detected by the KX1 module in a command message. This results in no response being returned, forcing the PCIU to timeout.

> **CAUTION:** Do not program any PC-to-PC communications on the data highway. Such communications can cause an excessive number of timeouts and loss of data to occur on the KX1-to-PCIU link.

Refer to Appendix A for an illustration of various message flows.

5.1.1 Message Framing

Messages on the PCIU link are transmitted on an RS-232-C interface in so-called RTU mode, which consists of a byte stream of 8-bit binary values. A byte frame in RTU is composed of a start bit, eight data bits, a parity bit (if used), and two stop bits. In a message stream, each byte of data is immediately followed by another byte with no 'dead' time in between. A break in this stream marks the end of a message. To determine the end of a message, the KX1 module monitors the elapsed time between each byte received. When this elapsed time reaches a byte transmission count of three at the current baud rate, the end of message is assumed. The next byte that is received is interpreted as the first byte of the next message frame.

5.1.2 Message Acceptance

The KX1 module determines whether to process a message received from the PCIU based on two levels of criteria:

- Integrity of the transmission
- Relevant PC destination station number

The KX1 module simply ignores a message that fails these acceptance tests: no response is provided.

Regarding transmission integrity, the KX1 module monitors for certain character errors and for message framing errors. If a character error is detected, such as a character overrun, the message frame is not rejected immediately, but all the characters up to 'end of frame' are read in. Once a complete message has been received and no character errors have been found, the KX1 module proceeds to test for "frame check errors". This is accomplished by subjecting the received message bytes to the same algorithm used by the PCIU in preparing the message. RTU mode uses the CRC-16 (cyclical redundancy count) algorithm that computes a check-count by processing every byte in the message against the CRC polynomial (X**16 + X**15 + X**2 + 1). The last two bytes of the message contain the CRC count computed by the PCIU. If the KX1 module obtains a value of zero by applying this same CRC algorithm to all the message bytes, including the message CRC bytes, then the module assumes that transmission integrity is acceptable.

The second level of message acceptance involves a test by the KX1 module to check whether the PC station address in the message falls within its allowed range. The range of valid PC station numbers is a function of the KX1 module station number. The first PC station has a station number equal to that of the KX1 module station number plus one, and the last PC station address in the range has a station number equal to the KX1 number plus the number of PCs defined by the switches in switch group SW-4 (see section 3.3). If the value in the address field of the message is within this range, the KX1 module accepts the message and proceeds to translate it into data highway format.

5.1.3 Reply Timeout by Interface

The completion of a transaction cycle at the KX1 module is determined by one of two events: a response from the destination station or a response timeout. Whenever the interface has translated and relayed a PCIU command message to a data highway station, it sets a timeout counter to limit the time it will wait for a response from that station. (The current implementation of the timeout sets the counter to 1000 ms.). If the timeout counter runs out before a valid response is received, the KX1 module terminates its transaction cycle. In this situation, no kind of response is sent to the PCIU.

For its part, the PCIU would also timeout and conclude that the message was undeliverable. The KX1 module timeout has been implemented to assure that the module will at some point resume receiving messages from the PCIU if a problem occurs at a data highway station in the middle of a transaction.

5.1.4 Unsolicited Messages from the Data Highway

The KX1 module is a directional gateway between the PROVOX system and the Allen-Bradley Data Highway. As such, it is designed to accept command messages from the PCIU only, not from the PCs on the data highway.

Regarding the data highway link, the KX1 module is prepared to accept only replies to PCIU commands it has forwarded to PC stations on the data highway. On the data highway, any other communications outside of valid replies to PCIU commands are ignored by the KX1 module. Programs executing in data highway PCs should not initiate messages to the KX1 module since they will never receive a reply nor any indication of misaddressing.

> **CAUTION:** Do not program any PC-to-PC communications on the data highway. Such data highway communications can cause errors in communication or loss of data on the KX1-to-PCIU link.

5.2 Command Message Format

A transaction cycle or communication sequence on the PCIU link of the KX1 module is initiated in the form of a command message by the PCIU station. Command messages request the performance of certain functions at the destination data highway station, such as reading or writing data in the PC data table.

The general format of a command message is as follows:

Command Message (General Format)

```
Offset    0     1     2         4         n
(bytes)   ------------------------\ \-------------
          |     |     |    |      |   |    |    |    |
          | DST | FNC | ADDR      | DATA   |   CRC   |
          |     |     | hi | lo   | hi | lo |   |    |
          ------------------------\ \-------------
```

The specific command fields are discussed in the following sub-sections.

5.2.1 Destination (DST)

DST is the identification number of a data highway station that is to receive the command. (Note that on the data highway each communicating station has a unique identification number that is defined by switch settings on the communication interface module.) The value in this field is an 8-bit binary number.

The destination address is based on the KX1 module's own station number, as mentioned in section 3.3. Since the KX1 station number can range from 010 to 360 octal, the DST values can range from 11 to 370 octal. The KX1 station number itself is not a valid destination address for a command from the PCIU. If DST contains a station number that is out of range or does not exist, the KX1 module ignores the command message. No response is returned.

5.2.2 Function (FNC)

FNC indicates the type of function to be executed by the destination station. This value is expressed as an 8-bit binary value. Functions implemented in the KX1 module are as follows:

FNC Code	Description
3	Word Read
5	Bit Write
6	Word Write

Section 5.4 gives a detailed description of each of these functions.

5.2.3 PC Memory Address (ADDR)

ADDR is a 16-bit (2-byte) binary-coded address of a PC processor memory location. The order of the two bytes is high order byte first, low order byte last.

The memory locations addressed by ADDR are viewed in one of two ways, depending on whether the function being performed is a word read/write or a bit write. To address a word location with a word read or write command, the PC octal word address is simply converted to binary. To address a specific bit with the bit write command, the PC bit address is converted to a single value representing the binary offset of the bit from base zero, as if the PC data table were a string of bits.

For example, to address the word at octal address 021 in a PC memory, the ADDR field would contain the octal value 21 represented in binary. To access the bit referenced as octal 012-15 in the PC program, the ADDR field would contain the decimal value 163 represented in binary. This is derived by adding 1 to the word address of 12 octal, multiplying the result (11 decimal) by 16 decimal (for 16-bit words), and subtracting the decimal equivalent of the PC bit number.

See Appendix B for memory mapping diagrams showing sample PC octal addresses and PCIU decimal equivalents.

Which PC memory locations can be accessed by a PCIU command depends on the type of command being executed. Word-read commands can access any area of PC data table memory, whereas word-write and bit-write commands can access only certain specified areas of the PC data table. These limited areas are specified by memory access rungs in the PC program itself. For an explanation of memory access rungs, refer to the appropriate PC interface module user's manual (publication 1771-801 or 1774-819).

PCIU commands also **cannot** write into the processor work areas of PC memory. (For a definition of processor work areas, refer to the appropriate PC user's manuals.) No error message is generated when this type of write is attempted. Therefore, it will appear that a write into a processor work area has executed successfully even though it has not.

5.2.4 Data Field (DATA)

DATA is a field of data bytes that varies in content according to the function. Field formats are explained for specific functions in Section 5.4.

5.2.5 Cyclical Redundancy Count (CRC)

The CRC field is added to the end of a message to help detect errors in transmission. The CRC field is a 16-bit word calculated by the originating station of the message using a CRC-16 algorithm. The receiving station applies a similar algorithm to all the bytes of the message including the CRC. The result should be equal to zero, else a transmission error is assumed.

5.3 Reply Message Format

A transaction cycle on the PCIU link of the KX1 module is normally terminated with a reply message. A reply can be of two types:

- Normal response
- Exception response

A normal response is an indication that the command message was received and processed normally by the destination (DST) station. An exception response indicates that some type of problem occurred in trying to process the command message.

5.3.1 Normal Response

A normal response takes two basic forms depending on the function in the command. For 'read' functions, the data requested is returned in the normal response message; for 'write' functions, the response is identical to the command message. (Refer to section 5.4 for details).

5.3.2 Exception Response

A problem in processing a command message is reported back to the initiating station through an exception response. The format of an exception response is:

```
Offset    0       1       2         3
(bytes)   ------------------------------------
          !       !       !         !     !      !
          ! DST   ! FNC   ! EXCPT   !    CRC     !
          !       !       ! CODE    !     !      !
          ------------------------------------
```

The DST field has the same value as the original command message.

The FNC field contains the original function code with a flag bit in the high-order bit position to indicate that this is an exception response. The flag bit is set to '1'.

The EXCPT field is a code in 8-bit binary that identifies an exception condition. The codes of possible error conditions are:

EXCPT Code	Condition
1	Function Code (FNC) is illegal.
2	Address field (ADDR) is invalid.
3	Data field (DATA) is invalid.
4	Destination PC (DST) failed to respond, or PC communication error.
6	Destination station (DST) is busy.

The CRC field is the normally derived CRC value for the bytes of this response.

5.4 Command Function Codes

The function codes that have been implemented for the KX1 module are:

FNC Code	Description
3	Word Read
5	Bit Write
6	Word Write

Detail descriptions are in the following sub-sections. Appendix C gives some programming recommendations for using these command functions.

5.4.1 Word Read

The word-read command is used to read 16-bit 'words' from the PC data table area. A word may contain a string of discrete values or a single numeric value in BCD (Binary Coded Decimal). Refer to Section 5.6 for a discussion on how to deal with various data types in the data table.

Command format:

```
Offset    0      1      2             4             6
(bytes)   -------------------------------------------
          |      |      |      |      |      |      |      |
          | DST  | FNC  |    ADDR     |    DATA     |    CRC      |
          |      | 03   | hi   | lo   | hi   | lo   |      |      |
          -------------------------------------------
```

FNC must equal a binary 3 for this function.

ADDR contains the binary address of the first 'word' location in the PC data table to be read.

The DATA field in the command contains the number of data words to be read from the DST station. The value is a 16-bit binary number that can range from 1 to 65 decimal. A value outside this range is flagged as an error.

Normal Response format:

```
Offset    0      1      2     3                            n
(bytes)   --------------------------\ \--------------------
          |      |      |     |     |     |     |     |     |
          | DST  | FNC  |DBC  |          DATA         |    CRC    |
          |      | 03   |     | hi  | lo  | hi  | lo  |     |     |
          --------------------------\ \--------------------
```

The DBC, or data byte count, is an 8-bit binary field that reflects the number of bytes in the following DATA field. It can range from 2 to 130 (decimal) for the 1 to 64 data words and one status word that can be requested.

The DATA field contains the requested 'word' data from the DST station. It is in the form of 16-bit words with the high-order byte of the word first.

5.4.2 Bit Write

The bit-write command is used to modify a single bit value in the destination PC data table.

Command format:

```
Offset    0      1      2           4           6
(bytes)   ---------------------------------------------
          !      !      !     !     !     !     !     !     !
          ! DST  ! FNC  !   ADDR    !   DATA    !    CRC    !
          !      ! 05   ! hi  ! lo  ! hi  ! lo  !     !     !
          ---------------------------------------------
```

FNC contains a binary value of 5 for this function.

The ADDR field contains the discrete bit location in the destination PC data table. The allowed range for the ADDR value is 1 to 8192 decimal. This value is the absolute bit offset from base zero in the data table (refer to section 5.2.3). Since the bit write is a protected command, the data table location must be defined in the access rungs of the PC program, otherwise an error condition will result.

The DATA field is used to indicate whether to turn on (set) or turn off (reset) the bit referenced in ADDR. Only the high-order portion of DATA is used for this indicator; the low-order byte of DATA is always zero. To set a bit, the value of DATA is 'FF00' hex; to reset a bit, the value of DATA is '0000' hex. Any other value is treated as an error.

The normal response is identical to the bit-write command.

Bit writes generate a type of data highway command known as a protected write. "Protected" means that this command can access only predefined data table sections at the receiving PC. To define which data table sections are accessible, program a memory access rung in the communication zone of the ladder diagram program at the PC station. (Refer to publication 1774-819 or 1771-801.)

NOTE: If you are using the KX1 in a backup configuration, then the PC station requires you to program separate memory access rungs for the primary and the backup KX1. This is because the primary and the backup KX1 have different station numbers (section 3.3.2).

5.4.3 Word Write

The word-write command is used to change the contents of a 16-bit 'word' in the destination PC data table. A word may contain a string of discrete values or a single numeric value in BCD (Binary Coded Decimal). Refer to Section 5.6 for a discussion on how to deal with various data types in the PC data table.

Command format:

```
Offset    0     1     2           4           6
(bytes)   ------------------------------------------
          |     |     |     |     |     |     |     |     |
          | DST | FNC |   ADDR    |   DATA    |    CRC    |
          |     | 06  | hi  | lo  | hi  | lo  |     |     |
          ------------------------------------------
```

FNC contains a binary 6 for this function.

ADDR contains a 'word' address in the destination PC data table that is to be overwritten by the contents of the DATA field. The data table location must be defined in the access rungs of the PC program, otherwise an error condition will result.

DATA is a field containing 16 bits of data that will replace the contents of the 16-bit word location specified in ADDR.

The normal response is identical to the word-write command.

Word writes generate a type of data highway command known as a protected write. "Protected" means that this command can access only predefined data table sections at the receiving PC. To define which data table sections are accessible, program a memory access rung in the communication zone of the ladder diagram program at the PC station. (Refer to publication 1774-819 or 1771-801.)

NOTE: If you are using the KX1 in a backup configuration, then the PC station requires you to program separate memory access rungs for the primary and the backup KX1. This is because the primary and the backup KX1 have different station numbers (section 3.3.2).

5.5 Error Processing

In the course of message processing, various error conditions may be detected in the command messages. These message errors fall into three categories:

- PCIU link communication errors
- Message content errors
- PC processing errors

5.5.1 PCIU Link Communication Errors

Included in the category of communication errors are character tranmission errors and the frame check error. Character transmission errors involve character framing, bit parity checks or character overrun problems at the I/O port. The frame check error is detected as a failure in the CRC error check. In conformance with the protocol conventions, communication errors result in the message being discarded by the KX1 module; that is, no response is sent to the PCIU.

5.5.2 Message Content Errors

The KX1 module will detect message content errors by examining the PCIU message fields before translating the message into the data highway format. Content errors include illegal function codes, values that are invalid or out of range for a particular data field, or an invalid set/reset specification for a bit-write function. The following table outlines the error EXCPT (exception) code that can be returned in an exception response for errors involving the different types of fields in the PCIU messages.

PCIU FIELD	RULE VIOLATION	EXCPT CODE
DST	Out of KX1's range	(no response)
FNC	Not a 3, 5, or 6	1 = Illegal function
ADDR	Not within PC's data table, or access rung violation	2 = Illegal data address
DATA	Not 1-65 for a read, or invalid set/reset value for a bit write	3 = Illegal data value

5.5.3 PC Processing Errors

Once a PCIU message has been translated by the KX1 module, it is forwarded to the destination PC station on the data highway. When at the PC level in the system, the command message may encounter various processing errors that will be reported by the PC through a code in its reply message to the KX1 module. The KX1 module monitors the replies for such errors and generates a corresponding exception response for the PCIU when an error is detected.

The following table presents a list of the PC error conditions and the associated EXCPT code that the KX1 module returns to the PCIU.

PC ERROR	EXCPT Code (in decimal)
- DST station out of buffer space	6 = busy, try later
- undeliverable message (no PC station with specified station number)	(no response)
- illegal command or command size	3 = data error
- memory verification error (protection violation)	2 = illegal data address
- interfaced device is disconnected	4 = PC failed to respond
- device/module communication error	4 = PC failed to respond
- privilege violation	2 = illegal data address
- function disallowed by option switches	1 = illegal function
- PC in program mode	6 = busy, try later
- PC communication zone is incorrect (protected write error)	2 = illegal data address

5.6 Data Types in Processor Memory

PC processors on the data highway use two basic data formats for storing data in their data tables: discrete bits and BCD (Binary Coded Decimal) numeric values in 16-bit words.

Discrete bits are usually related to input/output terminals on I/O modules or internal on/off program switches. They are arranged in groups of 16-bit words with the 'most significant bit' (MSB) stored on the left. The bits are referenced within a word as follows:

```
                   +-----------------------+-----------------------+
Decimal address    |15|14|13|12|11|10|09|08|07|06|05|04|03|02|01|00|
                   +-----------------------+-----------------------+

                   +-----------------------+-----------------------+
Octal address      |17|16|15|14|13|12|11|10|07|06|05|04|03|02|01|00|
                   +-----------------------+-----------------------+
```

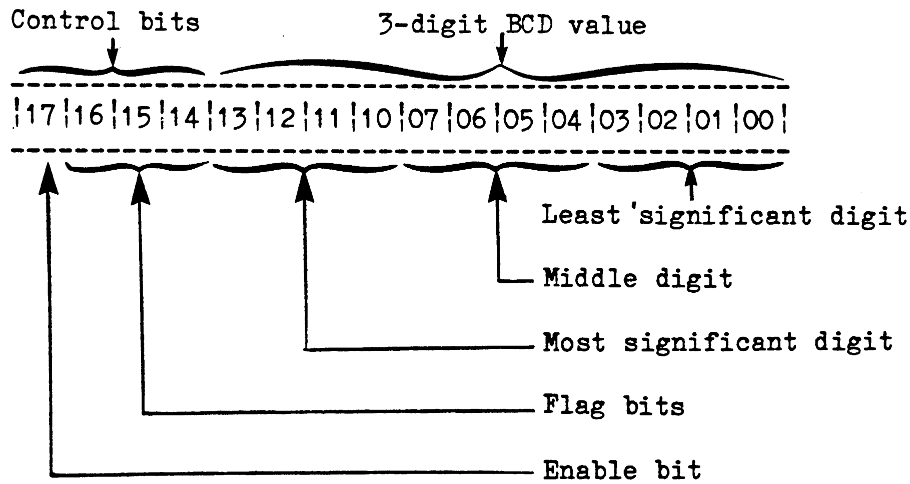
The octal references in this format match the discrete references of a PC's I/O modules.

Since any data table area can be addressed as a 'word', a user could arrange a set of discrete values in a 'word' and access them as a group by using a PCIU word-read or word-write function. In using a 'word' function to read or write bits, the memory address (ADDR) specified in the command is a 'word' address. The individual bits are manipulated according to the format mentioned above. The correlation of a command's address to a PC location is fairly direct. For example, a discrete bit at location 012-15 octal (word 12 - bit 15) could be accessed as a word by using a word-read command with word a address (ADDR) equal to 12 octal. Then bit 13 (decimal) in the word could be examined for an on/off status.

Note that if a word-write command is used to write bits to a PC's data table, all bits in the word can be modified at once, and the above arrangement of bits must be followed.

BCD numeric values are 'binary coded decimal' values stored in 16-bit words. The BCD format uses four bits to represent a decimal digit. There are three BCD digits in a 16-bit word of PC data table memory. The high-order four bits of the BCD word are used as flag bits for the value. The maximum value of one word is 999. However, two words can be concatenated to represent larger values.

The BCD format is used by the processor to store timer/counter accumulated values used by the PC program. In general, the BCD format is as follows:



It is important to note that the KX1 module does not convert data from one form to another when executing word read/write commands; the data is simply transmitted as a string of bits. Therefore, any conversion of BCD data is the responsibility of the command initiating station. Further details on BCD format are available in the appropriate PC programming manuals for the various processors.

To access a timer/counter word in PC memory, the address (ADDR) is derived by converting the octal word address to the binary equivalent as described in section 5.2.3.

Appendix

A

Message Flow Diagram

Appendix A Message Flow Diagrams

The message flow between the PCIU, the KX1 module, and the Allen-Bradley Data Highway is shown in the following diagrams depicting various message situations.

```
             CASE                       PCIU        KX1 Module     Data Highway

                                         !               !               !
   1. Normal                            CMD------------->
      command/response                                  CMD------------->
      sequence.                                         <--------------ACK
      Message addressed                                 <--------------REPLY
      to PC unit.                                       ACK------------->
                                        <--------------RESP

   2. PC station number not             CMD------------->NO ACTION
      within KX1 module's               <-/-/-/-/-/-/-/-NO RESP
      range.                        (timeout)

   3. Communication error               CMD------------->NO ACTION
      (CRC or I/O error).               <-/-/-/-/-/-/-/-NO RESP
                                    (timeout)

   4. Message content error             CMD------------->
      or PC detected error.                             CMD------------->
                                                        <---------------ACK
                                                        <---------------REPLY
                                                                  (w/ error)
                                                        ACK------------->
                                        <---------------RESP (w/ EXCP code-n)

   5. KX1 module timeout.               CMD------------->
                                                        CMD------------->
                                                        <---------------ACK
                                                                        .
                                                                        .
                                                                  (no reply)
                                        <-/-/-/-/-/-/-/-/-(timeout)NO RESP
                                    (timeout)
```

Appendix

B

PC Memory Addressing

B.0 General

This appendix shows how to convert PC octal word and bit addresses into their decimal equivalents for PCIU command functions.

B.1 Addressing Words

To address a PC word, convert the PC octal word address to a decimal number and add one.

PC Octal Word Address	PCIU Equivalent Decimal Word Address
000	001
001	002
002	003
003	004
004	005
005	006
006	007
007	008
010	009
011	010
012	011
.	.
.	.
.	.
100	065
101	066
102	067
.	.
.	.
.	.

For example, PC word 030 (octal) can be accessed by using the decimal value 25 in the ADDR field of the word-read or word-write function.

B.2 Addressing Bits

For writing discrete bits, the PC data table memory is viewed as a bit string wherein each bit has an address expressed as an offset from base zero. To calculate a bit offset, follow these steps:

1. Convert the octal PC word address to the equivalent decimal number.
2. Add 1 to the result from step 1.
3. Multiply the result from step 2 by 16 (decimal).

4. Convert the octal PC bit number to the equivalent decimal number.
5. Subtract the result of step 4 from the result of step 3.
6. The result of step 5 is the equivalent PCIU decimal bit address, as illustrated below.

PC Octal Bit Number

PC Octal Word Address	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
	PCIU Equivalent Decimal Bit Address															
000	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
001	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
002	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
~	~															~
775	81 61	81 62	81 63	81 64	81 65	81 66	81 67	81 68	81 69	81 70	81 71	81 72	81 73	81 74	81 75	81 76
776	81 77	81 78	81 79	81 80	81 81	81 82	81 83	81 84	81 85	81 86	81 87	81 88	81 89	81 90	81 91	81 92

For example, bit 15 (octal) of PC word 12 (octal) can be accessed by using the decimal value 163 in the ADDR field of the bit-write function.

Programmable Controller Programming Requirements

C.0 General

The programmable controller must format all desired data (discrete bits and integer values) into its memory words so that all of this information can be obtained by the PCIU in one command/response message exchange. This means, for example, that the 65 words to be accessed by a word-read function should be in 65 contiguous words of PC memory.

The actual arrangement of the data within the PC memory words is entirely up to the user, with the following qualifications:

- Each memory word must be used to report either discrete information (up to 16 bits) or a single integer value, exclusively. There is no allowance for subdividing a word into bytes.
- The first word returned to the PCIU word-read function is a status word from the programmable controller. This status word presents 16 independent bits of status information to the PCIU. These may be defined for any specific use within the programmable controller.

C.1 Status Word

The bits of a status word may represent any alarm or status condition within the programmable controller, such as backup battery status, input/output module failure, mathematical overflows, etc. Discrete binary logic must be programmed to monitor and remap this status information as required.

The actual mechanism for mapping the status bits into the memory words may vary with PC type. In general, the status bits should first be programmed into sequential discrete bit locations in the programmable controller. Second, this string of bits is transferred as a block of 16 bits into an unused word in the PC data table memory.

C.2 Discrete Bit Data

The discrete bit values within the PC can be grouped into two general catagories: actuator bits and monitor bits.

Actuator bits are those values which initiate some action within the programmable controller. The PCIU commands these actuator bits on or off via the bit write function. From the PCIU, these are called discrete outputs.

Monitor bits are not forced on or off, but are used to monitor the operational status of the programmable controller. From the PCIU, these are called discrete inputs.

All discrete bit values pertinent to controlling the PC's ladder diagram program must be mapped into PC memory, regardless of which general type these values might be. These discrete bits are mapped with the same method that the discrete status information is transferred into PC memory (refer to section C.1).

C.3 Integer Data

The integer values within PC memory can be grouped into two general catagories: output integers and monitor integer values.

Output integers are those integer values that can be changed from the PROVOX system via the word-write function of the PCIU. These include items such as counter maximum values, timer reset values, mathematical constants, etc. From the PCIU, these are called integer inputs.

Monitor integer values cannot be change by the PCIU, but they can be monitored via the word-read function.

All integer values pertinent to operating the PC's ladder diagram program must be mapped into PC memory, regardless of which general type these values are. These may be transferred into specific PC memory words using arithmetic operations (add zero, divide by one) or other data transfer logic within the programmable controller.

NOTE: It is not necessary for all values to be allocated storage separate and distinct from the PC data table. Output integer values can be kept within this data table, if desired. The programmable controller would simply reference this same word from the data table for any operations using that constant or value.

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