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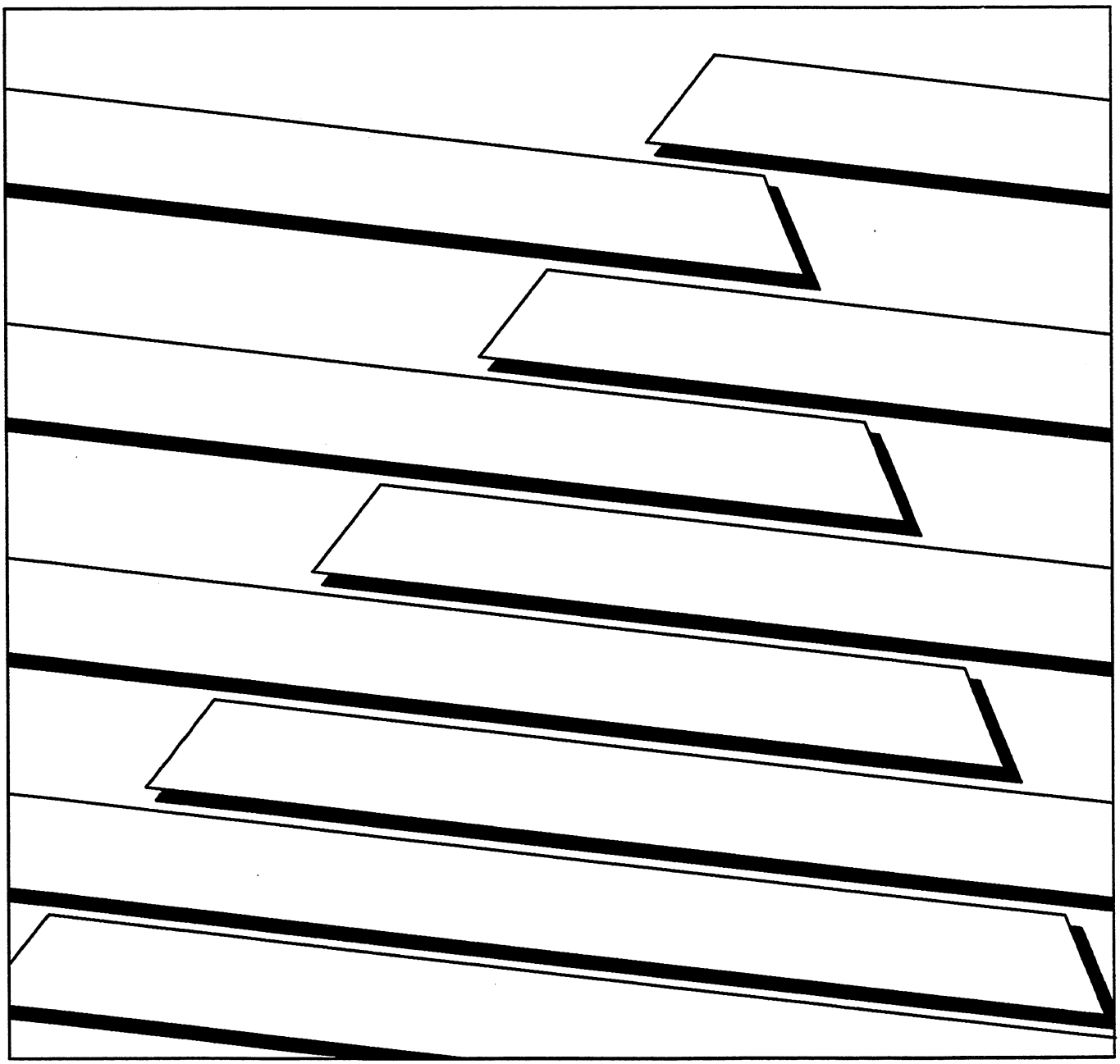
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ALLEN-BRADLEY

Data Highway Plus
PLC-2 Family
Communication Adapter Module

(Cat. No. 1785–KA3)

User's Manual



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Important User Information

Because of the variety of uses for this product and because of the differences between solid state products and electromechanical products, those responsible for applying and using this product must satisfy themselves as to the acceptability of each application and use of the product. For more information, refer to publication SGI-1.1 (Safety Guidelines For The Application, Installation and Maintenance of Solid State Control.)

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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Warnings tell readers where people may be hurt if procedures are not followed properly.



Cautions tell readers where machinery may be damaged or economic loss can occur if procedures are not followed properly.

Warnings and Cautions:

- Identify a possible trouble spot.
- Tell what causes the trouble
- Give the result of improper action
- Tell the reader how to avoid trouble.

Important: We recommend you frequently backup your application programs on appropriate storage medium to avoid possible data loss.

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Appendix: Title:

A Specifications

B PLC-2 Error Codes

C Switch Setting and Command Listing Record Forms

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Chapter 1
Using This Manual

Chapter Objectives

This chapter presents information on:

- terminology used throughout this manual
- where to locate information on related products

Purpose of This Manual

This manual describes the Data Highway Plus PLC-2 Family Communication Adapter Module (cat. no. 1785-KA3), and it includes:

- installing the module
- using the module
- troubleshooting the module

Who Should Read This Manual

Read this manual before you install or use the 1785-KA3. You should be familiar with:

- Allen-Bradley Programmable Logic Controllers (PLCs)
- PLC-2 programming
- the Allen-Bradley Data Highway Plus network

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Precautionary Notes

In this manual, you will see:

- **WARNINGS** -- indicate where personal injury may occur if you do not follow procedures properly
- **CAUTIONS** -- indicate where equipment may be damaged if you do not follow procedures properly
- **Important** -- notes that stress information critical to your understanding and use of the product

Frequently Used Terms

In this manual you will see these terms:

This Term:	Means:
Data Highway Plus	formerly the Peer Communication Link (PCL)
node	the point at which devices, such as programmable controllers, interface to the network. On Data Highway Plus, a node is an interface module, a PLC-5, or a series 1784 programming terminal. In some Allen-Bradley documentation, you may find the term **station** used in place of the term **node**.
PLC	Programmable Logic Controller, a generic term for any of Allen-Bradley's PLC product lines (such as PLC-2, PLC-3).
PLC-2	generic term for any PLC-2 family processor (such as a PLC-2/15 or PLC-2/30) unless otherwise specified
KA3	shortened term for PLC-2 Family Communication Adapter Module 1785-KA3

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Related Products

Allen-Bradley offers a wide range of products for Data Highway Plus, including:

Product:	Catalog Number:
Data Highway or Data Highway Plus Asynchronous (RS-232-C or RS-422-A) Interface Module	1770-KF2
Data Highway Plus to Data Highway Interface Module	1785-KA
Data Highway Plus RS-232-C Interface Module	1785-KE
PLC-2 Family Programming Software	6200-PLC2
PLC-3 Family I/O Scanner Communication Adapter Module	1775-S5,-SR5
PLC-5 Family Programmable Controllers	Series 1785
PLC-5 Programming Software	6200-PLC5
T50 Industrial Terminal System	1784-T50

Where to Read More

For more information about Data Highway Plus products, refer to the Data Highway Plus Overview (publication 1785-2.6), or contact the Allen-Bradley sales office nearest you.

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Chapter Objectives

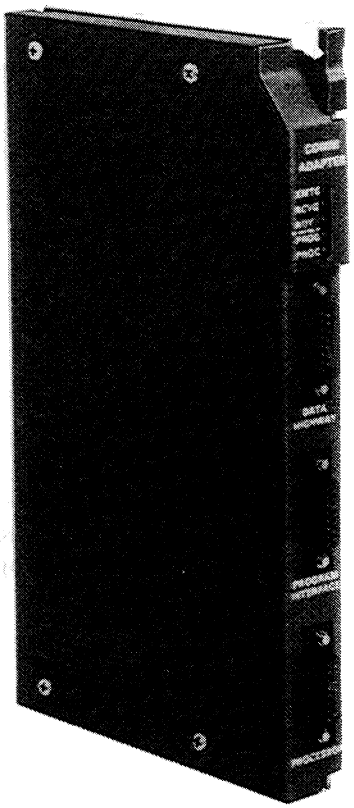
This chapter provides an overview of:

- the 1785-KA3 Data Highway Plus PLC-2 Family Communication Adapter Module
- programming the 1785-KA3

The 1785-KA3 Module

The 1785-KA3 module is a communication adapter that links a PLC-2 family processor (including PLC-2/30, -2/20,-2/17,-2/16,-2/15,-2/05,-2/02, and Mini-PLC-2) to an Allen-Bradley Data Highway Plus network.

Figure 2.1
1785-KA3 Communication Interface Module



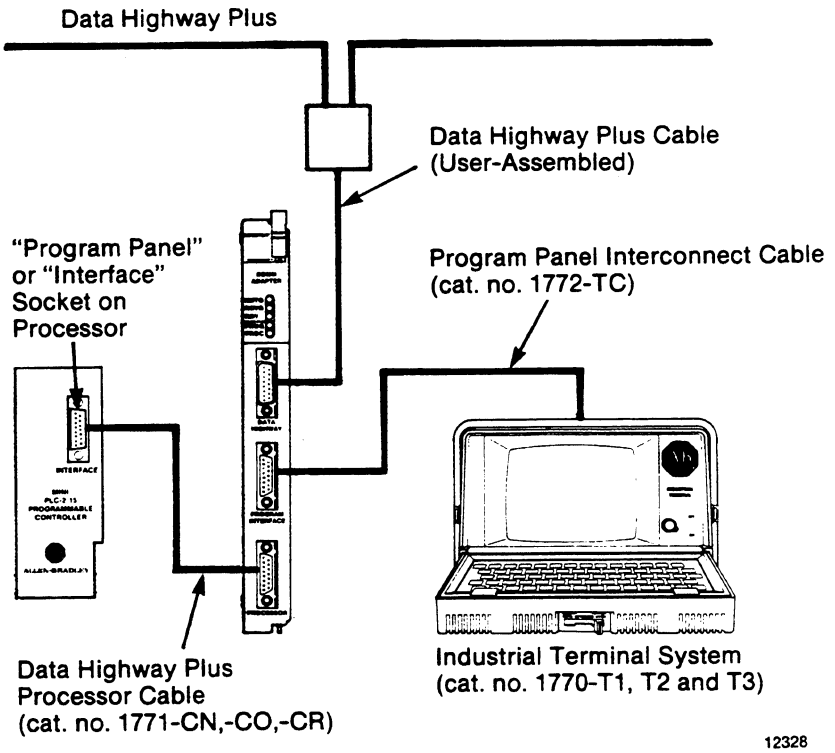
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A 1785-KA3 features extensive self-diagnostics. At power-up, the module tests its internal memory, timers, and firmware integrity. A failure causes indicators on the front panel to flash. The module continuously checks the memory and firmware during operation. For more information on the LED indicators on the front panel, refer to chapter 6.

How the 1785-KA3 Connects a PLC-2 to Data Highway Plus

Figure 2.2 shows an example of how the 1785-KA3 connects a PLC-2 family processor to a Data Highway Plus network.

Figure 2.2
1785-KA3 Example Configuration



You can daisy chain two 1785-KA3 modules. Refer to Chapter 3 for switch setting requirements. Refer to the next section for remote programming limitations when you are in a daisy chain configuration.

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Programming the PLC-2 to Communicate on Data Highway Plus

When you connect a PLC-2 family processor to a Data Highway Plus link with a 1785-KA3, you must add a **communication zone** to your PLC-2 application program. The communication zone rungs contain the commands for communication with other nodes on the Data Highway Plus network. For more information on programming your PLC-2 to communicate over the Data Highway Plus network refer to chapters 4 and 5 of this manual.

You can also program your PLC-2 from a remote 1784 Series Industrial terminal over Data Highway Plus. For more information, refer to the PLC-2 6200 Series Software (cat. nos. 6202-PLC2A, 6212-PLC2A) User's Manual (publication 6200-6.5.7

Remote Programming With A 1785-KA3

The 1785-KA3 supports remote programming for PLC-2s. A programming terminal such as a T50, T45, or an IBM PC-AT/XT* compatible, fitted with a 1784-KT and 6200 programming software, connects directly to the network and programs PLC-2s from a remote location. Since the PLC-2 processors were not designed to manage multiple programming terminals, a management function, called the **edit resource**, is designed into the KA3 module. But to protect the performance of data communication functions, there are some constraints on remote programming:

- To safeguard the integrity of the PLC-2 program memory, only one programming terminal at a time can obtain the edit resource, whether it is a locally connected T3, T50, T45, or compatible, or a remote terminal. When an edit session is completed, you must release the edit resource so that another user can access it. The edit resource is released by depressing the Mode Select key on a T3 terminal, or exiting the edit menu if you are using 6200 software.

- The KA3 will not support remote contact histograms.

- Forcing functions are available only with a local terminal. Remote forcing is not supported.

(continued)

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- A terminal connected to the program port of the KA3 (local connection) can neither monitor nor edit if a remote terminal has the edit resource. If the local terminal has the edit resource, remote terminals can neither monitor nor edit the program.

- If you use a KA3 as the first module in a daisy chain configuration, communication with the second module will be suspended if a remote terminal acquires the edit resource.

  This is because the KA3 cannot distinguish between a programming terminal or a communication module attached to the KA3 Program Interface port. If a remote terminal has the edit resource, the KA3 treats the second module the same as it would a T3 terminal and suspends communication with it.

- If switch 6 of SW1 is in the second module position, that module will not support any remote terminal functions.

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Chapter Objectives

Refer to this chapter for:

- setting switches on a 1785-KA3
- inserting the module in the chassis
- connecting cables to the module

Setting Switches on the 1785-KA3

Before you can connect a KA3 to the network it is on, you must set three groups of switches on the module:

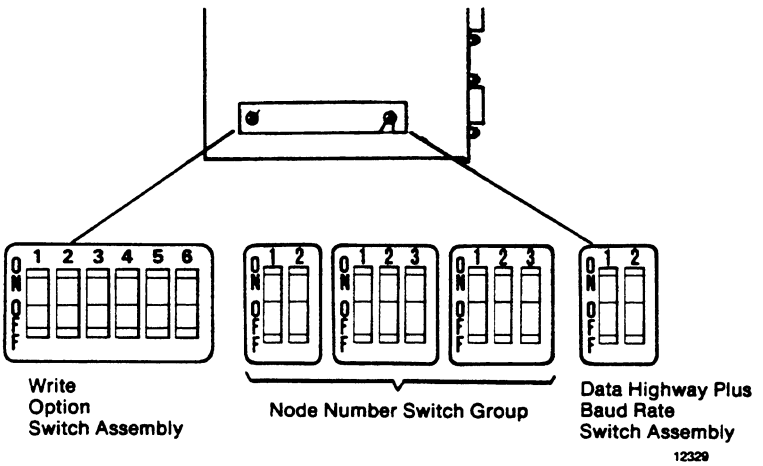
- write options
- node address
- Data Highway Plus baud rate

These switches define the way the 1785-KA3 communicates with other nodes on your network.

Use these steps to set the switches:

1. Locate the switch cover on the left side of the interface, near the bottom.
2. Loosen the two screws that hold the cover plate and rotate it to expose the switches.
3. Set the switches to where you want them.

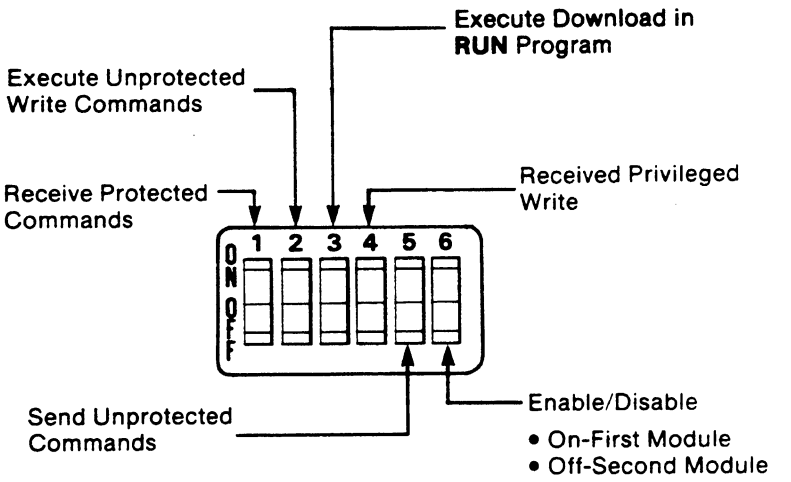
CAUTION: Set the switches with a ball-point pen or a similar instrument, but don't use a pencil. Graphite dust or chips could jam the switches.



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Write Option Switch Assembly (SW-1)

The Write Option switch assembly contains 6 switches:



If this switch:	Is:	the interface will:
1 Receive Protected Command	**ON**	execute a protected command received from the network
	OFF	do not execute a protected command received from the network
2 Execute Unprotected Write Commands	**ON**	execute unprotected write and bit write commands received from the network
	OFF	do not execute unprotected write and bit write commands received from the network
3 Execute download in Run/Program	**ON**	the KA3 will allow downloads when the PLC-2 keyswitch is in the Run/Program position
	OFF	downloading to a PLC-2 can only be done when the PLC-2 is in Program mode
4 Receive Privileged Write	**ON**	execute a privileged write command received from the network
	OFF	not execute a privileged write command received from the network

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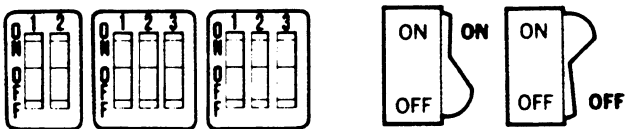
5	Send Unprotected Write	**ON**	be able to send unprotected write and bit write commands onto the network
		OFF	not be able to send unprotected write and bit write commands onto the network
6	Direct Connection or Daisy Chain	**ON**	operate as if it were connected to a PLC-2 processor; direct connection
		OFF	operate as if it were connected to another 1785-KA3 interface; daisy chain
			Refer to the caution at the beginning of this section for more information.

Node Address Switch Assemblies (SW-2, SW-3, and SW-4)

The Node Address switch group contains three different switch assemblies, SW-2, SW-3, and SW-4.

The Node Address switch group defines the node address of the 1785-KA3 on your Data Highway Plus network. Be sure to select a node address that is:

- not being used by another node
- between 010-077 octal



SWITCH SETTING		DIGIT
NO. 1	NO. 2	
OFF	OFF	0
OFF	ON	1
ON	OFF	2
ON	ON	3

a. First Digit

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	ON	7

b. Second and Third Digits

12331

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For example, to set the address 037 octal, you set:
SW-2 to 0
SW-3 to 3
SW-4 to 7

The Baud Rate Switch Assembly (SW-5)

The Baud Rate switch group is labeled SW-5 on the circuit board. Set both of these switches ON to allow the 1785-KA3 to communicate with other nodes on your network at a rate of 57.6 kilobaud.

CAUTION: Be sure that both of these switches are on. Setting these switches incorrectly may cause faulted transmission on your Data Highway Plus network.

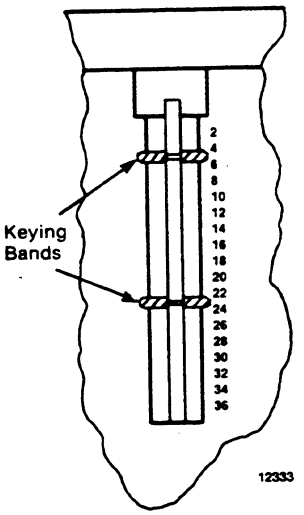
Inserting the Module Into the I/O Chassis

Use the following procedure to insert your module into a Bulletin 1771-I/O chassis.

1. Turn off the power to the chassis.

CAUTION: Always turn off the power to the chassis before removing or inserting a module. If you don't, the module could be damaged.

2. Locate the two keying bands that were shipped with the module. Position the upper keying band on the backplane between 4 and 6 and the lower keying band between 22 and 24, as shown:



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3. Insert the module into the backplane by sliding it along the plastic tracks on the top and bottom of the slot.

CAUTION: Apply firm, even pressure to seat the module in the slot. Do not force the module.

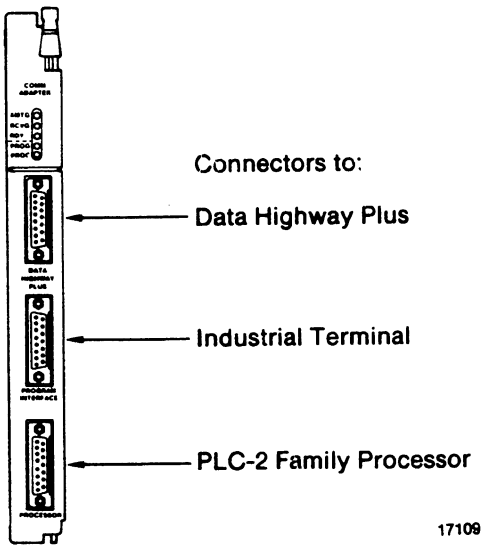
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4. Snap the plastic chassis latch over the module to firmly secure the module in the chassis.

Making Cable Connections to the Module

Three 15-pin connectors on the front panel of the 1785-KA3 module are used to connect your module to:

- a Data Highway Plus network
- a 1770-T3, 1784-T50, or a 1784-T45 terminal
- a PLC-2 Family processor



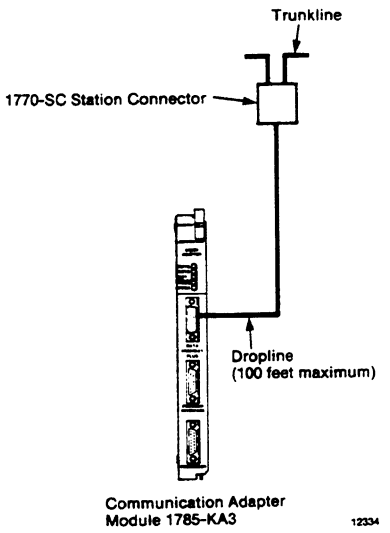
The following sections show you how to connect a 1785-KA3 module.

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CAUTION: Before connecting or disconnecting any cables to the 1785-KA3, be sure that power to the 1771-I/O chassis is off. Failure to do this may result in excessive noise interference on your network or a network fault.

Connecting the Module to Data Highway Plus

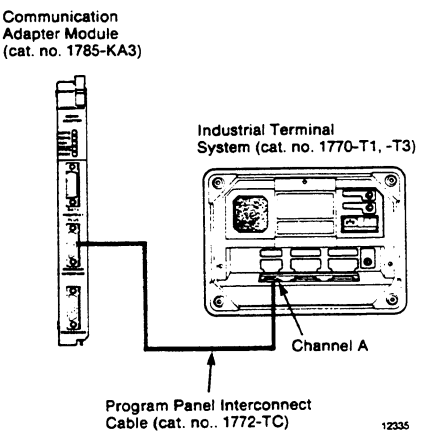
To connect a 1785-KA3 to your Data Highway Plus network, you must construct a Data Highway Plus dropline and connect it to the uppermost connector of the interface, labeled DATA HIGHWAY PLUS.



For information on constructing a Data Highway Plus dropline, refer to the Data Highway Cable Installation Manual (publication 1770-6.2.1).

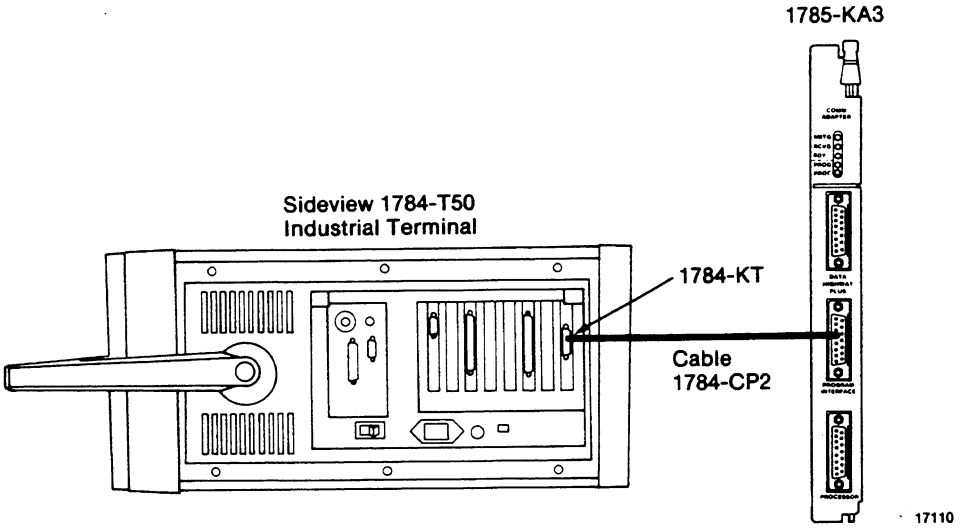
Connecting the Module to an Industrial Terminal

You connect a 1785-KA3 to an industrial terminal (cat nos. 1770-T3) with an Interconnect Cable (cat. no. 1772-TC), from channel A of your terminal system to the connector labeled PROGRAM INTERFACE.

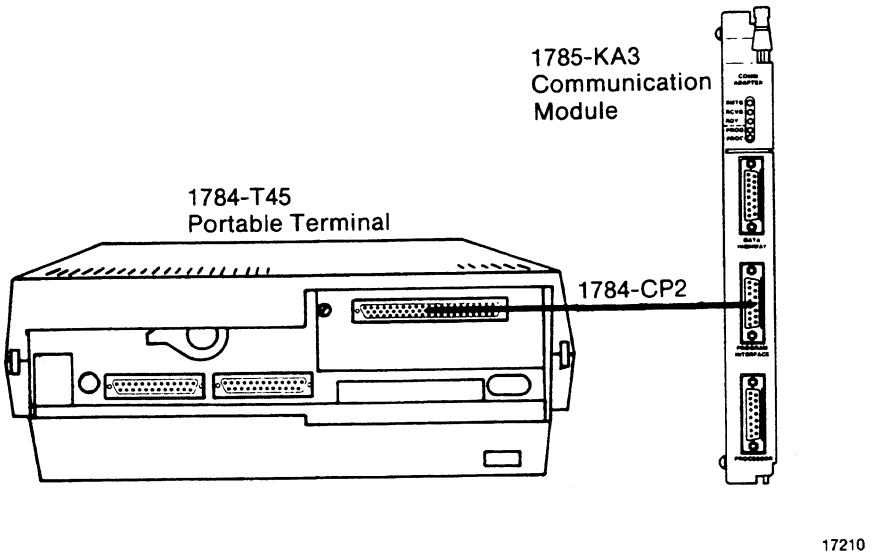


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You connect a KA3 to a 1784-T50 Industrial Terminal with interconnect cable 1784-CP2. One end of the cable is connected to the PROGRAM INTERFACE port on the KA3 and the other is connected to the 64-pin terminal on a 1784-KT interface module in the T50.



Connect a 1785-KA3 to a 1784-T45 Portable Terminal with a 1784-CP2 cable. Use the middle connector on the KA3 labeled PROGRAM INTERFACE, and the 62-pin card edge connector on the T45's 1784-KL module.



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Connecting the Module to a PLC-2 Family Processor

To connect a 1785-KA3 to a PLC-2 Family processor, connect the processor cable from the PLC-2 Family processor to the bottom connector on the interface, labeled PROCESSOR. See figures 3.1 and 3.2.

Figure 3.1
Connection to a PLC-2/20 or PLC-2/30

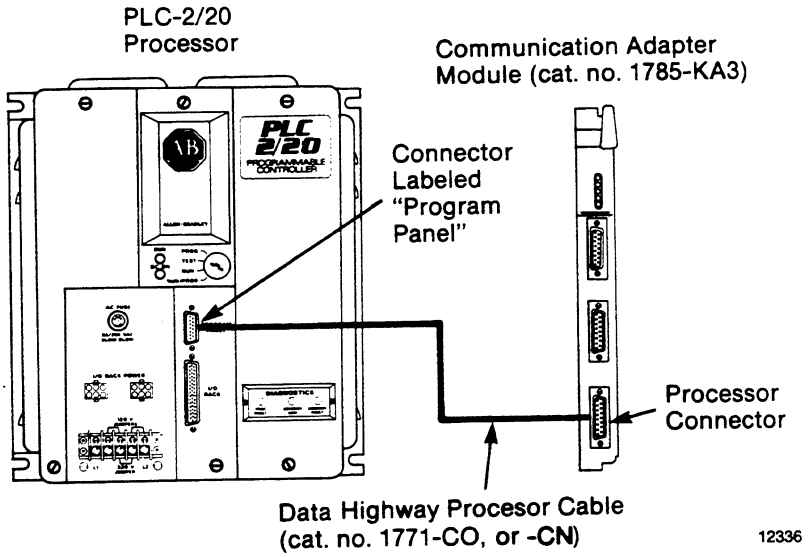
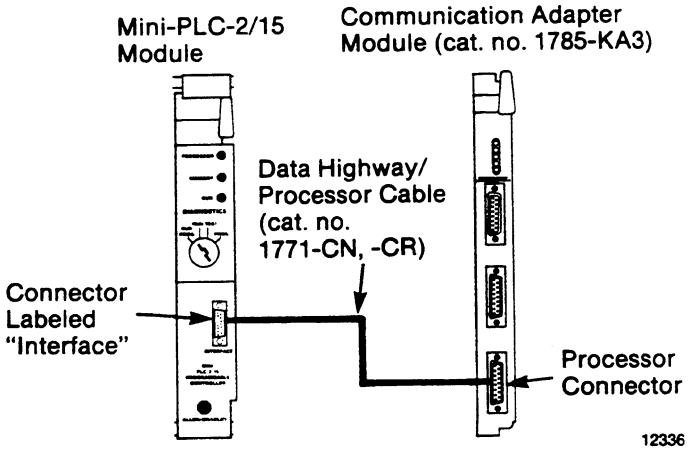


Figure 3.2
Connection to a Mini-PLC-2, Mini-PLC-2/05, Mini-PLC-2/15, Mini-PLC-2/16, Mini-PLC-2/17, Mini-PLC-2/02



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Chapter 4
PLC-2 Programming:
How to Program the Communication Zone

Chapter Objectives

This chapter tells you how to program the communication zone of ladder logic programs running on a PLC-2 family processor on a Data Highway Plus network.

Important: For a computer (and some PLCs) to accept commands from a PLC-2, you must provide a file at that node to simulate a PLC-2 data table. If you need to transmit commands to another type of Allen-Bradley PLC, refer to the programming manual for that PLC.

Understanding the Communication Zone

At the beginning of the ladder diagram program, you enter a special set of rungs that dictate communication adapter module activity. The 1785-KA3 scans this set of rungs at power-up for operating information.

> WARNING: Do not make on-line edits of the communication zone. Since the module scans the communication zone only when it powers up or when the processor changes state (from program to run), the changes will not affect module operation until you cycle power to the 1785-KA3 module or change the operating mode of the processor. Attempting such edits may cause unexpected communication on the Data Highway Plus.

Communication zone rungs use the standard controller instruction set. However, the meaning of these instructions and addresses differs significantly from their meaning in standard ladder diagram programming. For this reason, each programmed element in a communication zone rung must be understood as it is described in this chapter, **not** as it would normally be understood in a ladder diagram logic context.

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In several instances, the 3-digit or 5-digit number entered above the communication zone rung element has no relation to an actual data table address. This chapter specifically identifies this type of number as either a **station number** or **code.** Where one of these designations is given, the actual data table bit or word at that address is not affected by KA3 module operation and many be used in the balance of the user program.

For the purpose of this description, the reference point is termed the local station. All other stations are then considered remote stations. These rungs are entered at the local station so that it can send commands to, or receive commands from, a remote station.

Obviously, this reference point is not fixed. Each station, as it is being programmed, is considered the local station at that time.

The Communication Zone

Before any communication can occur between a remote node and your PLC-2 (through the 1785-KA3 module), you must provide a **communication zone** in your PLC-2's ladder diagram program.

The communication zone defines:

- areas of PLC-2 data table memory that are accessible by nodes on your network
- commands the PLC-2 sends out on the network and the destination node of each command

Actual communication zone rungs for the PLC-2 vary with each application. The length of this zone depends on the number of remote nodes with which the PLC-2 communicates and the number of types of commands sent to these remote nodes.

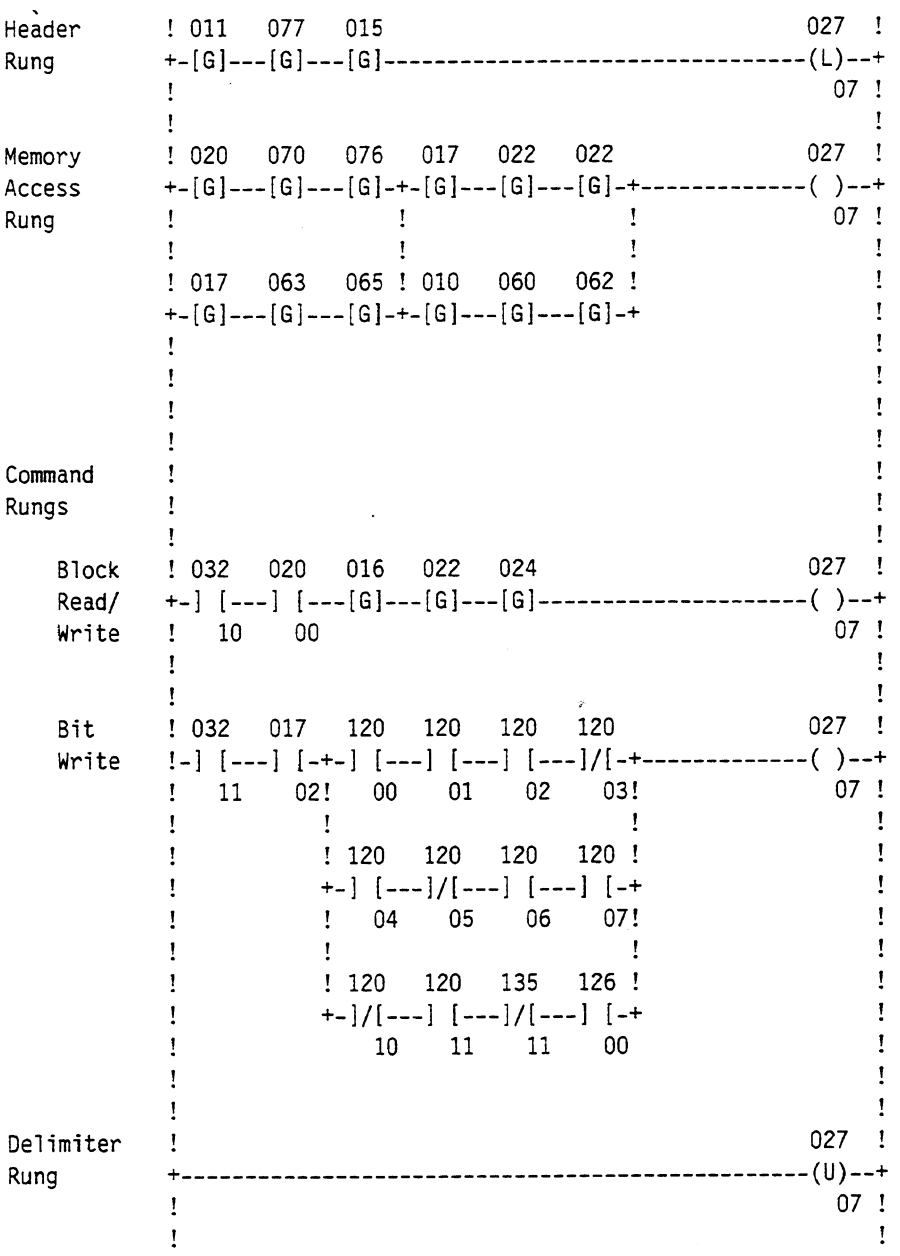
You use, in the order below, four types of rungs in the communication zone:

- Header rung
- Memory access rung(s, as needed)
- Command rung(s, as needed)
- Delimiter rung

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Figure 4.1 shows an example communication zone using these rungs.

Figure 4.1



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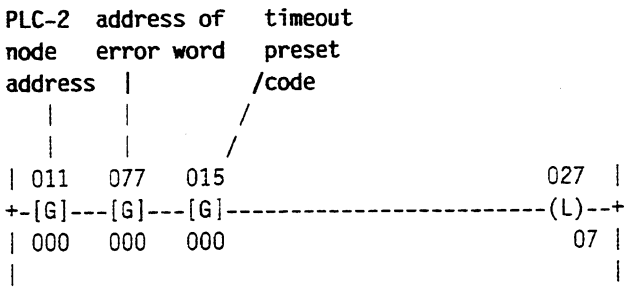
Header and Delimiter Rungs

You must use a **header rung** and a **delimiter rung** to specify the beginning and end of the communication zone. If you don't program these two rungs, the PROG indicator on the 1785-KA3 will light to signify a problem with the program.

Figure 4.2 shows an example of a header rung and a delimiter rung.

Figure 4.2

Header



Delimiter



The three GET instructions in the header rung specify the following:

- the Data Highway Plus node address of the 1785-KA3
- the address of the error word in PLC-2 data table memory
- timeout preset code

The node address (the first GET) must match the 3-digit number you selected with the address switches on the 1785-KA3 interface (see chapter 3). This address must be an octal number from 010 to 077.

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For the error word (the second GET), you can select any available word in the data table. The 1785-KA3 module will write any error codes into the word you select. For more information on the error word, refer to chapter 5.

You set the timeout preset code (the third GET) to provide a programmed timeout interval for the completion of commands sent from this node. Timeout preset monitoring is designed to signal any condition where the interface has not completed its communication with another node or detected some fault condition within a preset time. For more information on using the timeout preset, refer to chapter 5.

The header rung must consist of the three GET instructions and a latch 02707 instruction.

The delimiter rung must be programmed **exactly** as shown.

The latch and unlatch 02707 instructions in these rungs are interpreted as special codes. Word 027 is reserved for special functions such as this and cannot be used for other data table use.

Memory Access Rungs

Memory access rungs define the data table words that can be accessed by a remote node sending the following commands:

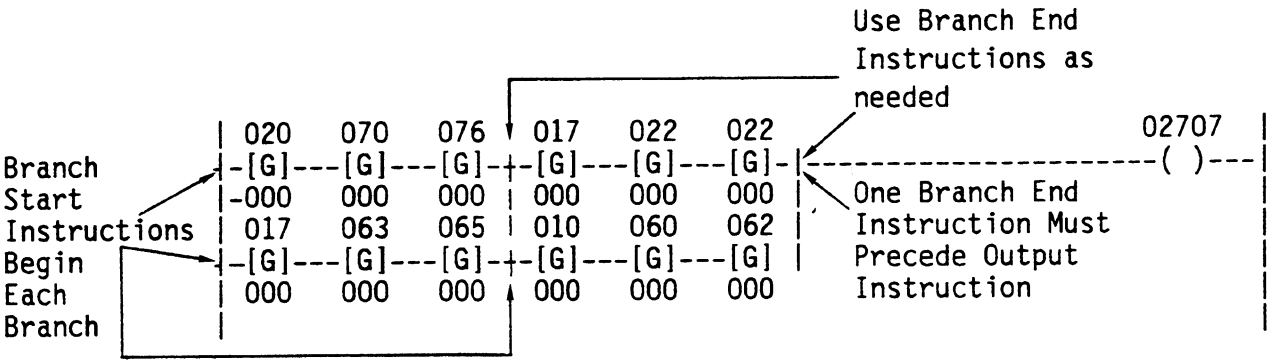
- protected block write
- protected bit write

Without memory access rungs, a PLC-2 does not accept protected commands from another node.

Important: You should use protected commands for most write operations between PLCs. Protected commands allow additional protection against writing to the wrong area of memory. See figure 4.3.

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Figure 4.3
Example Memory Access Rung



A memory access rung has one or more memory access branches. A branch start precedes a group of three GET instructions. The first is the node number of a remote node. The next two GET addresses define the area that can be accessed in the local PLC-2 data table memory. The remote node you specify in the first GET can use protected commands to control any bit or word within the area specified in the second and third GETs. One branch end instruction must precede the output instruction. You must end each memory access rung with an energize 02707 instruction.

Multiple memory access branches are listed in a single memory access rung. Each group of three GET instructions must be preceded by a branch start instruction. (This is true in all cases, even where only one memory access branch is defined.) Branch end instructions must be used to fit the memory access rung into the ladder diagram-display format.

In our example, the memory access rung allows the following nodes to control the following data table words using protected commands (all values in octal):

- Node 020 can control words 070-076
- Node 017 can control words 063-065 and word 022
- Node 010 can control words 060-062

One remote node may be identified in more than one memory access rung branch.

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Do not exceed the display area of the programming terminal when entering these rungs. More than one memory access rung can be programmed if needed. However, should you require multiple memory access rungs, you must enter them in succession in the communication zone, immediately following the header and before any command rungs.

Command Rungs

The **command rungs** direct the 1785-KA3 module to send command messages to a remote node. Each command rung lists the type of command and the memory areas affected. Once you have specified this information in a command rung, initiate the command execution in the user program by energizing the command rung's start bit.

The communication zone may have up to 255 rungs, including the header and delimiter rungs. A unique command rung is required for each command.

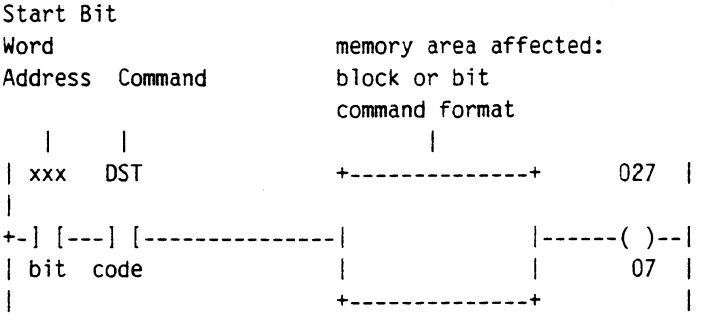
There are three command rung formats:

The **block command format** is for commands that transfer one or more data table words between nodes. These are unprotected block write, unprotected block read, and protected block write commands.

The **bit command format** is for commands that control one or more data table bits at another node. These are unprotected bit write and protected bit write commands.

Figure 4.4 shows the general format for these types of command rungs.

Figure 4.4



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The "OFF-LINK" command format is for sending commands across a bridge, such as a 1785-KA, to another network. The off-link commands can be either bit commands or block commands.

Figure 4.5 shows the general format for off-link commands.

Figure 4.5
Definition of Command Rungs

```
  The following is a definition of the command rungs that are allowed in
the 1785-KA3 -- PLC-2.

                SB     DST    ADD    ADD    ADD                  027
ONLINK  =   --| |---| |---[G]---[G]---[G]-----------------( )
                       CC

                    SB     DST    NODE  ADD    ADD    ADD           027
DHI-OFFLINK  =  --| |---| |---| |---[G]---[G]---[G]----------( )
                          17     CC

                    SB     DST    LINK  NODE  USER  ADD    ADD    ADD           027
DHII-OFFLINK =  --| |---| |---[=]---| |---[=]---[G]---[G]---[G]----------( )
                          16           CC

  SB = START BIT
  CC = COMMAND CODE
  DST = THE ONLINK STATION ADDRESS (85-KA IN DHI, OR 79-KP5 IN DHII)
  ADD = PLC ADDRESS LOCATIONS
  NODE = REMOTE DESTINATION STATION ADDRESS
  LINK = REMOTE DESTINATION LINK ID (FOR DHII, DHI DEFAULTS TO 00 00)
  USER = REMOTE DESTINATION USER NUMBER (FOR DHII, DHI DEFAULTS TO 00)

  The LINK and USER fields are actually 010 octal less then the number
given in the [=]. this is to allow for the numbers between 0 and 7 octal.
       EXAMPLE:
                    010
                    [=] IS ACTUALLY 0

                    011
                    [=] IS ACTUALLY 1

                    016
                    [=] IS ACTUALLY 6

                    021
                    [=] IS ACTUALLY 11
```

You must end each command rung with an output energize 02707 instruction.

The following subsections describe each element of the command rung.

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Examine Start Bit

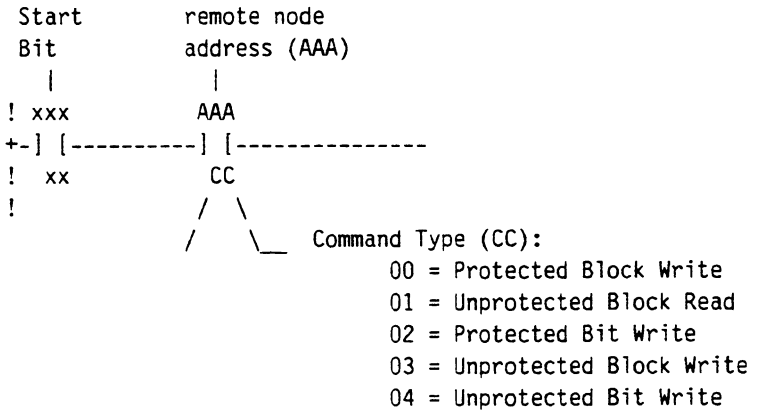
The first element of a command rung is an examine on instruction, addressing the start bit. Assign a unique start bit to each command rung. The start bits are examined by the 1785-KA3 module. When a start bit is on, the module carries out the programmed command.

Control the start bit through your ladder diagram program. Turn it on when you want to send the command message to the remote node. Refer to chapter 5 for guidelines on how to control the start bit from your ladder diagram program.

Command Code

The second element in a command rung is the command code. This element is an examine-on instruction. You use the command code to identify:

- the type of command
- the remote node address you are sending the command to

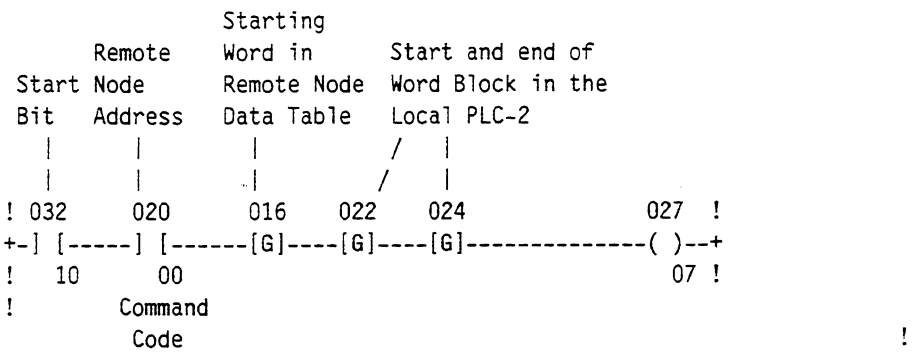


The command code uses an examine-on instruction, but does not examine or control any bit in the data table of the local node PLC.

Memory Areas Affected By Block Commands

When you enter a command code specifying a Protected Block Write, Unprotected Block Read, or Unprotected Block Write command, use the format shown.

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In the **block write** operation, the first GET in the command rung specifies the first word in the remote node's data table where memory is to be written. The second and third GET statements list the starting and ending words of the data you are writing from the local PLC-2 data table.

In the **block read** operation, the first GET element in the command rung specifies the first word in the remote node's data table where memory is to be read. The second and third GET statements list the starting and ending words in local PLC-2 memory where you will store the information.

In our example, the PLC-2 sends a protected block write command, 00, to node 020 (octal). Starting at word 016 (octal) of node 020, the PLC-2 writes words 022 to 024 (octal) from its own data table memory.

Only one set of GET instructions is allowed in a single command rung.

Memory Areas Affected By Bit Commands

When you enter a command code specifying a protected bit write or unprotected bit write command, use the format shown in figure 4.6.

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Figure 4.6
Bit Write Command Format

```
        Remote   Area may contain any legal combination
 Start  Node     of examine on/off instructions
 Bit    Address         |
   |     |   /---------------------\
! 032   017   120   120   120   120               027  !
!-] [---] [-+-] [---] [---] [---]/[-+-------------( )--+
!   11    02!   00    01    02    03!                07 !
!         CC!                       !                  !
!           ! 120   120   120   120 !                  !
!           +-] [---]/[---] [---] [-+                  !
!           !   04    05    06    07!                  !
!           !                       !                  !
!           ! 120   120   135   126 !                  !
!           +-]/[---] [---]/[---] [-+                  !
!               10    11    11    00                   !
```

Each examine element in this rung addresses a bit in the remote node. This format uses two types of examine instructions:

- o -] [- (examine on) -- instructs the remote node to turn the addressed bit on.

- o -]/[- (examine off) -- instructs the remote node to turn the addressed bit off.

These elements are programmed immediately following the command code.
Any combination of these elements may make up this type of command rung. Where necessary, branch start instructions and a branch end instruction may be used to fit these elements into the display area of the programming terminal. For practical reasons, do not exceed this display area. Multiple rungs of this type can be used as necessary.

In our example, the command rung turns **on** (1) bits 00, 01, 02, 04, 06, 07, and 11 of word 120, as well as bit 00 of word 126. The command rung turns **off** (0) bits 03, 05, and 10 of word 120, and bit 11 of word 135.

CAUTION: Do not use a bit write command to control:

- o a remote output bit that is controlled by the remote program

- o any bit that is in the same byte as bits controlled by a program

Such control could cause unexpected operation of devices on your network.

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Delivery Order of Commands

Important: If any node on a Data Highway, Data Highway Plus, or Data Highway II network initiates multiple commands (for example, the initiating node sets multiple bits at any one time), the order in which those commands are executed at the remote node cannot be guaranteed.

The initiating node, the network, and the receiving node execute commands that are based on network conditions, including but not limited to:

- nodes buffering commands
- re-tries due to noise on the network

If your application requires that commands be delivered in a specific order, your logic must control the initiation of one command at a time on the network and verify delivery before initiating additional commands. This verification is completed by:

- a done bit or an error bit in a PLC
- a reply message in a computer

A done bit or a successful reply should cause the next command to be initiated. If an error bit or a reply with non-zero status is returned, you must decide the appropriate action based on your application.

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Chapter 5
PLC-2 Programming:
How to Initiate and Monitor Command Execution

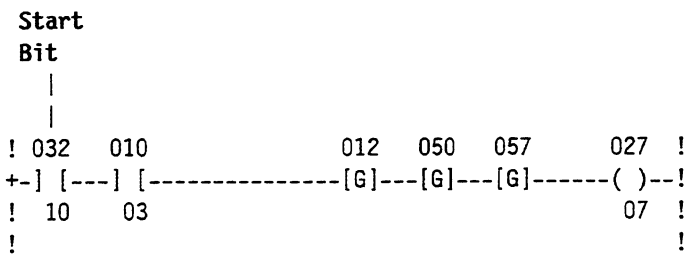
Chapter Objectives

This chapter tells you how to coordinate communication zone programming (chapter 4) with your application program.

Important: If you need to transmit commands to an Allen-Bradley PLC other than a PLC-2, refer to the user's manual for that PLC to learn how to address its data table. For a computer (and some PLCs) to accept commands from a PLC-2, you must provide a file at that remote node to simulate a PLC-2 Family data table.

How Your Program Controls Command Rungs

Here is a typical command rung from the communication zone:



This command rung sends an Unprotected Block Write command to node address 010, starting at word 012. For more information on command rungs in the communication zone, refer to chapter 4.

To send this command, an energize 032/10 command must be given. The following rung illustration shows how the start bit is energized from your application program when an arbitrary condition is satisfied.

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When your program energizes the start bit for a command rung, the command is sent. For more information on how to use a start bit to control a command rung, refer to the section entitled Using a Start Bit to Control Command Execution, later in this chapter.

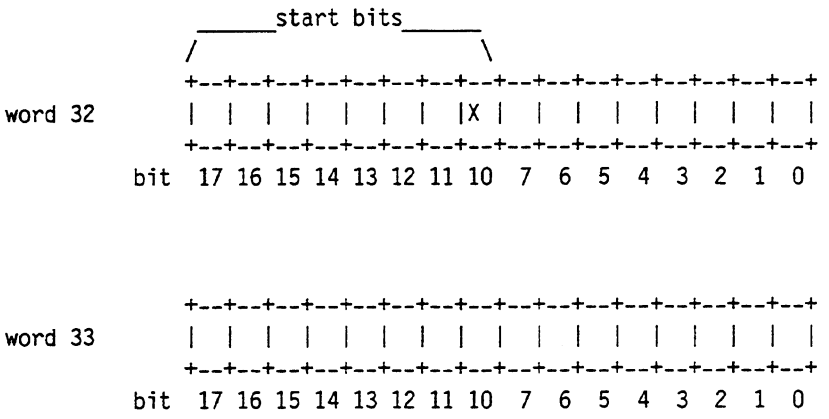
Choosing a Start Bit for a Command Rung

When you select a start bit for a command rung in the communication zone, you must choose a bit from the upper 8 bits (bits 10-17) of a word. After you choose a start bit, the module automatically reserves:

- the word the start bit is in
- the following word in the PLC-2 data table

These two words are known as **status words.** Each pair of status words can store the start bits for up to eight command rungs (bits 10-17 of the first word).

For example, if you use as your start bit for a command rung, bit 10 in word 32 of PLC-2 memory, the module uses words 32 and 33 as status words.



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When you are assigning start bits, follow these guidelines:

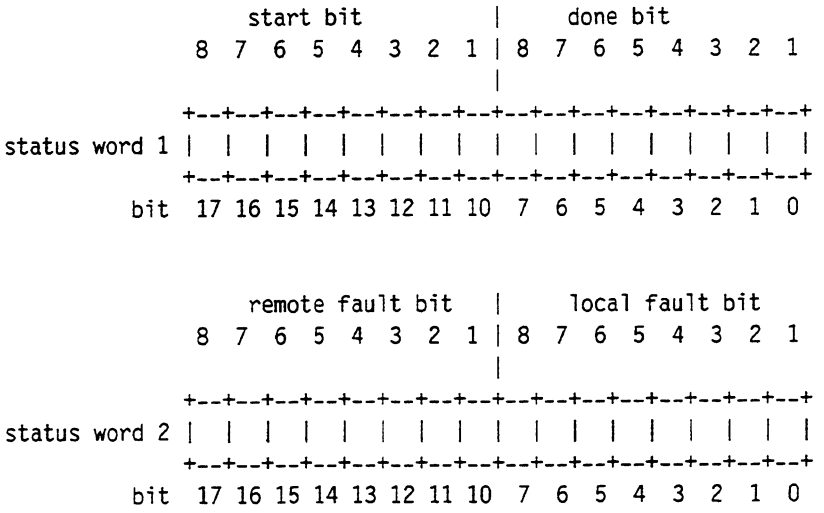
- Make sure the word that the start bit is in, and the word that directly follows, are not being used for another purpose.
- Do not use word 077 or the last data table word for start bits. These words do not have a word in memory that directly follows them.
- Use all eight start bits in one pair of status words before using another pair of status words.
- Try to assign the start bits sequentially. That is, the first command rung in the communication zone uses the first start bit, the second command rung uses the second bit, etc.

How the 1785-KA3 Selects the Other Status Bits

After you choose a start bit in your PLC-2 program, the 1785-KA3 module assigns three additional bits in the status words to help you monitor a command rung:

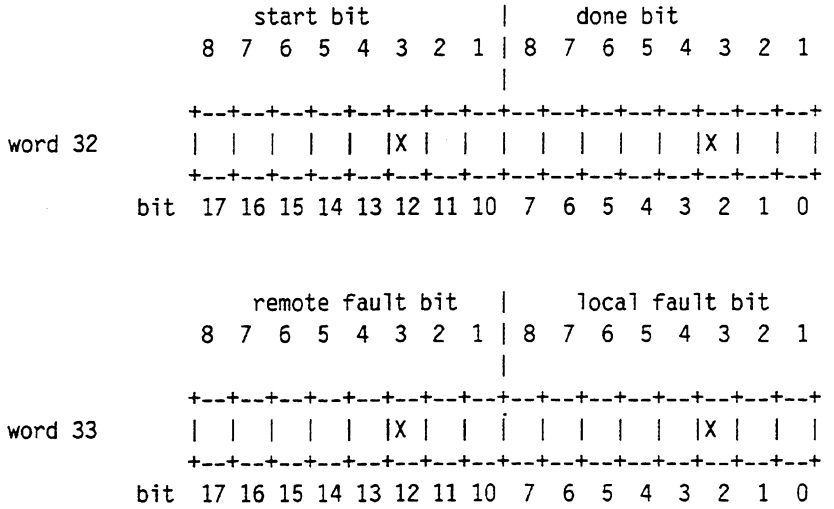
- a done bit
- a remote fault bit
- a local fault bit

The following illustration shows where the module stores these bits in a pair of status words.



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For example, if you choose bit 12 of word 32 as a start bit for a command rung, the 1785-KA3 assigns the other status bits as follows:



What is a Done Bit?

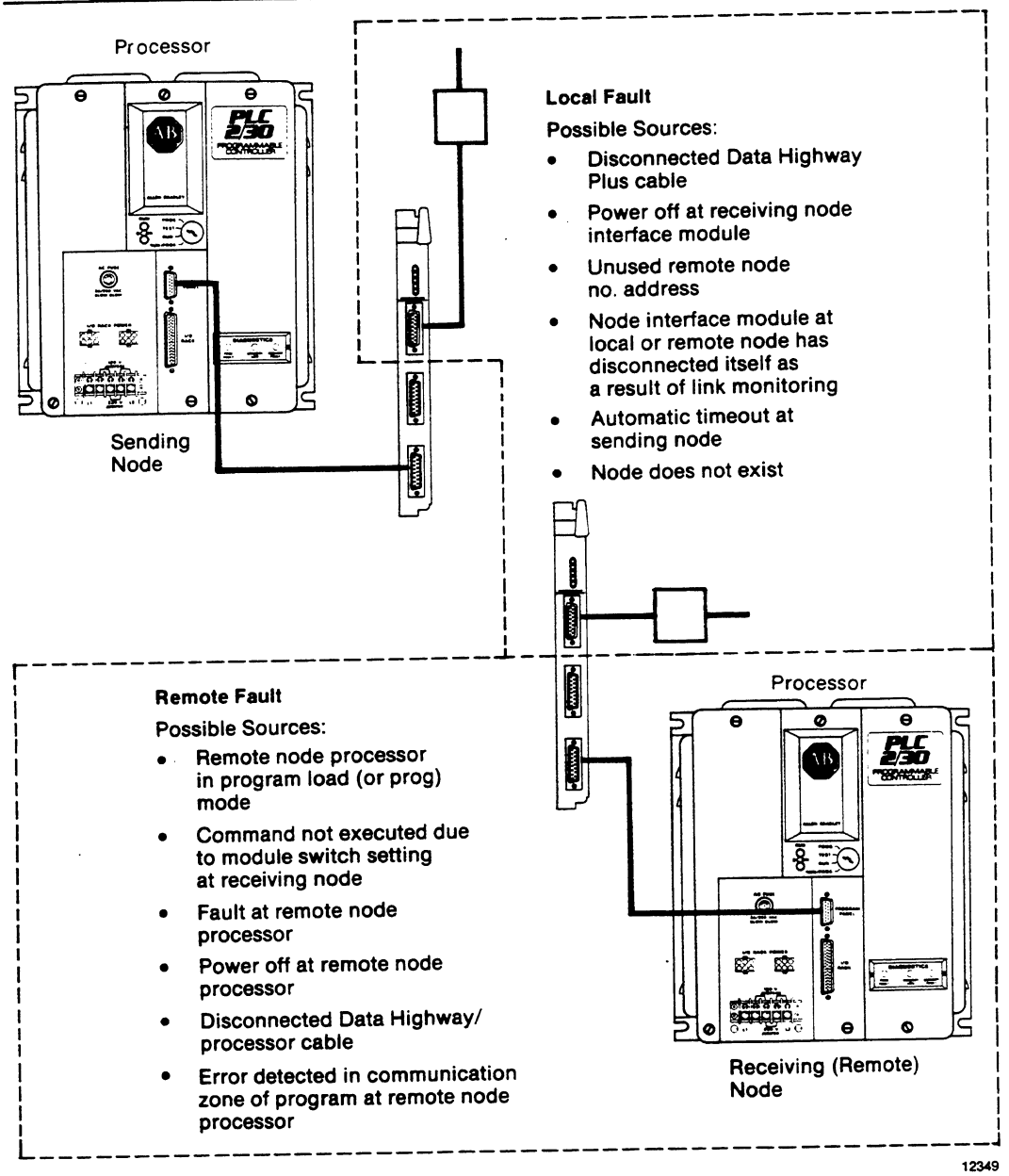
The done bit signifies that a command rung has successfully executed its command. The module sets the done bit when it receives acknowledgement that its command was executed successfully.

What are the Local and Remote Fault Bits?

A **remote fault bit** indicates that the remote module received a message, but could not communicate with its PLC to execute that command. A **local fault bit** indicates that the local node has not received a response from the remote node.

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REMOTE/LOCAL FAULT Bit Significance



How the Status Bits are Used for Communication

You must have the proper timing relationship of start bit, done bit, and fault bits when you initiate and terminate commands. The following sections describe the relationship of these bits in both normal and faulted operation.

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Timing of the Status Bits During Normal Operation

In a typical application, your PLC-2 program and the 1785-KA3 execute a command as follows:

1. Your PLC-2 program turns a start bit on, normally with a latch instruction.
2. The module detects that the start bit is on and begins the operations necessary to format and transmit a command message.
3. When the remote module receives the command message, it acknowledges it. Then, while normal operation continues, the remote module reacts to the command and prepares a reply message.
4. When the remote module receives the DH+ token, it transmits its reply message to the local node.
5. When the module receives the reply, it sets the done bit on at the local PLC-2. Your PLC-2 program must examine the done bit and, when the done bit or the fault bit is set, turn off the start bit.
6. After the start bit has been turned off, the module resets the done bit.

The following table summarizes the relationship between the start bit, the done bit, and the command.

Start Bit:	Done Bit:	The Command is:
0	0	idle
1	0	initiated or in progress
1	1	complete (including reply or error)
0	1	complete and acknowledged complete by the PLC. The module will reset the done bit on the next scan.

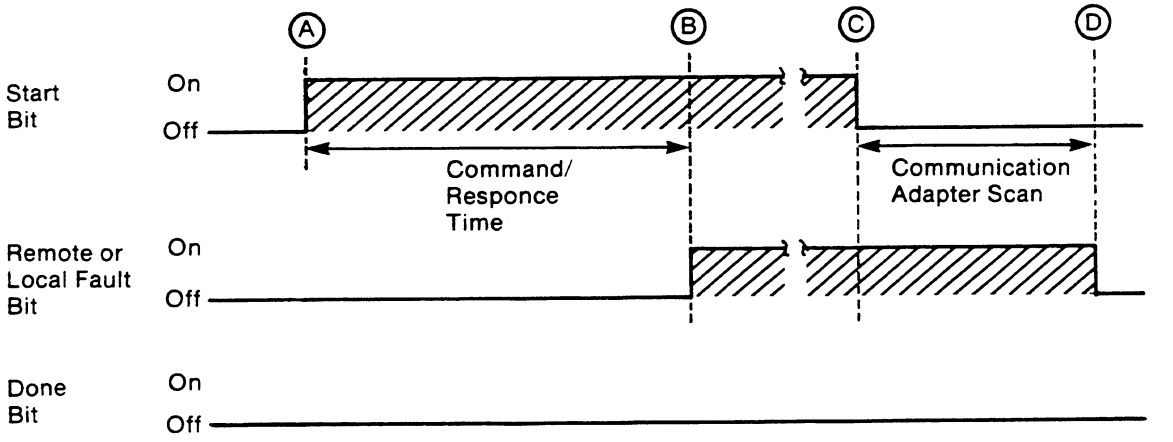
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Timing of the Status Bits During Faulted Operation

In a typical application, your PLC-2 program and the 1785-KA3 handle faulted operation as follows:

1. Your PLC-2 program turns a start bit on, normally with a latch instruction.
2. The module detects that the start bit is on and begins the operations necessary to format and transmit a command message.
3. The module detects a fault and sets the appropriate fault bit.
4. The program must turn off the start bit when it detects that the fault bit is on.
5. The module turns off the fault bit when it detects that the start bit has been turned off.

The following illustration shows the timing of the status bits during faulted operation.



Legend:

(A) Start bit turned on by the program

(B) Remote fault or local fault bit set on by the communication adapter module to indicate that a fault condition has been detected.

(C) Start bit turned off by program

(D) Fault bit turned off by the communication adapter module after it senses that start bit has been turned off.

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Once the fault bit is set, it remains on until your program turns off the start bit. The module must detect that the start bit has been turned off by the program before it will turn off the fault bit. The done bit is not set on if there is a fault condition.

If the start bit is turned off by the program before the module sets a done or fault bit, the module terminates the attempt to send the command. The local fault bit is pulsed on for approximately 100ms in this instance. This situation may occur, for example, if you program an event to unlatch the start bit before command completion.

Using a Start Bit to Control Command Execution

You control command rungs in your communication zone by setting start bits:

- **on** to initiate command execution
- **off** after command completion or after a fault is detected

To turn the start bit on, the program examines application conditions such as input/output device data, values, or other information from the controlled process. For the most part, a program uses one of these general types of application conditions:

- on or off status of a bit
- transition of a bit
- timed condition

The following subsections provide examples on how to turn a start bit on using the three techniques listed above.

To turn off the start bit, the program examines the response from the 1785-KA3 module. This response may be a:

- done bit
- remote fault bit
- local fault bit

When one of these bits are set on, your program should automatically turn off the start bit. We will discuss methods for monitoring the local and remote fault bits later in this chapter.

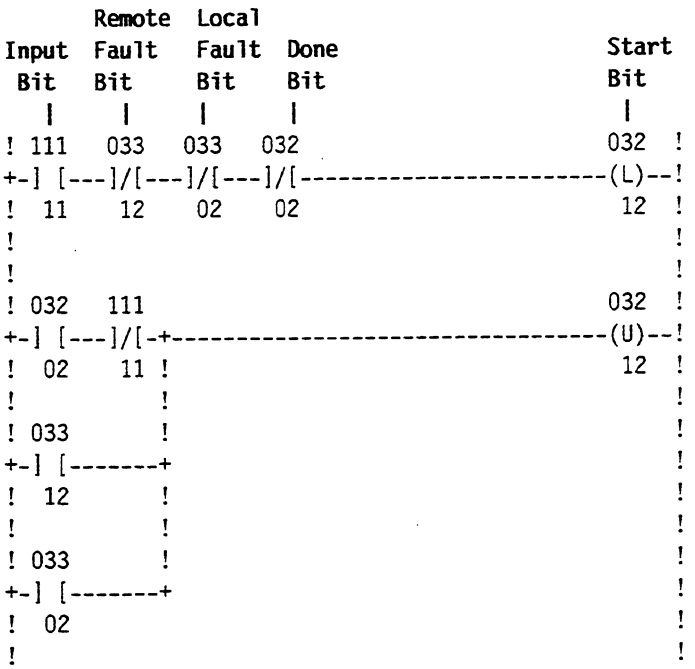
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Important: In the examples that follow, start bits are turned on with latch instructions and off with unlatch instructions. This technique is used because it is easy to explain, but is not necessarily the best technique for your application.

We also assume that the program that you write automatically re-tries transmission of a command in the event of a fault. In this case, only a done bit terminates an attempt to execute a command. Do not confuse the retry you use in your program with the re-try procedure of the module. The module automatically attempts three re-tries of a message before it sets a fault bit.

Using On/Off Input Status to Control the Start Bit

You can use the on or off status of an input device to latch the start bit. Example rungs used in this type of command initiation are shown below.



In this example, the first rung is programmed to latch the start bit when the input, bit 111/11, is on (provided that both fault bits are off). The second rung is programmed to unlatch the start bit if the module sets either the done bit or one of the fault bits to on.

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In normal operation, the start bit is latched by the input 111/11. The fault bits initially are off. This causes the module to format and send the command message. Then, when the command is completed, the module turns on the done bit. Input bit 111/11 must also be off to unlatch the start bit in this example. Input 111/11 must be turned off, then on again, to execute this command a second time. In normal operation, the start bit, after successful command completion, remains on until input 111/11 goes off. (Remember that the module holds the done bit on until after the start bit is turned off.)

Should a fault prevent normal execution, these rungs provide a programmed re-try of the command as long as bit 111/11 is on. A remote or local fault bit resets the start bit in the second rung. In the first rung, the start bit is latched again after the module resets the fault bit. (The module resets a fault bit only after the start bit has been turned off.)

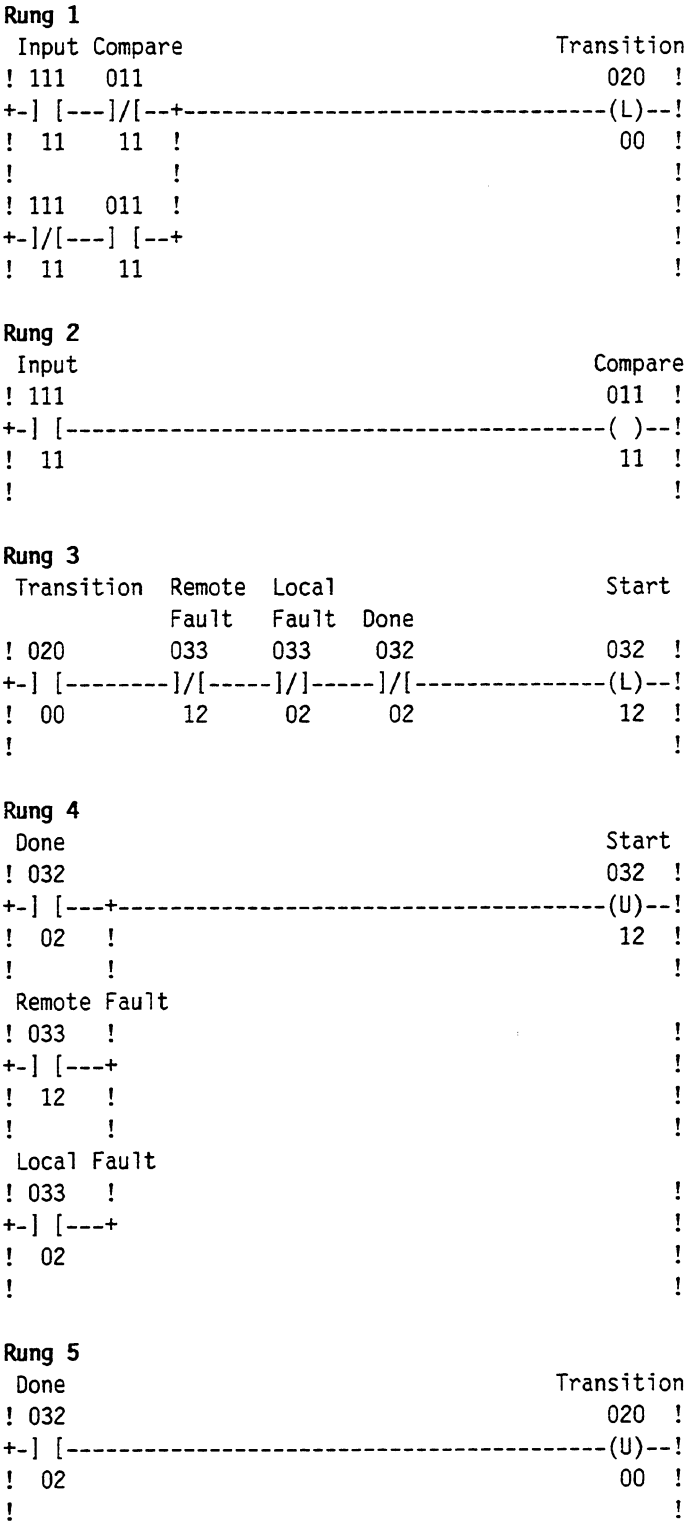
In some applications, it may be useful to send a command continuously between nodes. With the example above, you can accomplish this by eliminating the examine off instruction for input 111/11 in the second rung. This would cause the command to be sent continuously as long as input 111/11 remains on.

Even though the fault bits are continually reset with this method, their usefulness must not be overlooked. The section entitled **Monitoring Remote and Local Fault Bits** (later in this chapter) outlines a useful method to monitor fault bits (including the control of an output indicator based on fault bit status).

Using Transition of a Device to Control the Start Bit

You can use the transition of an input device (from on to off and from off to on) to latch the start bit. This allows you to send a command each time a condition changes state. The following example rungs show this type of command initiation.

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In this example, a storage bit, called the transition bit, is manipulated to control the sending of the command. This bit is latched whenever a transition of input 111/11 is detected, and unlatched only when the done bit is set on. A compare bit, 011/11 in this example, is used to manipulate the transition bit.

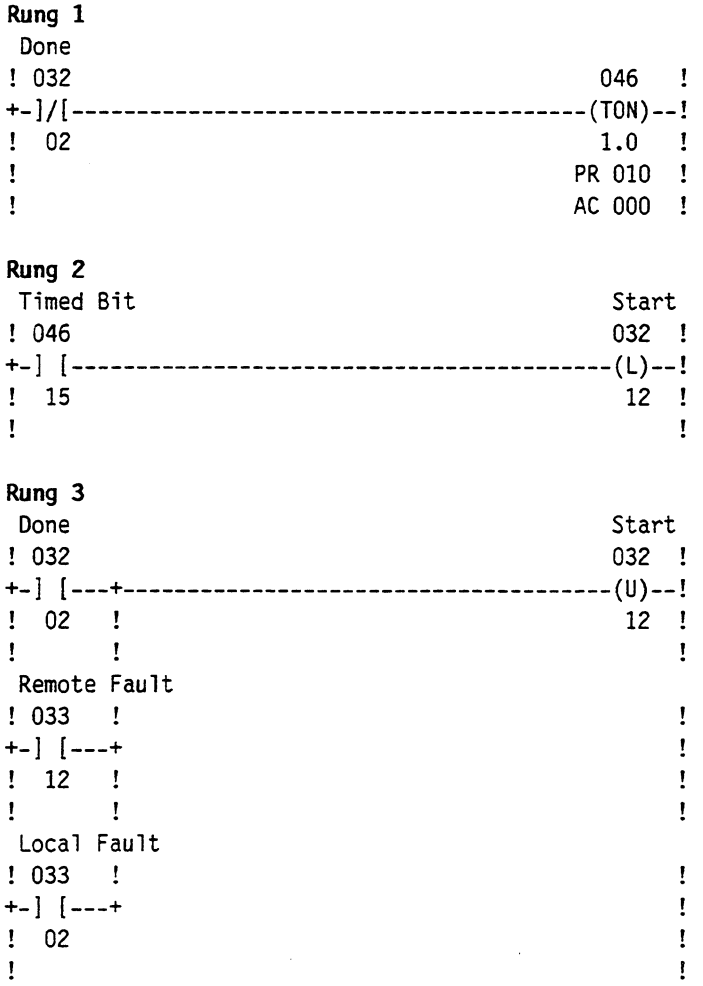
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In rung 2, the compare bit is controlled to match the on/off status of the input. Because the input and the compare bit are programmed to have matching states (both on or both off), the conditions of rung 1 can be true only when the input has just changed from on to off or from off to on. Thus, rung 1 conditions are sent only once, and are true only long enough to latch the transition bit. These rung conditions are false as soon as the PLC scans rung 2.

When the transition bit is latched, the start bit is latched in rung 3. This initiates the command. In normal operation, the done bit unlatches the transition bit in rung 4. In faulted operation, however, rung 3 repeatedly retries the command in much the same manner as in the previous example.

Using a Timed Bit to Control the Start Bit

You can use a timed bit to latch the start bit periodically, sending a command at a user-determined interval. The following illustration shows example rungs for this type of command initiation.



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In this example, timed bit 046/15 initiates the command at preset intervals (10 seconds). This bit is examined to latch the start bit. The start bit is unlatched when either the done bit, local fault bit, or remote fault bit is set on.

In normal operation, after the command is executed, the done bit is set on by the module. This causes the program to reset the timer and turn off the start bit. The timer then begins timing again once the done bit is off. (The module resets the done bit only after the start bit is turned off.)

This programming causes continuous retry of a command in the event of faulted operation.

Adding a Re-try Delay

When you use an automatic re-try (as we did in the previous examples) you can sometimes load the network unnecessarily. Message transfer attempts that result in local faults may take much more time than the normal message transfer time.

You can reduce the impact of automatic re-tries by providing a time delay before each re-try. The following illustration shows a transition-initiated command with a five-second time delay added.

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```
Rung 1
 Input Compare                                    Transition
! 111   011                                          020  !
+-] [---]/[--+-----------------------------------(L)--!
!  11    11  !                                      00  !
!            !                                          !
! 111   011  !                                          !
+-]/[---] [--+                                          !
!  11    11                                           !

Rung 2
 Input                                             Compare
! 111                                               011  !
+-] [-----------------------------------------( )--!
!  11                                              11  !
!                                                      !

Rung 3
 Transition  Timeout  Done                         Start
! 020        035      032                           032  !
+-] [--------] [-----  ]/]----------------------( )--!
!  00         15       02                           12  !
!                                                      !

Rung 4
 Local Fault
! 033                                               035  !
+-]/[---+-----------------------------------(TOF)--!
!  02   !                                          0.1  !
!       !                                        PR 050  !
 Remote Fault                                    AC 000  !
! 033   !                                              !
+-]/[---+                                              !
!  12                                                  !

Rung 5
 Done                                           Transition
! 032                                               020  !
+-] [-----------------------------------------(U)--!
!  02                                              00  !
!                                                      !
```

In this example, when the local or remote fault bit goes on, the timer starts. After the five second time delay, the start bit is turned on again to initiate an automatic retry of the command.

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Monitoring Remote and Local Fault Bits

The user program must monitor the remote and local fault bits for each command. This section describes various methods you can use to monitor fault bits.

Using Diagnostic Fault Rungs to Control a Fault Indicator Device

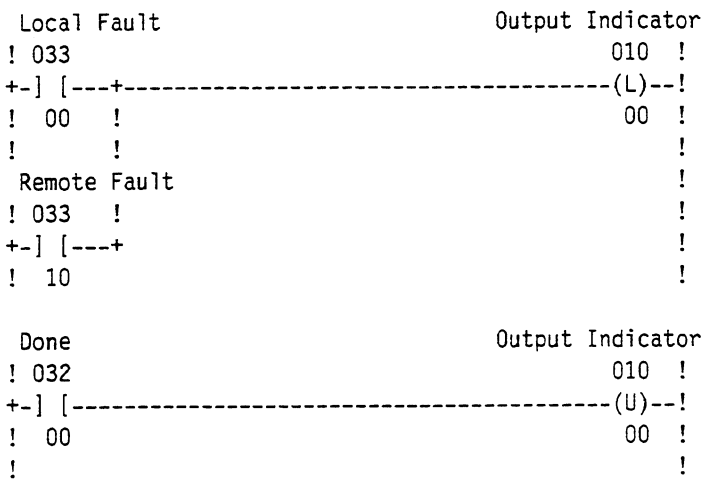
You monitor fault bits so that you can use output indicators to signal a fault condition. For example, if a fault bit is set, you can indicate that a fault has occurred with a device as simple as an A-B pilot light or as complex as a Dataliner message display.

By controlling the fault indicator device, the user program can alert personnel to the nature and location of a fault condition.

Because the fault bit can be constantly changing state at a rapid rate, the program must use some method of detecting this transient state of any fault bit and controlling the output device based on this state.

The following illustration shows a simple method you can use to control a fault indicator using your fault bits.

Figure 5.10
Fault Bit Diagnostic Rungs (Single Command)



In the example, either the remote or local fault bit can turn on the output indicator. The indicator remains on until the done bit is energized. The done bit unlatches the output indicator in the second rung. This example allows for the transience of the fault bits, since the first rung need only be true once for the output indicator to be latched.

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You can use the method in this example to monitor multiple commands from a node and control multiple output indicators as necessary. However, if more than one command is sent from a node, the use of multiple output indicators may not be practical. In this instance, a single output indicator can be used to signal all remote or local fault conditions for commands from that node.

The following example shows a method for controlling a single fault indicator for multiple commands.

```
Rung 1
! 033   033   033   033   033   033   033   033       055 !
+-]/[---]/[---]/[---]/[---]/[---]/[---]/[---]/[-------( )-+
   07    06    05    04    03    02    01    00        00 !

Rung 2
! 033   033   033   033   033   033   033   033       055 !
+-]/[---]/[---]/[---]/[---]/[---]/[---]/[---]/[-------( )-+
   17    16    15    14    13    12    11    10        01 !

Rung 3
 Local Fault                          Output Indicator
 Indicator
! 055                                              030    !
+-]/[---+-----------------------------------------(TOF)---!
!  00   !                                           0.1    !
!       !                                        PR 020    !
 Remote Fault Indicator                          AC 000    !
! 055   !                                                  !
+-]/[---+                                                  !
!  01                                                      !

Rung 4
 Timed Bit                                  Output Indicator
! 030                                                010   !
+-] [-----------------------------------------------( )--!
!  15                                                 00   !
!                                                          !
```

The preceding example shows the fault bit monitoring for eight commands. The eight local fault bits are monitored in rung 1. As long as all eight bits are off, status bit 055/00 remains on. However, should any local fault bit be on, status bit 055/00 is de-energized. In rung 2, the eight remote fault bits are monitored in the same manner to control status bit 055/01.

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The status bits controlled by rungs 1 and 2 are used to control an off-delay timer in rung 3. The off-delay timer begins to time when either of the status bits goes from off to on (when rung conditions go from true to false). Bit 030/15, the timed bit of the timer, controls the output indicator. As soon as the conditions of the indicator in rung 3 are true, this bit is set on, causing the indicator to be energized. Once on, this bit remains on as long as the timer is timing, that is, for at least as long as the preset interval. In the example, this preset is two seconds. It is recommended that this value is set at no less than 0.5 seconds.

The off-delay timer is useful in this application because it is continually reset when its rung conditions go true. This means that the timed bit, bit 030/15, remains on for as long as any fault bit is changing state during programmed retries. This keeps the output indicator on until after the done bit indicates command completion.

Important: Using the rungs of the previous example, the indicator goes on automatically at power-up, or whenever the mode select switch on the processor is changed from PROGRAM LOAD to any other position. However, the indicator only remains on initially for the preset interval. After this time, the indicator is valid for fault conditions.

Of course, other methods can be used to monitor remote and local fault bits. Such factors as availability of output terminals, memory space, and type of application dictate the specifics of fault bit monitoring and program response.

The use of fault bits in start-up and troubleshooting procedures is described in chapter 6.

Synchronizing Bits to Monitor Fault Bits

The 1785-KA3 module's scan and its control of the fault and done bits is asynchronous to the PLC-2's scan and its control of the start bits.

In the examples discussed so far, as in most applications, this lack of synchronization does not present any problems. However, you may want to use the PLC program to count the number of times a fault bit turns on or to store the error code each time a fault bit turns on. Because of the asynchronous relationship, you may not be able to do these types of functions accurately by examining fault bits directly.

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Instead of examining the fault bits directly, use a GET/PUT rung at the beginning of the program to copy the fault word into another word. You can then examine the corresponding bits of the other word any time during the program scan to determine the status of the fault bits as copied at the beginning of the program scan. Even though the 1785-KA3 module may change the state of fault bits in the middle of a program scan, the status of the bits in the copy word will not change until the start of the next scan.

Using a Timeout for Replies to Commands

When you use a 1785-KA3, you can use two types of timers to help monitor the replies from remote nodes:

- the 1785-KA3 preset timer set in the header rung of your communication zone
- a timer that you program in your PLC-2 program

The following sections describe these two types of timers.

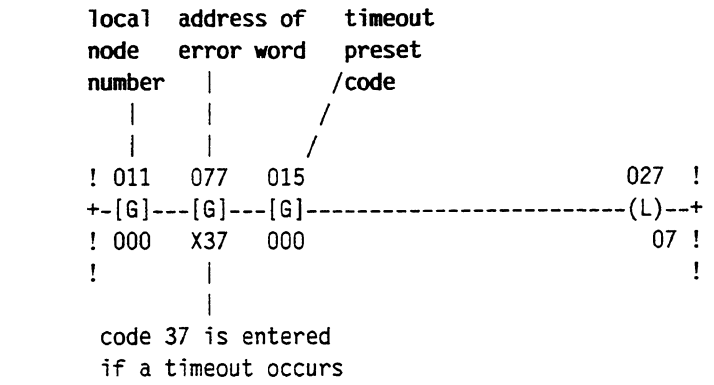
The 1785-KA3 Timeout Preset

The 1785-KA3 module provides an automatic timer for monitoring command completion. This feature enables the module to monitor command execution time without using timer (TON) instructions in the user program.

If you set the start bit for a command rung and do not receive a reply (either a done or fault bit) within the preset time limit, the 1785-KA3 will automatically return a local error to your program.

You program the value of the preset timer by inserting a preset timer code in the header rung of the communication zone. The following example shows the header rung in the communication zone.

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You obtain the timeout preset code by:

- o determining the number of seconds you want the time delay (in decimal, must be above 1 second)
- o converting this number to octal
- o adding 10 (octal)

For example, if you wanted a 9 second time delay, you would convert 9 to an octal number and add 10 octal:

9 decimal = 11 octal
11 octal + 10 octal = 21 octal

The following table lists the 3-digit codes for intervals from 2 to 10 seconds. The tolerance of this timer is plus 0 and minus 1 second.

Timeout (seconds):	Code:
2	012
3	013
4	014
5	015
6	016
7	017
8	020
9	021
10	022

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From the time the start bit is set on, the 1785-KA3 module must set either a done bit or a remote or local fault bit within the timeout preset interval. Should the module detect no done or fault bit response within the preset interval, a fault is assumed. As a response to this type of timeout situation, the module turns on the local fault bit and enters the value 37 in the lower byte of the error word defined by the header rung. The error word is discussed later in this chapter. For more information on the header rung and the communication zone, refer to chapter 4.

Because this timer is intended as a backup for some local fault type of situation, its preset value is not critical. In the examples of this publication, a nominal value of 5 seconds, (coded 015) is programmed as the timeout preset value. This value is appropriate for most small systems or when initially starting-up a system with only a few nodes. This value may need to be increased for larger systems.

System factors that may cause you to increase this timeout preset include:

- an increase in the number of nodes on the network
- noisy links
- modems with long turnaround times

The appropriate timeout is dependent on these system factors. If you consistently receive error 37 (timeout fault), increase the timeout preset interval until the number of occurrences of error 37 is significantly reduced.

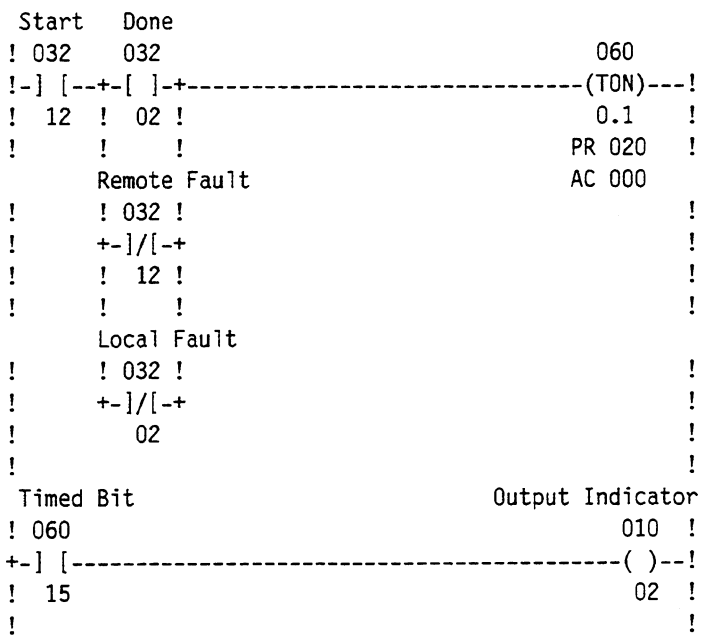
User-Programmed Timeout (Optional)

The automatic timeout of the module is a backup function. The automatic monitoring routine checks module interaction with other nodes, but does not check module communication with its own PLC. For a backup check on module/PLC communication, you might use an optional programmed on-delay timer instruction (TON).

The module relies on sending a local fault bit to the PLC after it reaches the preset timeout. However, in the event of faulted module/processor communication or faulted module operation, a response bit might not be set. Instead, the start bit would remain on in this instance until the fault situation was corrected.

You can use several programming methods to detect this condition. The simplest of these methods uses an on-delay timer. The following example shows typical rungs that you can program for this purpose.

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In the first rung of this figure, timer 060 times the interval between the setting of the start bit for a command and the done, local fault, or remote fault response of the module. If no response is received within the preset interval of this timer (10 second in our example), a fault may be indicated and bit 060/15 set on.

The second rung examines this bit to turn on an annunciator. Depending on the individual application, you could also use this bit to enable or disable various parts of the program.

The preset value of this programmed TON instruction is not critical. For this type of backup monitoring, the programmed preset must exceed the preset timeout interval (entered as a code in the header rung).

This user-programmed timeout is useful as a backup to the other monitoring functions of the 1785-KA3 module. Remote and local fault bits at other nodes indicate the same types of faults that can be detected using a user-programmed timeout. A programmed timeout would not be necessary for each command from a node. Instead, you can monitor a single command at each node in this manner. For this type of monitoring, select a command that is sent regularly.

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There may be other instances where program monitoring of commands is useful. In some cases, you might program a timeout to monitor the execution time of critical commands. An application may require that a critical message be sent within a certain limited amount of time. You can program a TON instruction for this purpose. In this example, however, its preset interval will generally be shorter than the interval entered as the timeout preset for the module.

Using the PLC-2 Error Word

When the 1785-KA3 cannot carry out a command due to a programming error or a discrepancy in data, it writes an error code to the lower byte of the PLC-2 error word.

You select the address of this error word in the header rung of the communication zone (see Chapter 4). This word stores the most recent error code written by the module.

We can group PLC-2 errors into five classes:

Error Numbers:	Error Type:	Description:
1-29	Syntax errors	errors in programming communication zone rungs. The module checks for these errors when you power it up and when you turn the processor mode select switch from PROGRAM to RUN. If it detects a syntax error, the module turns on its PROG Indicator and shuts down. The module cannot detect errors in the header rung of the communication zone. If the header rung is incorrect, the module assumes that no communication zone exists.
30-36	Message Formatting errors	errors that the module detects when it attempts to format a command message but before it actually tries to transmit the message. For some of these errors, the module turns on its PROG indicator and shuts down.
37, 50-59	Reply errors	errors that the local module detects in reply messages it receives from other stations. These include the timeout error (number 37), which occurs when the local station receives no reply message at all for one of its command messages.

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Error Numbers:	Error Type:	Description:
80-89	Remote errors	errors that a remote station might report in its reply to a command message from the local station. The local station module copies this code into the error code storage word at the local PLC-2. The local module also sets a remote fault bit in the local PLC-2's memory.
90-99	Local errors	errors that the local station module detects as it tries to transmit a command message. When one of these errors occurs, the module sets a local fault bit in PLC memory.

A code value of zero indicates a successful transmission. For a list of PLC-2 error codes and their meanings, refer to Appendix B.

The upper byte (first two digits) of the PLC-2 error word has one of two uses, depending on the error code:

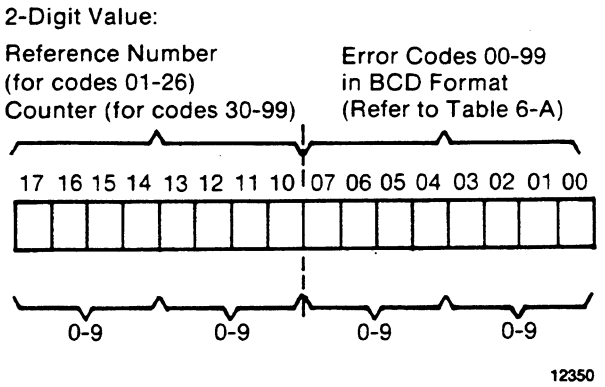
- for errors 01 to 29 -- it represents the rung number where the error occurred within the communication zone of the program. The first rung in the communication zone is rung 00, and subsequent rungs are numbered sequentially.
- for errors 30 to 99 -- it represents a count of the different errors reported by the module. This counter is incremented each time a subsequent error occurs.

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The header rung of your communication zone displays the lower three digits of the error word (the two-digit error and the lower counter digit). You may wish to externally display the 2-digit error code on a seven-segment LED display (controlled by output modules). This external display, mounted at your operator's station, may make it easier to spot an error.

Important: Error codes 8A and 8B are not displayed correctly on some seven-segment displays.

The following illustration shows the structure of the error word.



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Chapter Objectives

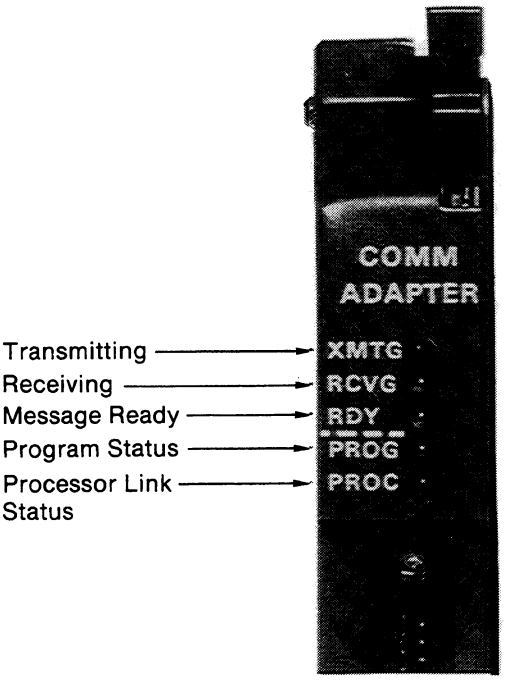
In this chapter, we provide information on using:

- LED indicators on the front of the 1785-KA3
- the 1785-KA3 diagnostic status bytes and a list of the status information
- the 1785-KA3 diagnostic counters and a list of the counters

Using the LED Indicators

Figure 6.1 shows the LED indicators on the front panel of the 1785-KA3 module. These indicators can help you in diagnosing problems with the module's installation and operation.

Figure 6.1
The LED Indicators



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The 1785-KA3 has 6 indicators on its front panel that provide you with the following diagnostic information:

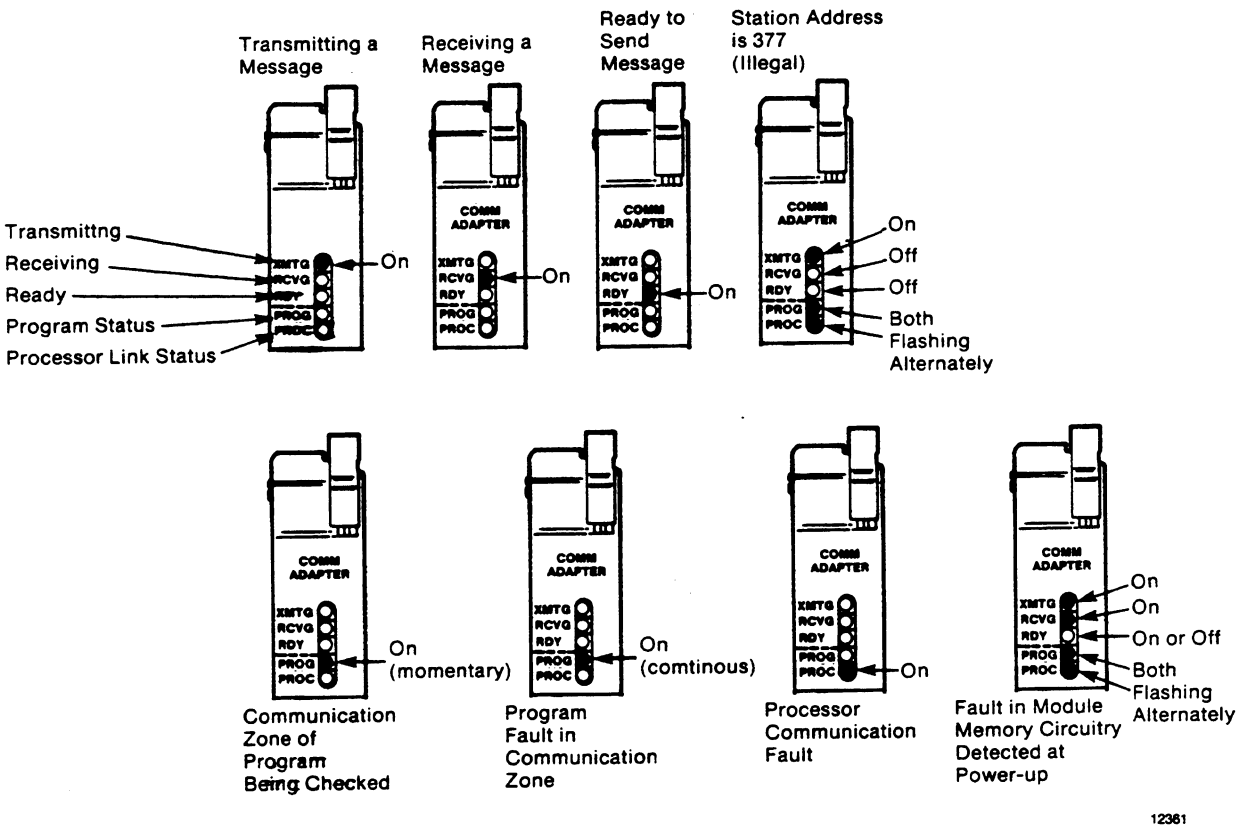
This Indicator:	Lights When:
XMTG	the module has the token and is transmitting a command or reply message on the network
RCVG	the module is receiving a command or reply message from another node on the network
RDY	the module has a message in its transmit buffer and is waiting to acquire the token so it can transmit the message
PROG	the 1785-KA3 is checking the communication zone rungs (chapter 4) for errors. If the module finds an error, the indicator remains on and communication to Data Highway Plus is disabled. When this occurs, check the error word (chapter 5) to see if it contains an error code. The 1785-KA3 checks the communication rungs: o on power up o when the PLC-2 is switched from PROG mode to TEST or RUN mode o after a privileged write command is executed o when the cable is reconnected between the module and the PLC-2 If the PROG light does not light at these times, the node address in the header rung may not match the node address set on the module.
PROC	A communication problem exists between the module and the PLC-2, such as: o the cable between the module and PLC-2 is disconnected o the PLC-2's power is OFF o there is a fault in PLC-2 operation o the processor link communication rate is incorrectly set on the module If both the PROG and PROC indicators are on at the same time, change the mode on the PLC-2 to PROG and then back to RUN to reset the module.

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If the 1785-KA3 is on Data Highway Plus and the RCVG LED remains lit and the XMIT LED appears to flicker, the module is passing the token or sending messages.

Figure 6.2 shows how the indicators react under specific situations.

Figure 6.2
Examples of How the Indicators React



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1785-KA3 Diagnostic Status Bytes

Diagnostic status bytes contain information about the module and Data Highway Plus.

To read the status bytes, you send a Diagnostic Status command from a computer on your Data Highway Plus network. For information on how to read diagnostic status bytes, refer to the Data Highway/Data Highway Plus Protocol and Command Set Reference Manual (publication 1770-6.5.16).

Diagnostic status bytes can be read from an intelligent device (computer) connected to your network. The following table contains a list of the 1785-KA3's diagnostic status bytes:

Byte:	Bit:	Meaning:
1		**Operating status of PLC-2**
	0-2	0 = Program load mode 1 = Test mode 2 = Run mode 3 = (not used) 4 = Remote program load 5 = Remote test 6 = Remote Run
	3	0 = Normal communication 1 = No communication with PLC-2
	4	0 = Normal 1 = Download mode
	5	0 = Normal 1 = Format error in communication zone of PLC-2 program
	6-7	Always zero
2		**Type of interface module and processor:**
	0-3 4-7	D = 1785-KA3 1 = PLC-2 processor 2 = PLC-2/20 (LP1) processor 3 = Mini-PLC-2 processor 5 = PLC-2/20 (LP2) processor 6 = PLC-2/15 processor 7 = PLC-2/30 processor E = The next byte is an expansion of the processor field
		Expansion of Byte 2, Bits 4-7
2'	all	1D = PLC-2/02 processor 1E = PLC-2/05 processor 1F = PLC-2/16 processor 20 = PLC-2/17 processor

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Byte	Bit	Meaning:
3-4	all	Octal address of the start of PLC program.
5-6	all	0 = not used
7-8	all	Starting byte address of diagnostic counters and timers.
9		Series and revision level of interface module.
	0-4	0 = Revision A 1 = Revision B, etc.
	5-7	0 = Series A 1 = Series B, etc.
10		Settings of the option switches on the node interface module.
	0-1	0 = Undefined 1 = Undefined 2 = Undefined 3 = 57,600 bits per second baud rate for Data Highway Plus
	2	0 = PLC-2 processor 1 = All other PLC-2-Family processors
	3	0 = Protected commands disabled 1 = Protected commands enabled
	4	0 = Unprotected commands disabled 1 = Unprotected commands enabled
	5	Not used
	6	0 = Physical writes disabled 1 = Physical writes enabled
	7	0 = Transmission unprotected command disabled 1 = Transmission unprotected commands enabled
		Terminal Information
11	0	0 = disconnected 1 = Local connected
	1	0 = Remote terminal not editing 1 = Remote terminal editing
	2	0 = Local terminal not editing 1 = Local terminal editing
	3-7	Not used

(continued)

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12	0-2	= Number of I/O racks being used by the PLC-2 processor
	3	0 = No bits being forced on or off 1 = At least one bit of I/O being forced on or off
	4-7	Not used

1785-KA3 Diagnostic Counters

The following sections tell you:

- what a diagnostic counter is
- how to read diagnostic counters
- what 1785-KA3 diagnostic counters contain

A Diagnostic Counter

A diagnostic counter records an event for debugging the module and for longer term reliability analysis.

The diagnostic counters occupy a block of the module's internal scratch RAM. Most are single byte counters that reset to zero when they overflow. The module has counters that provide a useful tool for diagnosing problems.

How to Read Diagnostic Counters

To read diagnostic counters, you must issue a **Diagnostic Read** command. This command can only be sent from a device:

- connected to the network through an interface module asynchronous port
- that can format the diagnostic commands

Therefore, a PLC user program is unable to initiate a Diagnostic Read command.

Important: The location of the diagnostic counters in a module varies:

- from module to module
- between revision levels of the same type module

You must first request the location of these counters by transmitting a **Diagnostic Status** command to the module. Based on the address returned, you can use the number of the counters which follow as an offset to calculate:

- the location of a particular counter
- how many counter values you want returned

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You can then use this information to format a **Diagnostic Read** command. The reply from the Diagnostic Read command contains the data stored in the counters.

For more information on the Diagnostic Status and Diagnostic Read commands, refer to the Data Highway/Data Highway Plus Protocol and Command Set Reference Manual (publication 1770-6.5.16).

1785-KA3 Data Highway Diagnostic Counters

The following table contains a list of 1785-KA3 Data Highway diagnostic counter bytes and what they contain (all two byte counters are read low byte first).

Counter Byte:	Counts the Number of Times:
0	received ACK with bad CRC
1	timeout expired with no ACK received
2	transmit retries exhausted
3	NAK/illegal protocol operation received
4	NAK/bad LSAP received
5	NAK/no memory received
6	received ACK/NAK too short
7	received ACK/NAK too long
8	something other than an ACK/NAK received
9	duplicate token found
10	duplicate node found
11	token pass timeout
12	token pass retries exhausted
13	claim token sequence entered
14	token claimed
15	bad CRC in received frame
16	NAK sent -- illegal protocol operation

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Counter Byte:	Counts the Number of Times:
17	NAK sent -- bad LSAP
18	NAK sent -- no memory
19	received frame too short
20	received frame too long
21	received a retransmission of a frame
22	received frame aborted (line noise)
23,24	message successfully sent (low byte first)
25,26	message successfully received (low byte first)
27,28	command successfully sent (low byte first)
29,30	reply successfully received (low byte first)
31,32	command successfully received (low byte first)
33,34	reply successfully sent (low byte first)
35	reply could not be sent (low byte first)
36	number of active nodes
37	breaks sent to the IT
38	PLC-2 resyc's
39	number of T3 errors to go before force table cleared (max = 5)
40	number of edit connections requested
41	number of edit connections granted
42	number of edit connections timed out

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Module Location:
- o Any I/O module slot of a 1771 I/O chassis except furthest left

Backplane Power Supply Requirement:
- o +5V DC at 1.2A

Keying (Top Connector):
- o Between 4-6
- o Between 22-24

Compatible PLC-2 Family Processors:

o	PLC-2	1771-LR
o	Mini-PLC-2	1772-LN1,-LN2,-LN3
o	Mini-PLC-2/02	1772-LZ,-LZP
o	Mini-PLC-2/05	1772-LS,-LSP
o	PLC-2/15	1772-LV
o	PLC-2/16	1772-LX,-LXP
o	PLC-2/17	1772-LW,-LWP
o	PLC-2/20	1772-LP2
o	PLC-2/30	1772-LP3

ENVIRONMENTAL CONDITIONS

Ambient Temperature Rating:
- o Operational: 0o to 60oC (32o to 140oF)
- o Storage: -40o to 85oC (-40o to 185oF)

Relative Humidity Rating:
- o 5% to 95% (without condensation)

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Appendix B
PLC-2 Error Codes

This appendix lists the error codes that the 1785-KA3 may send to the error word in the PLC-2 ladder diagram program. For more information on the error word, refer to chapter 5.

Low Byte: (hex)	Local Fault:	Remote Fault:	Meaning of Code:
00			No error.
02			Processor fault.
03			module ran out of internal memory space. This error can occur if the communication zone is too large. Try using fewer communication zone rungs.
04			First GET instruction incorrectly entered in memory access rung.
05			Invalid node number used in a memory access rung.
06			Second GET instruction incorrectly entered in memory access rung.
07			Third GET instruction incorrectly entered in memory access rung.
08			Starting address for memory access boundary (second GET) is greater than ending address (third GET).
09			Branch-end missing in memory access rung.
10			Output instruction missing at end of memory access rung.
11			Invalid first element in a communication zone rung.
12			Invalid address for start bit. Start bits must be in the upper byte (bits 10-17) of a word.

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Low Byte: (hex)	Local Fault:	Remote Fault:	Meaning of Code:
13			Invalid second element in a command rung.
14			Invalid command code.
15			Invalid node number in command rung.
16			Invalid element in bit write command rung.
17			First GET instruction incorrectly entered in word read or write command rung.
18			Second GET instruction incorrectly entered in word read or write command rung.
19			Third GET instruction incorrectly entered in word read or write command rung.
20			Output instruction missing at end of word read or write command rung.
21			Invalid beginning of command rung, or memory access rung follows command rung.
22			Local/remote fault word is outside the data table (start/done word incorrectly chosen).
23			Transmission of unprotected commands is disabled by switch settings.
26			Too many command rungs (255 is maximum).
27			Timeout setting too large. Valid timeout settings are 011 to 407. A setting of 010 disables the timeout.
28			Bad address in command rung.
29			Bad size in read/write command.
30			Processor memory discrepancy.
31			Communication problem on link between 1785-KA3 module and processor. May be processor fault.
32			Improper command message size.
33			Invalid command code.
34			Invalid node number.
35			Attempt to send unprotected command invalid.

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Low Byte: (hex)	Local Fault:	Remote Fault:	Meaning of Code:
36			Local processor turned off the start bit before the module set the done bit.
37			Transmission timed out because the local node did not receive a valid reply to its command. Frequent occurrence of this error might indicate that the timeout period is too short. A minimum timeout of 2 seconds is recommended.
38			Local processor entered the program mode.
50			Processor fault occurred at local node while module was processing a reply message.
51			Reply message contains invalid value in low byte of TNS field.
52			No communication zone in PLC program.
53			Module received a reply message for which the start bit is OFF. This error occurs if the processor turns OFF the start bit or if the timeout period is too short. This error often occurs after error 35 or 37.
55			Reply message received when module PROG indicator was ON or when processor was in program mode.
56			Reply message contains an invalid value in the high byte of the TNS field. This error occurs if the start bit is turned OFF and back ON before the done bit is turned ON.
57			Reply message is of incorrect size.
81	on		Invalid command due to error in CMD byte, FNC byte, size byte, or overall size of command message.
83		on	Processor fault or disconnection at remote node.
84		on	Remote node module could not communicate with its associated processor.

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Low Byte: (hex)	Local Fault:	Remote Fault:	Meaning of Code:
85		on	Access denied at remote node. This error occurs if the local node tries to access a word outside the remote node's data table, or if the local node sends a protected command bit for which the remote node's memory access rungs do not give the local node any access.
86		on	Execution of the command message is disabled by switch settings at the remote node.
87		on	The remote node processor is in program mode or is in the process of being downloaded from another node.
88		on	Remote node is in error shutdown mode. This error can occur if the remote module's PROG indicator is on.
89		on	Remote node interface module is out of buffer space and cannot store the received command message.
8B		on	Remote node is in download mode, or error in download command, or operation not allowed in upload or download mode, or operation not allowed when not in download mode.
92		on	Remote node fails to respond. This error occurs when the module has exceeded its maximum number of times to retry transmitting a command message. This error does not necessarily mean that the remote node did not receive the command message. If the remote node did receive the command, the local module may still set a done bit when it receives the proper reply.

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Appendix C
Switch Setting and Command Listing Record Forms

This appendix contains forms that you can use to keep track of:

- your 1785-KA3 switch settings
- commands sent to the 1785-KA3
- commands sent from the 1785-KA3

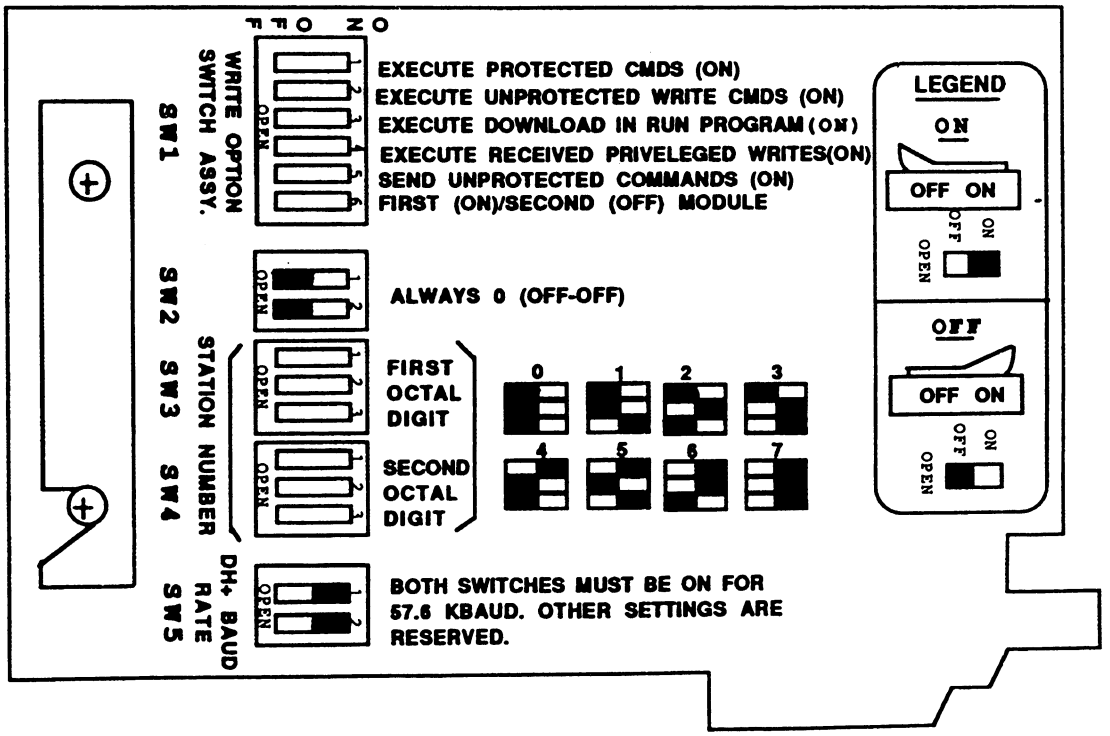
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Allen-Bradley Data Highway

SWITCH SETTINGS
COMMUNICATION ADAPTER MODULE
CAT. NO. 1785-KA3

Node No._____

PROPOSED LAYOUT FOR 1785-KA3
REAR PANEL SILKSCREEN (5-22-89)



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ALLEN-BRADLEY
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DATE: _____

BY: _____

Allen-Bradley Data Highway
COMMAND LISTING — TO NODE

Node No: _____

DIRECTIONS: USE THIS FORM TO DOCUMENT COMMANDS RECEIVED AT THIS NODE FROM OTHER NODES

EXAMPLE:

REMOTE NODE SENDING COMMAND NODE NO:	COMMAND TYPE	DATA WRITTEN TO ADDRESS(ES)	COMMENTS
010	WRITE	023-025	TEMP. VALUES

REMOTE NODE SENDING COMMAND NODE NO:	COMMAND TYPE	DATA WRITTEN TO ADDRESS(ES)	COMMENTS

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DATE: _____

BY: _____

Node No: _____

Allen-Bradley Data Highway
COMMAND LISTING — FROM NODE

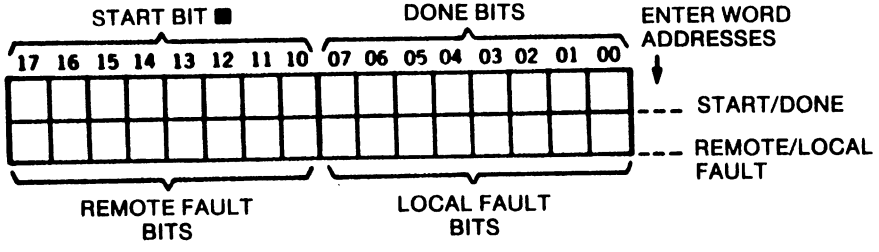
EXAMPLE:

START BIT	COMMAND TYPE	PRIORITY/ NORMAL	REMOTE STATION NO. ADDRESSED	AREAS CONTROLLED		COMMENTS
				AT LOCAL STATION	AT REMOTE STATION	
04010	WRITE	N	022	060-062	051-053	PARTS COUNT

COMMANDS AT THIS NODE (ENTER INFORMATION AS SHOWN)

START BIT	COMMAND TYPE	PRIORITY/ NORMAL	REMOTE STATION NO. ADDRESSED	AREAS CONTROLLED		COMMENTS
				AT LOCAL STATION	AT REMOTE STATION	

STATUS WORDS (DARKEN USED BITS FOR QUICK REFERENCE.)



ADJACENT STATUS WORDS

■ NOTE: WHEN A START BIT IS SELECTED, A DONE BIT, A REMOTE FAULT BIT AND A LOCAL FAULT BIT ARE AUTOMATICALLY ASSIGNED. REFER TO USER'S MANUAL, COMMUNICATION ADAPTER MODULE.

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