Allen-Bradley

ASCII I/O Module

(Cat. No. 1771-DA)

User Manual

Table of Contents

Preface

To Our Customers

Overview of This Manual

This manual tells you in a tutorial manner how to install and use your ASCII module.

In Chapter	Entitled	We Will Show You How To
1	Getting Started with Your ASCII Module	Read data from your ASCII module and write data to it using an industrial terminal
2	Choosing Module Features	Choose module features so you can match your ASCII module with your ASCII device
3	ASCII Module Tutorial	Select and demonstrate module features, and format messages
4	Handshaking	Program the handshaking logic that controls communication between your ASCII module and your PC processor
5	Functions of Control and Status Bits	Select desired features and read module status by describing the function of bits in command and status words
6	Troubleshooting Your ASCII Module	Interpret status indicators and status codes, and use a simple program to test your ASCII module.
-	Appendix	Program block transfer communication and estimate the time required for read/write handshaking. We have included numerous example programs
-	Index	Locate concepts and definitions in the text

Intended Audience

We assume that you are familiar with operating and programming your Allen-Bradley controller. Because of the functions that your module performs, your programming skills should include file manipulation and message formatting. Refer to the Programming and Operations Manual for your PLC-2 family controller or to the Programming Manual for your PLC-3 controller.

Notational Conventions

Some chapters in this manual contain examples of how you enter data or commands. When you read these chapters, remember the following notational conventions:

- A symbol or word in brackets represents a single key you would press. These include keys such as [ENTER], [SHIFT], or [↓].
- Spaces would be entered as shown, except that the space preceding and following the brackets is **not** an entered space. (We put a space before the left bracket and after the right bracket to make it easier to read).
- Numbers and capital letters not in brackets would be entered as shown.
- Punctuation such as commas, and symbols such as / would be entered as shown.

For example, typical data and a typical command that you would enter on the industrial terminal keyboard are as follows:

Enter: ALLEN 123/AB[ENTER] (data)
Enter: DD,O3:0,[SHIFT]%A[ENTER] (PLC-3 command)

We have included numerous examples of CRT displays resulting from data or commands that you enter. All CRT displays are shown with a shaded background. Enter all commands on the industrial terminal keyboard. The only exception is for some PLC-3 entries where we tell you to use the PLC-3 front panel.

Some Tips on Using This Manual

Read chapters 1 and 2 before proceeding to other chapters of this manual that pertain to your needs. For example, you may want to use only selected module features (chapter 3) and read only selected bit descriptions (chapter 5).

We have developed forms to assist you in selecting module features and in troubleshooting. Make a copy of each of the following and refer to them as needed.

- Initialization Words for Data Mode — Form 5175, chapter 2
- Initialization Words for Report Generation Mode — Form 5176, chapter 2
- Command and Status Words — Figure 5.2-5.4 chapter 5
- Fault Status — Table 6.E, chapter 6

You will use several procedures frequently in the tutorial chapters of this manual. You may want to memorize the steps or have a reference copy of the following procedures:

- Reading Data From Your ASCII Device
- Writing Data To Your ASCII Device
- Setting Bits in Initialization Words

Typical Applications

You can use an ASCII I/O module to input data to the processor from a data source such as a bar code reader, output messages from the processor to a display device, or bidirectionally exchange messages and/or data between an intelligent data terminal and the processor. Typical examples are as follows:

Devices	Type of Device	Applications
Bar code readers	Input	Part recognition, sorting, inventory control
Keypads	Input	Enter values, change data
Dot-matrix scrolling displays, terminals, or printers	Output	Display warnings or diagnostic messages, print production reports
Intelligent data terminals	Input/Output	Enter values, change data, monitor or troubleshoot a process
Computers	Input/Output	Exchange data files

Chapter 2

Getting Started With Your ASCII Module

ASCII is the acronym for American Standard Code for Information Interchange. The standard includes a 7-bit code for 128 data and control characters.

With your ASCII I/O module you can transfer data, by means of the I/O scan, from an ASCII device to the PC processor data table, and vice versa. The module has two modes of operation, data mode and report generation mode. In **data mode,** you can transfer ASCII, BCD, or hex characters. Generally, use this mode to transfer data to the processor data table. In **report generation mode,** you can include BCD values in the string of ASCII characters. Generally, use this mode when you want to transfer messages.

You can use your ASCII module with any Allen-Bradley programmable controller that has an expandable data table, block transfer capability, and uses the 1771 I/O structure. If you use a PLC-2/20 controller (cat. no. 1772-LP2), your programming will be lengthier because its processor does not have file move or block transfer instructions.

Getting Started with Your ASCII Module is a hands-on exercise. By going step by step through two easy examples, you will quickly learn operation of your module's basic features.

This chapter is divided into two sections, one for PLC-2 family processors, the other for PLC-3 processors. Proceed to the section that pertains to your processor.

PLC-2 Family Processors

What You Need to Get Started

You will demonstrate the operation of your ASCII module by reading data from the industrial terminal to the processor data table, and by writing data from the data table to the industrial terminal. You will use your industrial terminal as an ASCII device for entering data (read), and for displaying data (write).

You will need to set up a PC processor with an I/O chassis, power supply, industrial terminal, cables, and your ASCII module. You will need about an hour to complete the tutorial exercises in this chapter, and about two hours to complete those of chapter 3, once you have the equipment operating properly.

Equipment That You Need

You will need the following equipment (Table 1.A) using your existing system and/or spare equipment.

Table 1.A
Equipment (PLC-2 Family)

Equipment	Catalog Number
ASCII I/O module	1771-DA
Industrial Terminal	1770-T3
PLC-2 Family Keytop Overlay	1770-KCB
Alphanumeric Keytop Overlay	1771-KAA optional
Processor Interface Cable	1772-TC
IT/DH Adapter Cable	1770-CB (figure 1.4)
I/O Chassis	1771-A1, -A2, -A4
Processor PLC-2/20, -2/30	
Power Cable	1771-CJ, -CK
I/O Interconnect Cable	1777-CB, -CA
Local Adapter Module	1771-AL
Termination Plug	1777-CP

or	
Processor Mini-PLC-2/15	
Power Supply	1771-P1
Power Cable	1771-CL

Note: You must use battery back-up.

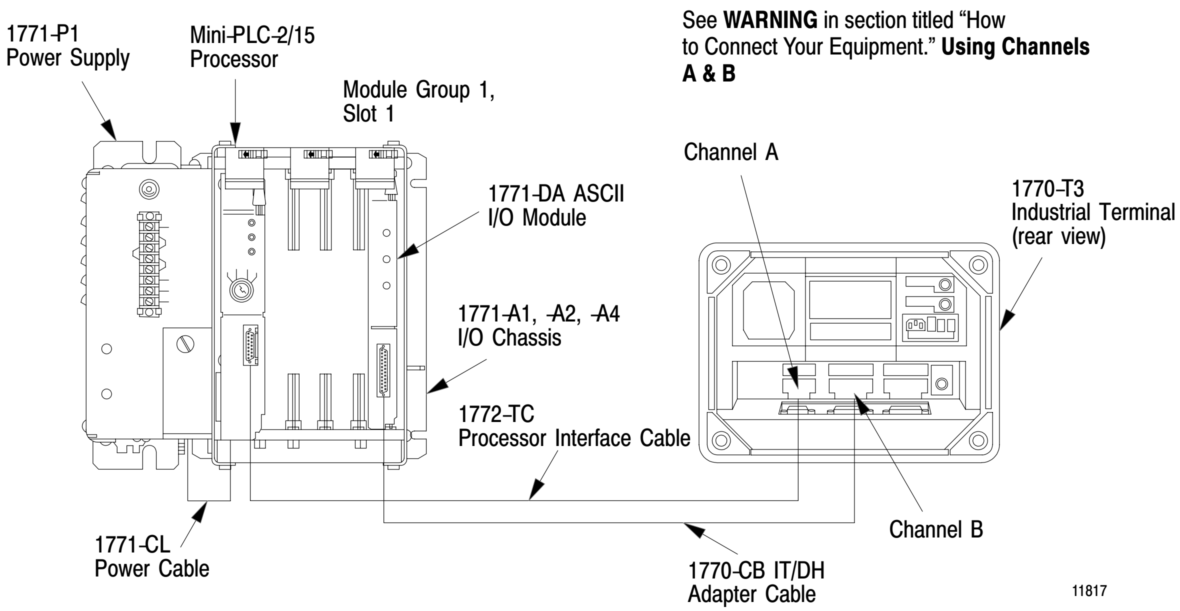
The ASCII module draws 1.3A from the backplane. Be sure that the total current drain of all modules in the chassis does not exceed the maximum for the backplane and power supply.

If you use an existing system, consider disconnecting all other chassis except the one containing your ASCII module. Disconnect field wiring arms from output modules for safety purposes.

How to Connect Your Equipment

Connect your equipment with the appropriate cables (Figure 1.1 for Mini-PLC-2/15 controllers, Figure 1.2 for PLC-2/20 or-2/30 controllers). Be sure that the end of your IT/DH adapter cable labeled CHANNEL B is connected to channel B on the industrial terminal.

Figure 1.1
Connections for Mini-PLC-2/I5 Controller

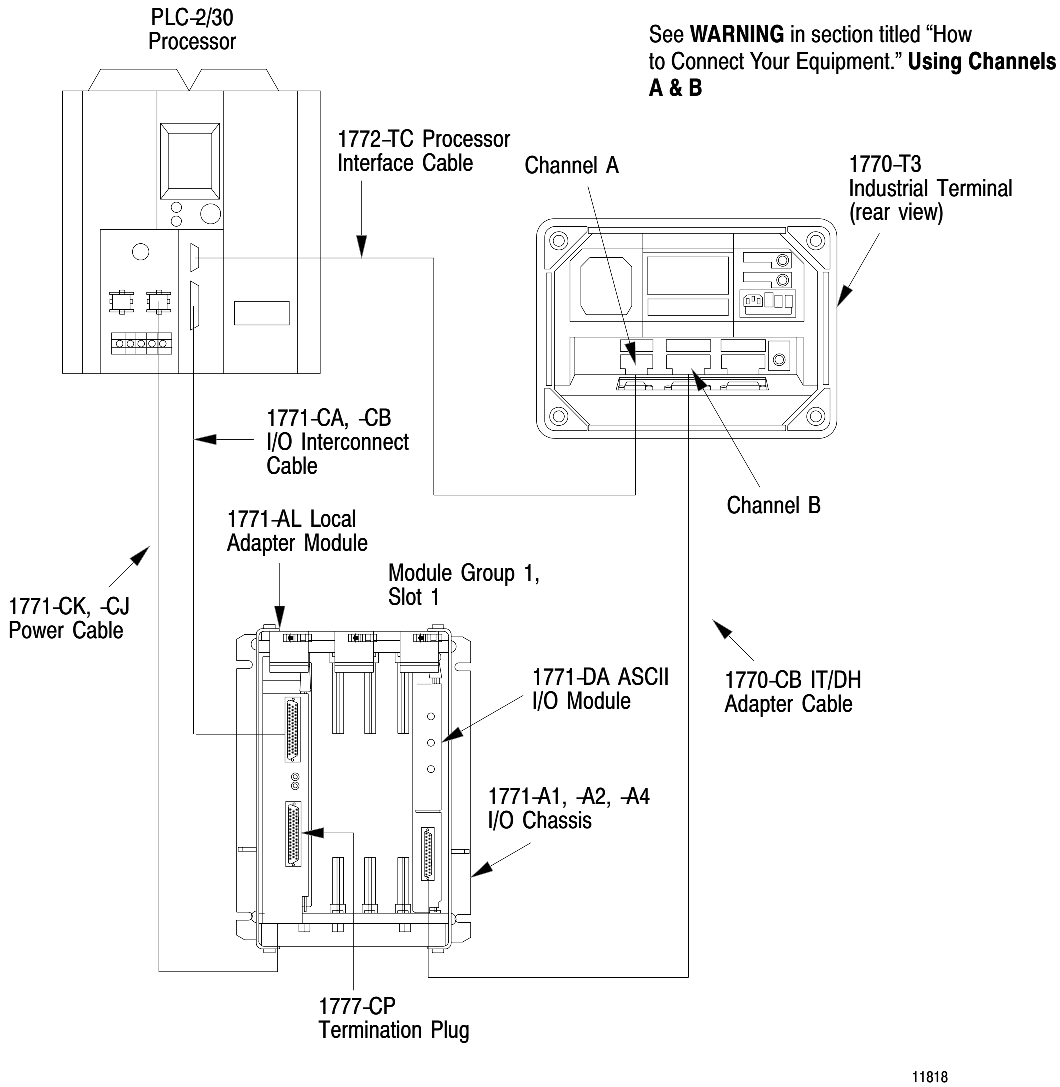


1. Connect the power cable between the power supply and the I/O chassis. The cable connects to the backplane of the I/O chassis behind the processor/adapter slot.

2. Connect the processor interface cable between the PC processor and channel A on the industrial terminal.

3. Connect the IT/DH adapter cable between the ASCII module and channel B on the industrial terminal.

Figure 1.2
Connections for PLC-2/20 or PLC-2/30 Controller



4. (PLC-2/20, -2/30, only) Connect the I/O interconnect cable between the PC processor and the I/O adapter module

If the IT/DH adapter cable is too short or not available, make your own. It should not exceed 50 feet (Figure 1.4).

Using Channels A and B

You may or may not be able to connect cables to channels A and B at the same time depending on the revision of your industrial terminal.

Industrial terminals manufactured before May 1982 allow cross talk between channels A and B. As a result, data table values could be altered. Therefore, you should alternate cables between channels for the tutorials of this manual when using these terminals. When using a series A industrial terminal, you must alternate cables.

Your industrial terminal has a date code stamped in white on the upper right corner of the rear label. If your industrial terminal (cat. no. 1770-T3/TA series B) is date coded T 8218 or earlier, or is not date coded, alternate cables and observe the following warning:

WARNING: When cables are connect to channels A and B at the same time, cross talk between these channels could cause the processor to misread inputs and/or misapply outputs, with possible damage to equipment and/or injury to personnel. For this reason, do not remove the slide bar that prevents you from connecting cables to channels A and B at the same time.

If your industrial terminal (cat. no. 1770-T3/TA series B) is date coded T 8219 or later, you can use channels A and B at the same time.

If alternating between channels A and B, connect the 1770-CB cable to channel B when using the industrial terminal in alphanumeric mode as a data terminal. Connect the 1772-TC cable to channel A when using the industrial terminal in PLC-2 (ladder diagram) mode.

As an alternative, use a second industrial terminal in alphanumeric mode on channel B, or use a Silent 700 data terminal. Connect either to the 1770-CB cable.

Checking ASCII Module Configuration

Your module is configured for RS-232-C operation when shipped from the factory. If you suspect that its internal configuration (settings of internal programing plugs) has been altered, you should check module configuration (refer to section titled Choosing the Mode of Communication in chapter 3). Do this as follows:

1. Remove covers from the module’s printed circuit board.

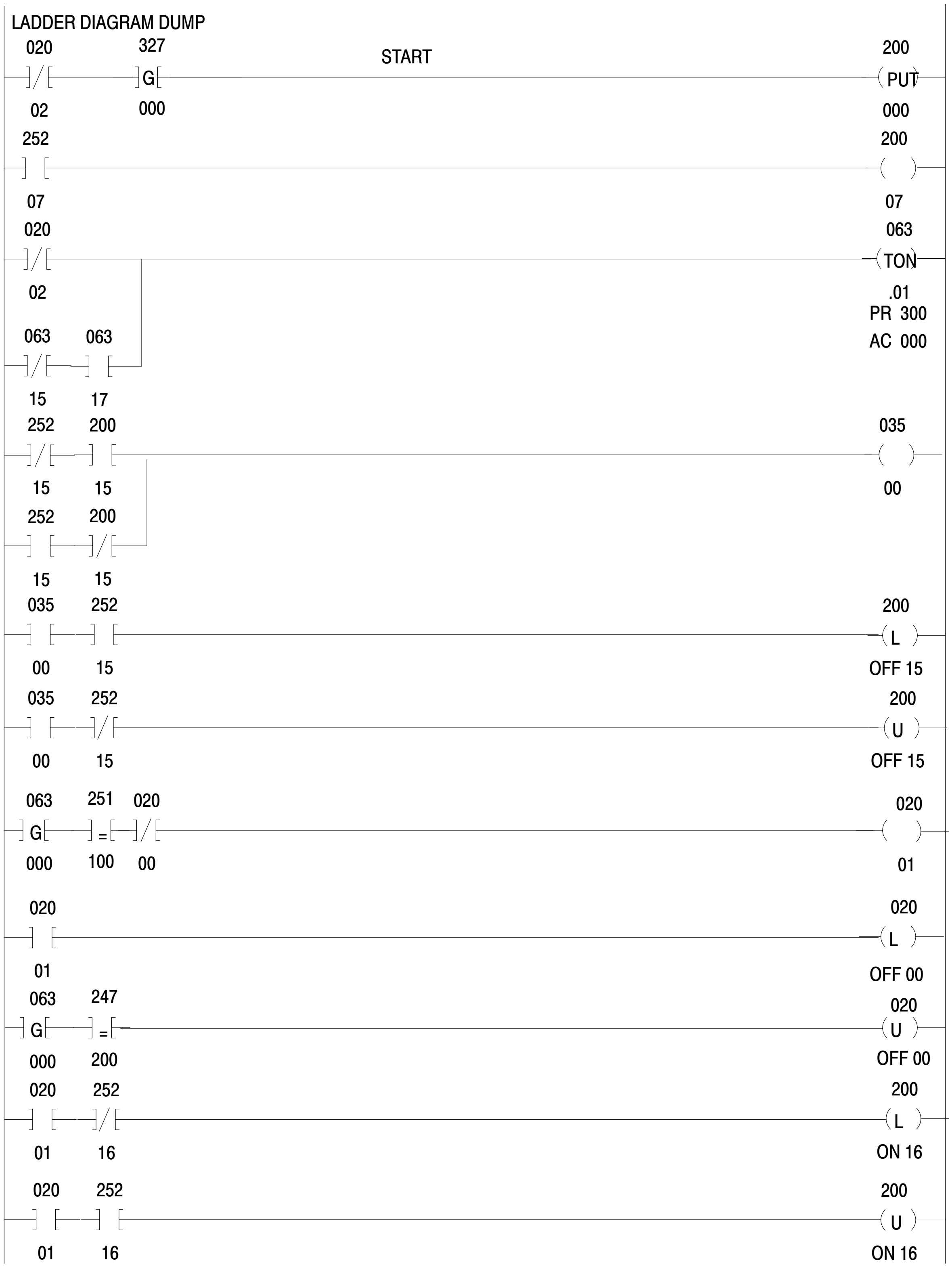
2. Locate the programming plugs and set them according to RS-232-C without control lines (figure 2.8).

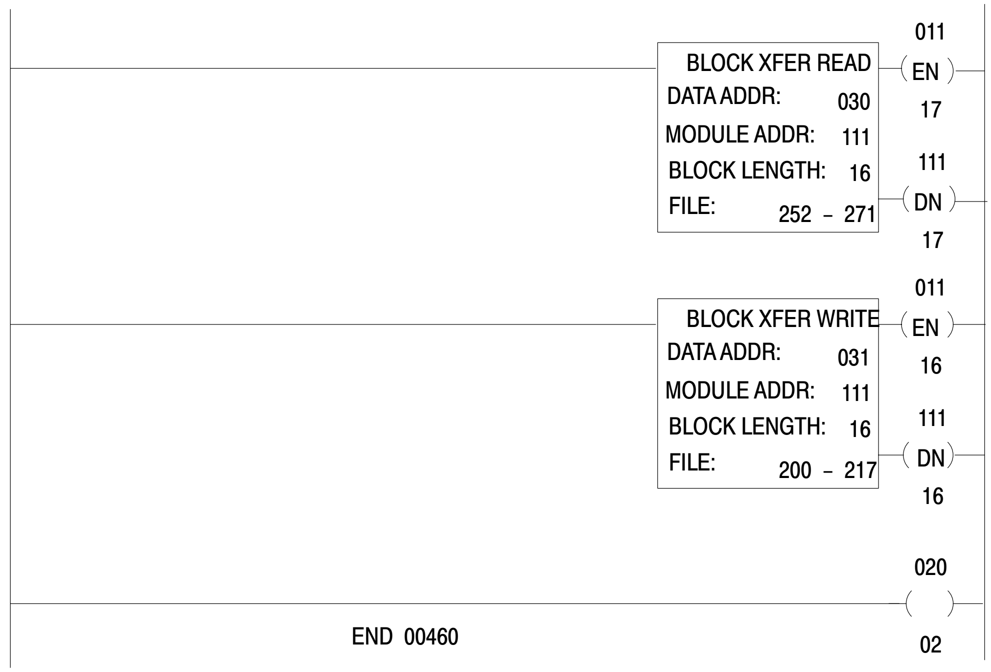
Entering the ““Getting Started Program””

You may want to record on tape the ladder diagram of your application program before proceeding because you will need to load ASCII logic into a cleared memory for chapters 1 and 3.

Using your industrial terminal, enter the ““Getting Started Program”” (Figure 1.3) into processor memory. At this point, you do not need to understand how the program works, but you should enter it exactly as shown.

Figure 1.3
“Getting Started Program” (PLC-2 Family)





NOTE: Configure the data table for two racks using [SEARCH][5][0] before entering this program.

Installing Your ASCII Module

Be sure that power to the I/O chassis is turned off when installing (or removing) your ASCII module as follows:

1. Remove power from the I/O chassis.

2. Insert the ASCII module in rack 1, module group 1, slot 1. The program makes the processor communicate with the ASCII module at that specific location. (If you must use another rack location and are familiar with block transfer operation, change the rack, group, and slot number of the module address in the block transfer read and write instructions, accordingly.)

3. Turn on power to the I/O chassis. Three LED indicators on the ASCII module illuminate momentarily. Their functions are:

FAULT: Normally off. This red LED indicator illuminates when the module detects an internal fault.

BUFFER FULL: Normally off. This yellow LED indicator illuminates when the input buffer becomes full.

CHANNEL ACTIVE: This green LED indicator illuminates when the industrial terminal is on, properly connected to the ASCII module's interface port, and set for alphanumeric mode.

Reading Data from Your ASCII Device

In this demonstration, you will enter data and observe how it is stored in the processor data table. You will use the industrial terminal in alphanumeric mode as an ASCII data terminal when you enter data. Then you will change the industrial terminal to PLC-2 mode and observe the transferred data by displaying the contents of the block transfer read file.

You will use the following procedures:

In Procedure	You Will
P1	Set your industrial terminal to alphanumeric mode
P2	Enter your data
P3	Set your industrial terminal to PLC-2 mode
P4	See how data is stored in the data table

Later in this chapter and in chapter 3 you will combine these procedures with others. The order in which you will perform them may vary.

Even if you are familiar with these procedures, we suggest that you read them completely. If you deviate from them, proper operation may not occur.

If you have not already done so, load the "Getting Started Program" (Figure 1.3) into processor memory.

Procedure P1
Set Your Industrial Terminal to Alphanumeric Mode

1. Turn on the industrial terminal.

2. Insert the Alphanumeric Keytop Overlay (cat. no. 1770-KAA).

To avoid switching keytop overlays every time you change the industrial terminal operating mode, you can label numbers, letters, and [RETURN] on the corresponding keytops of the PLC-2 family overlay.

3. Select alphanumeric mode.

Press 12 on the keyboard

The ASCII module's CHANNEL ACTIVE LED illuminates.

4. Set the communication rate to 300 baud.

Press 13 [RETURN]

The cursor in the upper left corner of a blank screen tells you the terminal is ready for your input.

5. Change the processor mode select switch to the RUN/PROG position. (Failure to do this step now will prevent a transfer.)

Procedure P2
Enter Your Data

1. Be sure the processor mode select switch is in the RUN/PROG position.

2. Enter data such as your first name followed by a couple of numbers. Enter 11 characters including a space between your name and numbers (Table 1.B).

Table 1.B
Commonly Used Data Characters

ASCII	Hex	ASCII	Hex	ASCII	Hex
space	20	A	41	N	4E
0	30	B	42	O	4F
1	31	C	43	P	50
2	32	D	44	Q	51
3	33	E	45	R	52
4	34	F	46	S	53
5	35	G	47	T	54
6	36	H	48	U	55
7	37	I	49	V	56
8	38	J	4A	W	57
9	39	K	4B	X	58
		L	4C	Y	59
		M	4D	Z	5A

The industrial terminal displays the characters as you enter them. If characters are not displayed, check the program that you loaded into memory. If you find no errors, refer to **Need Help?** below.

3. Change the processor mode select switch to the PROG position. (Failure to do this step now will prevent correct operation.)

Procedure P3
Set Your Industrial Terminal to PLC-2 Mode

1. Press [MODE SELECT]

2. Change the keytop overlay to PLC-2 family.

3. Select PLC-2 mode.

Press 11 on the keyboard

Procedure P4
See How Data Is Stored in the Data Table

1. Move the cursor to the rung containing the read block transfer instruction (rung 14). The cursor will illuminate the instruction title BLOCK XFER READ.

2. Display the contents of the read block transfer file in hex.

Press [DISPLAY] 1

Results The industrial terminal displays the name and numbers (first 10 characters) that you entered in step 2. For example,

ALLEN 12345 would be displayed as:

POSITION	FILE DATA	ASCII Equivalent
001	E010	status word one
002	0000	status word two
003	414C	A L
004	4C45	L E
005	4E20	N
006	3132	1 2
007	3334	3 4

Entering the eleventh character caused the module to transfer the data. Note the space entered between ALLEN and 12345.

The display of status word one (E010) and status word two (0000) indicates normal status of the module.

3. Terminate this display by pressing [CANCEL COMMAND], and return to ladder diagram.

Need Help?

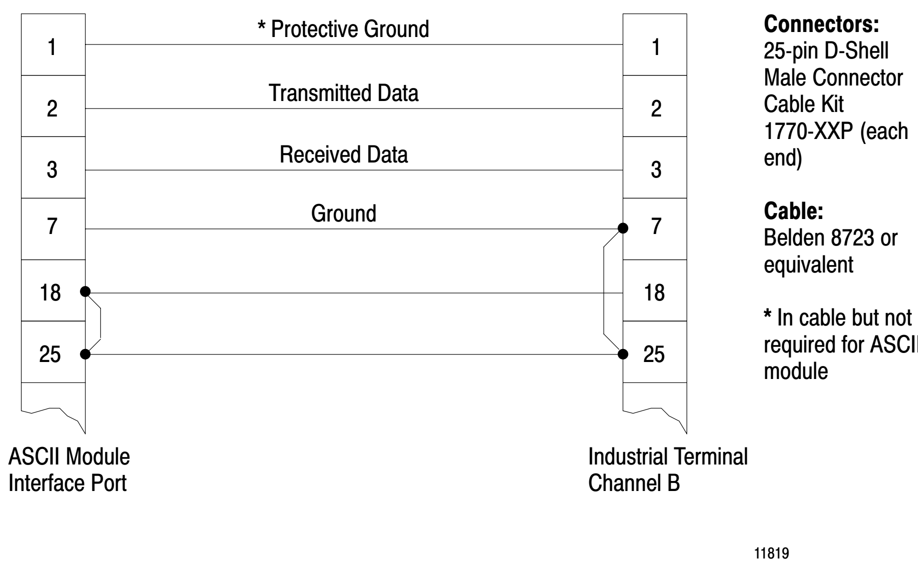
If your display was all zeros, the data did not transfer. You may have altered the procedure.

- Did you enter your program exactly as shown?
- Did the module's CHANNEL ACTIVE LED go on?
- Did you perform Procedure P1 before P2?
- Did you perform Step 1 in Procedure P2?
- Did you perform Step 3 in Procedure P2?

If you are still having trouble, refer to "Testing the ASCII Module and Cables," to verify communication between the ASCII module and the industrial terminal. If you suspect a cable problem, check the 1770-CB cable (Figure 1.4).

Then try again, starting at Procedure P1.

Figure 1.4
Minimum Connections in the 1770-CB Cable



Writing Data to Your ASCII Device

In this demonstration, you will load data characters into the write block transfer file and observe how they are displayed. You will use the industrial terminal in PLC-2 mode to load data. Then you will change the industrial terminal to alphanumeric mode and observe the transferred data.

You will use the following procedures where Procedures P1 and P3 are repeated from the section titled Reading Data from Your ASCII Device.

In Procedure	You Will
P3	Set your industrial terminal to PLC-2 mode
P5	Load data into the write block transfer file
P1	Set your industrial terminal to alphanumeric mode (and observe the transferred data)

Procedure P3
Set Your Industrial Terminal to PLC-2 Mode

NOTE: Skip this procedure if your processor is already in PLC-2 mode.

1. Press [MODE SELECT]

2. Check that the PLC-2 family keytop overlay is in place.

3. Select PLC-2 mode.

Press 11 on the keyboard

The beginning of your ladder diagram program will be displayed.

Procedure P5
Load Data into an Instruction File

1. Check that the processor mode select switch is in the PROG position.

2. Move the cursor to the instruction whose file you want to load (BLOCK XFER WRITE).

3. Display the file in hex.

Press [DISPLAY] 1

4. Load new data starting in position 003 for a write block transfer instruction, position 001 for other file instructions. (Positions 001 and 002 are reserved for command words in a write block transfer instruction.)

For example, load the following hex codes that are equivalent to BRADLEY 12345 as follows: (Note the space between BRADLEY and 12345.)

POSITION	FILE DATA	ASCII Equivalent
003	4252	B R
004	4144	A D
005	4C45	L E
006	5920	Y
007	3132	1 2
008	3334	3 4
009	3500	5

Check your display of FILE DATA to be sure that you entered all data exactly as shown.

Don't forget to press [INSERT][↓] after entering data in each position. Use the shift key to enter the hex character C.

Procedure P1
Set Your Industrial Terminal to Alphanumeric Mode

1. Insert the alphanumeric keytop overlay.

2. Select alphanumeric mode.

Press [MODE SELECT] 12

3. Set the communication rate to 300 baud.

Press 13 [RETURN]

The module's CHANNEL ACTIVE LED turns on.

4. Change the processor mode select switch to the RUN/PROG position.

Results The following display appears at the upper left corner of the industrial terminal:

BRADLEY 12345

5. Terminate the display and return to ladder diagram. Use the PLC-2 family keytop overlay.

Press [MODE SELECT] 11

Summary

Now that you have demonstrated the transfer of data from your ASCII device to the data table and vice versa, you are ready to use these procedures further. First, read the next chapter, "Choosing Module Features." It defines key words and concepts. Then in chapter 3, "ASCII Tutorial", you will use these procedures to demonstrate operating characteristics of your module.

PLC-3 Processors

What You Need To Get Started

You will demonstrate the operation of your ASCII module by reading data from the industrial terminal to the processor data table, and by writing data from the data table to the industrial terminal. You will use your industrial terminal as an ASCII device for entering data (read), and for displaying data (write).

You will set up a test I/O chassis with a PC processor, power supply, industrial terminal, cables, and your ASCII module. You will need about an hour to complete the procedures in this chapter and about two hours to complete the procedures in chapter 3.

You may want to record your application ladder diagram program before proceeding because you will need to load ASCII logic into a cleared memory for tutorial chapters 1 and 3 in this manual.

Equipment That You Need

You will need the following equipment (Table 1.C) using your existing system and/or spare equipment.

Table 1.C
Equipment (PLC-3)

Equipment	Catalog Number
PLC-3 Main Chassis	1775-A1
Main Processor Module	1775-L1,-L2
I/O Scanner-Programmer Interface Module	1775-S4A
Memory Module	1775-MR
Power Supply	1775-P1
Industrial Terminal	1770-T4
PLC-3 Keytop Overlay	1770-KDA
I/O Chassis	1771-Al,-A2,-A4
Remote I/O Adapter Module	1771-AS
ASCII i/O Module	1771-DA
Twinaxial I/O Interface Cable	1770-CD
IT/DH Adapter Cable	1770-CB
PLC-3 Industrial Terminal Cable	1775-CAT [1]
Chassis Power Cable	1775-CAP [2]
I/O Power Cable	1775-CH
Terminators	1775-XT

[1] Supplied with the Industrial Terminal
[2] Supplied with the PLC-3 Main Chassis

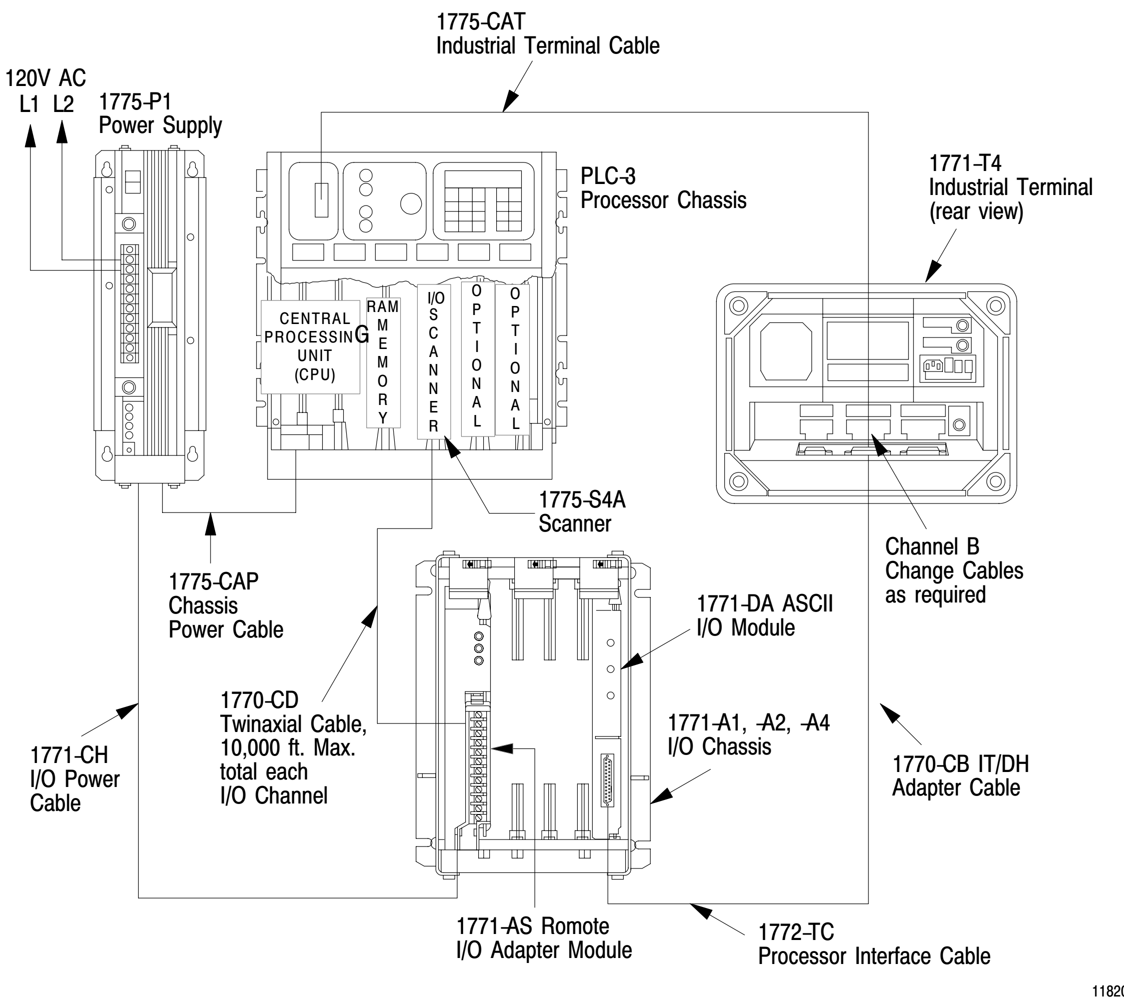
If you use an existing system, place the ASCII module in a chassis on a separate channel. Use a spare scanner module (cat. no. 1775-S4A,-S4B) if necessary.

The ASCII module draws 1.3A from the backplane. If you place the module in a chassis containing other modules, be sure that the total current drain of all modules in the chassis does not exceed the maximum for the backplane and power supply.

How to Connect Your Equipment

Connect your equipment using the appropriate cables (Figure 1.5).

Figure 1.5
Connections for PLC-3 Controller

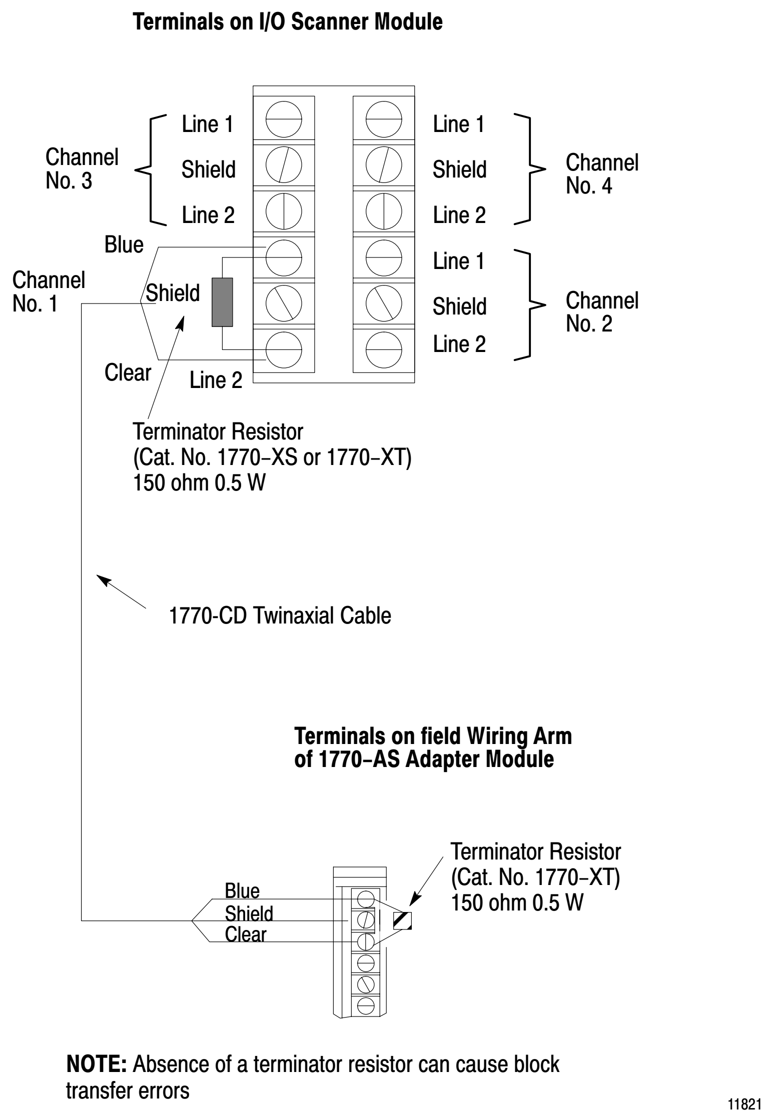


1. Connect the chassis power cable between the power supply and the processor chassis.

2. Connect the I/O power cable between the power supply and the I/O chassis.

3. Connect the twin axial cable between the I/O scanner in the processor chassis and the remote I/O adapter module in the I/O chassis (Figure 1.6).

Figure 1.6
Twinaxial Cable Terminations



4. Connect the industrial terminal cable between channel B of the industrial terminal and the processor chassis.

5. Connect the IT/DH adapter cable between the ASCII module and channel B of the industrial terminal.

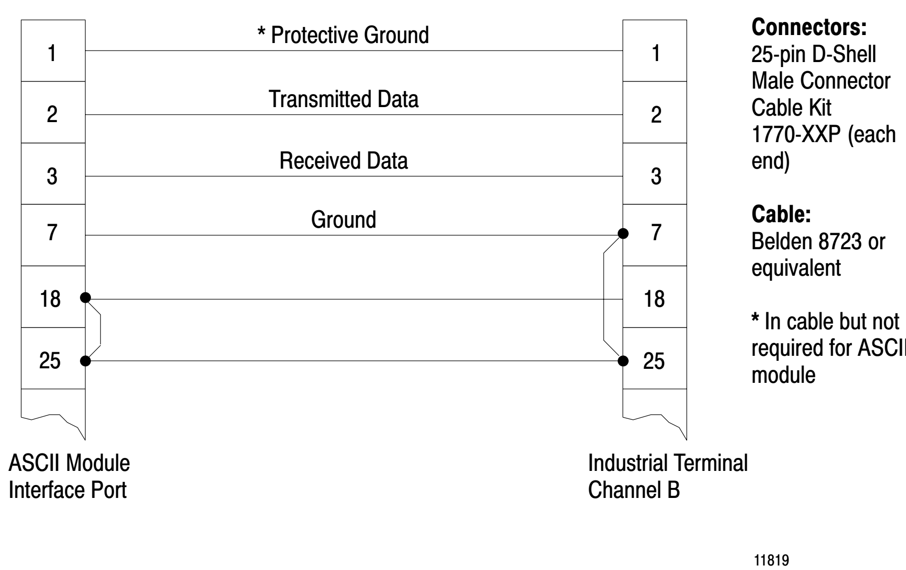
Channel B

Periodically you will have to switch the cables that connect to channel B of the industrial terminal.

- You will use the industrial terminal cable (cat. no. 1775-CAT) when using the industrial terminal in PLC-3 mode and entering or displaying data in the PLC-3 data table.
- You will use the IT/DH adapter cable (cat. no. 1770-CB) when using the industrial terminal in alphanumeric mode as an ASCII device connected to your ASCII module.
- Be sure to observe the labels on the cable connectors and connect each to its designated port.

Also, if the IT/DH adapter cable is too short or not available, make your own. It should not exceed 50 feet (Figure 1.7).

Figure 1.7
Minimum Connections in the 1770-CB Cable



Refer to your PLC-3 Programmable Controller Installation and Operation Manual (publication 1775-800) for additional installation information such as switch settings for the adapter module and I/O chassis, and for grounding information.

Checking ASCII Module Configuration

Your module is configured for RS-232-C operation when shipped from the factory. If you suspect that its internal configuration (settings of internal programming plugs) has been altered, you should check module configuration (refer to section titled ”Choosing the Mode of Communication,” in chapter 2). Do this as follows:

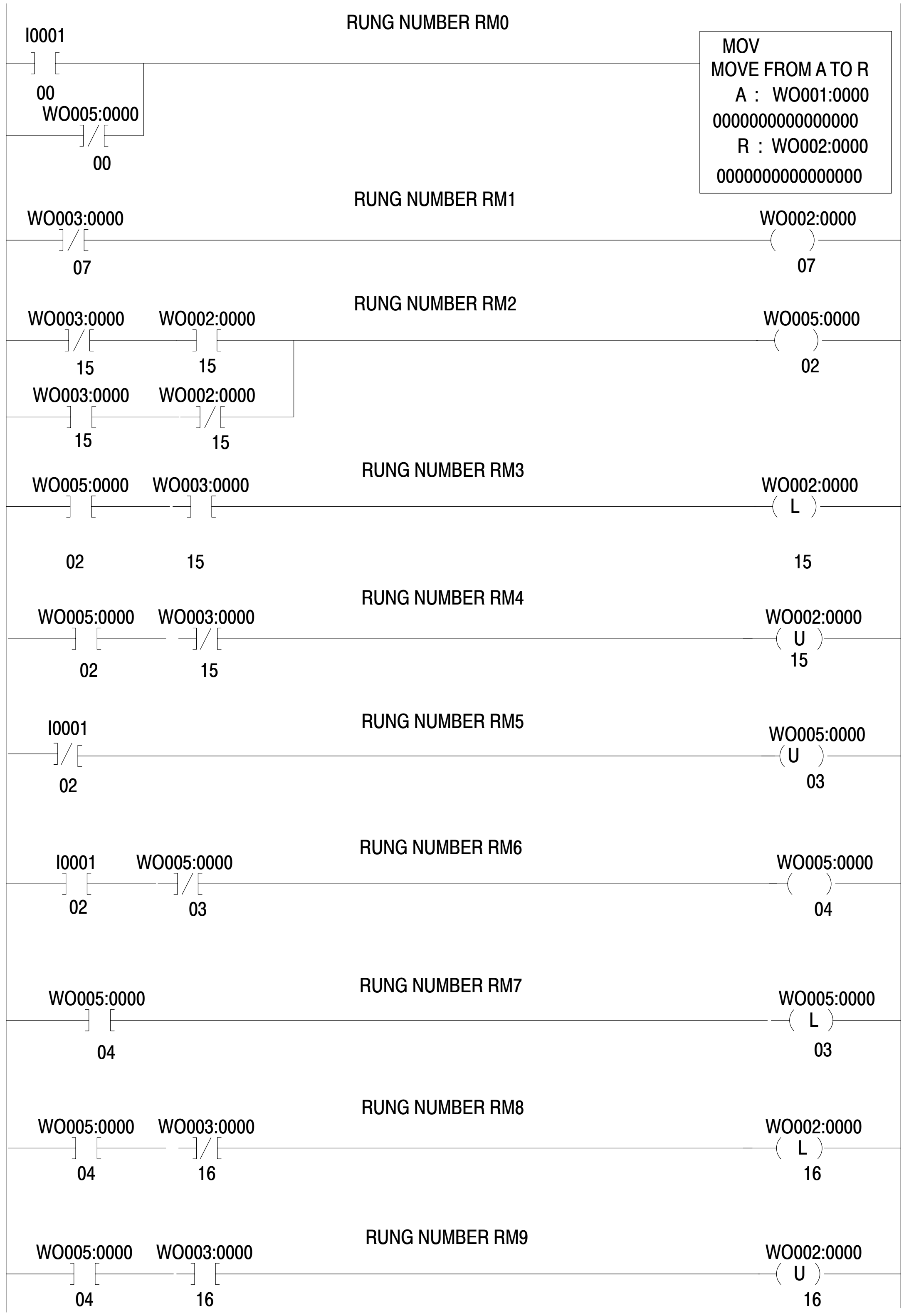
1. Remove the covers from the module’s printed circuit board.

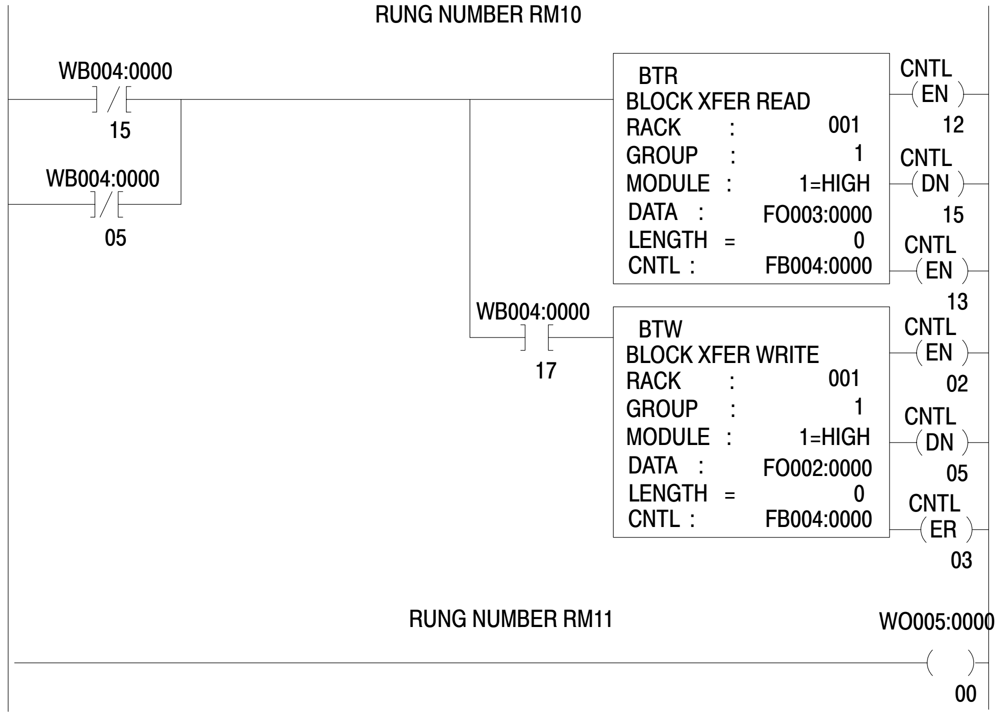
2. Locate the programming plugs, and set them according to RS-232-C without control lines (Figure 2.8).

Entering the “Getting Started Program”

Using your industrial terminal, enter the “Getting Started Program” (Figure 1.8) into processor memory. At this point, you do not need to understand how the program works, but you should enter it exactly as shown.

Figure 1.8
"Getting Started Program" (PLC-3)





1. Connect the 1775-CAT cable to channel B of the industrial terminal.

2. Turn on power to the I/O chassis and PLC-3 controller.

3. Turn off the memory protect switch on the front panel of the PLC-3 controller.

4. Select program load mode on the PLC-3 front panel.

   Press [SHIFT][LIST] 3 [ENTER]

5. Turn on the industrial terminal. It should automatically display ladder diagram mode. If not,

   Press [SHIFT][MODE]1

6. Enter the following key sequence on the industrial terminal keyboard before entering your program.

   Press[INSERT][SHIFT][RUNG][ENTER]

The displayed power bars will be replaced by I's at the left and right margins of the screen. The prompt EDITING will blink.

7. Enter your instructions and addresses. Refer to the PLC-3 Programming Manual (publication 1775-801) as needed.

NOTE: Be sure that you have entered the prefix F (file) in the addresses of your block transfer read (BTR) and block transfer write (BTW) instructions. Create a (nominal) 64 word file for your BTR and BTW data files as follows:

Press CR,<file address>100,Y [ENTER]

where the <> symbols are not entered but designate data that you enter. Example file addresses are O3:0 and O2:0.

8. Assemble your program.

Press ASM,Y[ENTER]

The power bars now become solid lines.

9. Check your program using the consecutive display mode starting with the first rung.

Press [SHIFT][DISPLAY][ENTER]SR[ENTER]

Use [RUNG ↓] and [RUNG ↑] as needed to move from rung to rung.

Installing Your ASCII Module

Be sure that power to the I/O chassis is turned off when installing (or removing) your ASCII module as follows:

1. Turn off power to the I/O chassis.

2. Insert the ASCII module in rack 1, module group 1, slot 1. The program makes the processor communicate with the ASCII module at that specific location. (If you must use another rack location and are familiar with programming block transfer instructions, change the rack, group, and slot number of the module address in the block transfer read and write instructions, accordingly.)

3. Turn on power to the I/O chassis. Three LED indicators on the ASCII module illuminate momentarily. Their functions are:

FAULT: Normally off. This red LED indicator illuminates when the module detects an internal fault.

BUFFER FULL: Normally off. This yellow LED indicator illuminates when the input buffer becomes full.

CHANNEL ACTIVE: This green LED indicator illuminates when the industrial terminal is on, properly connected to the ASCII module's interface port, and set for alphanumeric mode.

Reading Data from Your ASCII Device

In this demonstration you will enter data and observe how it is stored in the processor data table. You will use the industrial terminal in alphanumeric mode as an ASCII data terminal when you enter data. Then you will change the industrial terminal to PLC-3 mode and observe the transferred data by displaying the contents of the block transfer read file. You must alternate cables that connect to channel B of the industrial terminal, one cable for alphanumeric mode, the other for PLC-3 mode. You will simulate the action of an input bit through the PLC-3 front panel to enable a write block transfer.

You will use the following procedures.

In Procedure	You Will
P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode
P2	Enter your data
P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
P4	See how data is stored in the data table

Even if you are familiar with these procedures, read them completely. If you deviate from these procedures, proper operation may not occur.

If you have not already done so, load the "Getting Started Program" (Figure 2.8) into processor memory.

Procedure 1
Set Your Industrial Terminal to Alphanumeric Mode

1. Turn on the industrial terminal.

2. Connect the 1770-CB cable to channel B of the industrial terminal.

3. Select alphanumeric mode.

Press [SHIFT][MODE] 2

The CHANNEL ACTIVE LED on the module illuminates.

4. Set operating parameters:

- Communication rate to 300 baud. Press A (as needed) until the communication rate, as displayed on the screen, reaches 300 baud.
- Hardware handshaking to ON. Press D
- DUPLEX to FULL. Press F
- B and C to any setting.
- E, and G thru M to OFF.
- Press [ENTER] to load parameters.

The prompt, ENTERING ALPHANUMERIC TERMINAL MODE, tells you the terminal is ready for your input.

Procedure P2
Enter Your Data

1. Check that the PLC-3 controller is operating in run monitor. Use the PLC-3 front panel.

Press [SHIFT][LIST] 2 [ENTER]

2. Enter data, such as your first name, followed by a couple of numbers. Enter 11 characters counting the space between your name and numbers. Select the characters from commonly used data characters (Table 1.D).

Table 1.D
Commonly Used Data Characters

ASCII	Hex	ASCII	Hex	ASCII	Hex
space	20	A	41	N	4E
0	30	B	42	O	4F
1	31	C	43	P	50
2	32	D	44	Q	51
3	33	E	45	R	52
4	34	F	46	S	53
5	35	G	47	T	54
6	36	H	48	U	55
7	37	I	49	V	56

ASCII	Hex	ASCII	Hex	ASCII	Hex
8	38	J	4A	W	57
9	39	K	4B	X	58
		L	4C	Y	59
		M	4D	Z	5A

The industrial terminal displays the characters as you enter them. If characters are not displayed, check the program that you loaded into memory. Check step 3, operating parameters, for errors. If you find no errors, refer to **Need Help?** below.

Procedure P3
Set Your Industrial Terminal to PLC-3 Mode

1. Connect the 1775-CAT cable to channel B.

2. Display your ladder diagram.

Press [SHIFT][MODE]1

Procedure P4
See How Data Is Stored in the Data Table

1. Display the block transfer read file. Enter the address of that file (O3:0) with the following key sequence.

Press DD,O3:0, [SHIFT]%A [ENTER]

Results The name and numbers (11 characters or more) that you entered are displayed. For example, if you had entered

ASCII 7890123

the space between ASCII and 78790123 would count as an entered character, and your display would show 10 characters as follows:

RADIX = %A START = WA011:0248								
WORD #	0	1	2	3	4	5	6	7
00000	E0H11H	00H00H	A S	C I	I	7 8	9 0	00H00H

2. Display the same file in hex.

Press,%H [ENTER]

The following display appears:

RADIX = %A START = WA011:0248								
WORD #	0	1	2	3	4	5	6	7
00000	E011	0000	4153	4349	4920	3738	3930	0000

3. You can display the file in other number bases by replacing the H in step 2 with D for decimal, B for binary, or A for ASCII.

Compare the following displays.

Number Base	Display										Zero Value
ASCII (A)	A	S	C	I	I		7	8	9	0	00H00H
Hex (H)	41	53	43	49	49	20	37	38	39	30	0000
Decimal (D)	41	53	43	49	49	20	37	38	39	30	000

Results Entering the eleventh character caused the module to transfer the data.

Status word one (E011) and status word two (0000) indicate normal operation of the module. These are shown in display words 0 and 1, respectively.

4. Terminate this display and return to ladder diagram.

Press [SHIFT][MODE]1

Need Help?

If your display was all zeros (00H00H), ASCII display), the data did not transfer. You may have altered the procedure.

- Did you enter your program exactly as shown?
- Did the module's CHANNEL ACTIVE LED go on?
- Did the CHANNEL 1 LED on your scanner go on?
- Did the ACTIVE LED on your adapter go on?
- Have you configured your PLC-3 controller (LIST function)?

If you are still having trouble, refer to "Testing the ASCII Module and Cables," to verify communication between the ASCII module and the industrial terminal. If you suspect a cable problem, check the 1770-CB cable (Figure 1.7).

Then try again starting with Procedure P1.

Writing Data to Your ASCII Device

In this demonstration you will load data characters into the write block transfer file and observe how they are displayed by the industrial terminal. You will use the industrial terminal in PLC-3 mode to load data. Then you will change the industrial terminal to alphanumeric mode and observe the transferred data.

The procedures that you will follow are described below.

In Procedure	You Will
P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
P5	Load data into the file
P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode
P6	Enable the transfer of new data

Procedure P3
Set Your Industrial Terminal to PLC-3 Mode

NOTE: Skip this procedure if the industrial terminal is already in PLC-3 mode.

1. Connect the 1770-CAT cable to channel B.

2. Set your industrial terminal to PLC-3 mode, and display the beginning of your ladder diagram program.

Press [SHIFT][MODE]1

Procedure P5
Load Data into a File

1. Place the processor in program load mode using the PLC-3 front panel.

Press [SHIFT][LIST]3[ENTER]

2. Display the file that you want to load by entering the address of that file (O2:0) with the following key sequence.

Press DD,O2:0,[SHIFT]%A[ENTER]

3. Load ASCII data into the file starting with the third word (display word 2) for block transfer instructions (the first word for file move instructions). The first and second words of a write block transfer instruction are reserved for command words (handshaking). Press [ENTER] and [→] after loading each word.

For example, if you load the following:

BRADLEY 1234

Your file will appear as

RADIX = %A START = WA011:0248								
WORD #	0	1	2	3	4	5	6	7
00000	60H00H	00H00H	B R	A D	L E	Y	1 2	3 4

4. Change the display to hex and observe how the equivalent data is displayed.

Press,[SHIFT]%H[ENTER]

Your file display will change to the following:

RADIX = %A START = WA011:0248								
WORD #	0	1	2	3	4	5	6	7
00000	E011	0000	4252	4144	4C45	5920	3132	3334

Check the display of data to be sure that you entered all data exactly as shown.

Procedure P1
Set Your Industrial Terminal to Alphanumeric Mode

1. Connect the 1770-CB cable to channel B.

2. Select alphanumeric mode.

Press [SHIFT][MODE]2

3. Check operating parameters:

- Communication rate is 300 baud.
- Hardware handshaking is ON.
- DUPLEX is FULL.
- B and C are any setting.
- E, and G thru M are OFF.
- Press [ENTER] to load parameters.

The module's CHANNEL ACTIVE LED turns on.

4. Change the operation of your PC-3 controller to run monitor from the PLC-3 front panel.

Press [SHIFT][LIST]2[ENTER]

Procedures P6
Enable the Transfer of New Data

1. Set bit I001/02 to enable program logic (the write block transfer handshaking) using the PLC-3 front panel.

Press [CLEAR][SHIFT]I0[SHIFT][BIT]1[BIT]2
[DISPLAY]

The front panel displays the bit address with an asterisk showing its status, 1 or 0.

I000:0001/02*0

2. Set the bit using the PLC-3 front panel.

Press 1 [ENTER]

Results The industrial terminal displays

BRADLEY 12345

at the upper left corner of the screen.

3. Reset the bit using the PLC-3 front panel.

Press 0 [ENTER]

4. Terminate the display and return to ladder diagram by connecting the 1770-CB cable to channel B, and entering the following keystrokes on the industrial terminal keyboard.

Press [SHIFT][MODE]1

Summary

Now that you have demonstrated how data is transferred from your ASCII device to the data table and vice versa, you are ready to use these procedures further. Next, read "Choosing Module Features," Chapter 2. It will define key words and concepts. Then, in Chapter 3, "ASCII Tutorial," you will use these procedures to demonstrate operating characteristics of your module.

Chapter 3

Choosing Module Features

Chapter Objectives

Because of the many types of ASCII devices available and the variety of possible applications, you must configure your module according to the ASCII device and specific application that you have chosen. To do this, you must make some decisions. We will show you how to configure your module using programming plugs and by setting bits in initialization words.

Following the description of each module feature, we will show you how to record your decision whether to use the feature, and when appropriate, the quantity pertaining to the feature. At the end of this chapter, you will consolidate your decisions on a worksheet. You can use the worksheet to configure your module for your specific ASCII device and application.

This manual uses the following notation when referring to initialization words and bits. There are four initialization words to configure your module: IW1, IW2, IW3, and IW4. Bits within an initialization word are shown in parentheses after the word. For example, bits 10 thru 17 in initialization word three would appear as IW3(10-17).

Choosing the Mode of Communication

The ASCII module responds to three modes of communication.

RS-232-C
Current Loop, 20mA
A-B Long Line

RS-232-C

Use this mode for communicating up to approximately 50 cable feet between a printer or CRT and the ASCII module. The Electronics Industry Association (EIA) standard RS-232-C sets data and control line voltage levels for serial data communication. Data transmission is negative true logic: -5 to -15Vdc for a logic 1, +5 to +15Vdc for a logic 0. Control line commands are positive true logic: +5 to +15Vdc for enable, -5 to -15Vdc for inhibit. The standard also specifies a 25-pin connector and defines pin functions. Most systems use only the following pins:

Pin	Signal
2	transmit data
3	receive data
4	request to send
5	clear to send
7	ground

Refer to Table 2.A for a detailed listing of RS-232-C pin functions.

Table 2.A
RS-232-C Connector Pin Functions

Pin No	Signal Name	EIA Circuit	Source	Functions
2	Transmitted Data	BA	DTE	Data Transfer to 1771-DA (DCE)
3	Received Data	BB	1771-DA (DCE)	Data Transfer to DTE
4	Request to Send	CA	DTE	Tells the 1771-DA data is transmitted.
5	Clear to Send	CB	1771-DA (DCE)	Tells DTE that data is transmitted. Enabled only if pin 4 is -Vdc (off).
6	Data Set Ready	CC	1771-DA (DCE)	Tells DTE that 1771-DA (DCE) is ready.
7	Signal Ground	AB	-	Common ground for all signals thru interface port on 1771-DA.
8	Receive Line Signal Detector	CF	1771-DA (DCE)	Tied to +12V dc
20	Data Terminal Ready	CD	DTE	Tells 1771-DA (DCE) that DTE is ready. Must be +V dc to send or receive.

Current Loop

Use the current loop for communicating up to approximately 500 cable feet between your ASCII device and ASCII module. A current loop has high immunity to errors caused by electrical noise, has no signal attenuation, eliminates ground loops, and is low cost.

A current loop is a loop that carries current (generally 20mA) between electronic equipment by means of a twisted pair of wires. A transmitting device in the loop transmits digital signals by interrupting the current flow. A receiving device in the loop senses the interruptions. By convention, a logic 1 corresponds to the presence of loop current; a logic 0 corresponds to the absence of loop current.

A current loop transmitter or receiver can be either of two types: active (source) or passive (sink). An active transmitter supplies current to the loop. Any receivers or other transmitters within that loop must be passive units that accept the supplied loop current. Alternately, an active receiver supplies current to passive transmitters or other passive receivers in the loop.

Current sources that power a current loop vary in complexity. The simplest is a resistor and voltage source. More complex current sources contain active elements or integrated circuits to provide constant current under various power supply and load conditions.

Refer to Table 2.B and Table 2.C for a detailed listing of current loop pin functions.

Table 2.B
Current Loop Connector Pin Functions
Passive Receive/Passive Transmit

Pin No.	Signal Name	Source	Function
11	Module Transmitter Circuit	Peripheral or Power Supply	Controls current loop, allowing peripheral device to read data
12	Module Receiver Circuit	Peripheral Device	Completes current loop, allowing transfer of data to 1771-DA
18	Module Transmitter Circuit Return		Return for module transmitter circuit
24	Module Receiver Circuit Return		Return for module receiver circuit

Table 2.C
Current Loop Connector Pin Functions
Passive Receive/Active Transmit

Pin No.	Signal Name	Source	Function
11	Module Transmitter, Circuit Control and Return		Controls current loop, allowing peripheral device to read data. Serves as return for transmitter circuit.
12	Module Receiver Circuit	Peripheral Device	Completes current loop, allowing transfer of data to 1771-DA
13	Module Transmitter Circuit Source	1771-DA	Supplies current for current loop interface
24	Module Receiver Circuit Return		Return for module receiver circuit

A-B Long Line

Use A-B Long Line for communicating up to 5000 cable feet between an industrial terminal, serving as an ASCII device, and the ASCII module.

Refer to Table 2.D for a detailed listing of A-B Long Line pin functions.

Table 2.D
A-B Long Line Connector Pin Functions

Pin No.	Signal Name	Source	Function
2	Transmitted Data	A-B Long Line Device	Data Transfer to 1771-DA
7	Transmitted Data Return		Return for transmitted data
11	Received Data	1771-DA	Data transfer to A-B Long Line Device
25	Received Data Return		Return for received data

Selecting the Communication Mode

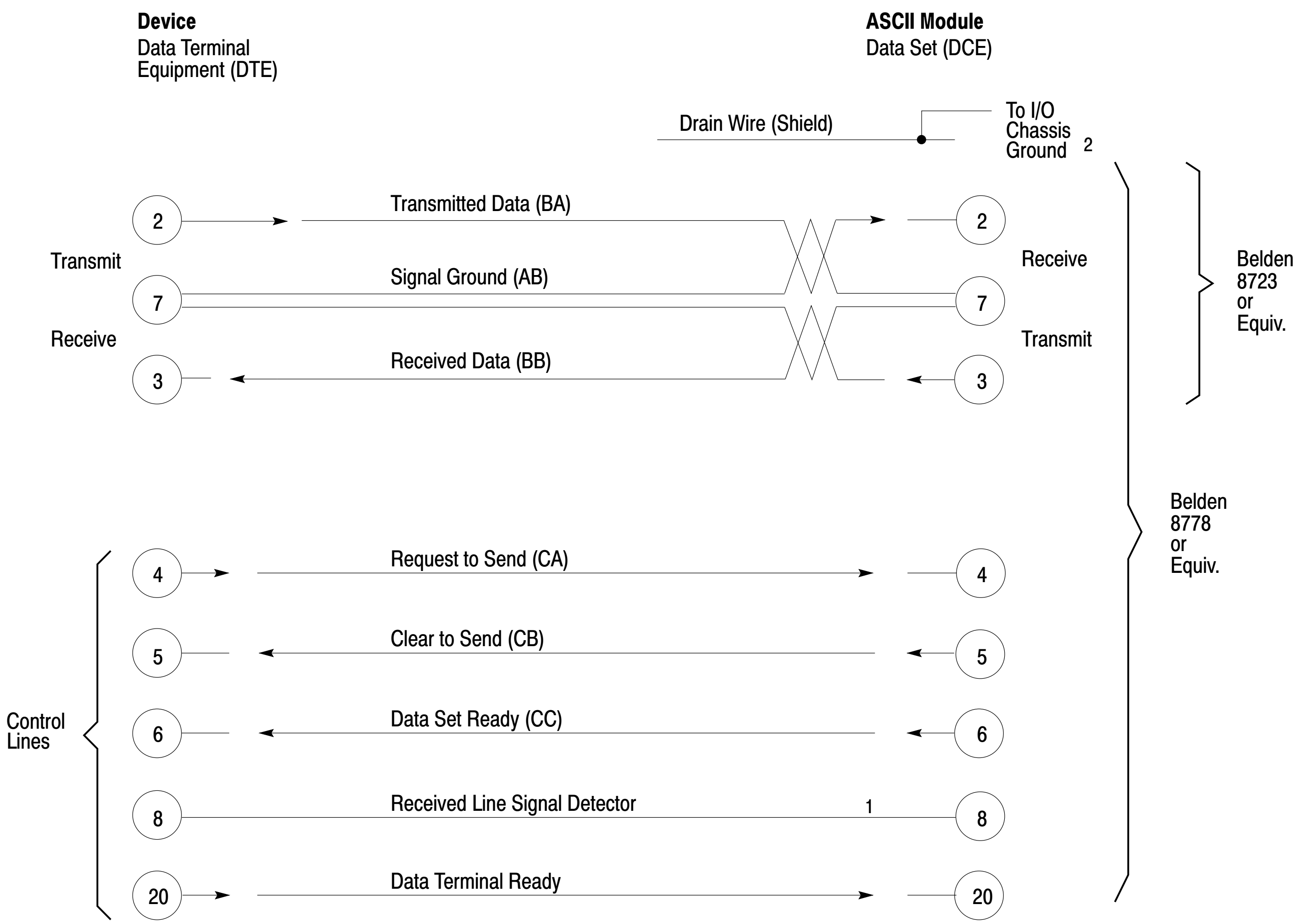
The communication mode that you choose depends on the cable distance from your ASCII device to your ASCII module, and on characteristics of your ASCII device (Table 2.E).

Table 2.E
Mode of Communication

If Distance is Less Than	And Your ASCII Device is a	Then Choose this Transmission Mode
50 feet	Data Terminal Equipment (DTE) and conforms to RS-232-C	RS-232-C (Figure 2.1)
	without control lines	4-wire cable
	with control lines	8-wire cable
	Data Set (modem) and conforms to RS-232-C	RS-232-C (Figure 2.2)
	without control lines	4-wire cable
	with control lines	8-wire cable
500 feet	DTE and provides a 20mA current source for the transmit line, only	Current Loop (Figure 2.3) The module powers its own transmit line.
	DTE and requires a 20mA external current source for its transmit line	Current Loop (Figure 2.4) You add the power supply for the DTE.
	DTE and provides 20mA current sources for transmit and receive lines	Current Loop (Figure 2.5) The module operates in passive transmit.
5000 feet	A-B industrial terminal or contains a line driver receiver for A-B long line operation.	A-B Long Line (Figure 2.6)

The functions of the cable conductors (Figure 2.1 thru Figure 2.7) are referenced to your ASCII device, not to your ASCII module.

Figure 2.1
RS-232-C Connections (50 ft. max): Data Terminal to Data Set
(Refer to specifications in Appendix D)



1 Tied to +12Vdc
2 Solder an external ground wire (14 ga.) to the drain wire at the cable connector. Connect it to the I/O chassis ground lug. Ground the shield at this end only.

NOTE: (AB) thru (CD) refer to RS-232-C circuit labels.

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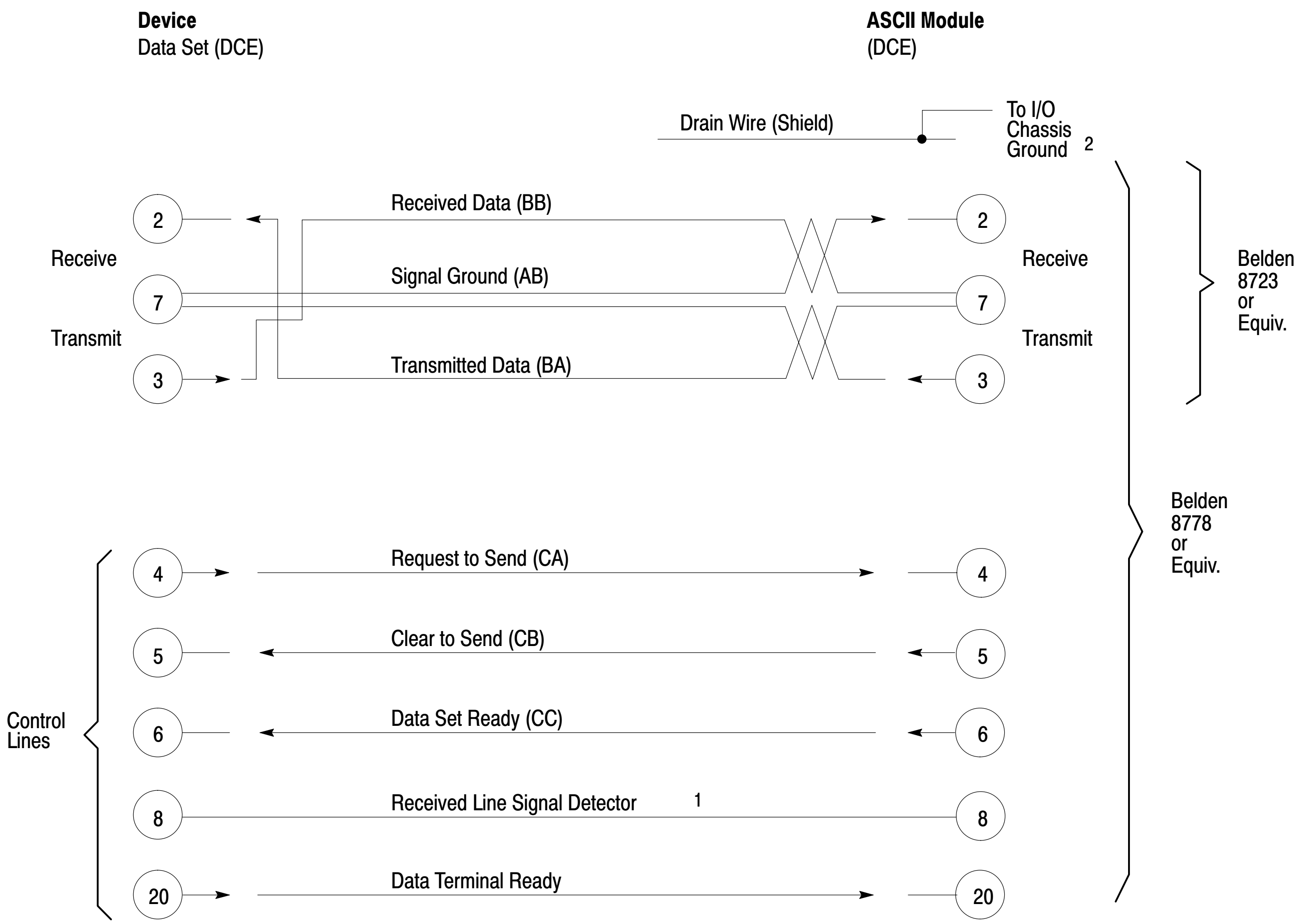
Figure 2.2
RS-232-C Connections (50 ft. max): Data Set to Data Set
(Refer to specifications in Appendix D)



1 Tied to +12Vdc

2 Solder an external ground wire (14 ga.) to the drain wire at the cable connector. Connect it to the I/O chassis ground lug. Ground the shield at this end only.

NOTE: (AB) thru (CD) refer to RS-232-C circuit labels.

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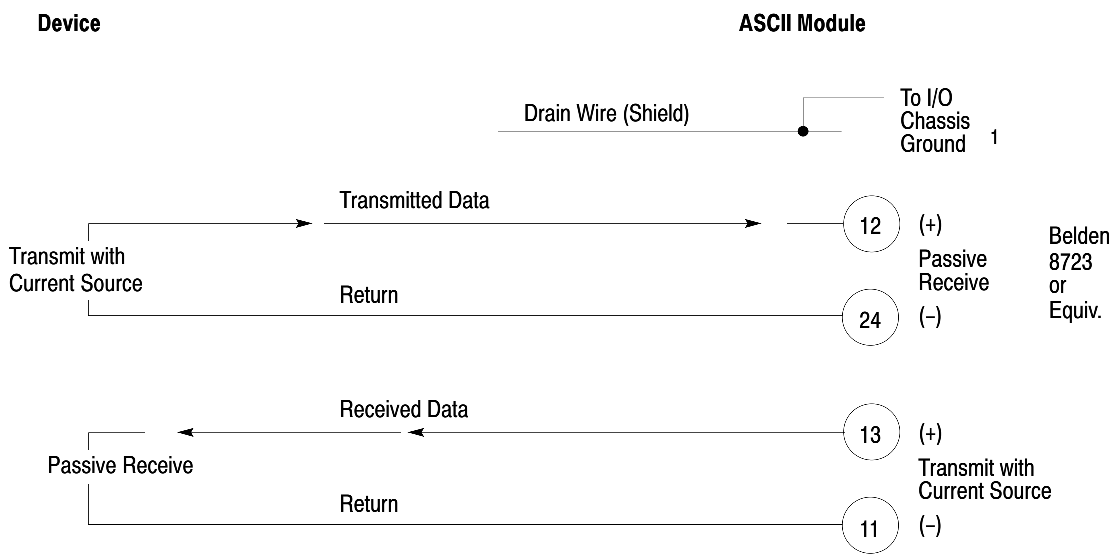
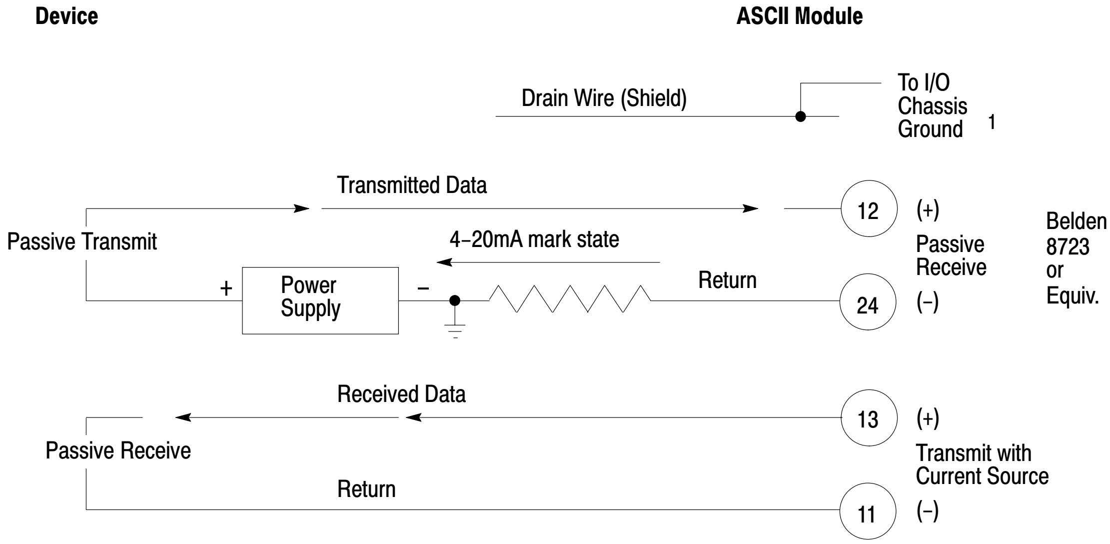
When configured for current loop and you use terminals 13 and 11 for transmit, your ASCII module powers its own transmit loop (Figure 2.3 and Figure 2.4). Your module can accept an active receive current loop powered by the ASCII device. In this case, module operation is passive transmit and you use module terminals 11 and 18 (Figure 2.5).

Figure 2.3
Current Loop Connections (500 ft. Max): Device is Active Transmit, Passive Receive (Refer to specifications in Appendix D)



1 Solder an external ground wire (14 ga.) to the drain wire at the cable connector. Connect it to the I/O chassis ground lug. Ground the shield at this end only.

Figure 2.4
Current Loop Connections (500 ft. max): Device is Passive Transmit, Passive Receive (Refer to specifications in Appendix D)



1 Solder an external ground wire (14 ga.) to the drain wire at the cable connector. Connect it to the I/O chassis ground lug. Ground the shield at this end only.

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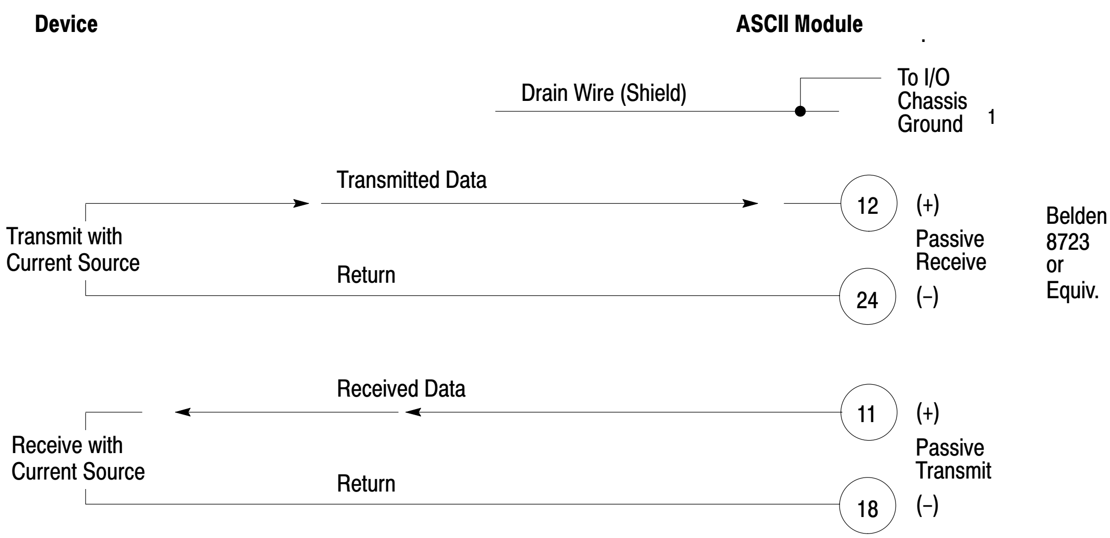
Figure 2.5
Current Loop Connections (500 ft max.): Device is Active Transmit, Active Receive (Refer to specifications in Appendix D)



1 Solder an external ground wire (14 ga.) to the drain wire at the cable connector. Connect it to the I/O chassis ground lug. Ground the shield at this end only.

NOTE: Device and its power supply must float in respect to the module for passive transmit.

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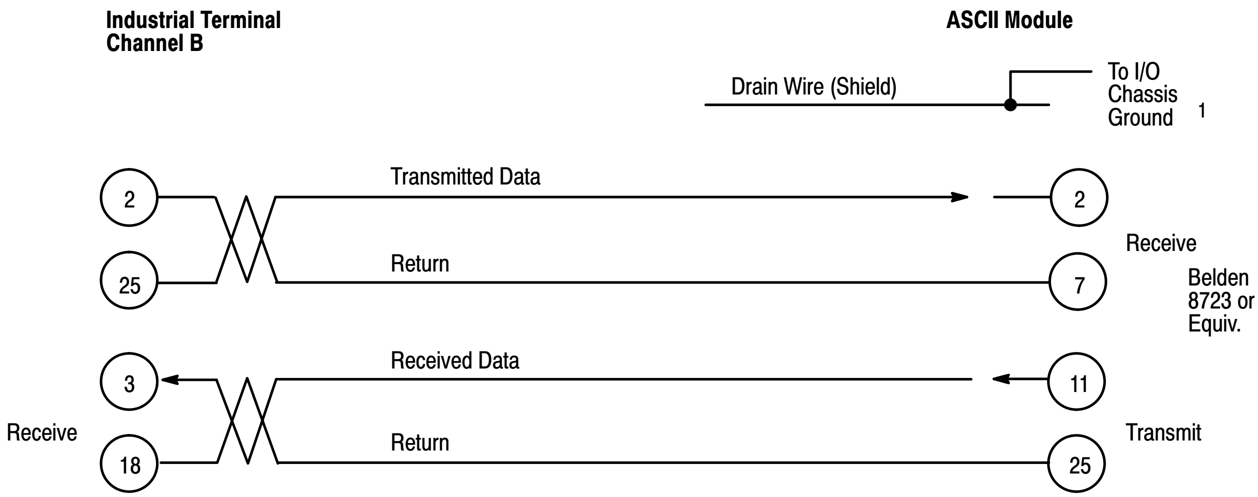
Use a 25-pin male D-shell connector such as Amp DB-25P for your cable connections to the ASCII module. Terminate the shield to pin 1 at the module end only.

Figure 2.6
A-B Long Line Connections (5000 ft max)



1 Solder an external ground wire (14 ga.) to the drain wire at the cable connector. Connect it to the I/O chassis ground lug. Ground the shield at this end only.

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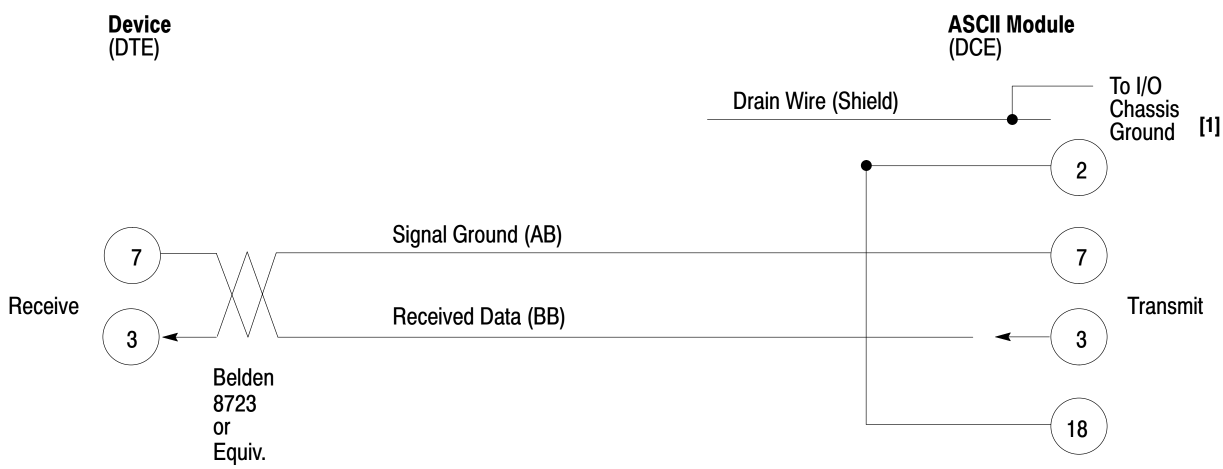
Figure 2.7
RS-232-C Simplex Write Connections
(Refer to Specifications in Appendix D)



[1] Solder an external ground wire (14 ga.) to the drain wire at the cable connector. Connect it to the I/O chassis ground lug. Ground the shield at this end only.

NOTE: Jumper pin 2 to pin 18 at the module end of the cable (special case).

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Setting the Module's Programming Plugs

Implement your choice of cable configuration by setting programming plugs inside the module. Remove the module's left-hand cover plate (the one without the labels). Locate and adjust the programming plugs according to Figure 2.8.

NOTE: The locations of programming plug sockets (Figure 2.8) are labeled El thru E16 on the printed circuit board. The settings of programming plugs are defined as follows:

IN refers to the plug jumpering the pair of pins at the designated location.

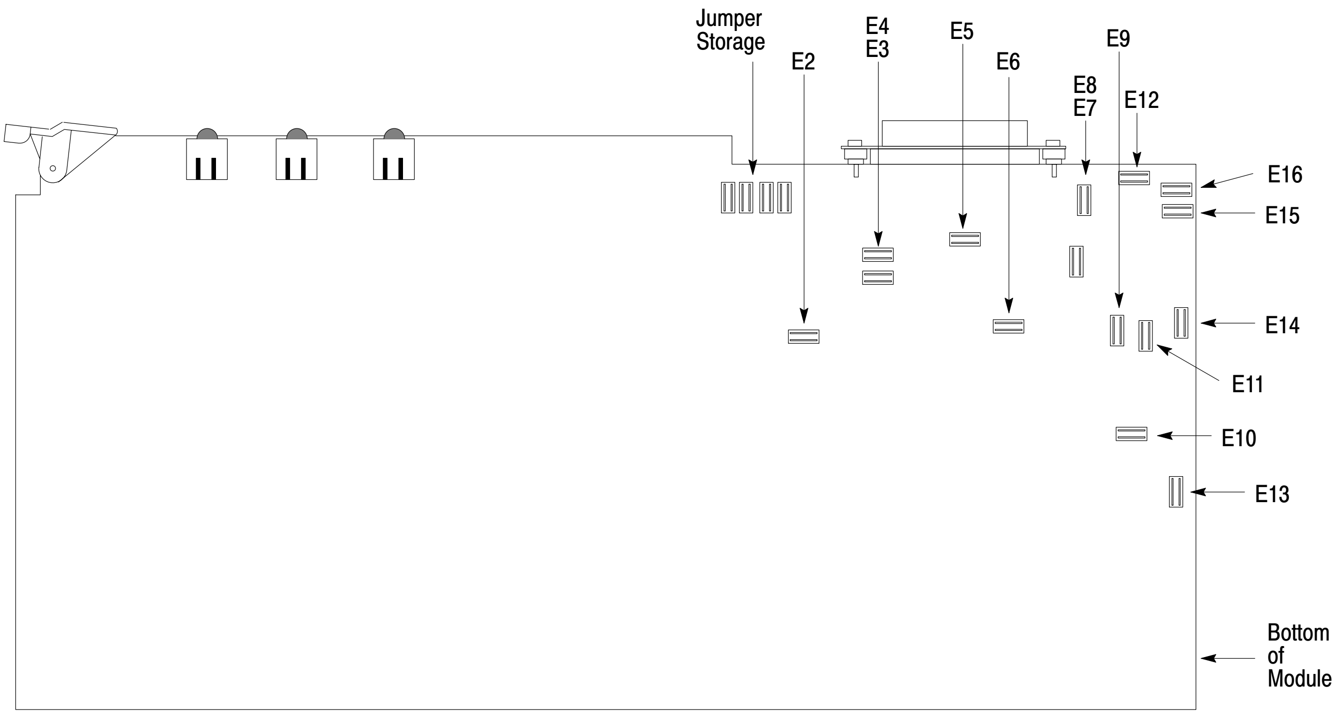
1-2 or 2-3 refers to the pins on which you insert the plug. Pins 1 and 3 are labeled on the circuit board next to the pins.

OUT refers to removing the plug or inserting it on only one pin (electrically floating). You can store up to four plugs in the area labeled JUMPER STORAGE at the right-hand side of the board.

SPECIAL CASE When operating an ASCII device in RS-232-C simplex write mode without a transmit line from the ASCII device (Figure 2.7), jumper pin 2 to pin 18 at the cable connector (module end of cable) and **insert** a programming plug in location **E16** on the ASCII module.

Re-assemble the module after you have finished setting and/or checking the programming plugs.

Figure 2.8
Programming Plug Locations and Settings



Programming Plug Location	RS-232-C Without Control Lines	RS-232-C With Control	Current Loop	A-B Long Line Operation
E-1				
E-2	1-2 [1]	1-2	2-3 [1]	1-2
E-3	Out	Out	In	Out
E-4	In [3]	Out	In [3]	In [3]
E-5	In	In	Out	Out
E-6	In	In	In	In
E-7	Out	Out	In	Out
E-8	Out	Out	In	In
E-9	Out	Out	1-2	1-2
E-10	1-2	1-2	2-3	2-3
E-11	Out	Out	Out	In
E-12	In	In	In	Out
E-13	In	In	Out	Out
E-14	In	In	Out	Out
E-15	In	In	Out	Out
E-16 [2]	Out	Out	In	In

[1] 3-prong connector: 1-2 place programming plug toward pin 1 as labeled on the circuit board
2-3 place programming plug toward pin 3 as labeled on the circuit board

[2] See Special Case, “Choosing the Mode of Communication”

[3] Remove E4 when initializing the module (IW 1 B05, B06, B07) in half-duplex mode

Setting and Recording Initialization Words

The remaining features are configured by using initialization words. These words are write block transferred to the module at power-up or upon command. You will record your selections of module features by writing codes (0 or 1) for corresponding initialization bits. You can do this with either of the initialization word forms at the end of this chapter. Use one form for data mode operation of the module, the other form for report generation mode of operation. These modes of operation are described next in this chapter. You can also record your selections in the space provided in the text that describes each module feature. Then, at the end of the chapter, you will be asked to rewrite the codes onto the appropriate initialization word form. You will use this information in chapter 4 when you demonstrate module features.

Choosing the Mode of Module Operation, IW1(02-04)

The mode of module operation that you choose depends on the application and type of ASCII device. Typically, use data mode when you are reading data from an ASCII device, such as a bar code reader. Use report generation mode when you are writing messages to an ASCII data terminal (Table 2.F).

Table 2.F
Mode of Module Operation

Use	When
Data Mode	All of your data is converted by the ASCII module and stored in the data table as a single data type using any one of the following data conversions: 2 ASCII characters per word 1 ASCII character per word 3 BCD characters per word 4 BCD characters per word 4 Hex characters per word String length is from 1 to 62 characters You want to select right to left justified margins and/or data
Report Generation Mode	You want to mix ASCII characters with BCD values. In addition to the 2 ASCII characters per word that your module uses in report generation mode, you must choose one of the following types of data conversion: 3 BCD characters per word 4 BCD characters per word String length is from 1 to 999 characters Your margin is left justified for ASCII data but right justified for BCD values within the ASCII data

Select data mode using code 000, or report generation mode using code 001. Record your selection in IW1(02-04) using the initialization word form (found at the end of this chapter) or the boxes below.

Mode of Operation

	04	03	02
IW1			

Choosing Data Conversion, IW2(14-16)

Data conversion refers to the number and type of characteers that you store in a data table. word. The selections of data conversion from which you choose depend on the mode of module operation (Table 2.G).

Table 2.G
Data Conversion

When In	Select One	Using Code
Data mode, you must select one type of data conversion (quantity and type of characters per word). To change data conversion, you must reinitialize the module.	2 ASCII/word 3 BCD/word 4 BCD/word 1 ASCII/word 4 Hex/word	000 001 010 011 100
Report generation mode, your text is 2 ASCII characters per word. You must select either 3 BCD or 4 BCD characters per word for your BCD values within your text.	3 BCD/word 4 BCD/word	001 010

Record your selection based on your choice of module operation by writing the code in IW2(14-16) using the form (found at the end of this chapter) or the boxes below.

	Data Conversion		
IW2	16	15	14

Using BCD Delimiters (Report Generation Mode, Only), IW4(10-16)

A BCD delimiter is a character that you place before and after BCD values. It tells the ASCII module to interpret the values as BCD, not as ASCII for conversion.

In report generation mode when using BCD values with ASCII data characters, you must separate BCD values by means of a delimiter. For example, if you want to use the BCD value of 297 in a message and you have selected the asterisk (0101010 in binary or 2A in hex) as the BCD delimiter, you would place the asterisk before and after the BCD value, *297*. Otherwise, the 7-bit ASCII equivalent of BCD 297 would be transferred as unwanted characters.

Select the BCD delimiter from the following hex characters:: 0A-0F, 1A-1F, 2A-2F, 3A-3F, 4A-4F, 5A-5F, 6A-6F, or 7A-7F.
Do not use:

- Any character that otherwise would appear in the message
- The end-of-string delimiter that you will select later

ASCII characters and their codes are listed in tables in appendix C.

Record your selection by writing either the 7-bit binary code, or the 2-digit hex code for the BCD delimiter in IW4(10-16) using the form (found at the end of this chapter) or the boxes below.

BCD Delimiter

IW4	17	16	15	14	13	12	11	10
	0							

NOTE: The module defaults to the colon (:) as the BCD delimiter if you do not use initialization word four (IW4). However, if you use IW4, you must enter a BCD delimiter.

Justifying Margins, IW3(03)

Margin justification refers to the manner in which data is displayed by your ASCII device or stored in the data table (Table 2.H).

Margin justification is particularly evident when the number of data characters transferred is less than maximum.

Your choice of margin justification depends on the mode of module operation (Table 2.I).

Table 2.H
Margin Justification

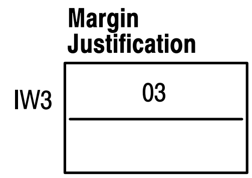
When Justified	Each New Line Is Displayed with the Same	and Data Is Stored in the Data Table by Placing
Left	Left margin Example: Text is left justified.	The first character in the upper byte of the lowest word address. Blanks or zeros fill the higher word addresses. Example: PLC-2 Family ABCD EF00 0000 Example: PLC-3 Family A B C D E F 0 0 0 0 0 0
Right	Right margin Example: Dollar values are right justified	The last character in the lower byte of the highest word address. Blanks or zeros fill the lower word addresses. Example: PLC-2 Family 0000 00AB CDEF Example: PLC-3 Family 0 0 0 0 0 0 A B C D E F

Table 2.I
Margin Justification/Mode of Operation

When Module Mode of Operation Is	Your Justification Is
Data Mode	Either left or right (you select)
Report Generation Mode	ASCII data is left justified. BCD values, contained in the string of ASCII data, are right justified.

Record your selection based on your choice of module operation. If you choose data mode, choose either left justification IW3(03) =1 or right justification IW3(03)=0. Record your selection by writing a 1 or 0 in IW3(03) using the form (found at the end of this chapter) or the box pn the next page.

If you choose report generation mode, the module ignores this bit.



Using the End-of-String Delimiter, IW3(10-16)

When the module encounters the end-of-string delimiter in data received from the ASCII device, the module allows the read block transfer of data to the processor. If your ASCII device generates an end-of-string delimiter, use that delimiter. (Refer to the specifications of your device.)

When you use the carriage return as the end-of-string delimiter and the data terminal encounters the end-of-string delimiter, the print head or the cursor of the data terminal returns to the left margin. When using a data terminal, select any ASCII character as the end-of-string delimiter, except the same character as the BCD delimiter. You will get an initialization error and the module will not operate.

In most applications, you will select an end-of-string delimiter. If you do not select an end-of-string delimiter, the module will default to the null (CTRL 0) as the end-of-string delimiter.

Refer to tables in appendix C.5 for the complete list of ASCII characters and their codes.

Sending End-of-String Delimiter to Processor (Report Generation Mode, Only), IW3(04)

In report generation mode, you may want to send the end-of-string delimiter code to the processor. You would do this if you want to display single-line messages, and your program uses the carriage return as the end-of string delimiter. You may also want line feed with each carriage return. In this kind of report generation application, you would send the end-of-string delimiter to the processor by setting IW3(04)=1. You would enable line feed on carriage return by setting IW3(05)=1.

Record the 7-bit ASCII code in binary or hex for the end-of-string delimiter in IW3(10-16) using the form (found at the end of this chapter) or the boxes on the next page.

End-of-String Delimiter

	17	16	15	14	13	12	11	10
IW4	0							

Setting String Length, IW2(00-13)

String length is the maximum number of characters that your ASCII module can transfer as a unit from the ASCII device to the processor data table. You set the string length to match that of your ASCII device (data mode), or according to your message requirements (report generation mode) up to the maximum that the module can handle. The maximum number of characters that your ASCII module can handle as a string depends on the module's mode of operation. In data mode, the module can handle a string of up to 62 characters per block transfer. In report generation mode, the module can handle a string of up to 999 characters, transferred over several block transfers.

The string of characters sent from the device to the module can be fixed or varied in length. Refer to the specifications of your ASCII device. Some ASCII devices generate the same string length for each transfer by adding fill characters, described later, when the amount of data in each transfer varies. The device adds fill characters and an end-of-string delimiter at the end of each message (Table 2.J).

Table 2.J
String Length

If Your ASCII Device	You Determine Maximum String Length By
Automatically places the end-of-string delimiter to separate data such as bar codes	Setting the module's string length to the (longest) length that the ASCII device can transmit (module in data mode)
Is a data terminal	Setting the string length to the longest message or line, and entering the end-of-string delimiter at the end of each message or line (report generation mode)

You will use the string length to determine the block length of the read block transfer instruction and the size of the data table file that receives the string. Refer to section titled Determining Block Transfer Length, P. 2-20, and to section titled Choosing Single or Multiple Transfers IW2(17) P. 2-25 for additional information.

If the string length from the ASCII device exceeds the string length that you set for the module, the next character (beyond the set string length) received in the module's input buffer causes the module to transfer the string. That character and any additional characters remain in the input buffer until the next transfer.

Set the string length equal to the longest string of characters that your ASCII device can generate in your application. Record the string length in IW2(11-13) by writing the BCD value of the string length using the form (found at the end of this chapter) or the boxes below.

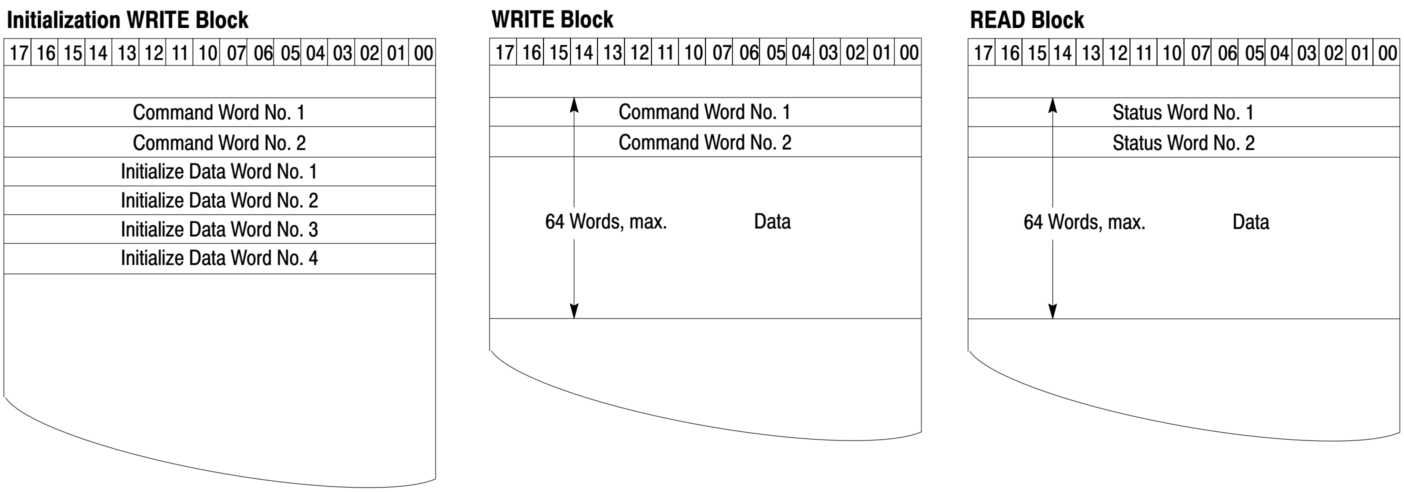
ASCII Characters/String

IW2	13	12	11	10	07	06	05	04	03	02	01	00

Determining Block Transfer Length

The highest number of words that you can transfer in one block transfer is 64. You must include two command words in each write block transfer and two status words in each read block transfer in addition to your data words. You can also transfer up to four initialization words (Figure 3.9).

Figure 2.9
Block Lengths for Read and Write Block Transfers



The longest data string read from the ASCII device determines the block length of the read block transfer instruction. In the PLC-2 family, the read and write block lengths must be equal to ensure correct operation. For PLC-3 processors, the block lengths can be different.

Compute block length by dividing the number of data characters in the longest string length by the type of data storage, i.e. 1, 2, 3, or 4 characters per word. For example, a string of 80 data characters having 2 ASCII characters per word, data storage would require a block transfer block length of 42 words. Don't forget to add two status words or two command words.

80/2 + 2 = 40 + 2 = 42

A string of 37 data characters having 3 BCD characters per word of data storage would require a block length of 15 words. Round remainders to the next highest whole number.

37/3 + 2 = 12 1/3 + 2 = 13 + 2 = 15

When you have a mix of BCD and ASCII data characters in report generation mode, allow space for right justification of BCD values within the data string. Overestimate your read block transfer block length. Observe how the transferred data is stored, then reduce the block length if possible.

Removing the Fill Character (Data Mode, Only), IW4(10-16)

Some ASCII devices add fill characters such as spaces, nulls, or some ASCII symbol when sending data to the module. These devices have the capability to vary the number of data characters, and to add fill characters so that the sum of data and fill characters is always the same for each transfer.

The module removes the fill character that you select whenever the module encounters it in the data received from the device. For example, suppose the device inserted a dash as the fill character (2D in hex) after data characters, and varied the number of data characters sent to the module. Then the device generated the following two transfers:

31 33 32 35 36 39 38 2D 2D 2D 2D	first transfer
37 35 39 31 2D 2D 2D 2D 2D 2D 2D	second transfer

The module would remove the fill character and store the data as follows (assume right justified data, a string length of 11, and two ASCII characters per word).

First Transfer	Second Transfer
2020	2020
2020	2020
2031	2020
3332	2020
3536	3735
3938	3931

The module removed the fill characters inserted by the device (2D hex), right justified the data, and added its own fill character (20 hex).

Select any ASCII character as the fill character that the module will remove except:

- Any character that otherwise would be included in the data
- The end-of-string delimiter that you chose in section titled Using the End-of-String Delimiter, IW3(10-16), P. 2-17.

ASCII characters and their codes are listed in tables in appendix A.

Record your selection by writing the 7-bit ASCII code in binary or hex in IW4(10-16) for the fill character to be removed. Use the form (found at the end of this chapter) or the boxes below.

Removed Fill Character

IW4	17	16	15	14	13	12	11	10
	0							

Your ASCII Module Inserts Fill Characters

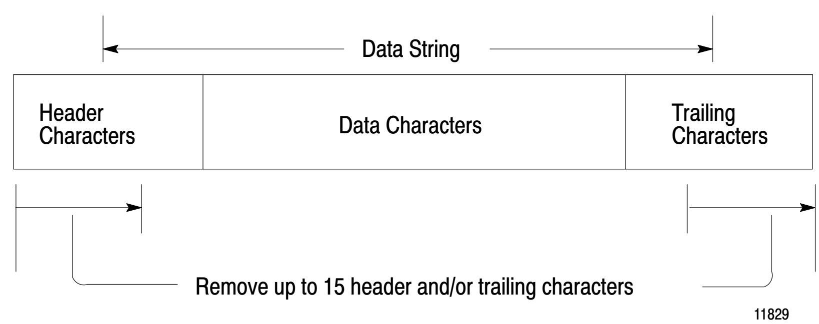
The module has two non-selectable internal fill characters, the space (20 hex) that is displayed at a data terminal as a space and the null (00 hex) that is not displayed. When justifying data, the module inserts fill characters according to the data conversion that you have selected. It inserts a space (20 hex) for one ASCII or two ASCII characters per word conversion, or it inserts a zero (00 hex) for BCD and hex data conversion.

The module also adds a fill character to justified BCD data. The fill character that it inserts is a zero for each missing digit. The module also inserts zeros leading a BCD number, if necessary, to align the BCD number on a word boundary (right justified).

Removing Header and Trailing Characters, IW4(00-03, 04-07)

Some ASCII devices, such as bar code readers, generate a series of characters that precede and/or trail data characters. Often, some or all of these leading or trailing characters contain no information of use to the PC processor. If your ASCII device generates header and/or trailing characters that are not used, you can remove them. You can remove up to 15 characters of either type (Figure 2.10). If you do not want to remove any, set the corresponding bits to zero.

Figure 2.10
Removing Header and Trailing Characters



Record the number of trailing characters in IW4(04-07) and the number of header characters in IW4(00-03) that you want to remove. Write the binary code for the numbers on the form (found at the end of this chapter) or in the boxes below.

Removed Trailing Characters

IW4	07	06	05	04

Removed Trailing Characters

03	02	01	00

Choosing I/O Buffer Size, IW3(00-02)

Your ASCII module has a 1536 word (3072 byte) buffer for I/O data. The percentage of buffer memory that you choose for input and output depends on the operation of your ASCII device, and on relative transmission rates into and out of the ASCII module's I/O buffer. You should proportion the size of your input and output buffers for maximum storage (Table 2.K) so that the buffer does not fill and result in loss of data, a condition known as spillover.

Table 2.K
I/O Buffer Size

When Your ASCII Device	And When	Select	Using Code
Is bidirectional	You want to divide buffer space equally	50% Input 50% Output	000
Can only generate input data to the ASCII module	You want to maximize the number of characters that the module's input buffer can store before spilling data	100% Input	001
Is bidrectional but most data is read from the ASCII device	Same as block above	75% Input 25% Output	010
Is bidirectional but most data is written to your ASCII device	You want to maximize the number of characters that the module's output buffer can store before spilling data	25% Input 75% Output	011
Can only display data	Same as block above	100% Output	100

Record the percentage of input to output that you want the buffer to have by writing the corresponding 3-digit code in IW3(00-02). Use the form (found at the end of this chapter) or the boxes below.

I/O Buffer Size

IW3	02	01	00

Choosing Transmission Mode, IW1(05-07)

The transmission mode that you choose is determined by the specifications of your ASCII device and the requirements of your application (Table 2.L).

Table 2.L
Mode of Transmission

If Your ASCII Device Is	And Your Application Requires	Then Select	Using Code
Full Duplex	That your ASCII device displays data sent to the ASCII module	Full Duplex with Echo	000
	That no data is displayed	Full Duplex without Echo	001
Simplex Read	Only the transmission of data from your ASCII device	Simplex Read or Full Duplex	010
Simplex Write	Only the display of data received by your ASCII device	Simplex Write or Full Duplex	011
Half Duplex	That your ASCII device displays data sent to the ASCII module	Half Duplex with Echo	100
	That no data is displayed	Half Duplex without Echo	101

Record the mode of transmission selection by writing the 3-digit code in IW1(05-07). Use the form (found at the end of this chapter) or the boxes below.

Mode Transmission

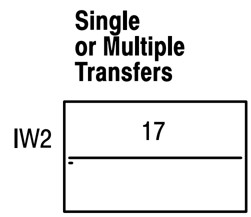
	07	06	05
IW1			

Choosing Single or Multiple Transfers, IW2(17)

Choose single transfer when you want the module to send a single string to the processor in each block transfer, or when the string is long enough to require more than one block transfer.

Choose multiple transfers when your ASCII device transmits short strings (31 characters per string or less) at a high rate of transmission. Then the module will include more than one string in each block transfer. The highest number of strings that you can transfer in one block transfer is the number of complete strings that the module can load into 62 (or fewer) block transfer words.

Record your choice by writing a 0 (single transfer) or 1 (multiple transfer) in IW2(17). Use the form (found at the end of this chapter) or the boxes below.

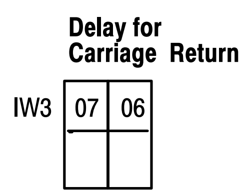


Selecting Delay for Carriage Return, IW3(06-07)

When using an unbuffered data terminal, select a time for the ASCII module to delay outputting data while the mechanical carriage return is operating. Your selections are:

Delay Time (ms)	Code
0	00
50	01
100	10
200	11

Record your selection by writing the code in IW3(07,06) using the form (found at the end of this chapter) or the boxes below.



Setting Remaining Bits in IW1(10-17)

Set the remaining bits in initialization word one according to the specifications of your ASCII device.

Communication Rate

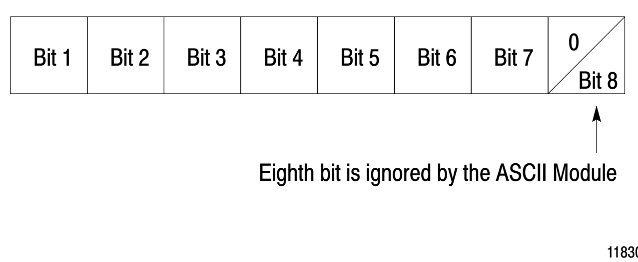
Match the communication rate of your ASCII module with that of your ASCII device. Set bits IW1(10-12) accordingly. Your selections are:

Communication Rate	Code
300 baud	000
600 baud	001
1200 baud	010
2400 baud	011
4800 baud	100
9600 baud	101
110 baud	110

Number of Data Bits

Your ASCII device generates either seven or eight data bits per character (Figure 2.11). The ASCII module neither stores nor outputs the eighth bit, but must know if it is there. Use the default value (eight bit data) if this information is not available. Set bit IW1(113) accordingly.

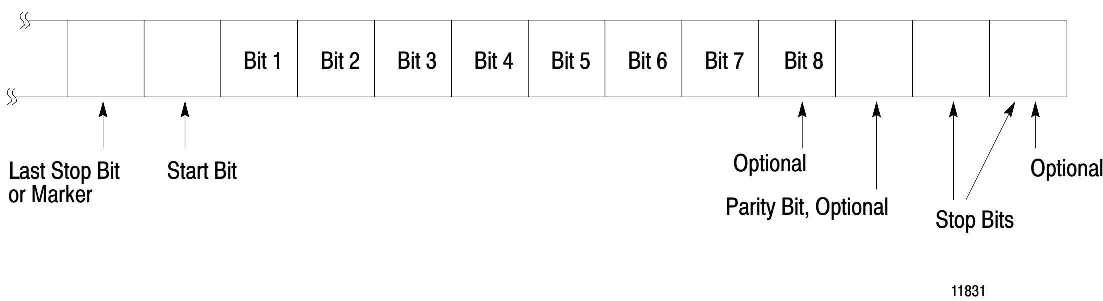
Figure 2.11
Data Byte Storage in Module



Parity

Your ASCII device generates either odd, even, or no parity bit with each character (Figure 2.12). Use the default value (no parity) if this information is not available. Set bits IW1(14,15) accordingly.

Figure 2.12
Serial Data on RS-232-C Line



Number of Stop Bits

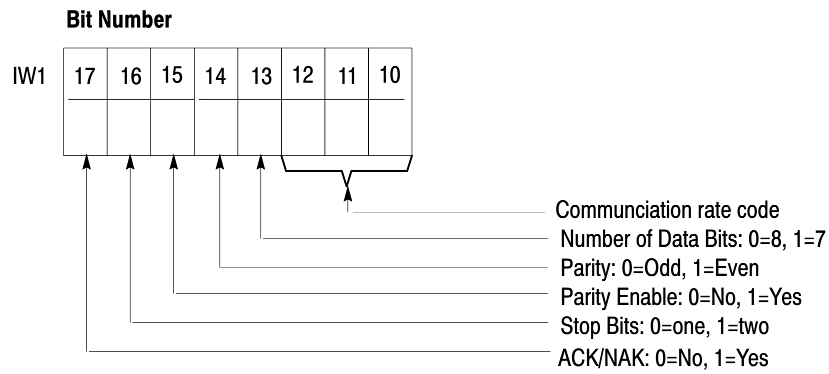
Your ASCII device generates either one or two stop bits (Figure 2.12). Use the default value (one stop bit) if this information is not available. Set bit IW1(16) accordingly.

ACK/NAK

Some ASCII devices require an ACK/NAK response from the ASCII module. An acknowledgment of no errors found in a string (ACK) or acknowledgment of an error found in the string (NAK) is required by some ASCII devices in order to complete its transmission. Other ASCII devices do not require acknowledgment.

The ASCII module does not require an ACK/NAK to complete its transmission. Most ASCII devices do not require transmission acknowledgment. Set bit IW1(17) accordingly.

Record features that apply to your ASCII device by writing a 0 or 1 in corresponding bits IW1(10-17) using the form (found at the end of this chapter) or the boxes below.

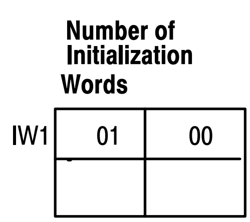


Selecting the Number of Initialization Words, IW1(00-01)

Select the number of initialization words for transfer to the ASCII module after deciding which of the module features are required for your ASCII device and application. You select module features by setting bits in four initialization words. Set the number of initialization words equal to the highest numbered initialization word used. For example, if you need a feature found in word four, you must select all four initialization words.

Number of Words	Code
Word 1	00
Words l and 2	01
Words 1, 2, and 3	10
Words 1, 2, 3, and 4	11

Review your selections of module features. Record the code for the number of initialization words that you need in IW1(00-01). Use the form (found at the end of this chapter) or the boxes below.



Recording Bit Settings in Initialization Words

The next two pages are forms for recording bit settings in the four initialization words. Form 5l75 is for data mode operation of your module; form 5176 for report generation mode. Copy these forms and use them to record your selections of module features.

You will use the information that you record on these forms in chapter 3 to set bits in initialization words and to demonstrate the features that you have selected.

Form 5175
Initialization Words for Data Mode

IW1	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
	ACK NAK	Stop Bits	Parity Enable	Parity Odd, even	No. of bits	Communication Rate			Mode of Transmission			Mode of Operation			Number of Initialization Words	
	0 = * No 1 = Yes	0 = 1* Stop Bit 1 = 2 Stop Bits	0 = * No 1 = Yes	0 = * Odd 1 = Even	0 = 8* Bit Data 1 = 7 Bit Data	000 = 300 Baud* 001 = 600 Baud 010 = 1200 Baud 011 = 2400 Baud 100 = 4800 Baud 101 = 9600 Baud 110 = 110 Baud 111 = 110 Baud			000=Full Duplex w/Echo* 001=Full Duplex w/o Echo 010=Simplex Read 011=Simplex Write 100=Half Duplex w/Echo 101=Half Duplex w/o Echo						00 = Word 1* 01 = Words 1 & 2 10 = Words 1, 2 & 3 11 = Words 1, 2, 3 & 4	
Record Your Selections →												0	0	0		

Hex Equivalent →

IW2	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
	Rate	Data Conversion			Number of ASCII Characters Per String											
	0 = * Single 1 = Multi.	0 0 0 = 2 ASCII 0 0 1 = 3 BCD 0 1 0 = 4 BCD 0 1 1 = 1 ASCII 1 0 0 = 4 Hex			Default = 10, Maximum = 62 BCD Digit 2				BCD Digit 1				BCD Digit 0			
Record Your Selections →																

Hex Equivalent →

IW3	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
	Enable E-O-S Del.	End-of-String Delimiter (E-O-S Del.)							Delay for CR		LF if CR	Send E-O-S Del	Data Just.	I/O Buffer Split Input/Output %		
	0 = * Yes 1 = No	Null * (CTRL 0)							00 = 0 ms* 01 = 50 ms 10 = 100 ms 11 = 200 ms		0 = * No 1 = Yes	0 = * No 1 = Yes	0 = * Right 1 = Left	000 = 50 / 50 * 001 = 100 / 0 010 = 75 / 25 011 = 25 / 75 100 = 0 / 100		
Record Your Selections →	0								0	0		0				

Hex Equivalent →

IW4	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
		Fill Character Removed							Number of Trailing Characters Removed				Number of Header Characters Removed			
		(:) * Must not be same as IW3 (10 - 16)							0 * - 15 binary				0 * - 15 binary			
Record Your Selections →	0								0	0		0				

Hex Equivalent →

* = default value

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Form 5176
Initialization Words for Report Generation Mode

	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
IW1	ACK NAK	Stop Bits	Parity Enable	Parity Odd, even	No. of bits	Communication Rate			Mode of Transmission			Mode of Operation			Number of Initialization Words	
	0 = * No 1 = Yes	0 = 1* Stop Bit 1 = 2 Stop Bits	0 = * No 1 = Yes	0 = * Odd 1 = Even	0 = 8* Bit Data 1 = 7 Bit Data	000 = 300 Baud* 001 = 600 Baud 010 = 1200 Baud 011 = 2400 Baud 100 = 4800 Baud 101 = 9600 Baud 110 = 110 Baud 111 = 110 Baud			000 = Full Duplex w/Echo* 001 = Full Duplex w/o Echo 010 = Simplex Read 011 = Simplex Write 100 = Half Duplex w/Echo 101 = Half Duplex w/o Echo						00 = Word 1* 01 = Words 1 & 2 10 = Words 1, 2 & 3 11 = Words 1, 2, 3 & 4	
Record Your Selections →												0	0	0		

Hex Equivalent →

	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
IW2	Rate	Data Conversion			Number of ASCII Characters Per String											
	0 = * Single 1 = Multi.	0 0 1 = 3 BCD 0 1 0 = 4 BCD			Default = 124, Maximum = 999 BCD Digit 2				BCD Digit 1				BCD Digit 0			
Record Your Selections →																

Hex Equivalent →

	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
IW3	Enable E-O-S Del.	End-of-String Delimiter (E-O-S Del.)							Delay for CR		LF if CR	Send E-O-S Del	Data Just.	I/O Buffer Split Input/Output %		
	0 = * Yes 1 = No	Null * (CTRL 0)							00 = 0 ms* 01 = 50 ms 10 = 100 ms 11 = 200 ms		0 = * No 1 = Yes	0 = * No 1 = Yes	0 = * Right 1 = Left	000 = 50 / 50 * 001 = 100 / 0 010 = 25 / 75 011 = 25 / 75 100 = 0 / 100		
Record Your Selections →	0								0	0		0				

Hex Equivalent →

	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
IW4		Fill Character Removed							Number of Trailing Characters Removed				Number of Header Characters Removed			
		(:) * Must not be same as IW3 (10 - 16)							0 * - 15 binary				0 * - 15 binary			
Record Your Selections →	0								0	0		0				

Hex Equivalent →

* = default value

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Chapter 4

ASCII I/O Module Tutorial

Chapter Objectives

You will use three general procedures in this tutorial.

- Setting bits in your initialization words
- Reading data from your industrial terminal
- Writing data to your industrial terminal

You will observe the results of setting bits in your initialization words by reading data from or writing data to your ASCII device. The procedures for reading and writing data were covered in chapter 1. The procedure for setting bits in your initialization words is covered after you have added initialization logic to your program.

As in chapter 1, this chapter is divided into two parts. One is for PLC-2 family processors, the other is for the PLC-3 processor. Proceed to the part that pertains to your processor.

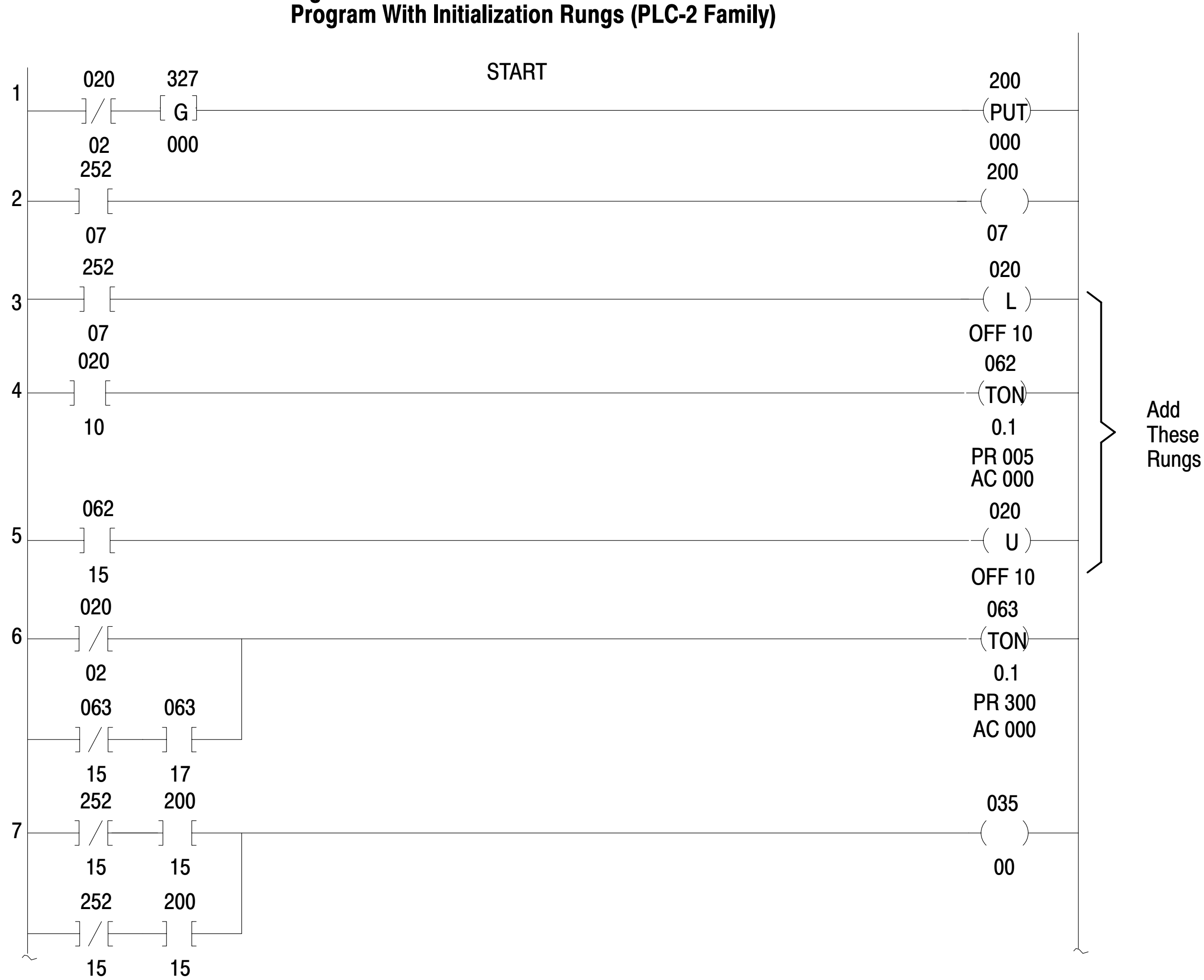
PLC-2 Family Processors

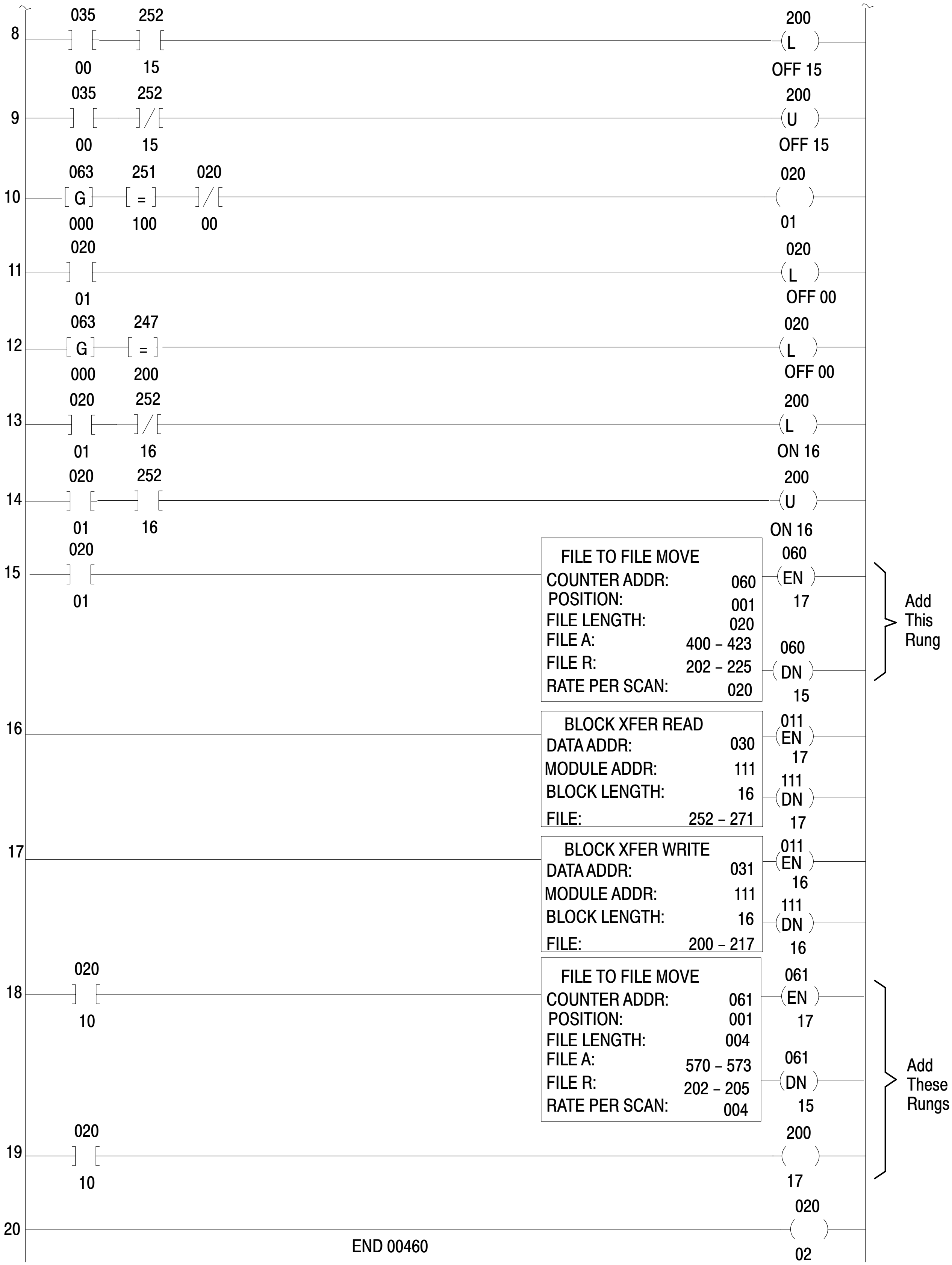
Adding Initialization Rungs

You must add initialization rungs to your "Getting Started Program". Place the processor mode select switch in the PROG position and insert the additional rungs exactly as shown (Figure 3.1).

To insert one or more rungs into your program, place the cursor on the output instruction in the previous rung. Press [INSERT][RUNG], then enter the instructions for one rung. You must press [INSERT][RUNG] before inserting each new rung.

Figure 3.1
Program With Initialization Rungs (PLC-2 Family)




8
035 00
252 15
200 L OFF 15
9
035 00
252 15
200 U OFF 15
10
063 G 000
251 = 100
020 00
020 01
11
020 01
020 L OFF 00
12
063 G 000
247 = 200
020 L OFF 00
13
020 01
252 16
200 L ON 16
14
020 01
252 16
200 U ON 16
15
020 01
FILE TO FILE MOVE
COUNTER ADDR: 060
POSITION: 001
FILE LENGTH: 020
FILE A: 400 – 423
FILE R: 202 – 225
RATE PER SCAN: 020
060 EN 17
060 DN 15
Add This Rung
16
BLOCK XFER READ
DATA ADDR: 030
MODULE ADDR: 111
BLOCK LENGTH: 16
FILE: 252 – 271
011 EN 17
111 DN 17
17
BLOCK XFER WRITE
DATA ADDR: 031
MODULE ADDR: 111
BLOCK LENGTH: 16
FILE: 200 – 217
011 EN 16
111 DN 16
18
020 10
FILE TO FILE MOVE
COUNTER ADDR: 061
POSITION: 001
FILE LENGTH: 004
FILE A: 570 – 573
FILE R: 202 – 205
RATE PER SCAN: 004
061 EN 17
061 DN 15
19
020 10
200 17
Add These Rungs
20
END 00460
020 02

Setting Bits in Initialization Words

Set bits in your initialization words to select desired module features as follows:

1. Place the cursor on the file-to-file move instruction in rung 18. It contains the file of initialization words.

2. Display the file.

Press [DISPLAY]1 for hex, or [DISPLAY] 0 for binary.

The file is displayed either in hex or binary as follows:

```
     HEXADECIMAL
     DATA MONITOR

POSITION      FILE DATA
  001           0000
  002           0000
```

```
          BINARY
       DATA MONITOR

POSITION           FILE DATA
  001        00000000  00000000
  002        00000000  00000000
```

Header information was deleted for brevity.

3. Enter initialization data into each file word by pressing [INSERT] after you have entered data into the command buffer at the bottom of the screen. Press [↓] to move to the next file word.

Enter data in binary or hex. Binary is easier to understand because you set actual bits. Hex is faster and more convenient when you can convert from binary to hex as follows (Table 3.A)

Table 3.A
Binary/Hex Conversion

Binary	Hex	Binary	Hex	Binary	Hex	Binary	Hex
0000	0	0100	4	1000	8	1100	C
0001	1	0101	5	1001	9	1101	D
0010	2	0110	6	1010	A	1110	E
0011	3	0111	7	1011	B	1111	F

4. Terminate data entry and return to ladder diagram.

Press [CANCEL COMMAND]

You will often use the above procedure and the procedures from chapter 1 in this tutorial.

Expanding the Number of Initialization Words

The module has four words that you use to select operating features. You do this by setting one or more bits for each feature that you want to use.

You increase the number of initialization words according to the module features that you want to use. For example, if you want a feature that is selected in initialization word three, you must use initialization words one, two, and three.

1. Set your module for initialization words one, two, and three using bits 00 and 01 of initialization word one, IWl (00-01). Use the procedure in the section titled "Setting Bits in Initialization Words," P. 3-4.

Results Position 001 contains initialization word one (IW1). This chapter will show both the binary and hex display.

	File Data	
POSITION	Hex	Binary
001	0020	00000000 00000010

Changing the Module's String Length (Read, Only)

String length is a 3-digit BCD number. You can set the string length in BCD, or you can set the BCD digits in binary. The binary equivalent of BCD and Hex is identical for 0 thru 9.

1. Set the string length to 15 characters in IW2 (00-13) using the procedure in the section titled "Setting Bits in Initialization Words".

DISPLAY The file-to-file move instruction displays your setting as follows:

	File Data	
POSITION	Hex	Binary
002	0015	00000000 00010101

2. Demonstrate the string length by entering 16 data characters. When you enter the 16th data character, the module transfers the string of 15 characters to the read block transfer file in the data table, where you can observe it. (The sixteenth character is not transferred but remains as the first character in the input buffer.) Do the following example where the processor will read data from your ASCII module. Refer to the procedures in section titled "Reading Data from Your ASCII Device", P. 1-28.

Enter ALLEN BRADLEY 12 (enter spaces as shown)

Procedure P1	Set your industrial terminal to alphanumeric mode
Procedure P2	Enter your data
Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P4	Observe how data is stored in the data table

Results The read block transfer file displays the 15 data characters in positions 003 thru 010 (Table 3.B).

Table 3.B
String Length Display

Position	File Data	ASCII Equivalent	
001	A010 or E010	status word one	
002	0000	status word two	
003	2041	A	
004	4C4C	LL	
005	454E	EN	15
006	2042	B	transferred
007	5241	RA	characters
008	444C	DL	
009	4559	EY	
010	2031	I	

The space (20) in position 003 was placed there by the module due to right justification of data.

Initialization Error

If the characters were not displayed when you entered them (ALLEN-BRADLEY 12), and the display of transferred data contained only the code X4XX in status word one, you have an initialization error. (X is any value.) Repeat the procedure in section titled "Setting Bits in initialization Words" (P. 3-4), exactly as shown setting IWl (00-01)=10 in binary or 2 in hex. A setting of IW1 (00-01)=11 in binary or 3 in hex will not work in this example.

Justifying Data

The module justifies data before it transfers this data to the processor data table. The module left justifies data by placing the first character in the upper byte of the first word address of the file. The module right justifies data by placing the last character in the lower byte of the last word of the file.

You can tell the difference between the storage of left and right justified data by looking at the first and last words. In left justified data, spaces or fill characters, if needed, are added to the last file word. In right justified data, space or fill characters, if needed, are added to the first file word.

If the number of characters transferred is less than the string length that you set in IW2(00-13), the module completes the string by inserting fill characters or spaces. Fill characters or spaces are stored ahead of the data (lower addresses) for right justified data, or following the data (higher addresses) for left justified data.

Demonstrating Margin Justification Storage

In this demonstration, you compare data table storage of right justified data with left justified data. When the module operates in data mode, margins are right justified (default) unless you select left justified. The demonstration in the section titled "Changing the Module's String Length (Read, Only)" showed data table storage of right justified data (Table 3.B). In this demonstration, you set the margin justification bit IW3(03) for left justification, repeat the procedures in "Changing the Module's String Length (Read, Only)" (P. 3-5) and compare the two displays.

1. Set IW3(03) for left justification using the procedure in section titled "Setting Bits in Initialization Words"

Display Your file-to-file move instruction displays your setting as follows:

POSITION	File Data	
	Hex	Binary
003	0008	00000000 000010000

2. Repeat step 2 of section titled "Changing the String Length."

Results The read block transfer file displays the 15 data characters in positions 003 thru 010 with the data left justified (Table 3.C).

Table 3.C
String Length, Left Justified

POSITION	FILE DATA	ASCII Equivalent
001	E010	status word one
002	0000	status word two
003	414C	A L
004	4C45	L E
005	4E20	N
006	4252	B R
007	4144	A D
008	4C45	L E
009	5920	Y
010	3120	1

The module placed the space (20) in position 010 because it left justified the data.

Displaying Right Justified Data

In this demonstration, assume that your margin justification bit IW3(03) had been reset for right justification (in data mode, only), and that initialization words one and two are set as follows: IW1=0002 and IW2=0015.

1. Use file-to-file move instruction to store data you want write block transferred to your industrial terminal for display. Load your file-to-file move instruction (**rung 15**) exactly as shown (Table 4.D) starting in position 001. Use the procedure in section titled "Writing Data to Your ASCII Device", P. 1-14.

Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P5	Load data into the file-to-file move instruction

Table 3.D
String Length, Right Justified

POSITION	FILE DATA	ASCII Equivalent
001	2020	
002	2020	
003	2020	
004	2020	
005	2042	B
006	5241	R A
007	444C	D L
008	4559	E Y

2. Display the data on your industrial terminal using the procedure in entitled "Writing Data to Your ASCII Device", P.1-14.

Set your industrial terminal to alphanumeric mode. Switch the processor mode select switch to the RUN/PROG position.

Results Your industrial terminal displays the following:

BRADLEY

BRADLEY is displayed in a position eight spaces from the left margin. This example is equivalent to transferring seven right justified data characters when the set string length is 15 characters and the data conversion is 2 ASCII characters per word.

Demonstrating End-of-String Delimiter

In this demonstration you will select an end-of-string delimiter and demonstrate its use.

Select the carriage return (CR) as the end-of-string delimiter and set IW3(10-16) accordingly. The ASCII code for carriage return is 0D in hex, 0001101 in binary.

1. Set IW3(10-16) for the end-of-string delimiter, CR, and reset the margin justification bit IW3(03) to zero for right justification using the procedure in section titled "Setting Bits in Initialization Words", P. 3-4.

DISPLAY The file-to-file move instruction displays your setting as follows:

POSITION	FILE DATA	
	Hex	Binary
003	0D00	00001101 00000000

String Length Less Than Module's String Length

Whenever the ASCII module receives an end-of-string delimiter from the ASCII device, it transfers the data in its input buffer to the processor. To demonstrate this, you will enter a data string less than the set string length as determined by IW2(00-13).

1. Enter: 12345[RETURN]

Refer to the procedures in section titled "Reading Data from Your ASCII Device", P. 1-10.

Procedure P1	Set your industrial terminal to alphanumeric mode
Procedure P2	Enter your data
Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P4	Observe how data is stored in the data table

Results The read block transfer file displays the five character string in positions 003 thru 010 (Table 3.E).

Table 3.E
String Length < String Length, Right Justified

POSITION	FILE DATA	ASCII Equivalent
001	E011	status word one
002	0000	status word two
003	2020	
004	2020	
005	2020	
006	2020	
007	2020	
008	2031	1
009	3233	2 3
010	3435	4 5

Notice the following:

- The new string (data and fill characters) completely replaced the previous data.
- The data is right justified.
- Fill character spaces (20) were added by the ASCII module.

String Length Greater Than Module's String Length

When the module receives a string of data greater than the set string length, it does the following:

- Immediately transfers the number of characters equal to its set string length to the processor.
- Sets bit 14 in status word one, Input String>Maximum, SW1(14). Bit 14 is immediately reset when the processor confirms receipt of data.
- Retains the balance of data in its input buffer.
- Transfers the balance of data with new data when it receives enough new data to complete the string, or when the new data contains an end-of-string delimiter.

In this demonstration you will enter a string of data greater than the set string length and observe its storage in the data table. (The set string length, IW2(00-13), is 15 characters.)

1. Enter 12345678901234567890

Do **not** enter [RETURN]

Refer to procedures in section titled "Reading Data from Your ASCII Device", P. 1-10.

Procedure P1	Set your industrial terminal to alphanumeric mode
Procedure P2	Enter your data
Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P4	Observe how data is stored in the data table

Results The read block transfer file displays the number of characters equal to the string length, 15, in positions 003 thru 010 (Table 3.F).

Table 3.F
Transfer of Full String

POSITION	FILE DATA	ASCII Equivalent
001	E011	status word one
002	0000	status word two
003	2031	1
004	3233	2 3
005	3435	4 5
006	3637	6 7
007	3839	8 9
008	3031	0 1
009	3233	2 3
010	3435	4 5

Notice how the 15 characters of the string are stored (right justified), and that the module added one fill character.

Characters 6, 7, 8, 9, and 0 remain in the module's input buffer. They will be erased in step 2 because the procedure clears the input buffer.

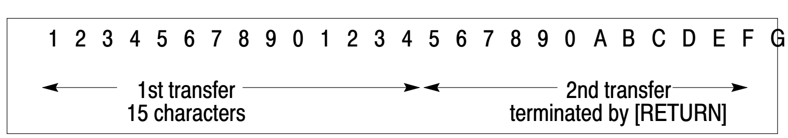
2. Enter: 12345678901234567890ABCDEFG[RETURN]

Refer to procedures in section title "Reading Data from Your ASCII Device" if necessary.

Procedure P1	Set your industrial terminal to alphanumeric mode
Procedure P2	Enter your data
Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P4	Observe how data is stored in the data table

Results Two transfers took place in step 2 (Figure 3.2). The second transfer wrote over the first, and is displayed in the read block transfer file (Table 3.G).

Figure 3.2
Division of Data Between Two Transfers



11834

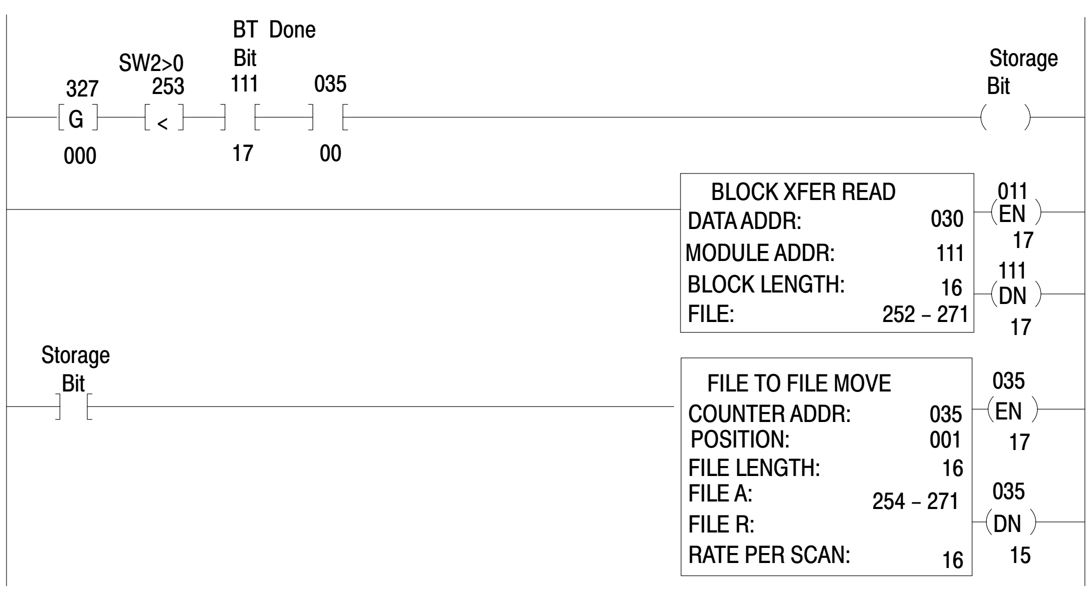
Table 3.G
Transfer of Balance of String

POSITION	FILE DATA	ASCII Equivalent
001	E011	
002	0000	
003	2020	
004	2020	
005	3637	6 7
006	3839	8 9
007	3041	0 A
008	4243	B C
009	4445	D E
010	4647	F G

Your program must include instructions for processing new data read from the module. If not, data in your read block transfer file will be written over in the next read block transfer.

You can do this by examining whether status word two (SW2) contains data, using a greater-than instruction. When the value in SW2 is greater than zero (new data flag), move new read block transfer data to an alternate storage file. Your program can process it before it is overwritten by the next transfer of new data (Figure 3.3). Make the address of the source file of the file-to-file move instruction (file A) the same address as the read block transfer file. Also examine the BTR done bit.

Figure 3.3
Example Programming, New Data Flag



Removing the Fill Character

Whenever the module encounters the ASCII character that you defined in IW4(10-16) as the fill character to be removed, the module removes it from the string. Then the module transfers only data, justifies the data, and adds its own fill character. The number of fill characters that it adds is equal to the number of those it removed. (The fill character that the module inserts is described in section titled "Your ASCII Module Inserts Fill Characters"), P. 2-22. If your ASCII device uses fill characters for positioning data, you may choose not to remove them because the position has meaning.

In this demonstration you will select a fill character that the module will remove, and observe its operation.

1. Increase the number of initialization words to four by setting appropriate bits. Set IW1=0003. Use the procedure in section titled "Setting Bits in Initialization Words", P. 3-4

2. Select the slash symbol (/) as the fill character to be removed. The ASCII / is 2F in hex. Set IW4=2F00.

Display The file-to-file move instruction displays your settings as follows:

POSITION	FILE DATA	
	Hex	Binary
001	0003	00000000 00000011
002	0015	00000000 00010101
003	0D00	00001101 00000000
004	2F00	00101111 00000000

3. Enter: //AS//23//AS//4[RETURN]

Refer to procedures in section titled "Reading Data from Your ASCII Device" if necessary.

Procedure P1	Set your industrial terminal to alphanumeric mode
Procedure P2	Enter your data
Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P4	Observe how data is stored in the data table

Results The module transferred the data characters, extracted the fill character, added its own fill character, and right justified the data (Table 3.H).

Table 3.H
Extraction of Fill Character

POSITION	FILE DATA	ASCII Equivalent
001	E011	status word one
002	0000	status word two
003	2020	
004	2020	
005	2020	
006	2020	
007	2041	A
008	5332	S 2
009	3341	3 A
010	5334	S 4

This feature does not allow your program to add data characters in place of fill characters removed from the string. This feature changes the position of data.

Removing Header and Trailing Characters

When the module removes header and trailing characters from a data string, it counts only the balance of characters as data in the string. The module does not remove trailing characters until the data string exceeds the set string length. The module counts the first characters of the string as header characters, and removes them regardless of the number of characters in the string.

1. Set the number of header characters (three) and trailing characters (four) to be removed by setting IW4(00-03) and IW4(04-07) to three and four, respectively. Use the procedure in section titled "Setting Bits in Initialization Words", P. 3-4.

Display The file-to-file move instruction displays your setting as follows:

POSITION	FILE DATA	
	Hex	Binary
004	2F43	000010111 01000011

2. Enter: 12345678901234567890 12

Refer to procedures in section titled "Reading Data From your ASCII Device", P. 1-10.

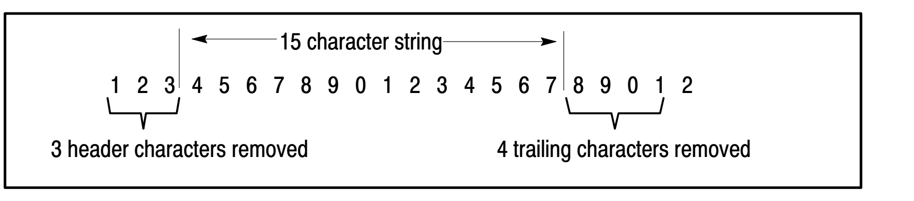
Procedure P1	Set your industrial terminal to alphanumeric mode
Procedure P2	Enter your data
Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P4	Observe how data is stored in the data table

Results The read block transfer file displays 15 data characters (Table 3.I). Removed header and trailing characters are shown in Figure 3.4.

Table 3.I
Display After Removing Characters

POSITION	FILE DATA	ASCII Equivalent	
001	E011	status word one	
002	0000	status word two	
003	2034	4	
004	3536	5 6	
005	3738	7 8	
006	3930	9 0	set string length=
007	3132	1 2	15 data characters
008	3334	3 4	
009	3536	5 6	
010	3738	7 8	

Figure 3.4
Removed Header and Trailing Characters



Demonstrating Data Conversion

When in data mode, select a data conversion type compatible with the characters transmitted by the ASCII device. Your selection is limited to one of the following conversion types:

Conversion Type	Data Characters
2 ASCII characters per word 1 ASCII character per word	ASCII standard code
3 BCD characters per word 4 BCD characters per word	0 thru 9
4 hex characters per word	0 thru 9, A thru F

When operating in report generation mode, the module selects two ASCII characters per word for message characters. You choose the data conversion for message variables (BCD values) placed between delimiters. Your selection is limited to one of the following:

Conversion Type	Data Characters
3 BCD characters per word 4 BCD characters per word	0 thru 9

The manner in which the module converts data depends on the type of data conversion that you select. For example, if you load a file with ASCII characters and transfer the file to the industrial terminal for display, the module will interpret the data according to the data conversion that you selected. You will demonstrate this by transferring data in a file-to-file move instruction (Table 3.J) from processor to industrial terminal. The industrial terminal will display the data (Table 3.K) one line at a time. Each line is the result of selecting a different data conversion.

Table 3.J
Storage File

POSITION	FILE DATA
001	3132
002	3334
003	4142
004	4344
005	20AB
006	CDEF

Table 3.K
Display of Converted Data

Line	Conversion	Display	Notes
1	2 ASCII/word	1 2 3 4 A B C D + M 0	1
2	1 ASCII/word	2 4 B D + 0	1 2
3	4 Hex/word	3132 3334 4142 4344 20AB CDEF	
4	4 BCD/word	3132 3334 4142 4344 20AB CDEF	
5	3 BCD/word	132 334 142 344 0AB DEF	3

1 - 2 ASCII/word conversion examines the 7 bit code in each byte: AB=10101011=+; CD=11001101=M; EF=11101111=o (Note that lower case letters are displayed as upper case letters.)
2 - Bits 10-17 are not used in 1 ASCII/word conversion
3 - Bits 14-17 are not used in 3 BCD/word conversion

Verify the conversions (Table 3.K) as follows:

1. Load the file of the file-to-file move instruction (rung 15) starting at position 001 exactly as shown in Table 3.J. Use procedure P3 and P5 from "Writing Data to Your ASCII Device", P. 1-14.

Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P5	Load data into the file-to-file move instruction

2. Set initialization word one to data mode, and select three initialization words. Set IW1=0002. Use the procedure in section titled "Setting Bits in Initialization Words", P. 3-4.

3. Change your data conversion to 2 ASCII characters per word and set the string length to 12, (IW2=0012).

4. Remove the BCD delimiter from initialization word four. Set IW4=0000.

5. Change operation of your industrial terminal to alphanumeric mode. Transfer data to the industrial terminal by changing the processor mode select switch to the RUN/PROG position.

Results The industrial terminal displays

1234ABCD+M0(table 4.K, line1)

6. Verify the remaining conversions in lines 2, 3, 4 and 5 (Table 3.K) by setting IW2(16-14) as follows:

Conversion	Bit Setting 16	15	14	Hex Setting
1 ASCII/word	0	1	1	IW2 = 3012
4 Hex/word	1	0	0	IW2 = 4012
4 BCD/word	0	1	0	IW2 = 2012
3 BCD/word	0	0	1	IW2 = 1012

Results The industrial terminal displays the corresponding line in Table 3.K.

Selecting Report Generation Mode, Data Conversion, and BCD Delimiter

In report generation mode you can mix BCD digits with ASCII characters. The module sets the ASCII data conversion to two ASCII characters per word. You select the type of data conversion for BCD digits (either three BCD of four BCD digits per word) in initialization word two (IW2). If you want to transfer BCD digits, increase the number of initialization words to four in IW1 and select the BCD delimiter in IW4.

In this demonstration you will select the following:

- Four initialization words using IW1(00-01)
- Report generation mode using IW1(02-04)
- Data conversion of 3 BCD digits per word using IW2(14-16)
- Slash symbol (/) as BCD delimiter using IW4(10-16)

1. Set the bits in all four initialization words using the procedure in section titled “Setting Bits in Initialization Words”, P. 3-4.

Display The file-to-file move instruction displays your settings as follows:

POSITION	FILE DATA Hex	Binary
001	0007	00000000 00000111
002	1015	00010000 00010101
003	0D00	00001101 00000000
004	2F00	00101111 00000000

Next, you will demonstrate the transfer of BCD digits to the data table, and observe how BCD digits are stored with ASCII characters when the data string contains both.

2. Enter: ABCD/1234567/A12

Use procedures in section title “Reading Data From Your ASCII Device” (chapter 1), if necessary.

Procedure P1	Set your industrial terminal to alphanumeric mode
Procedure P2	Enter your data
Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P4	Observe how data is stored in the data table

Results The read block transfer file displays the 15 data characters in positions 003 thru 010 (Table 3.L).

Table 3.L
Storage of BCD and ASCII Characters

POSITION	FILE DATA	ASCII Equivalent
001	E010	status word one
002	0000	status word two
003	4142	A B
004	4344	C D
005	002F	/
006	0001	1
007	0234	2 3 4
008	0567	5 6 7
009	2F41	/ A
010	3100	1

Notice the following:

- The data string is left justified.
- BCD digits in the string are right justified. (The module inserted leading zeros in positions 005 through 008.)
- The number of characters transferred is 15.

3. For comparison, enter a string with a different number of BCD values. Observe how they are stored.

Enter ABC/123456/A123

Results The read block transfer file displays the 15 data characters in positions 003 thru 010 (Table 3.M).

Table 3.M
Storage of BCD and ASCII Characters

POSITION	FILE DATA	ASCII Equivalent
001	E010	status word one
002	0000	status word two
003	4142	A B
004	432F	C /
005	0123	1 2 3
006	0456	4 5 6
007	2F41	/ A
008	3132	1 2
009	3300	3
010	0000	

Notice the following:

- The module used fewer leading zeros.
- The module used one less storage word to store the 15 character string.

When your program transfers BCD values, be sure you know how the data will be stored (how leading or trailing zeros will position data into different storage addresses).

Formatting a Single-Line Message

When formatting a message, you store the message text and you write program logic to insert variables into your message. Consider the message PRODUCED (quantity) PARTS. The message text is PRODUCED....PARTS. The variable that you want to communicate is the quantity. The variable can be timer or counter accumulated values, analog I/O values, or any other data table word, byte, or bit that changes value.

Format the message PRODUCED (quantity) PARTS as follows:

1. Create a file for your message using file A (source file) of a file-to-file move instruction (FFM 060) in rung 17. Load your message text (Table 3.N) into file A of FFM 060 starting with position 001. Equivalent data table addresses are listed in the left-hand column, the message is tabulated in the right-hand column. Use the slash as your BCD delimiter.

Do this using procedure P5 in section titled "Writing Data To Your ASCII Device" (chapter 2).

Table 3.N
Message File

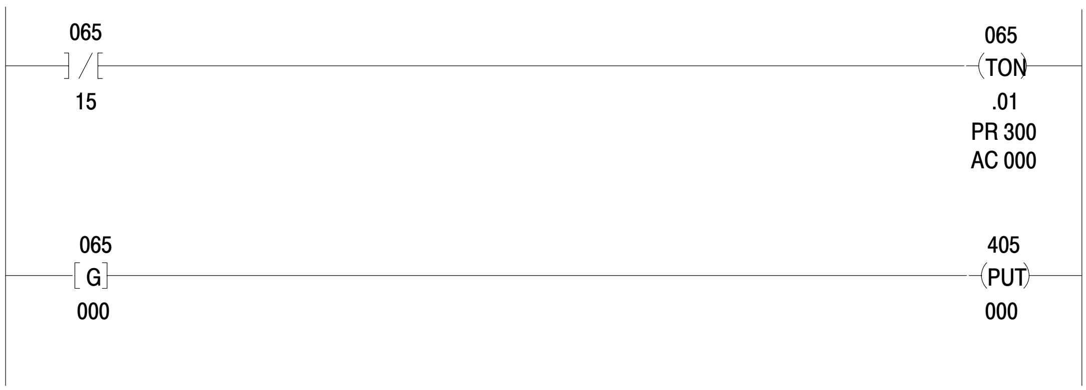
Equivalent Word Address	HEXADECIMAL DATA MONITOR POSITION	FILE A DATA	ASCII Equivalent
400	001	5052	P R
401	002	4F44	O D
402	003	5543	U C
403	004	4544	E D
404	005	202F	/
405	006	0000	
406	007	2F20	/
407	008	5041	P A
408	009	5254	R T
409	010	5300	S

Store the delimiter preceding the BCD value in the lower byte of the word preceding the BCD storage word. Store the delimiter following the BCD value in the upper byte of the word following the BCD storage word (Table 3.N). If necessary, add an extra space before the first delimiter to properly position it.

2. Program the insertion of the variable using get/put instructions. In this example, use the accumulated value of free-running timer 065 as the variable. Your program will put this value into word 405 (position 006) of your message file (Table 3.N).

Do this by entering the following rungs (Figure 3.5) just ahead of the rung in which you just stored your message.

Figure 3.5
Example Programming for the Message Variable



3. In this demonstration you will select the following features:

- Four initialization words using IW1(00-01)
- Report generation mode using IW1(02-04)
- Data conversion of 3 BCD digits per word using IW2(14-16)
- Slash symbol (/) as BCD delimiter using IW4(10-16)

Set the bits in all four initialization words using the procedure in section titled “Setting Bits in Initialization Words”, P. 3-4.

Display The file-to-file move instruction displays your settings as follows:

	FILE DATA	
POSITI ON	Hex	Binary
001	0007	00000000 00000111
002	1015	00010000 00010101
003	0D00	00001101 00000000
004	2F00	00101111 00000000

4. Display your message on the industrial terminal. Typically, you would enable your message with a pushbutton switch and program logic. In this example, set your industrial terminal to alphanumeric mode and switch the processor’s mode select switch to the RUN/PROG position.

Results Your industrial terminal displays

PRODUCED XXX PARTS

where XXX is the accumulated value of the free running timer that your program inserted.

Formatting a Multi-Line Message

When formatting a multi-line or multi-column message using the industrial terminal, use the ASCII equivalent of the following control codes for positioning the message.

Control Codes	Hex or ASCII Equivalent
CTRL P	10
Column number	31, 32, 33,...
:	3B
Line number	31, 32, 33,...
A	41

When you enter the ASCII equivalent of these control codes into the message file, they will position the cursor at the column and line number that you specify.

For example, suppose you want to display a column of 8-digit diagnostic codes that indicate the status of system operation. The diagnostic codes are the variable that your program moves into your message file at the appropriate addresses. In this example, set initialization words (Table 4.O) as follows:

Table 3.O
Example Initialization Words

Initialization Words	Selected Features
IW1 = 0007	Report generation mode, 4 initialization words, 300 baud
IW2 = 2032	4 BCD characters/word, 32 characters/string
IW3 = 0D00	End-of-string delimiter is carriage return
IW4 = 3A00	BCD delimiter is a colon (:)

For a display of the following diagnostic codes

12345678
ABCD4321
FACEBAC2

your message file (Table 4.P) would appear as:

Table 3.P
Example Message File

POSITION	FILE DATA	Description (FILE DATA)	
001	1041	CTRL P	A
002	1031	CTRL P	Column number
003	3B31	;	Line number
004	413A	A	BCD delimiter
005	1234		Diagnostic code
006	5678		Diagnostic code
007	3A00	BCD delimiter	
008	1031	CTROL P	Column number
009	3B32	;	Line number
010	413A	A	BCD delimiter
011	ABCD		Diagnostic code
012	4321		Diagnostic code
013	3A00	BCD delimiter	
014	1031	CTRL P	Column number
015	3B33	;	Line number
016	413A	A	BCD delimiter
017	FACE		Diagnostic code
018	BAC2		Diagnostic code
019	3A0D	BCD delimiter	EOS delimiter

Notice the following:

- Home position of the cursor appears once (position 001) before you specify line and column numbers.
- Column numbers remain constant at 31 in this example.
- Line numbers advance by one (31, 32, 33,...) in this example.
- BCD delimiter precedes and follows the variable.
- End-of-string (EOS) delimiter is placed at the end of this single string.

You would have entered zeros for your variables (diagnostic codes) in positions 005 and 006, 011 and 012, 017 and 018 when setting up your file. Your program inserts values when you enable the display.

Verify that this message file displays the diagnostic codes as shown.

1. Load the message file into the file-to-file move instruction 9rung 15) exactly as shown in table 3.P. Use procedures P3 and P5 from "Writing Data to Your ASCII Device", P. 1-14.

Procedure P3	Set your industrial terminal to PLC-2 mode
Procedure P5	Load data into the file-to-file move instruction

2. Set your initialization words (Table 4.O)

3. Change the block length of the BTW instruction (rung 17) from 16 to 22.

4. Change your industrial terminal to alphanumeric mode. Transfer data to the industrial terminal by changing the processor mode select switch to the RUN/PROG position.

Results The industrial terminal displays the column of diagnostic codes in the upper left corner of the screen.

```
12345678
ABCD4321
FACEBAC2
```

With a read/write program, you can enter the text of your message into processor memory by using the industrial terminal as an ASCII data terminal (as compared with entering data with the data monitor mode of the industrial terminal described in the previous two examples). When entering data from an ASCII data terminal, you can use the rubout or delete key. Pressing either key deletes the previous character from the ASCII module's input buffer. You can delete one or more characters up to the entire string bounded by the previous end-of-string delimiter.

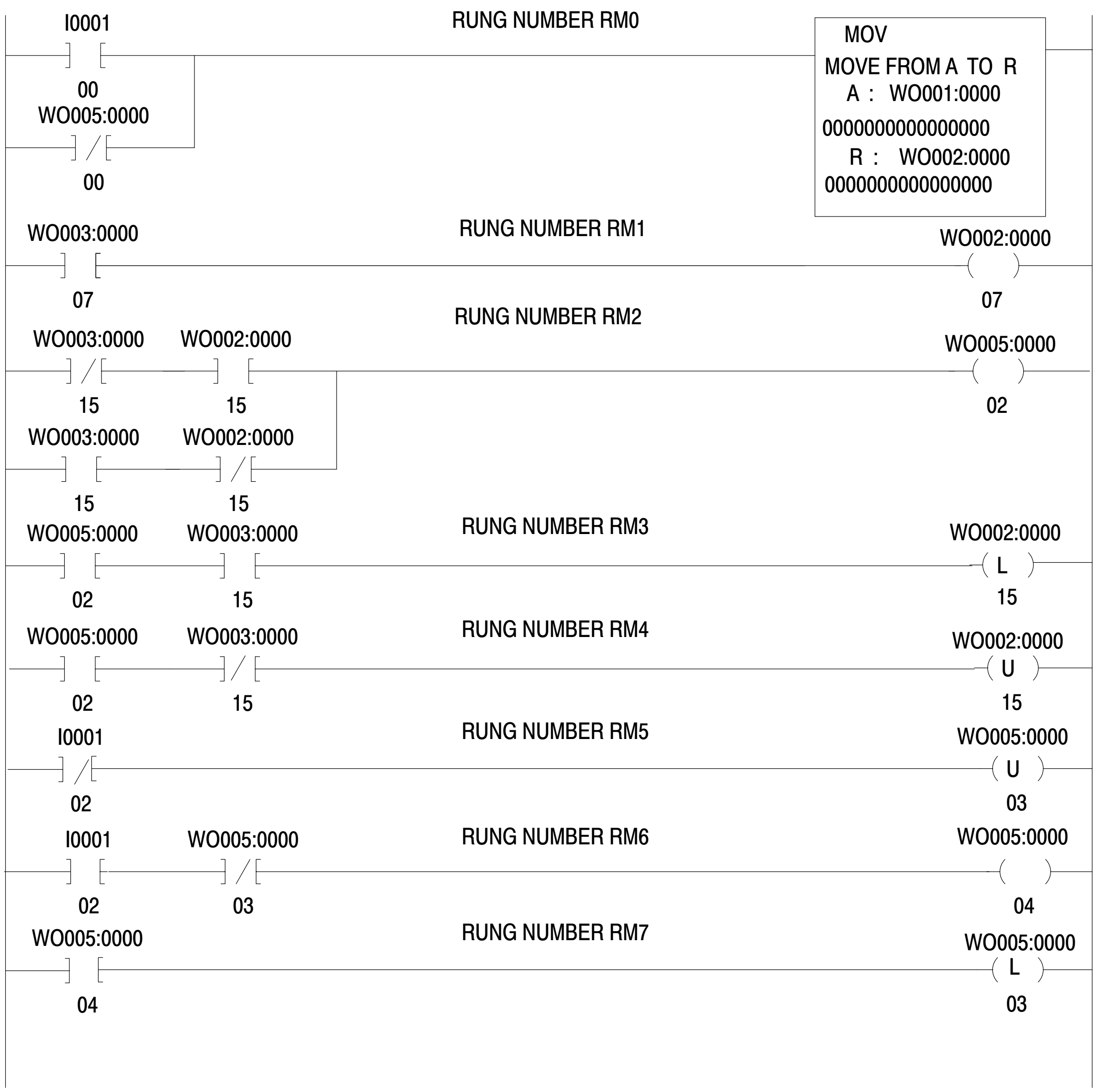
NOTE: The correct operation of your module depends on proper handshake programming for read and write block transfer instructions. Be sure to read the description of handshaking in chapter 4, and study the handshake programming examples.

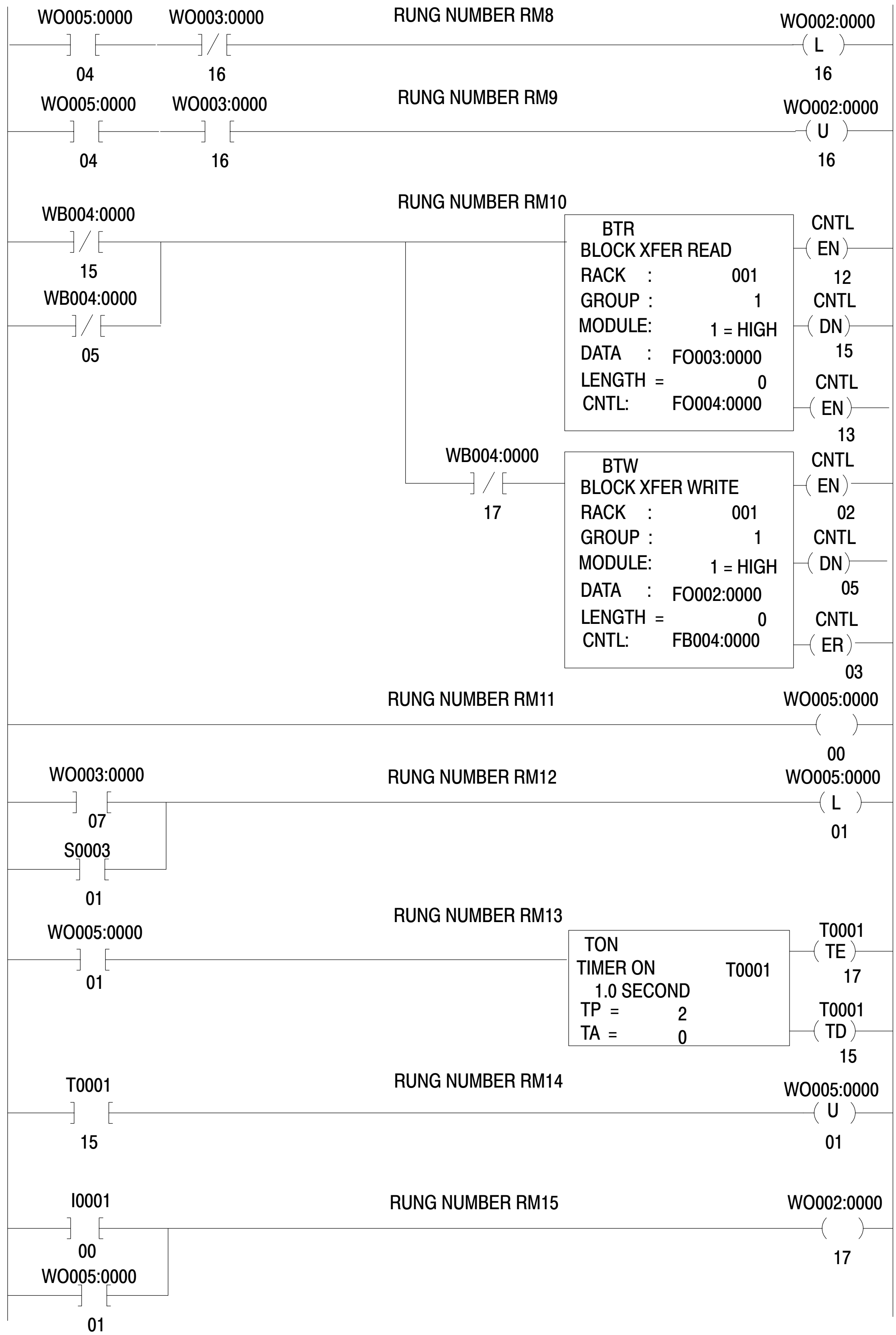
PLC-3 Processors

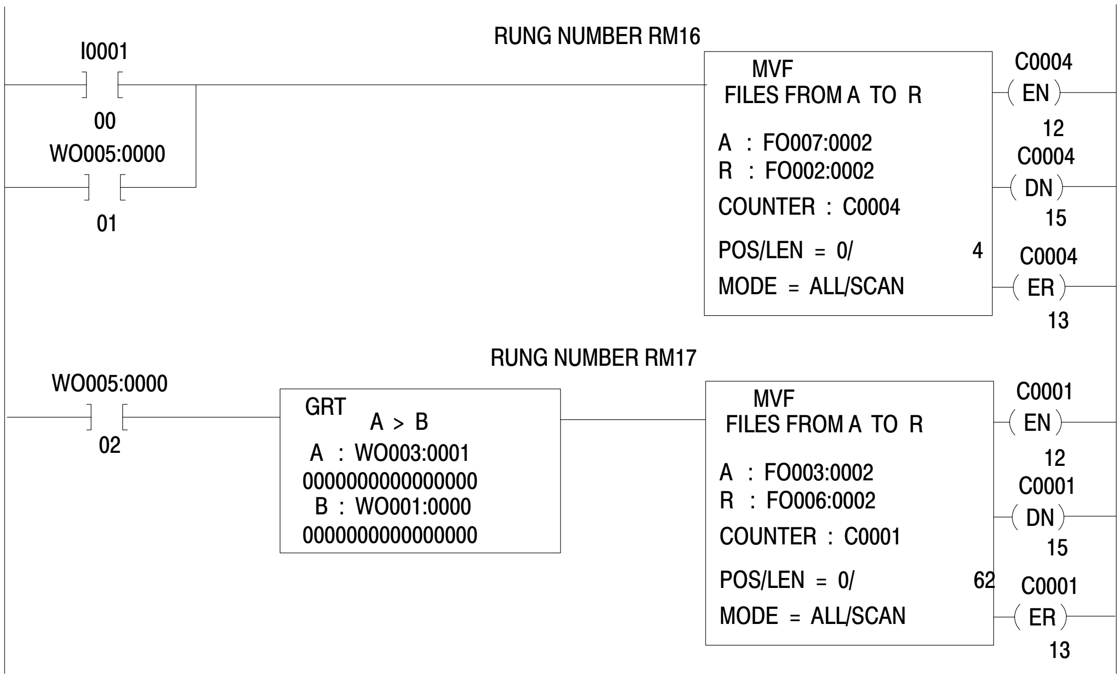
Adding Initialization Rungs

Add initialization rungs and file move logic to your “Getting Started Program” (Figure 3.6 rungs 12 thru 17) so that you can configure your module.

Figure 3.6
“Getting Started Program” (PLC-3)




WO005:0000
04
WO003:0000
16
RUNG NUMBER RM8
WO002:0000
L
16
WO005:0000
04
WO003:0000
16
RUNG NUMBER RM9
WO002:0000
U
16
RUNG NUMBER RM10
WB004:0000
15
WB004:0000
05
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FO004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
EN
13
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03
RUNG NUMBER RM11
WO005:0000
00
WO003:0000
07
S0003
01
RUNG NUMBER RM12
WO005:0000
L
01
WO005:0000
01
RUNG NUMBER RM13
TON
TIMER ON
T0001
1.0 SECOND
TP = 2
TA = 0
T0001
TE
17
T0001
TD
15
T0001
15
RUNG NUMBER RM14
WO005:0000
U
01
I0001
00
WO005:0000
01
RUNG NUMBER RM15
WO002:0000
17


RUNG NUMBER RM16
I0001
00
WO005:0000
01
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM17
WO005:0000
02
GRT
A > B
A : WO003:0001
0000000000000000
B : WO001:0000
0000000000000000
MVF
FILES FROM A TO R
A : FO003:0002
R : FO006:0002
COUNTER : C0001
POS/LEN = 0/ 62
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER
13

1. Place the PLC-3 processor in program load mode. Press

[SHIFT][LIST]3[ENTER]

on the PLC-3 front panel, and insert the additional rungs exactly as shown on the industrial terminal.

To insert one or more rungs into your program, place the cursor on the input instruction in the following rung. Press [INSERT][SHIFT][RUNG][ENTER]. Then enter the instructions for one rung. You must press [RUNG ↓] before inserting each new rung.

2. After you enter the additional rungs, create a source file (file A) for the file move instruction in rung 16 and a result file (file R) in rung 17. To set the size of the source file in rung 16 to 4 words (word 0 thru 3), press

CR,O7:3,Y[ENTER] (for rung 16)

PLC-3 file display starts with word 0. Initialization words 1, 2, 3, and 4 are numbered in the display as words 2, 3, 4, and 5 because of the addresses assigned in the file move instruction.

To set the size of the result file in rung 17 to 64 words (words 0 thru 100 octal) press

CR,O6:100,Y[ENTER] (for rung 17)

3. Check the data table to see that file O7:0 was properly created. Press the following key sequence to display file O7:0.

DD,O7:3[ENTER]

4. Check that file O6:0 was properly created. Press [RUNG ↓].

Setting Bits in Initialization Words

The file initialization words is the file move instruction in rung 16. Set bits in your initialization words to select desired module features as shown in the following steps:

1. Display the initialization file FO007:0002. Press

DD,O7:2

The cursor is on the first word of the file (word 2).

2. Convert the data to hex or binary. Press

,[SHIFT]%H[ENTER]for hex

,[SHIFT]%B[ENTER] for binary

3. Enter hex (or binary) data into each file word (word 2 thru 5) by pressing [ENTER] after you have entered data into the command buffer at the bottom of the screen. Press [→] to move the next file word. Do not load data into words 1 and 2. They are not part of the initialization file.

When entering data, binary is easier to understand because you set actual bits. Hex is faster and more convenient when you convert from binary to hex as follows:

Binary	Hex	Binary	Hex	Binary	Hex	Binary	Hex
0000	0	0100	4	1000	8	1100	C
0001	1	0101	5	1001	9	1101	D
0010	2	0110	6	1010	A	1110	E
0011	3	0111	7	1011	B	1111	F

4. To terminate the file display and return to ladder diagram, press [CANCEL COMMAND].

Initialization data must be transferred to the module before the module can respond to features that you selected. The initialization logic that you added (Figure 3.6) allows you to initialize the module by changing the PLC-3 operating mode from program load to run monitor and back again. Press

3[ENTER]2[ENTER]

You will use the above procedure and the procedures from chapter 1 often in this tutorial.

Expanding the Number of Initialization Words

The module has four words that you use to select operating features. You do this by setting one or more bits for each feature that you want to use.

You increase the number of initialization words according to the module features that you want to use. For example, if you want a feature that is selected in initialization word four, you must use all four initialization words.

1. Set your module for initialization words 1, 2, and 3 using bits 00 and 01 of initialization word one, IW1(00-01). The bit setting is 02 in hex or 10 in binary. Use the procedure in section titled "Setting Bits in Initialization Words", steps 1 thru 4, for loading the file in rung 16.

Display The initialization word file is displayed in hex and binary, respectively, as follows.

```
RADIX = %H  START = WO007:0000
WORD #      0       1       2       3       4       5        ...
 00000     0000    0000    0002    0000    0D00    0000
```

```
START = WO007:0000
WORD #           0                 1                  2
 00000   0000000000000000   0000000000000000   0000000000000010      . . .
```

Changing the Module's String Length (Read, Only)

String length is a 3-digit BCD number. You can set the string length in BCD, or you can set the BCD digits in binary. The binary equivalent of BCD and hex is identical for 0 thru 9.

1. Set the string length to 15 characters in IW2(00-13). Use the procedure in section titled "Setting Bits in Initialization Words" for loading the file in rung 16. (P. 3-30)

Display The initialization word file is displayed in hex or binary, respectively, as follows:

RADIX = %H START = WO007:0000						
WORD #	0	1	2	3	4	5
00000	0000	0000	0002	0015	0000	0000

START = WO007:0000				
WORD #	1	2	3	
00000	**00000000**0000000	**00000000**00000010	**00000000**00010101	. . .

NOTE: Binary words 0, 4, and 5 were omitted for brevity.

2. Demonstrate the string length by entering 16 data characters. When you enter the 16th data character, the module will transfer the string of 15 characters to the read block transfer file in the data table where you can display it. Do the following example where you will read data from your ASCII device. Refer to the procedures in section titled "Reading Data From your ASCII Device" (chapter 2), if necessary.

Enter: ALLEN BRADLEY 12
(Note the space between the two words.)

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters)
•	Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6.0

Results The example 15-character data string is displayed in ASCII or hex, respectively, as follows:

RADIX = %A START = WO006:0000								
WORD #	0	1	2	3	4	5	6	7
00000	10H	00H00H	A	L L	E N	B	R A	D L
00010	E Y	1	00H00H	00H00H	00H00H	00H00H	00H00H	00H00H
RADIX = %H START = WO006:0000								
WORD #	0	1	2	3	4	5	6	7
00000	2010	0000	2041	4C4C	454E	2042	5241	444C
	4559	2031	0000	0000	0000	0000	0000	0000

The number of characters transferred was 15, the value you set in IW2(00=13).

The module added a fill character, blank in ASCII or 20 in hex, in the first data word (display word 2) ahead of the data string due to right justification of data.

Block Transfer Error

If characters were not displayed when you entered them, examine the BTR and BTW instructions for an error. You clear an error by resetting control word FB004:0000 bits 03 and 13. Press

DD, B4:0

0[ENTER][CANCEL COMMAND]

Initialization Error

If characters were not displayed when you entered them, but the display of transferred data contained only the code X4XX in status word one, you have an initialization error. Repeat the procedure in section titled “Setting Bits in Initialization Words” exactly as shown, setting IW1(00-01)=10 in binary or 2 in hex. A setting of IW1(00-01)=11 in binary or 3 in hex will not work in this example.

Justifying Data

The module justifies data before it transfers this data to the processor data table. The module left justifies data by placing the first character in the upper byte of the first word address of the file. The module right justifies data by placing the last character in the lower byte of the last word of the file.

You can tell the difference between the storage of left and right justified data by looking at the first and last words. In left justified data, spaces or fill characters, if needed, are added to the last file word. In right justified data, spaces or fill characters, if needed, are added to the first word.

If the number of characters transferred using an end-of-string delimiter is less than the string length that you set in IW2(00-13), the module completes the string by inserting fill characters or spaces. The fill characters or spaces are stored ahead of the data (lower numbered storage words) for right justified data, or following the data (higher numbered storage words) for left justified data.

Demonstrating End-of-String Delimiter

In this demonstration you will select an end-of-string delimiter and demonstrate its use.

You will select the carriage return CR as the end-of-string delimiter and set IW3(10-16) accordingly. The carriage return is the [ENTER] key on the industrial terminal keyboard.

The ASCII carriage return is 0D in hex, 0001101 in binary.

1. Set IW3(10-16) for the end-of-string delimiter CR using the procedure in section titled "Setting Bits in Initialization Words", P. 3-4.

Display The initialization word file is displayed in hex and binary, respectively, as follows:

```
RADIX = %H  START = WO007:0000
WORD #     0       1       2       3       4       5       6       7
 00000    0000    0000    0002    0015    0D00    0000

START = WO007:0000
WORD #          2                  3                  4
 00000   0000000000000000   0000000000010101   0000110100000000     . . .

NOTE:  Binary words 0, 1, and 5 were omitted for brevity.
```

String Length Less Than Module's String Length, Right Justified

Whenever the ASCII module receives an end-of-string delimiter from the ASCII device, it transfers the data in its input buffer to the processor. You will enter a data string less than the set string length as determined by IW2(00-13). You will also observe how the data is stored in the data table file.

1. Enter: 12345[ENTER]

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters)
•	Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6.0

Refer to the procedures in section titled "Reading Data From Your ASCII Device" (P. 1-10).

RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H						
00010	2 3	4 5	00H00H	00H00H	00H00H	00H00H	00H00H	00H00H

RADIX = %H START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	2020	2020	2020	2020	2020	2031
00010	3233	3435	0000	0000	0000	0000	0000	0000

Results The file displays the five character string in ASCII or in hex, respectively. The data is right justified.

Notice the following:

- The data string of five characters was transferred when you entered the end-of-string delimiter.
- The end-of-string delimiter was not transferred to the data table.
- The module added fill characters, blank in ASCII or 20 in hex, in display words 2, 3, 4, 5, and 6 to complete the string.
- The data was right justified.

String Length Less Than Module's String Length, Left Justified

In this demonstration, you will set the margin justification bit IW3(03) and repeat the transfer of five characters.

1. Set the margin justification bit IW3(03) for left justification.

Display The initialization word file is displayed in hex and binary, respectively, as follows:

```
RADIX = %H  START = WO007:0000
WORD #      0       1       2       3       4       5
 00000     0000    0000    0002    0015    0D08    0000

START = WO007:0000
WORD #          2                   3                   4
 00000    0000000000000010    0000000000010101    0000110100001000     . . .

NOTE:  Binary words 0, 1, and 5 were omitted for brevity.
```

2. Enter: 12345 [ENTER]

Refer to the procedures in section titled "Reading Data From Your ASCII Device," if necessary

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters)
•	Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6.0

Results The file displays the five character string in ASCII or in hex, respectively. The data is left justified.

RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H						
00010			00H00H	00H00H	00H00H	00H00H	00H00H	00H00H

RADIX = %H START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	3132	3334	3520	2020	2020	2020
00010	2020	2020	0000	0000	0000	0000	0000	0000

Notice the following:

- The data string of five characters was transferred when you entered the end-of-string delimiter.
- The end-of-string delimiter was not transferred to the data table.
- The data was **left** justified.
- The module added fill characters, blanks in ASCII or 20 in hex, in display words 4 (lower byte), 5, 6, 7, 20, and 11 to complete the string.

String Length Greater Than Module's String Length

When the module receives a string of data greater than the set string length, it does the following:

- Immediately transfers the number of characters equal to its set string length to the processor.
- Sets bit 14 in status word one, Input String > Maximum, SW1(14). The bit is immediately reset when the processor confirms receipt of data.
- Retains the balance of data in its input buffer.
- Transfers the balance of data with new data when it receives enough new data to complete the string, or when the new data contains an end-of-string delimiter.

In this demonstration, you will enter a string of data greater than the set string length and observe how it is stored in the data table.

Retain the same initialization data: 15 character string length, end-of-string delimiter, and left justified data.

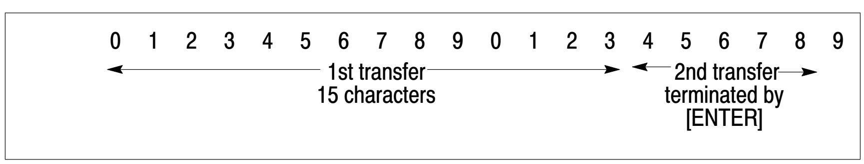
1. Enter: 01234567890123456789[ENTER].

Refer to the procedures in section titled “Reading Data From Your ASCII Device” (P. 1-10).

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters)
•	Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6.0

Results Two transfers took place (Figure 3.7). The first transfer occurred when the string length exceeded the set string length (when you entered the second 5) If you could have looked into the file, it would have appeared in ASCII or in hex, respectively, as follows:

Figure 3.7
Division of Data Between Two Transfers



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RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H	0 1	2 3	4 5	6 7	8 9	0 1
00010	2 3	4	00H00H	00H00H	00H00H	00H00H	00H00H	00H00H

RADIX = %H START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	3031	3233	3435	3637	3839	3031
00010	3233	3420	0000	0000	0000	0000	0000	0000

The second transfer occurred when you pressed [ENTER] and transferred the balance of data from the module's input buffer. The balance of data is displayed in ASCII or hex, respectively, as follows:

RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H	5 6	7 8	9			
00010			00H00H	00H00H	00H00H	00H00H	00H00H	00H00H

RADIX = %H START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	3536	3738	3920	2020	2020	2020
00010	2020	2020	0000	0000	0000	0000	0000	0000

Your program must include instructions for processing new data read from the module. If not, data in your read block transfer file will be written over in the next read block transfer.

Your program does this by moving new data from the read block transfer file into storage file MVF O6:0 in rung RM17 (Figure 3.6). The rung moves only new data when transferred from the module.

Removing the Fill Character

Whenever the module encounters the ASCII character that you defined in IW4(10-16) as the fill character to be removed, the module removes it from the string. Select a fill character to be removed that is identical to the fill character of your ASCII device. Then the module transfers only data, justifies the data, and adds its own fill character equal in number to those it removed. (Refer to section titled "Your ASCII Module Inserts Fill Characters," (P. 2-22). If your ASCII device uses fill characters for positioning data, remove them with caution because their positioning value can be nullified.

In this demonstration you will select a fill character and observe how the module removes it.

1. Increase the number of initialization words to four by setting appropriate bits. Set IW1=0003. Use procedure in section titled “String Length Less Than Module’s String Length”, P. 3-10.

2. Select the slash symbol (/) as the fill character to be removed using procedure in section titled “Setting Bits In Initialization Words”, P. 3-30. The ASCII / is 2F in hex. Set IW4 = 2F00.

Display The initialization word file is displayed in hex and binary, respectively, as follows:

RADIX = %H START = WO007:0000

WORD #	0	1	2	3	4	5
00000	0000	0000	0003	0015	0D00	2F00

START = WO007:0000

WORD #	2	3	4	5
00000	**00000000**00000010	**00000000**00010101	**00001101**00001000	**00101111**00000000

NOTE: Binary words 0 and 1 were omitted for brevity.

3. Enter: //AS//23//AS//4[ENTER]

Refer to procedures in section titled “Reading Data From Your ASCII Device” (P. 1-28).

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters) Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6:0

Results The module transferred the data characters, extracted the fill character, added its own fill character, and right justified the data.

RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H					A	S 2
00010	3 A	S 4	00H00H	00H00H	00H00H	00H00H	00H00H	00H00H

RADIX = %H START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	2020	2020	2020	2020	2041	5332
00010	3341	5334	0000	0000	0000	0000	0000	0000

This feature does not allow your program to add data characters in place of fill characters removed from the string. This feature changes the position of the data.

Removing Header and Trailing Characters

When header and trailing characters are removed from a data string, only the balance is counted as data in the string. Trailing characters are not removed until the data string exceeds the set string length. The first characters of the string are counted by the module as header characters and can be removed regardless of the number of characters in the string.

1. Set the number of header characters (three) and trailing characters (four) to be removed be setting IW4(00-03) and IW4(04-07) to 3 hex and 4 hex, respectively. Use the procedure in section titled "Demonstrating End-of-String Delimiter", P. 3-9. Retain previous initialization data.

Display The initialization word file is displayed in hex and binary, respectively, as follows:

RADIX = %H START = WO007:0000

WORD #	0	1	2	3	4	5
00000	0000	0000	0003	0015	0D00	2F43

START = WO007:0000

WORD #	2	3	4	5
00000	**00000000**00000010	**00000000**00010101	**00001101**00001000	**00101111**00000000

NOTE: Binary words 0 and 1 were omitted for brevity.

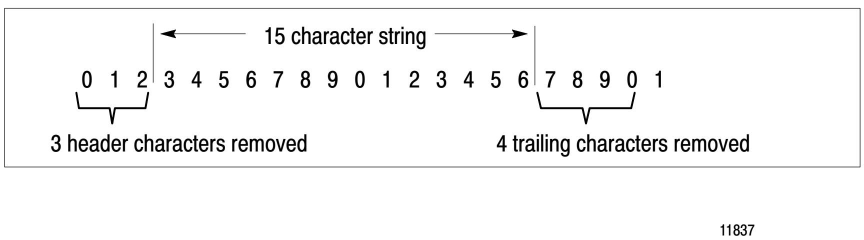
2. Enter: 01234567890123456789O1[ENTER]

Refer to procedures in section titled "Reading Data From Your ASCII Device" (P. 1-28), if necessary.

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters)
•	Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6:0

Results The module removed header and trailing characters, and transferred 15 data characters, the set string length (Figure 3.8)

Figure 3.8
Removed Header and Trailing Characters



RADIX = %A START = WO006:0000								
WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H	3	4 5	6 7	8 9	0 1	2 3
00010	4 5	6 7	00H00H	00H00H	00H00H	00H00H	00H00H	00H00H

RADIX = %H START = WO006:0000								
WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	2033	3435	3637	3839	3031	3233
00010	3435	3637	0000	0000	0000	0000	0000	0000

Notice the following:

- Although you entered 22 characters, the module removed the first three characters and the four trailing characters.
- The module transferred 15 characters, the set string length.

Selecting Report Generation Mode, Data Conversion, and BCD Delimiter

In report generation mode you can mix BCD digits with ASCII characters. The module sets the ASCII data conversion to two ASCII characters per word. You select the type of data conversion for BCD digits (either three BCD or four BCD digits per word) in initialization word two (IW2). If you want to transfer BCD digits, increase the number of initialization words to four in IW1 and select the BCD delimiter in IW4.

In this demonstration, you will select the following:

- Four initialization words using IW1(00-01)
- Report generation mode using IW1(02-04)
- 4 BCD digits per word data conversion using IW2(14-16)
- Slash symbol (/) as BCD delimiter using IW4(10-16)

1. Set the bits in all four initialization words using the procedure in section titled “Setting Bits in Initialization Words”, P. 3-30.

Display The initialization word file is displayed in hex and binary, respectively, as follows:

RADIX = %H START = WO007:0000

WORD #	0	1	2	3	4	5
00000	0000	0000	0007	2015	0D00	2F00

START = WO007:0000

WORD #	2	3	4	5
00000	**00000000**00000111	**00100000**00010101	**00001101**00000000	**00101111**00000000

NOTE: Binary words 0 and 1 were omitted for brevity.

Next you will demonstrate the transfer of BCD digits to the data table and observe how BCD digits are stored with ASCII characters when the data string contains both.

2. Enter: ABCD/12324/56ABC[ENTER]

Use procedures in section titled “Reading Data From Your ASCII Device” (chapter 1), if necessary.

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters)
•	Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6:0

Results The file displays the 15 data characters, which include ASCII characters and BCD values segregated by delimiters.

RADIX = %H START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	4142	4344	002F	1234	2F35	3641
00010	4243	0000	0000	0000	0000	0000	0000	0000

RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H	A B	C D	00H /	12H 4	/ 5	6 A
00010	B C	00H00H	00H00H	00H00	00H00H	00H00H	00H00H	00H00H

Notice the following:

- The BCD delimiter is stored as a character in the string.
- The number of characters transferred is 15.
- The data is stored in seven words.
- The ASCII display did not correctly present BCD digits (see hex display). The industrial terminal cannot correctly display BCD values in an ASCII display.

3. For comparison of data storage, enter the following. The BCD delimiter segregates five digits instead of four.

Enter ABCD/12345/6ABC[ENTER]

Results The file displays 15 data characters, which include ASCII characters and BCD values segregated by delimiters.

RADIX = %H START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	4142	4344	002F	0001	2345	2F36
00010	4142	4300	0000	0000	0000	0000	0000	0000

RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H	A B	C D	00H /	00H01H	# E	/ 6
00010	A B C	00H	00H00H	00H00	00H00H	00H00H	00H00H	00H00H

Notice the following:

- BCD values are right justified between delimiters in the hex display.
- One more storage word was used to store the 15 character string because of the justification of BCD values.
- The data string was left justified in file storage.
- The industrial terminal cannot correctly display BCD values in an ASCII display.

When your program transfers BCD values, be sure you know how the data will be justified in the storage file. Justification of BCD values can require extra storage words.

Formatting a Single-Line Message

When formatting a message, you store the message text, and you write program logic to insert variables into your message. Consider the message PRODUCED (quantity) PARTS. The message text is PRODUCED....PARTS. The variable that you want to communicate is the quantity. The variable can be timer or counter accumulated values, analog I/O values, or any other data table word, byte, or bit that changes value.

You will use file MVF O6:0 to store your message. The quantity in your message will be the BCD accumulated value of a free running timer. You will move the accumulated value into your message storage file, and store it in the storage word located between two BCD delimiters.

Format the message PRODUCED (quantity) PARTS as follows:

1. In this demonstration you will increase the string length to 21 characters, the length of your message. Otherwise, use the same initialization data as before.

- Four initialization words using IW1(00-01)
- Report generation mode using IW1(02-04)
- String length of 21 characters using IW2(00-13)
- 4 BCD digits per word data conversion using IW2(14-16)
- Slash symbol (/) as BCD delimiter using IW4(10-16)

Set the bits in all four initialization words using the procedure in section titled “Setting Bits in Initialization Words”, P. 3-30.

Display The initialization word file is displayed in hex as follows:

RADIX = %H START = WO007:0000						
WORD #	0	1	2	3	4	5
00000	0000	0000	0007	2021	0D00	2F00

2. Enter: PRODUCED/0000/PARTS[ENTER]

Refer to the procedures in section titled "Reading Data From Your ASCII Device" (P. 1-28).

Procedure P1	Connect the 1770-CB cable, and set your industrial terminal to alphanumeric mode (check parameters) Initialize the module by changing PLC-3 operation mode 3[ENTER]2[ENTER]
Procedure P2	Enter your data
Procedure P3	Connect the 1775-CAT cable, and set your industrial terminal to PLC-3 mode
Procedure P4	Observe how the data string is stored in data table file O6:0

Display Your 21 character message is stored in file O6:0. You can display it in ASCII or in hex as follows:

RADIX = %A START = WO006:0000								
WORD #	0	1	2	3	4	5	6	7
00000	00H00H	00H00H	P R	O D	U C	E D	/	00H00H
00010	/	P A	R T	S 00H	00H00H	00H00H	00H00H	00H00H

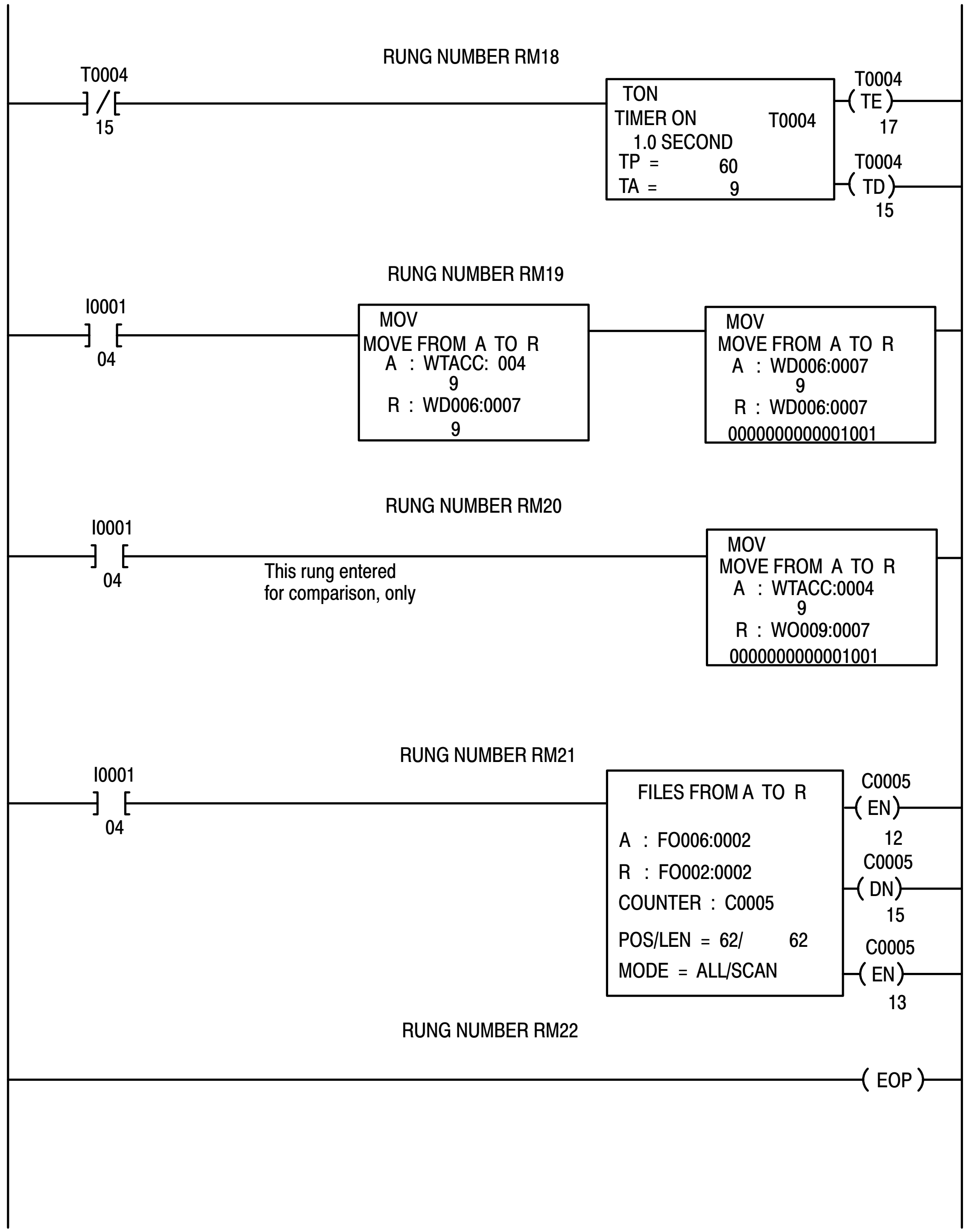
RADIX = %H START = WO006:0000								
WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	5052	4F44	5543	4544	202F	0000
00010	2F20	5041	5254	5300	0000	0000	0000	0000

Store the delimiter preceding the BCD value in the lower byte of the word preceding the BCD storage word. Store the delimiter following the BCD value in the upper byte of the word following the BCD storage word. This is shown above. If necessary, add an extra space before the first delimiter to properly position it.

3. Identify the storage word in the message file into which your program will move the message variable (accumulated value). In this example, it is display word 7.

4. Add program logic that moves your message variable into the proper storage word in your message file, and moves your message file into the write block transfer file (Figure 3.9). Add these rungs to the end of your program.

Figure 3.9
Example Message Logic (PLC-3)



5. Transfer your message for display on the industrial terminal.

Refer to the procedures in section titled “Writing Data To Your ASCII Device” (chapter 1), if necessary.

Procedure P1	Connect the 1770-CB cable, and set the industrial terminal to alphanumeric mode (check parameters)
Procedure P6	Enable the MVF instruction. With the PLC-3 in run monitor, enter I001:04 and enable that bit; then I001:02 and enable that bit (in that order)

Results The industrial terminal displays your message.

PRODUCED XXX PARTS

The value XXX is the instantaneous accumulated value of the free running timer at the moment you enabled bit I001/04.

Formatting a Multi-Line Message

When formatting a multi-line or multi-column message, use the ASCII equivalent of the following control codes for positioning the message.

Control Codes	Hex or ASCII Equivalent
CTRL P	10
Column number	38 (fixed in this example)
;	3B
Line number	36, 37, 38,...
A	41

When you enter the ASCII equivalent of these control codes into the message file, they will position the cursor at the column and line number that you specify.

Position Codes			A	BCD	Diagnostic	BCD	
Home	Col #	Line #		Del	Codes	Del	
1041	1038	3B36	41	3A	00000000	3A	00
	1038	3B38	41	3A	00000000	3A	00
						3A	0D*

*OD = end-of-string delimiter

For example, suppose that you want to display a column of 8-digit diagnostic codes that indicate the status of system operation. The diagnostic codes are the variable that your program moves into your message file at the appropriate addresses.

To display the following diagnostic codes

12345678
ABCD4321
FACEBAC2

you will load your message file in hex as follows. Do this later in step 2.

RADIX = %A START = WO006:0000

WORD #	0	1	2	3	4	5	6	7
00000	0000	0000	1041	1038	3B36	413A	1234	5678
00010	3A00	1038	3B37	413A	ABCD	4321	3A00	1038
00020	3B36	413A	FACE	BAC2	3A0D	0000	0000	0000

Notice the following:

- The home position of the cursor (1041) appears once before you specify line and column numbers.
- The column numbers remained constant at 31 in this example.
- The line numbers advanced by one (31, 32, 33,...) in this example.
- The BCD delimiter (3A) precedes and follows the variable.
- The end-of-string delimiter (0D) is placed at the end of this single string.

Normally, you would enter zeros for variables (diagnostic codes) when setting up your file, and your program would move real values into the storage words for the variables. In this example, you will load the diagnostic codes into the file.

Verify that this message file will display the diagnostic codes as shown.

1. Set your initialization words as follows:

RG mode, 4 initialization words, 300 baud	IW1 = 0007
4 BCD characters/word, 32 characters/string	IW2 = 2032
End-of-string delimiter is a carriage return	IW3 = OD00
BCD delimiter is a colon (:)	IW4 = 3A00

Display The initialization word file is displayed in hex as follows:

RADIX = %H START = WO007:0000

WORD #	0	1	2	3	4	5
00000	0000	0000	0007	2032	0D00	3A00

2. Writing over the previous data, load the message into file O6:0 (hex display) as shown above. Load diagnostic codes into display words 6 and 7; 14 and 15; 22 and 23.

Refer to procedures P3 and P5 from section titled "Writing Data To Your ASCII Device" (chapter 1).

Procedure P3	Connect the 1775-CAT cable, and set the industrial terminal to PLC-3 mode
Procedure P5	Load data into the file O6:0

3. Transfer your message for display on the industrial terminal. Refer to the procedures in section titled "Writing Data to Your ASCII Device" (chapter 1).

Procedure P1	Connect the 1770-CB cable, and set the industrial terminal to alphanumeric mode (check parameters)
Procedure P6	Enable the MVF instruction. With the PLC-3 in run monitor, enter I001:04 and enable that bit; then I001:02 and enable that bit (in that order)

Results The industrial terminal displays the column of diagnostic codes at the left of the screen.

```
123245678
ABCD4321
FACEBAC2
```

Demonstrating Data Conversion

When in data mode, select a data conversion type compatible with the characters transmitted by your ASCII device. Your selection is limited to one of the following conversion types:

Conversion Type	Data Characters
2 ASCII characters per word 1 ASCII character per word	ASCII standard code
3 BCD characters per word 4 BCD characters per word	0 thru 9
4 hex characters per word	0 thru 9, A thru F

When operating in report generation mode, the module selects two ASCII characters per word for message characters. You choose the data conversion for message variables (BCD values) placed between delimiters. Your selection is limited to one of the following:

Conversion Type	Data Characters
3 BCD characters per word 4 BCD characters per word	0 thru 9

How Binary and BCD Differ

The PLC-3 manipulates message variables such as timer/counter preset and accumulated values in signed binary (sign in bit 16). If your program does not convert message variables to BCD, the module will display erroneous values because the binary and BCD bit patterns of a value are different. For example, compare how the bit pattern 10110 would be interpreted in binary and in BCD (Figure 3.10).

Figure 3.10
Binary and BCD Interpretation of 10110

Binary Place Value									**BCD** Place Value							
128	64	32	16	8	4	2	1		80	40	20	10	8	4	2	1
			1	0	1	1	0					1	0	1	1	0

16 + 4 + 2 = 22

10 + 4 + 2 = 16

NOTE: To obtain the value in either base, add the place values wherever a 1 appears.

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1. Observe the difference between binary and BCD representation of an accumulated value (free running timer) in rungs RM19 and RM20 of your program.

Output word R WO009:0007(rung RM20) shows binary
Output word R WO006:0007(rung RM19) shows BCD

2. Enable input bit I0001/04 and compare the binary and BCD values that are displayed just below output word R in the instruction.

Procedure P3	Connect the 1775-CAT cable, and set the industrial terminal to PLC-3 mode
Procedure P6	Enable bit I001/04. With the PLC-3 in run monitor, enter the bit and enable it

Results Binary and BCD representation of selected accumulated values are tabulated in Table 3.Q.

Table 3.Q
Comparison of Binary and BCD Interpretation of the Same Bit Pattern

Accumulated Value	WO009:0007 Binary	WO006:0007 BCD
1	1	1
9	1001	1001
10	1010	1000
20	10100	100000
30	11110	110000
40	101000	1000000
50	110010	1010000

Converting Binary to BCD

You convert binary values to BCD values by moving them to a decimal file. Use a MOV instruction.

Source word A is the message variable in binary.
Destination word R is the message variable converted to BCD.

Your program converts binary to BCD in rung RM19 (Figure 3.6).

Using Output Files

The PLC-3 makes no conversion when moving data out of or into output and input files. Use output files to store your ASCII data and/or messages along with message variables that your program has converted to BCD.

Inserting the Message Variable

When you enter the message into the message storage file using the data monitor mode of the industrial terminal, do the following:

1. Identify the file word(s) that you reserved for the message variable (Figure 3.9,RM19, WO006:0007).

2. Separate the message variable from the rest of the message using BCD delimiters.

3. Locate the first delimiter in the lower byte of the word before, the second delimiter in the upper byte of the word after the word(s) containing the message variable.

4. Enter the (first) word containing the message variable as the destination word R in the decimal-to-output MOV instruction (Figure 3.9, RM 19, WO006:0007).

For example, refer to rung RM19 (Figure 3.9) and display the message file O6:0. Look at display words 6, 7, and 8 containing the delimiters and message variable. The message variable is stored in word 7.

Summary

When programming your module in report generation mode, do the following:

- Convert message variables such as timer/counter accumulated values to BCD by moving them to a decimal file.
- Use output files for storing messages to avoid unwanted conversions.
- Move message variables into words segregated by delimiters in your message file.

With a read/write program, you can enter the text of your message into processor memory by using the industrial terminal as an ASCII data terminal (as compared with entering data in the data monitor mode of the industrial terminal described in sections titled "Formatting a Single-Line Message" and "Formatting a Multi-Line Message." When entering data from an ASCII data terminal, you can use the rubout or delete key. Pressing this key deletes the previous character from the ASCII module's input buffer. You can delete one or more characters up to the entire string bounded by the previous end-of-string delimiter.

NOTE: The correct operation of your module depends on proper handshake programming for read and write block transfer instructions. Be sure to read the description of handshaking in chapter 4, block transfer programming in appendix A, and study the handshake programming examples.

Chapter 5

Handshaking

Chapter Objectives

In this chapter you will read about the use of handshaking to control the transfer of data from the ASCII module to the PC processor and vice versa.

Understanding Handshaking Fundamentals

The term handshaking refers to a set of software bits that coordinate the transfer of data between two devices. Handshaking ensures that new data is neither duplicated nor lost. Your ladder program must contain read and write handshake logic. This logic is separate from block transfer routines that use enable and done bits of block transfer instructions. Handshaking requires the successful completion of both a read and write block transfer to read new data from the module, or write new data to the module. The handshake logic uses control and status bits of the ASCII module. New data is transferred only after correct handshaking is achieved.

Become familiar with the following operations. Refer to the "Complete Getting Started Program" with rung descriptions for PLC-2 family or PLC-3 controllers in the appendix.

Write

Data is transferred to the module in each write block transfer. The module inhibits transmission of data to the ASCII device until one-shot handshaking is achieved. Then the module transmits data to the ASCII device in a single transmission. The module will not transmit more data to the device until the module receives one-shot handshaking with new data.

When your program writes data to the ASCII module, the program must toggle the write handshake bit, CW1(16). The status of this bit accompanies the data. When the module detects the changed status of the handshake bit, it transmits the data to the ASCII device.

Read

Data and/or module status is transferred to the processor data table with each block transfer. When the ASCII module detects a change in its status, receives new data that is terminated by an end-of-string delimiter in its input buffer, and/or receives a string greater than the one specified in IW2, the module toggles the handshaking bit, SW1(15). The module also places data in status word two (SW2). Bit SW1(15) and SW2 accompany new data. Your program logic should be written to inhibit using the read data and/or module status until confirmed as new by examining bit SW1(15) and word SW2. We recommend that you examine word SW2>0 as a new data condition and examine the status of the read block transfer done bit, BTR(07,17).

Acknowledgment

The module must receive acknowledgment of the read block transfer (your program toggles handshake bit CW1(15)) before it can transfer **new** read data.

Your program should detect that the module acknowledged receipt of the write block transfer (module toggles handshake bit SW1(16) before your program enables another write block transfer.

Handshaking Words

Handshaking is communicated by means of command word one and status word one. Do not allow data files to overlap the addresses of command and status words. The first two words of read and write block transfer files are reserved for command and status words. Data files, which your program moves into the write block transfer file or out of the read block transfer file, should overlap all but the first two words of the read or write block transfer files. PLC-2 family controller example: If the read and write block transfer files start at addresses 400 and 500 respectively, the corresponding data files should start at 402 and 502, respectively. PLC-3 controller example: If the read and write block transfer files start at FB003:0000 and FB002:0000 respectively, the corresponding data files should start at FB003:0002 and FB002:0002.

Reading Status and/or Data from the Module

Handshaking in a read operation requires the module to toggle bit 15 in status word one, SW1(15), when the module transfers a change in module status and/or new data to the processor. When it transfers new data to the processor, the module also sets in status word two, SW2, the number of data words per string that it is transferring.

After the processor receives and processes new status and/or data, your program must toggle bit 15 in command word one, CW1(15), and return the toggled status to the module to acknowledge receipt (Figure 4.1 and Table 5.A).

Figure 4.1
Read Handshaking

The ASCII Module	Data Transfer	The Ladder Program
Toggles SW1(15) when it receives new data from the ASCII device and/or detects a change in module status		
Sets the number of transferred words per string in SW2 when new data is transferred		
	-------------------------------->	
	SW1(15),BTR(07,17), and SW2>0 for new data. SW1(15) for change in status	
		Detects that SW1(15) has been toggled
		Acts on the change in module status according to program logic
		When it also detects SW2>0 and BTR(07,17) it acts on new data according to program logic
		Toggles CW1(15) and returns its new status to acknowledge receipt. CW1(15)=SW1(15)
	<---------------------------------	
Repeats the cycle when it detects a change in CW1(15), and when new data is received from the ASCII device, and/or when module detects a change in its status		

NOTE: A read block transfer of data can occur every scan. Your program should process new data only when it detects that SW1(15) has been toggled and that SW2>0.

Table 5.A
Logic Conditions for a Read

If	Then
a) SW1(15) ≠ CW1(15) and b) SW2>0 and BTR (07,17) =1 at processor	Program acts on new module status (a, only) or Program acts on new data (a and b) and Program sets CW1(15)=SW1(15) to acknowledge.
SW1(15)=CW1(15) at module	Module resets for next transfer of new data and/or status. Module sets SW1(15) ≠ CW1(15) to transfer new status and/or data, and sets SW2>0 to transfer new data.

A read (only) program requires only read handshaking. A read/write program requires both read and write handshaking.

Writing Data to the Module

Handshaking in a write operation requires your program to toggle bit 16 in command word one, CW1(16). When the toggled bit status is transferred with data to the ASCII module, the module processes the data to the output buffer where it is transferred to the ASCII device. Your program must contain a one-shot to ensure that CW1(16) is toggled only once with each transfer of new data.

After the module processes the data, it toggles bit 16 in status word one, SW1(16), and returns the toggled bit status to the processor to acknowledge receipt (Figure 4.2 and Table 5.B).

Figure 4.2
Write Handshaking

The Ladder Program	Data Transfer	The Module
Toggles bit CW1(16) and transfers its new status with data to the module		
	---------------------------------> CW1(16) and new data	
		Detects that CW1(16) has been toggled
		Moves data to output buffer where it is sent to the ASCII device
		Toggles SW1(16) and returns new status to acknowledge receipt
	<---------------------------------- SW1(16)	
Repeats the cycle when it detects a change in SW1(16), and when you enable the one-shot		

NOTE: The processor can write data to the module but the module will not process the data to its output buffer (inhibits data to the ASCII device) until the module detects that your program has toggled SW1(16).

Table 5.B
Logic Conditions for a Write

If	Then
SW1(16) = CW1(16) at processor	Module has acknowledged processing the previous block of data Program sets CW1(16) = SW1(16) when you enable the one-shot to write new data
CW1(16) ≠ SW1(16) at module	Module moves new data to output buffer (to ASCII device) Module sets SW1(16) ≠ CW(16) to acknowledge that it processed the data

A write (only) program requires only write handshaking. A read/write program requires read and write handshaking.

The module can handle handshaking and data simultaneously. For example, read block transfers could contain new data and acknowledgment of the previous write block transfer.

Refer to “Complete Getting Started Program,” Appendix A for PLC-2 family and for PLC-3 controllers. Handshaking bits in the ASCII module’s command and status words used in these programs are defined as follows:

Word	Bit	Description	PLC-2 Address	PLC-3 Address
Command Word 1	15 16	CW1(15) CW1(16)	200/15 200/16	WD002:0000/15 WD002:0000/16
Status Word 1	15 16	SW1(15) SW1(16)	252/15 252/16	WD003:0000/15 WD003:0000/16

Choose program addresses that are compatible with your programming needs.

Chapter 6

Function of Control and Status Bits

Chapter Objectives

In this chapter you will read about control bits found in command word one and in four initialization words. You will also read about status bits found in status words one and two.

Command Words

The first two words in every write block transfer are command words. Command word one contains control bits. Command word two is set to zero and is reserved for future enhancements. The bits in command word one (CW1) are as follows.

Command Word One, CW1

Bit: CW1(00)
Function: Reserved for Future Use
Description: Reset this bit to zero.

Bit: CW1(01)
Function: Reserved for Future Use
Description: Reset this bit to zero.

Bit: CW1(02)
Function: Reserved for Future Enhancements
Description: Reset it to 0.

Bit: CW1(03)
Function: Resets input buffer full bit.
Description: Set this bit to reset status bit 03, input buffer full, in status word one. This turns off the BUFFER FULL LED indicator. Otherwise, reset this bit to zero.

Bit: CW1(04-06)
Function: Reserved for Future Enhancements
Description: Reset it to zero.

Bit: CW1(07)
Function: Resets power-up and handshaking bits.

Description: Set this bit to reset the following status bits in status word one:

- Bit 07 Power-up initialization
- Bit 15 Read data available
- Bit 16 Write data acknowledge

Bit: CW1(10, 11)
Function: Reserved for Future Enhancements
Description: Reset it to zero.

Bit: CW1(12)
Function: Self Diagnostics
Description: Set this bit to enable the module's self-diagnostic routine which tests the module's firmware, memory and timers. During the self-diagnostic test, the module discontinues communication. After completion, the module re-initializes itself to power-up default mode. You must then re-initialize the module if you want it to operate in any mode other than default.

Bit: CW1(13)
Function: Port Disable
Description: Set this bit to disable I/O communication thru the interface port on the ASCII module. Otherwise, reset this bit to zero.

Bit: CW1(14)
Function: Incomplete String
Description: Set this bit to tell the module to transfer an incomplete string in the next bock transfer. It allows you to examine the contents of the input buffer. This command is intended for troubleshooting purposes. Avoid using it during normal operation. Reset this bit to zero.

Bit: CW1(15)
Function: Read Data Acknowledge
Description: After the processor receives and processes new status and/or data, the program toggles this bit. The toggled status, CW(15)=SW(15), is returned to the module to acknowledge receipt.

Bit: CW1(16)
Function: Write Data Available
Description: Your program must toggle this bit to transfer data from the ASCII module's output buffer to the ASCII device. The toggled status, CW(16) $\neq$ SW(16), accompanies the data. The program must receive acknowledgment of the previous write block transfer, toggled status of

SW(16), before it sends new data. Otherwise, new data could be mixed with old data or lost.

Bit: CW1(17)
Function: Initialization
Description: Set this bit to tell the module that up to four initialize data words follow command word one and two. Otherwise, reset it to zero.

Command Word Two, CW2

This word is reserved for future enhancements. Reset it to zero.

Initialization Words

Set bits in your initialization words to match the characteristics of your ASCII module to those of your ASCII device. The bits in the four initialization words, IW1, IW2, IW3, and IW4, are described below.

You can operate the module in data mode without setting initialization bits, and without sending initialization data to the module. However, then the module operates only with default features. Select additional features by setting initialization bits. To operate in report generation mode, you must set initialization bits.

Initialization Word One, IW1

Bits: IW1(00-01)
Function: Number of Initialization Words
Description: The setting of bits 00 and 01 tells the module the number of initialization words you will use to transfer initialization data to the module.

01	00	Words Used
0	0	word 1
0	1	words 1 and 2
1	0	words 1, 2, and 3
1	1	words 1, 2, 3, and 4

Bits: IW1(02-04)
Function: Mode of Module Operation
Description: Choose data mode (default) when

- You want to automatically convert ASCII characters to any one of five data types for convenient data table storage and usage
- Your data string is from 1 to 62 characters

Choose report generation mode when

- Your data is message oriented
- You want to include BCD numbers in your message
- Your data string is from 1 to 999 characters

Select the mode of module operation from the following:

04	03	02	Mode of Operation
0	0	0	Data mode
0	0	1	Report generation mode
all other			Invalid

When the module detects an invalid setting of bits 02-04 or bits 05-07, it faults due to an initialization error. The module disables its interface port and sets status bit SW1(12).

Bit: IW1(05-07)
Function: Mode of Transmission
Description: The modes of transmission that the module can handle are full or half duplex with or without echo, and simplex read or write. The codes for setting modes of transmission are:

07	06	05	Mode of Transmission
0	0	0	Full duplex with echo (default)
0	0	1	Full duplex without echo
0	1	0	Simplex read
0	1	1	Simplex write
1	0	0	Half duplex with echo
1	0	1	Half duplex without echo
all other			Invalid

Select full duplex when your ASCII device is set for full duplex, or when your ASCII device transmits and receives data simultaneously. You can also select full duplex when your ASCII device only transmits or only receives data.

Select half duplex when your ASCII device is set for half duplex, or when your ASCII device transmits or receives data one way at a time.

Select simplex read when your ASCII device only transmits data. You should set the ASCII module's I/O buffer to 100% input in IW3(00-02).

Select simplex write when your ASCII device only receives data. You should set the ASCII module's I/O buffer to 100% output in IW3(00-02).

Select echo when you want your ASCII data terminal to display the characters it sends to the module.

Do not select echo when your ASCII device cannot display the characters it sends to the module.

Bits: IW1(10-12)
Function: Communication Rate
Description: The communication rates that the module can handle are listed below. Select the rate that you chose for your ASCII device.

12	11	10	Communication Rate
0	0	0	300 baud
0	0	1	600 baud
0	1	0	1200 baud
0	1	1	2400 baud
1	0	0	4800 baud
1	0	1	9600 baud
1	1	0	110 baud
1	1	1	110 baud

Bit: IW1(13)
Function: Number of Data Bits
Description: Reset it to zero (default) when your ASCII device generates 8 data bits per character. Set it when your ASCII device generates 7 data bits per character. Note that the module treats all input data as 7-bit ASCII characters.

Bit: IW1(14)
Function: Parity
Description: Reset it to zero (default) for odd parity. Set it for even parity. Ignore it if you do not enable parity, IW1(15)=0.

Bit: IW1(15)
Function: Parity Enable
Description: Reset it to zero (default) when your ASCII device does not generate a parity bit. Set it when your ASCII device generates a parity bit for each character. See IW1(14).

Bit: IW1(16)
Function: Stop Bits
Description: Reset it to zero (default) when your ASCII device generates only one stop bit per character. Set it when your ASCII device generates two consecutive stop bits per character. Refer to chapter 2, Figure 2.12.

Bit: IW1(17)
Function: ACK/NAK
Description: Reset it to zero (default) when the ASCII device does not require an ACK/NAK from the module to complete the transmission. Set it when an acknowledgment of no error per character string (ACK), or error found in the string (NAK), is required by the ASCII device to complete the transmission. The ASCII module does not require an ACK/NAK to complete its transmission.

Initialization Word Two, IW2

Bit: IW2(00-13)
Function: Number of ASCII Characters Per String (read, only)
Description: In data mode, enter a 3-digit BCD number for the maximum number of ASCII characters per string generated by your ASCII device. Count header and trailing characters, not removed by the module, as part of the string length.

In report generation mode, enter a 3-digit BCD number for the number of characters generated by your longest message line. Normally, the end-of-string delimiter is not counted as a character in the string (data mode or report generation mode). Count the end-of-string delimiter as a character in your string only if you send the end-of-string delimiter to the processor by setting IW3(04).

The default string length of the module is 10 characters in data mode, 124 characters in report generation mode. The maximum string length that the module can accept is 62 characters in data mode and 999 characters in report generation mode.

When the module detects that you set the string length greater than 62 characters in data mode, it faults due to an initialization error. The module disables its interface port and sets bit SW1(12).

Bits: IW2(14-16)
Function: Type of Data Conversion
Description: When operating in data mode, select any one of five types of data conversion to match your ASCII device, or to match your requirements for manipulating data.

16	15	14	Data Conversion
0	0	0	2 ASCII characters/word
0	0	1	3 BCD characters/word
0	1	0	4 BCD characters/word
0	1	1	1 ASCII character/word
1	0	0	4 HEX characters/word
all other			Invalid

The type of data conversion refers to the manner in which data is converted by the module and stored in the processor data table. You can change from one type of data conversion to another only by re-initializing the module.

When operating in report generation mode, you must select either 3 BCD or 4 BCD characters per word for storing BCD numbers. The module automatically selects 2 ASCII characters per word for non-BCD data. Your choice of 3 BCD or 4 BCD characters per word depends on your requirements for manipulating data and/or on the characteristics of your ASCII device.

When the module detects an invalid setting for data conversion, it faults due to an initialization error. Refer to Fill Character Bit, IW4(10-16), and "Your ASCII Module Inserts Fill Characters," P. 2-22.

Bit: IW2(17)
Function: Single or Multiple String Transfer (Rate)
Description: Reset it to zero (default) when you want the module to send a single string to the PC processor in a block transfer, or when more than one block transfer is required to transfer the string.

Set it when you want the module to send more than one string in each block transfer. This feature is limited to strings that fill 31 words or less. Select this feature when the transmission rate of data from the ASCII device to the ASCII module's input buffer exceeds the transmission rate of **single string** block transfers to the PC processor. The block transfer time in a remote system is approximately the same regardless of the number of strings contained in a transfer. So send as many full strings as you can fit in 62 words. (Two words of each block transfer are reserved for status or command words). The module will not divide a string between two or more block transfers when set for multiple string transfer.

If the rate of transfer between ASCII module and processor cannot keep up with the communication rate from the ASCII device, data will be lost when the ASCII module's input buffer becomes full. You can program the examination of the input buffer 75% full bit, SW1(02), to alert the operator to turn off the ASCII device before the loss of data occurs. When you use RS-232-C with control lines, the module turns off the clear-to-send (CTS) signal when the input buffer is full.

Initialization Word Three, IW3

Bit: IW3(00-02)
Function: I/O Buffer Split
Description: The I/O buffer capacity is 1024 words. You can subdivide the buffer between percentage of input and output according to the transmitting and receiving capacity of your ASCII device. Select the percentage of input to output.

02	01	00	Input/Output (%)
0	0	0	50/50
0	0	1	100/0 (invalid for simplex write)
0	1	0	75/25
0	1	1	25/75
1	0	0	0/100 (invalid for simplex read)
all other			50/50

If the module detects an invalid I/O buffer split, it faults because of an initialization error. The module disables its interface port and sets status bit SW1(12).

Bit: IW3(03)
Function: Margin Justification
Description: Reset this bit to zero (default) for right justification, or set it for left justification of data in data mode. The module ignores this bit when operating in report generation mode.

You can select either right or left justification of data in data mode, only. When operating in report generation mode, ASCII data is left justified. BCD numbers included in the ASCII data string are right justified. Justification refers to the positioning of string data in the data table when the transferred string length is less than the set string length. It also refers to the positioning of string data that is displayed by an ASCII device. Refer to P. 3-7 for additional information on justification.

Bit: IW3(04)
Function: Sends End-of-String Delimiter to PC
Description: Set this bit when you want to send the end-of-string delimiter to the processor for storage in the data table. Otherwise, reset this bit to zero.

When generating single line messages, select the carriage return as the end-of-string delimiter, set this bit, and set IW3(05), Output Line Feed if Carriage Return.

Use this bit only in report generation mode. If the module detects that you set this bit in data mode, the module defaults due to an initialization error. The module disables its interface port and sets status bit SW1(12).

Bit: IW3(05)
Function: Output Line Feed If Carriage Return
Description: Reset this bit to zero (default) to inhibit this function. Set this bit when you want line feed (LF) transmitted automatically whenever the ASCII module transmits a carriage return (CR). Setting this bit saves storing line feed control characters in the data table. You can use this bit with IW3(04).

When generating multi-line messages, select some control code, such as escape for the end-of-string delimiter, not carriage return. Set this bit, IW3(05), but not IW3(04). Use the carriage return to terminate each line.

Bits: IW3(06-07)
Function: Delay for Carriage Return
Description: Select a time for the ASCII module to delay outputting data to allow for the mechanical carriage return when using an unbuffered data terminal.

07	06	Delay (ms)
0	0	0
0	1	50
1	0	100
1	1	200

Bits: IW3(10-16)
Function: End-of-String Delimiter
Description: The end-of-string delimiter causes the module to transfer the string of characters to the PC processor data table (single string transfer). When you select multi-string transfer, the module transfers the number of strings that fills one block transfer.

In data mode, select the end-of-string delimiter the same as that of your ASCII device. If your ASCII device does not generate an end-of-string delimiter, set IW3(17). Then, the ASCII module ignores these bits. Without an end-of-string delimiter, the module transfers your data string immediately after its input buffer receives the next characters beyond your selected string length. The next characters remain in the buffer as the beginning of the next string, and the cycle repeats.

In report generation mode, select any ASCII character as the end-of-string delimiter.

If a series of BCD numbers in a string is divided by a block transfer, either one of two results can occur. If the string of correct length is divided by a block transfer, the balance of BCD characters will be transferred correctly in the next transfer. If you erroneously allowed the string to exceed your selected string length, the balance of the BCD numbers will be transferred as ASCII characters.

Do not enter the same ASCII character in IW3(10-16) and IW4(10-16), or allow them to be equal by default. When you are not using IW4, IW4(10-16) defaults to the colon, 3A hex, in either mode of module operation. Therefore, when using three initialization words, or fewer, do not user the colon, 3A hex, as your end-of-string delimiter. When the module detects that IW3(10-16) is equal to IW4(10-16), it will not operate due to an initialization error.

Bit: IW3(17)
Function: Enables End-of-String Delimiter
Description: Reset it to zero (default) to enable the end-of-string delimiter that you selected in IW3(10-16). Set it when not using an end-of-string delimiter. When set, the module will transfer your data string when its input buffer receives the next character beyond your selected string length.

When the end-of-string delimiter is not enabled (IW3(17)=1), the null character, CTRL 0, is treated as an end-of-string delimiter even though you have not selected it.

Initialization Word Four, IW4

Bits: IW4(00-03)
Function: Removes Header Characters
Description: Select the number of header characters, up to 15, preceding the data string that you want the module to remove when it sends data to the PC processor data table. If no bits are set, the module defaults to zero (no header characters are removed).

Set bit 00-03 to the binary code for the number of header characters that you want the module to remove.

Bits: IW4(04-07)
Function: Removes Trailing Characters
Description: Select the number of trailing characters, up to 15, following the data string that you want the module to remove when it sends data to the PC processor data table. This number does not include the end-of-string delimiter unless you are sending the end-of-string delimiter to the processor. If no bits are set, the module defaults to zero (no trailing characters are removed).

Set bits 04-07 to the binary code for the number of trailing characters that you want the module to remove.

Bits: IW4(10-16)
Function: BCD Delimiter/Removes Fill Character
Description: BCD Delimiter (Report Generation Mode)

When operating in report generation mode, use these bits to select a BCD delimiter. Insert a BCD delimiter before and after BCD numbers in your message. The BCD delimiter instructs the module to convert and store numbers in the BCD format (3 or 4 characters per word that you chose in IW2(14-16)).

Select the BCD delimiter from any one of the following hex codes: (Refer to the Hex/ASCII Conversion Table in the appendix C).

OA–OF	2A–2F	4A–4F	6A–6F
1A–1F	3A–3F	5A–5F	7A–7F

The module defaults to the colon (:) as the BCD delimiter if you do not use initialization word four.

You can use the default value of IW4(10-16) only when you select three (or fewer) initialization words. If you select four initialization words, you must enter a value in IW4(10-16). This value cannot be the same value as the end-of-string delimiter that you entered in IW3(10-16) or an initialization error will occur. This applies to both functions of IW4(10-16), BCD Delimiter, and removing the fill character.

Description: Removes Fill Character (Data Mode)

When operating in data mode, use these bits to select the fill character, generated by the ASCII device, that the module removes. Some ASCII devices vary the number of data characters per string, and insert fill characters to make all strings of equal length. The module deletes the fill character whenever encountered in the string. The module justifies the data (changing its position), and substitutes its own fill characters for the ones it removes.

Select the fill character to be removed identical to the fill character of your ASCII device. The module removes the colon (:) if you do not select a character using IW4(10-16).

The module has its own internal fill characters that are not selectable. When justifying data, the module inserts fill characters according to the data conversion that you have selected.

Data Conversion	Internal Fill Character	Displayed at a Data Terminal as
3 BCD per word	00	0
4 BCD per word	00	0
4 Hex per word	00	0
1 ASCII per word	20	blank
2 ASCII per word	20	blank

Bit: IW4(17)
Function: Reserved for Future Enhancements
Description: Reset it to zero.

Status Words

The first two words in every read block transfer are status words. Status word one (SW1) reflects the module's response to command word one. Status word two (SW2) indicates the number of words and/or data blocks transferred to the PC processor in each read block transfer.

Status Word One, SW1

Bit: SW1(00)
Function: Input Buffer Empty
Description: The module sets this bit (to 1) when it detects that the buffer is empty. The module resets this bit when data enters the input buffer.

Bit: SW1(01)
Function: Input Buffer 50% Full
Description: The module sets this bit when it detects that the buffer is 50% full. The module resets this bit when the input buffer is less than 50% full.

Bit: SW1(02)
Function: Input Buffer 75% Full
Description: The module sets this bit when it detects that the buffer is 75% full. The module resets this bit when the input buffer is less than 75% full.

Bit: SW1(03)
Function: Input Buffer Full
Description: The module latches this bit (on) when it detects that the buffer is full. It is reset by CW1(03) when the input buffer is empty.

Bit: SW1(04)
Function: Output Buffer Empty
Description: The module sets this bit when it detects that the output buffer is empty. The module resets this bit when it detects that data entered the output buffer.

Bit: SW1(05)
Functions: Output Buffer Full
Description: The module sets this bit when it detects that the output buffer is full. The module resets this bit when the output buffer is less than full.

Bit: SW1(06)
Function: Reserved for Future Enhancements
Description: The module sets this bit to zero.

Bit: SW1(07)
Function: Power-up Initialization
Description: The module sets this bit to show that the module has undergone power-up initialization. Buffers have been cleared and communication thru the module's interface port has been turned off. This bit must be reset by program logic in order to complete the power-up initialization routine. This bit is reset by setting bit 07 of command word one, CW1(07). When CW1(07) is set, bits 07, 15, and 16 of status word one are reset. Then you can operate the module in default mode or initialize the module to any other operating mode.

Bit: SW1(10)
Function: Data Complete
Description: The module sets this bit when it detects the end-of-string delimiter in a transfer. When a long string of data is transferred over two or more block transfers, the module sets this bit only in the last transfer containing the end-of-string delimiter. For example, when a 300 character string is transferred over three block transfers, the bit is not set until the third transfer (Figure 5.1).

Figure 5.1
Operation of Data Complete Bit

Block Transfer Data	Status of SW1(10)
BT1 containing SW1, SW2, and first 124 characters	SW1(10)=0
BT2 containing SW1, SW2, and second 124 characters	SW1(10)=0
BT3 containing SW1, SW2, and remaining characters*	SW1(10)=1
*with end of string delimiter	BT=block transfer

The module also sets this bit when it transfers a string equal to the set string length when the input string exceeds maximum, SW1(14)=1.

Bit: SW1(11)
Function: Reserved for Future Enhancements
Description: The module sets this bit to zero.

Bit: SW1(12)
Function: Initialization Error
Description: The module sets this bit and ceases to operate when it detects an error in your initialization data. For example, the same character has been selected for delimiter and fill character. It is reset when the module receives valid initialization data. Refer to Initialization Errors, Table 6.A, for a complete list of settings that cause an initialization error.

Bit: SW1(13)
Function: ASCII Device or Link Error
Description: The module sets this bit when it detects a parity, framing, or overrun error in the string of characters from the ASCII device. When multiple strings are transferred in one read block transfer, program logic can detect the error but cannot detect which string(s) contained the error. The module resets this bit when it detects no errors.

Bit: SW1(14)
Function: Input String Exceeds Maximum
Description: The module sets this bit when it detects an input string longer than the string length that you selected in IW2(00-13). The module transfers the number of characters equal to the set string length. The remaining string characters (spillover) are stored in the module's input buffer as the first data of the next string. If the spillover was terminated by an end-of-string delimiter, the module would transfer it as another string. If not terminated by a delimiter, subsequent data strings could be out of sequence. The bit is reset when the module processes a string without spillover.

Bit: SW1(15)
Function: Read Data Available
Description: When the module detects a change in its status or receives new data from the ASCII device, it toggles this bit. Then the module sends new status and/or data to the processor with the toggled status of this bit. The module must receive acknowledgment in a subsequent write block transfer (toggled status of CW1(15)) before it can send new status and/or data. When sending new data to the processor, the module also enters the number of transferred data words into status word two (SW2) which accompanies the transfer.

Bit: SW1(16)
Function: Write Data Acknowledge
Description: The module acknowledges receipt of a valid write block transfer by copying the status of CW1(16) into this bit, which is returned to the processor in the next read block transfer.

Bit: SW1(17)
Function: Channel Active
Description: The module sets this bit to tell the processor that the ASCII device is enabled. It is reset when the ASCII device is turned off or disconnected.

Status Word Two, SW2

Bit: SW2(00-07)
Function: Number of Words Per String (Read, Only)
Description: This 2-digit BCD number shows the number of words used by the module to transfer the data string that you selected in IW2(00-13). The number of words will be approximately equal to the number of characters per string divided by the type of data conversion such as 2 ASCII characters or 3 BCD characters per word.

When a data string requires more words than the maximum for a read block transfer, these digits display the maximum number of data words (62) in the read block. A data string could require several read block transfers.

Bit: SW2(10-17)
Function: Number of Strings Per Block Transfer (Read, Only)
Description: This 2-digit BCD number shows the number of data strings that are transferred to the PC processor in each read block transfer when you select the transfer of multiple data strings, IW2(17)=1.

When transferring multiple strings, the module will not split a string between two block transfers, and the string length cannot exceed the number of characters that can be transferred in 31 words. Two strings of 31 words, three strings of 20 words, and so forth, must total 62 words or less. Remember that two of the 64 block transfer words are reserved for status words. Do not confuse the transfer of multiple strings per block with the transfer of one long string between two or more block transfers. The module will split one long string between block transfers when you have selected single string transfer, IW2(17)=0.

Command word one, status word one, and status word two are summarized in Figure 5.2, Figure 5.3, and Figure 5.4, respectively. Command, initialization and status words are summarized in the tables on the following pages. Copy the figures and tables so that you can refer to them as needed.

Figure 5.2
Command Word One, CW1

17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
Initialization	Write Data Available	Read Data Acknowledge	Send Incomplete String	Port Disable	Self Diagnostics	0		Reset Power up and Handshaking Bit	0			Reset Input Buffer Full Bit	0	0	

Figure 5.3
Status Word One, SW1

17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
Chan - nel Active	Write Data Ack- now- ledge	Read Data Avail- able	Input String > Maxi- mum	ASCII De- vice Link Error	Ini- tiali- zation Error	0	Data Com- plete	Power Up Ini- tiali- zation	0	Output Buffer		Input Buffer			
										1 = Full	1 = Empty	1 = Full	1 = 75% Full	1 = 50% Full	1 = Empty

Figure 5.4
Status Word Two, SW2

17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
Number of Strings per Block Transfer 00-62								Number of Data Words per String 00-62							
BCD Digit 1				BCD Digit 0				BCD Digit 1				BCD Digit 0			

Command Word One

Bit	Function	Status
17	Initialization	0 = Reset 1 = Up to four initialization words will follow command words CW1 CW2
16	Write Data Available	Toggled status, CW(16) ≠ SW(16), tells module that transfer contains new data
15	Read Data Acknowledge	Toggled status, CW(15) = SW(15), tells module that processor received previous transfer
14	Incomplete String	0 = Reset 1 = Used for installation debugging, not for normal operation
13	Port Disable	0 = Reset 1 = Disables communication thru the interface port
12	Self Diagnostics	0 = Reset 1 = Enables self diagnostics. You must re-initialize the module
11, 10	Not used	Set them to zero
07	Resets Power-up and Handshaking	0 = Reset 1 = Resets SW1 (07) Initialization bit, SW1(15) Read data available bit, and SW1(16) Write data acknowledge bit
06, 05, 04	Not used	Set them to zero
03	Resets Input Buffer Full Bit	0 = Reset 1 = Resets SW1(03) buffer full
02	Not used	Set it to zero
01	Reserved for future use	Reset this bit to zero
00	Reserved for future use	Reset this bit to zero

Initialization Word One

Bit	Function	Status
17	ACK/NAK	0* = Not used by ASCII device 1 = ACK/NAK required by device
16	Stop Bits	0* = Device generates one stop bit 1 = Device generates two stop bits
15	Parity Enable	0* = Device does not use parity bit 1 = Device generates a parity bit
14	Parity	0* = Odd 1 = Even
13	Number of Data Bits	0* = Device generates 8-bit data 1 = Device generates 7-bit data
12, 11, 10	Communication Rate	000* = 300 baud 001 = 600 baud 010 = 1200 baud 011 = 2400 baud 100 = 4800 baud 101 = 9600 baud 110 = 110 baud 111 = 110 baud
07, 06, 05	Mode of Transmission	000* = Full duplex with echo 001 = Full duplex without echo 010 = Simplex read 011 = Simplex write 100 = Half duplex with echo 101 = Half duplex without echo all other codes are invalid
04, 03, 02	Mode of Operation	000* = Data mode 001 = Report Generation (RG) mode
01, 00	Number of Initialization Words	00* = Word 1 01 = Words 1 and 2 10 = Words 1, 2, and 3 11 = Words 1, 2, 3, and 4
*Default value when you do not select that initialization word		

Initialization Word Two

Bit	Function	Status
17	Single or Multiple String Transfer (Rate)	0*=Module sends single string 1=Module sends two or more strings per block transfer
16, 15, 14	Data conversion	000* = 2 ASCII characters per word 001 = 3 BCD characters per word** 010 = 4 BCD characters per word** 011 = 1 ASCII character per word 100 = 4 Hex characters per word
13-00	Number of ASCII Characters per String	Bits 00-03 = BCD digit 0 Bits 04-07 = BCD digit 1 Bits 10-13 = BCD digit 2 Data mode: default = 10, max = 62 RG mode: default = 124, max = 999
*Default value when you do not select that initalization word. **Must select either one in RG mode		

Initialization Word Three

Bit	Function	Status
17	Enables End-of-string (EOS) Delimiter	0 = Module transfers data when it detects EOS delimiter 1 = Module ignores EOS delimiter
16-10	End-of-string Delimiter	Bits 10-13 = First ASCII character Bits 14-16 = Second character The module defaults to null (CTRL 0) if IW3 is not used.
07, 06	Delay for Carriage Return (RG mode, only)	00* = 0ms 01 = 50ms 10 = 100ms 11 = 200ms
05	Line Feed if Carriage Return	0*= Inhibits function 1 = Enables function
04	Sends EOS Delimiter to Processor (RG mode, only)	0* = Inhibits function 1 = Enables function
03	Margin Justification (Data mode, only)	0* = Right justification 1 = Left justification In RG mode, ASCII data is left justified, BCD values within string are right justified, automatically.

Bit	Function	Status
02-00	I/O Buffer Split	000* = 50/50 Input/output 001 = 100/0 Input 010 = 75/25 Input/output 011 = 25/75 Input/output all other = 50/50
*Default value when you do not select that initialization word.		

Initialization Word Four

Bit	Function	Status
17	Not used	Set it to zero
16-10	Removes Fill Character (Data mode) BCD Delimiter (RG mode)	Bits 10-13 = First ASCII character Bits14-16 = Second character Module defaults to colon (:) if IW4 is not used.
07-04	Removes Trailing Characters	Bits 04, 05 = First Hex digit Bits 06, 07 = Second Hex digit Module removes 15 characters, max. Zero characters for default
03-00	Removes Header Characters	Bits 00, 01 = First Hex digit Bits 02, 03 = Second Hex digit Module removes 15 characters, max. Zero characters for default

Status Word One

Bit	Function	Status*
17	Channel Active	0 = Reset 1 = The ASCII device is enabled
16	Write Data Acknowledge	Module toggles SW1(16)=CW1(16) to tell PC that new data was received
15	Read Data Available	Module toggles SW1(15) $\neq$ CW1(15) when it detects a change in status or receives new data from ASCII device
14	Input String Exceeds Maximum	0 = Reset 1 = Input string >set string length in IW2(00-13)
13	ASCII Device/Link Error	0 = Reset 1 = Module detects parity, framing or overrun error in string from the ASCII device
12	Initialization Error	0 = Reset 1 = Module ceases to operate
11	Not Used	Module sets it to zero
10	Data Complete	0 = Reset 1 = Module detects delimiter at end of string that is distributed over one or more block transfers.
07	Power-up Initialization	0 = Reset by CW1(07) 1 = Power-up initialization is complete
06	Not used	Module sets it to zero
05	Output Buffer Full	0 = Reset when less than full 1 = Output buffer full
04	Output Buffer Empty	0 = Reset when data enters buffer 1 = Output buffer empty
03	Input Buffer full	0 = Reset by CW1(03) when input buffer is empty 1 = Input buffer is full
02	Input Buffer 75% Full	0 = Reset when less than 75% full 1 = Input buffer is 75% full
01	Input Buffer 50% Full	0 = Reset when less than 50% full 1 = Input buffer is 50% full
00	Input Buffer Empty	0 = Reset when data enters buffer 1 = Input buffer is empty

*The module sets these bits (unless toggled) when it detects the subject condition.

Status Word Two

Bit	Function	Status*
17-10	Number of strings per Block Transfer (when transferring multiple strings., IW2(17) = 1)	Bits 10-13 = BCD digit 0 Bits 14-17 = BCD digit 1
07-00	Number of Words per String	Bits 00-03 = BCD digit 0 Bits 04-07 = BCD digit 1
*The module sets these bits (unless toggled) when it detects the subject condition.		

Chapter 7

Troubleshooting

Chapter Objectives

In this chapter you will read about recognizing initialization errors, interpreting status indicators, and status codes for troubleshooting purposes. We will also show you how to conduct a test to verify that your ASCII module is operating correctly.

Recognizing Initialization Errors

If you should set bits of initialization words to an invalid range, the module detects an initialization error and will not operate. Invalid settings of initialization words are listed in Table 6.A.

Table 6.A
Initialization Errors

Feature	Word (Bit)	Invalid Setting or Range
Mode of module operation	IW1(02-04)	Above 001 (binary)
Mode of transmission	IW1(05-07)	Above 101 (binary)
String length	IW2(00-13)	Data mode: above 62 characters Either mode: non-BCD digits using A-F hex
Data conversion	IW2(14-16)	Data mode: above 100 (binary) Report generation mode: 000=1 ASCII/word 011= 2 ASCII/word 100= 4 hex/word above 100 (binary)
I/O buffer split	IW3(00-02)	Simplex read: 100=100% output Simplex write: 001=100% input
Send EOS delimiter to PC	IW3(04)	Set in data mode

Feature	Word (Bit)	Invalid Setting or Range
End-of-string delimiter	IW3(10-16)	Same value as IW4(10-16) when you use IW3 and IW4 3A hex, when you do **not** use IW4 (3A is default of IW4(10-16) when IW4 is not used)
BCD delimiter	IW4(10-16)	No value entered when using all four initialization words (00 hex is an illegal BCD delimiter value)

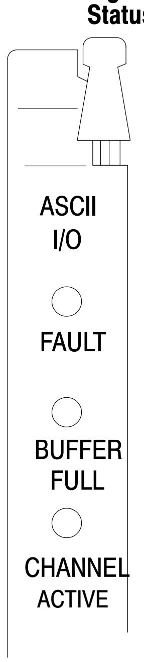
How You Interpret Status Indicators

There are three LED status indicators on the front of the module. They are labeled:

FAULT
BUFFER FULL
CHANNEL ACTIVE

The location of these LED indicators and how you interpret them is described in Figure 6.1.

Figure 6.1
Status Indicators



FAULT - This red indicator illuminates when the module detects an internal hardware fault. It is normally off.

BUFFER FULL - This yellow indicator illuminates when the input buffer is full. It must be reset by program logic using CW1(03).

CHANNEL ACTIVE - This green indicator illuminates when an ASCII device is turned on and is properly connected to the INTERFACE port. The module examines only the received data line for channel active indication. This indicator does not monitor communication between the processor and the ASCII module.

NOTE: In RS-232-C and current loop modules, disregard the CHANNEL ACTIVE indicator when in simplex mode of transmission. The simplex write mode disregards the status of the receive line, which is indicated by the CHANNEL ACTIVE indicator.

When the input buffer is full and when you use control lines, the module signals the ASCII device to stop sending data. If you do not use control lines and the ASCII device continues to send data when the input buffer is full, the data spills over and is lost.

Typical examples of fault conditions displayed by status indicators, and corrective action that you can take, are shown in the troubleshooting chart (Table 6.B). If the FAULT indicator should remain on, return the module to Allen-Bradley for service.

Table 6.B
Troubleshooting Chart

Indication	Description	Recommended Action
○ FAULT ○ BUFFER FULL ● CHANNEL ACTIVE	Normal operation	
○ FAULT ○ BUFFER FULL ● CHANNEL ACTIVE	ASCII characters are not transferred but all LEDs give normal indication.	1. Check for invalid initialization data (SW1=X4XX). (X = any hex value) 2. Check parity setting on ASCII device with setting of IW1(14,15).
● FAULT ○ BUFFER FULL ● CHANNEL ACTIVE	Hardware failure in module.	Return module for repair
○ FAULT ● BUFFER FULL ● CHANNEL ACTIVE	Input buffer full. Loss of spillover data if control lines are not used.	1. Check for loss of data. 2. Increase ratio or input buffer to output buffer in IW3(00-02). 3. Increase block transfer rate by transferring multiple strings in each transfer. Set IW2(17)=1 and modify your program. 4. Decrease communication rate from ASCII device.
○ FAULT ○ BUFFER FULL ○ CHANNEL ACTIVE	ASCII characters are transferred but all LEDS are OFF.	1. Check programming plugs for correct placement . See section titled "Setting the Module's Programming Plugs", P. 2-11 2. If a multiple port ASCII device is being used, check for use of correct port. 3. Check 1772-TC Cable.
○ = off ● = on		

How You Interpret Codes in Status Word One

During installation and start-up you will find the codes displayed in status word one (SW1) very helpful. You can observe them when you display the read block transfer file in your program's BLOCK XFER READ instruction. Typical codes for correct operation (Table 6.C), buffer status (Table 6.D), and fault status (Table 6.E) are shown on the following pages.

Table 6.C
Correct Operation Codes

Hex	Binary	Description
A011	10100000 000 10001	Input buffer empty Output buffer empty Read data available Channel active
8010	10000000 00010000	Input buffer contains data Output buffer empty Channel active
A010	1010000 00010000	Input buffer contains data Output buffer empty Read data available Channel active
E010	11100000 00010000	Input buffer contains data Output buffer empty Read data available Write data acknowledge Channel active
C011	1100000 00010001	Output buffer empty Output buffer empty Write data acknowledge Channel active
E0001	11100000 00000001	Input buffer empty Output buffer conatins data Read data available Write data acknowledge Channel active

Table 6.D
Buffer Status Codes

Hex	Binary	Description
8011	10000000 00010001	Input buffer empty
A010	10100000 00010000	Input buffer contains data
A012	10100000 00010010	Input buffer 50% full
A016	10100000 00010110	Input buffer 75% full
A01F	10100000 00011110	Input buffer 100% full

Table 6.E
Fault Status Codes

Hex	Binary	Description
0001	00000000 00000001	ASCII device neither connected nor turned on Channel active light not on
0010	00000000 00010000	Lost cable to ASCII device Channel active light not on
2010	00100000 00010000	ASCII device lost power or turned off Loss of channel active was read to the processor
2491	00100100 10010001	Initializating Error Input buffer empty Output buffer empty Power-up initialization Invalid initialization data Read data available Channel active light is off

Testing the ASCII Module and Cables

You can verify cable connections and operation of your installed ASCII module on your industrial terminal as follows.

1. Turn off power to I/O chassis. Place your module in module group 1, slot 1. Turn on power.

2. Load a brief program into processor memory. Use the program (Figure 6.2 for PLC-2 family controllers, Figure 6.3 for PLC-3 controllers) if your processor memory is empty. If you have loaded your "Getting Started Program", insert only rungs 3 and 4 following rung 2 of the "Getting Started Program". Add a temporary end instruction (PLC-2 family), or an end rung (PLC-3 controller).

3. Set your industrial terminal to alphanumeric mode and select a communication rate of 300 baud. Do this by entering the following key sequence using the alphanumeric keytop overlay.

Press [MODE SELECT]1213[RETURN]

The cursor appears at the upper left corner of a blank screen.

The module's CHANNEL ACTIVE LED illuminates when the industrial terminal is in alphanumeric mode and the module has power.

4. Place the processor in run/program mode (PLC-2 family controller) or in run monitor (PLC-3 controllers).

5. Enter characters on the keyboard.

Results Characters should be displayed as you enter them.

If not, check the following:

- The module's internal programming plugs are set correctly (chapter 3, Figure 3.8).
- Cables to the I/O chassis are connected correctly.
- PLC-3 controller LIST functions are entered correctly, and/or adapter module switch is set correctly. (Does the proper channel number LED indicator illuminate on the 1775-S4A I/O scanner, and does the ACTIVE LED indicator illuminate on the 1771-AS remote I/O adapter module?)

Figure 6.2
Test Program (PCL-2 Family)

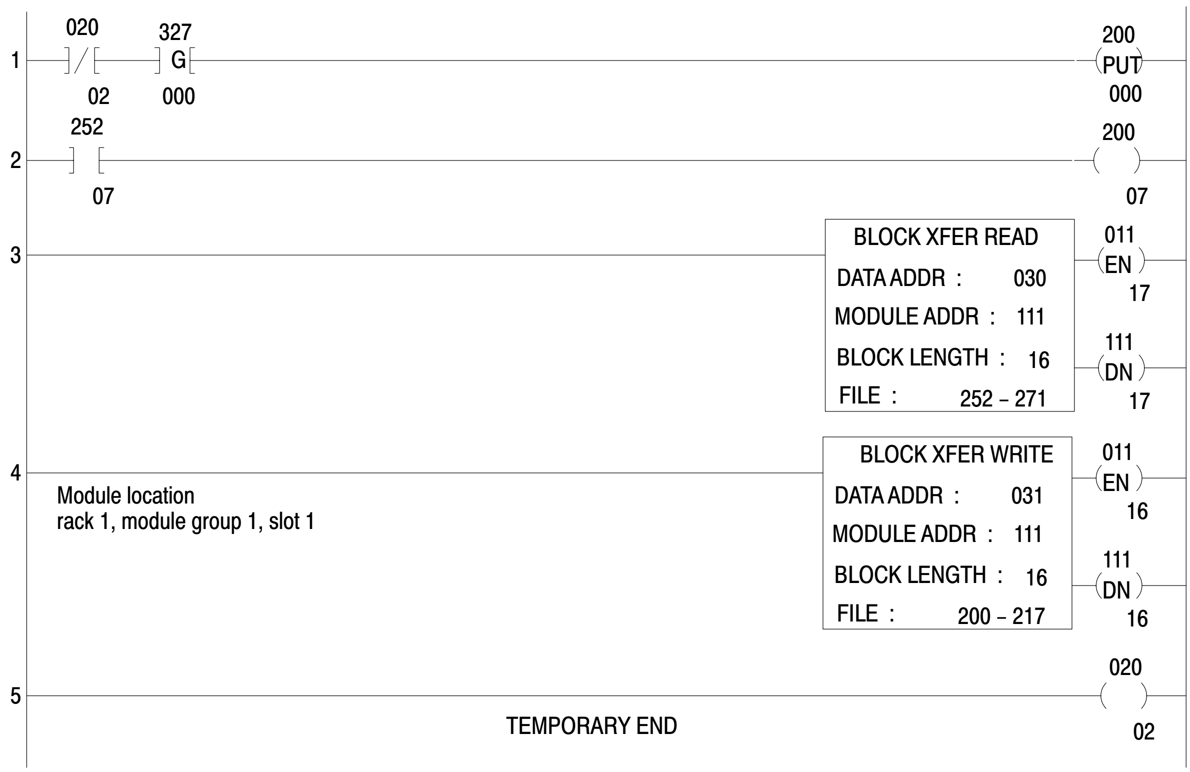
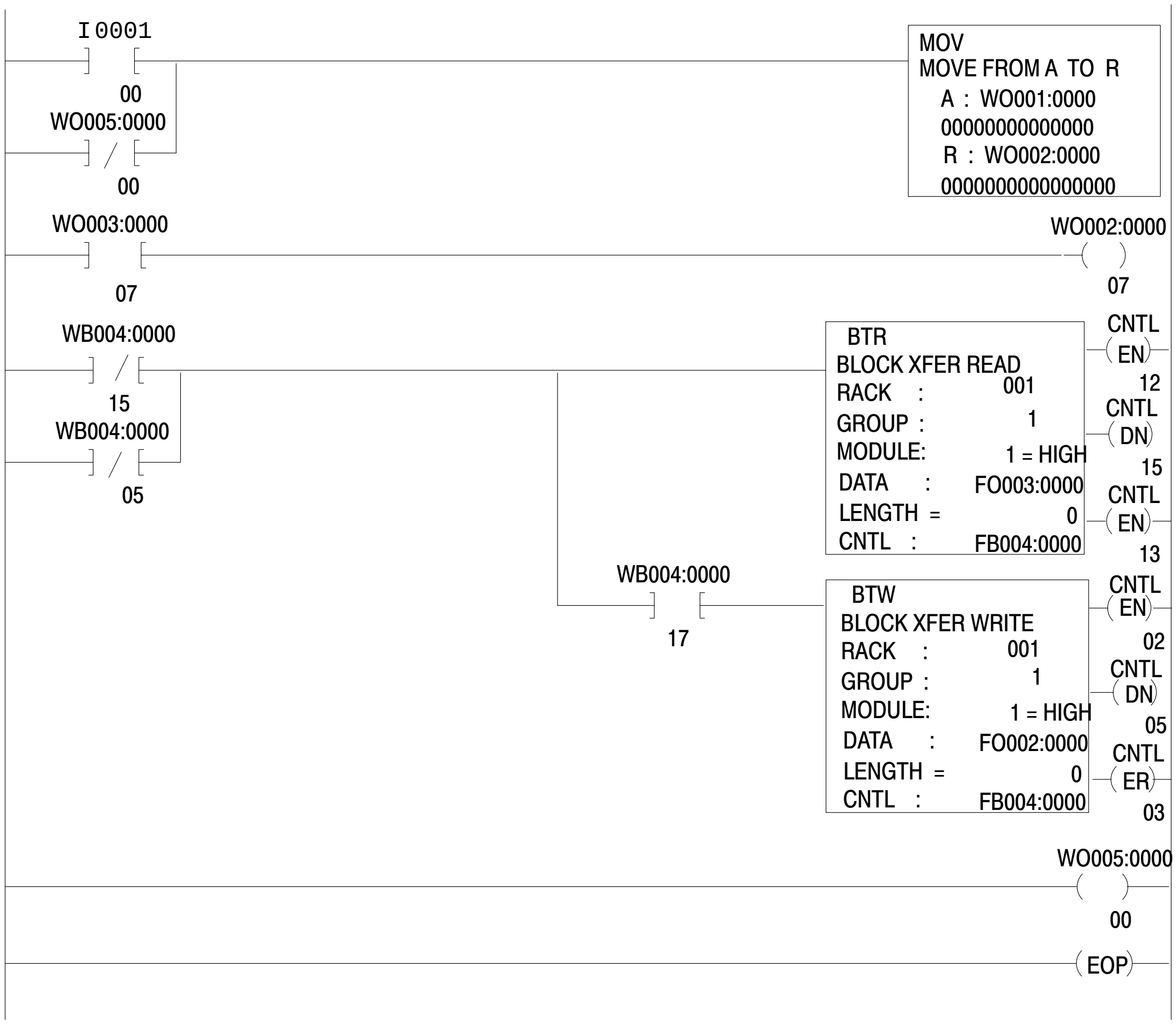


Figure 6.3
Test Program (PLC-3)



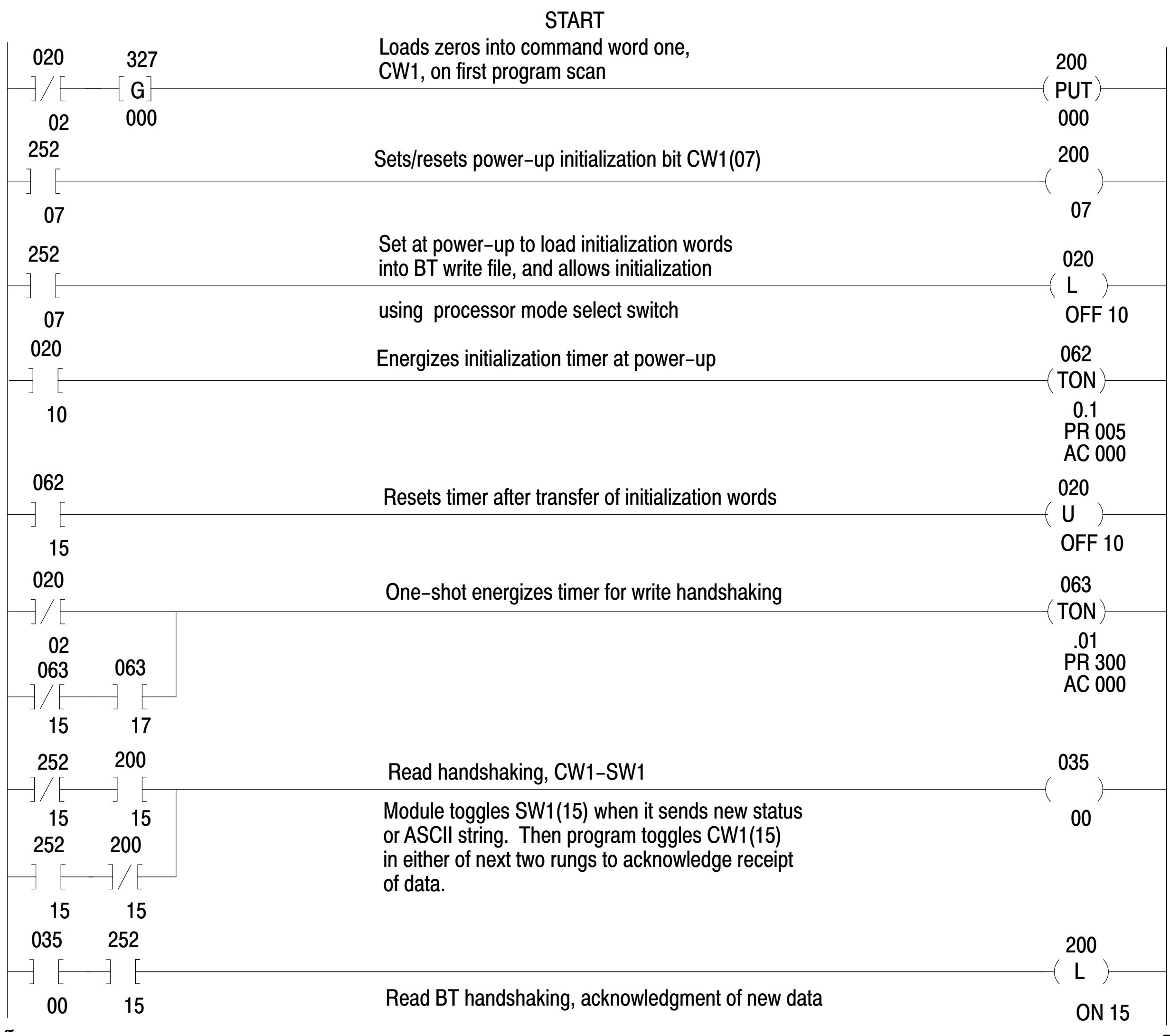
PLC-2 Family Processors

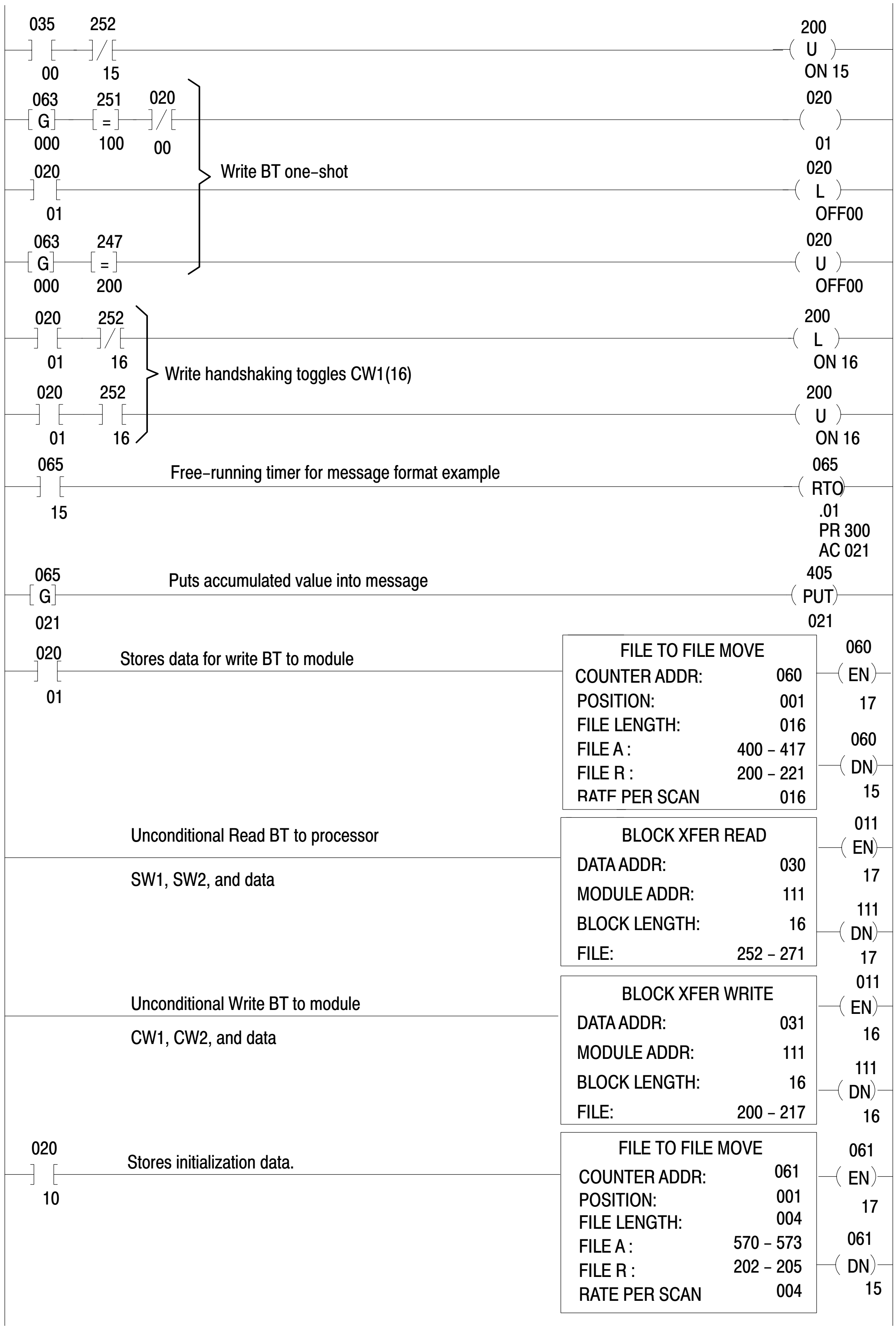
Complete Getting Started Program, PLC-2 Family

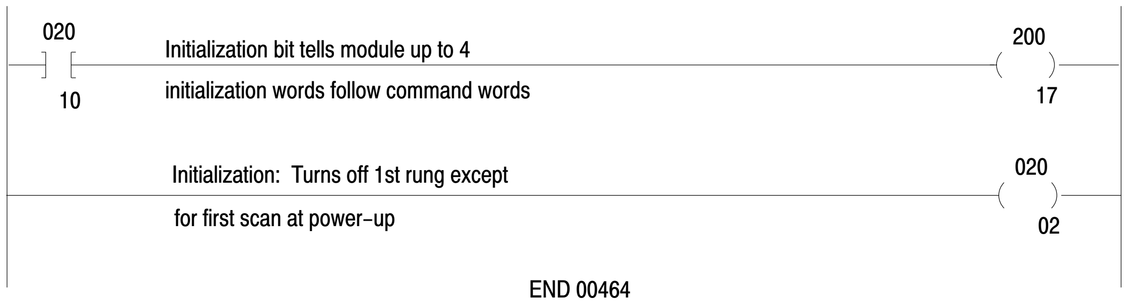
The complete Getting Started Program with rung desriptions is described in Figure A.1.

Figure A.1
Complete Getting Started Program (PLC-2 Family)

LADDER DIAGRAM DUMP




035 00
252 15
200 U ON 15
063 G 000
251 = 100
020 00
020 01
Write BT one–shot
020 01
020 L OFF00
063 G 000
247 = 200
020 U OFF00
020 01
252 16
Write handshaking toggles CW1(16)
200 L ON 16
020 01
252 16
200 U ON 16
065 15
Free–running timer for message format example
065 RTO .01 PR 300 AC 021
065 G 021
Puts accumulated value into message
405 PUT 021
020 01
Stores data for write BT to module
FILE TO FILE MOVE
COUNTER ADDR: 060
POSITION: 001
FILE LENGTH: 016
FILE A : 400 – 417
FILE R : 200 – 221
RATE PER SCAN 016
060 EN 17
060 DN 15
Unconditional Read BT to processor
SW1, SW2, and data
BLOCK XFER READ
DATA ADDR: 030
MODULE ADDR: 111
BLOCK LENGTH: 16
FILE: 252 – 271
011 EN 17
111 DN 17
Unconditional Write BT to module
CW1, CW2, and data
BLOCK XFER WRITE
DATA ADDR: 031
MODULE ADDR: 111
BLOCK LENGTH: 16
FILE: 200 – 217
011 EN 16
111 DN 16
020 10
Stores initialization data.
FILE TO FILE MOVE
COUNTER ADDR: 061
POSITION: 001
FILE LENGTH: 004
FILE A : 570 – 573
FILE R : 202 – 205
RATE PER SCAN 004
061 EN 17
061 DN 15



Block Transfer Programming

All communication between the ASCII module and the PC processor data table is controlled by program logic using block transfer programming. The Mini-PLC-2/15 and PLC-2/30 programmable controllers use block transfer instructions. The PLC-2/20 uses multiple get instructions for programming block transfer. Refer to the July 1982 or later edition of the Programming and Operations Manual for the Mini-PLC-2/15 or PLC-2/30 for a detailed description of block transfer. These are publications 1772-804 and 1772-806 respectively.

The remainder of this section describes block transfer concepts for programming the ASCII module using the block instructions of the Mini-PLC-2/15 and PLC-2/30 programmable controllers.

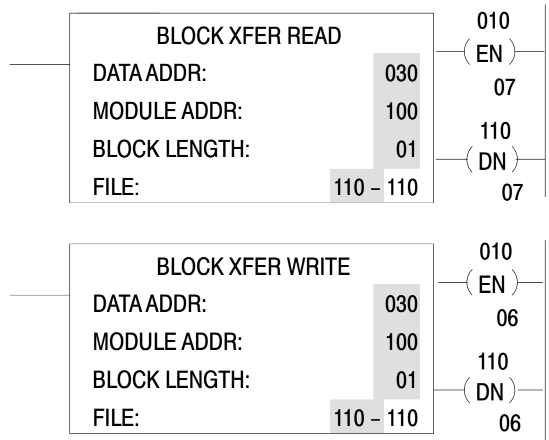
Bidirectional Block Transfer

Bidirectional block transfer is the performance of alternating read and write operations. A read operation transfers data from the module to the processor data table. A write operation transfers data from the data table to the module. User program logic contains the block transfer read instruction and block transfer write instruction. The format of these block instructions and definitions of terms are shown in Figure A.2.

Figure A.2
Block Format Block Transfer Instructions

A block transfer instruction is programmed in the ladder diagram by depressing the [BLOCK XFER] key followed by [1] (for a READ) or [0] (for a WRITE). The appropriate read or write block, as shown, will appear on the industrial terminal screen.

Numbers shown are default values. Numbers in shaded areas must be replaced by user-entered values. The number of default address digits initially displayed, 3, 4, or 5 will depend on the size of the data table. Initially displayed default values are governed by the I/O rack configuration.



Data Address	: First possible address in accumulated value area of data table.
Module Address	: Rack, module group, and slot number.
Block Length	: Number of words to be transferred. (00 can be entered for default value or for 64 words).
File	: Address of first word in the file. Storage is 100_8 above the data address.
Enable Bit (EN)	: Automatically entered from the module address. Set on when rung containing the instruction is true.
Done Bit (DN)	: Automatically entered from the module address. Remains on for 1 scan following successful transfer.

11121

Data and Module Addresses

The data address is the block transfer instruction address. It is used to store the I/O rack address of the ASCII module (module address). The module address is stored in BCD by rack, module group, and slot number and identifies the module's location in the I/O rack. You enter the data address in the instruction after you enter the instruction.

The data address of a block transfer instruction should be the first available address in the timer/counter accumulated area of the data table. This address is 030 for the Mini-PLC-2/15 controller. For the PLC-2/30 controller, this address depends on the number of I/O racks connected to the processor module, i.e. address 020 for one I/O rack, 030 for two racks, etc. to 070 for six racks and 200 for seven racks. When more than one block transfer module is used, the data addresses should be consecutive.

Two consecutive data addresses must be used in bidirectional block transfer. Both contain the I/O rack address of the ASCII module.

A boundary word containing zeros should be entered in the data table following the last block transfer data address. When the processor sees this boundary word, it will terminate the block transfer search routine so subsequent data table values cannot be interpreted as rack, module group, and slot numbers associated with block transfer data addresses.

File Addresses

The block transfer read and write instructions each require a file. The file of the read instruction receives data transferred from the module. The file of the write instruction temporarily holds data to be sent to the module. Each file address is stored in the preset area of the data table, 100_8 above the corresponding data address in the accumulated area. You enter the file address in the instruction after you enter the instruction. The files themselves can be located elsewhere in the data table.

Enable and Done Bits

The read enable bit is bit 07 or 17 of the module's output image table byte depending on whether the block transfer module is in a lower or upper slot, respectively. The write enable bit is bit 06 or 16 of this byte. These bits are entered automatically in the instruction when you enter the module address.

The done bit has the identical bit number as the enable bit but the done bit is set in the module's input image table word. The done bit is set in the I/O scan that the transfer is made, provided that the transfer was successfully completed.

The done bit remains set for one program scan.

Example Instructions

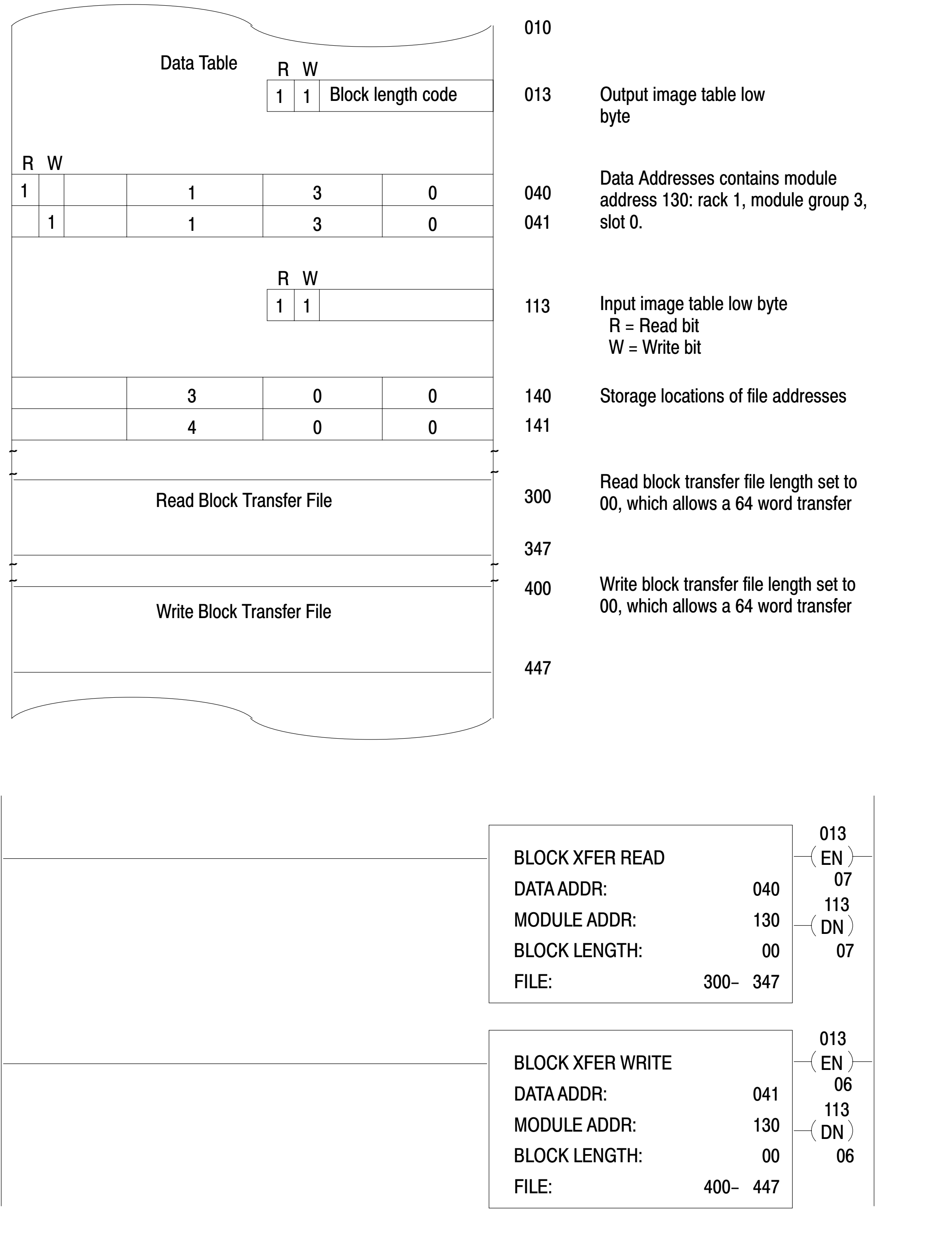
Example bidirectional block transfer instructions and their associated data table map are shown in Figure A.3.

Block Transfer Timing

The time for a block transfer read or write operation for PLC-2 family processors depends on the system, scan time(s), the number of words to be transferred, the I/O configuration, and the number of enabled block transfer instructions in the ladder diagram program during any program scan. A block transfer module will not accept another transfer until finished processing the previous transfer. For a worst case calculation of the time between block transfers, assume that the number of enabled block transfer instructions during any program scan is equal to the number of block transfer modules in the system. Also assume that the ASCII module is transferring 64 words in a write or read operation and 2 words in the alternate operation. The module will toggle, when done, from one operation to the other in the next program scan.

The method for calculating the worst case time between block transfers will be covered for the following cases: PLC-2/30 remote and local systems, and Mini-PLC-2/15 controller.

Figure A.3
Example Data Table Locations for Bidirectional Block Transfers



PLC-2/30 (PLC-2/20) Remote System

The system scan time for a remote PLC-2/30 or PLC-2/20 system is the sum of the processor scan time, the processor I/O scan time (between processor and remote distribution panel), and the remote distribution panel I/O scan time. Assume that for a remote system, the remote distribution panel can process only one block transfer operation per remote distribution panel scan.

The procedure for calculating the worst case time between transfers under normal operating conditions can be done in three steps.

1. Calculate the system values that are determined by the system configuration.

- Program Scan, PS = (5ms/1K words) x (number of program words)
- Processor I/O Scan, PIO = (0.5ms/rack number) x (declared rack numbers)
- Remote Distribution I/O Scan, RIO = (7ms/chassis) x (number of chasses)
- Number of Words Transferred, W = 64 words for one operation, 2 words for the other

2. Calculate the block transfer time TW for the write operation and TR for a read operation.

TW = PS + PIO + 2 RIO + 0.5W + 13

TR = PS + PIO + 2 RIO + 0.5W + 4

These equations are valid for up to 10,000 cable feet between the remote distribution panel and remote I/O chassis and for a baud rate of 57.6k, or 5,000 cable feet at 115k baud rate.

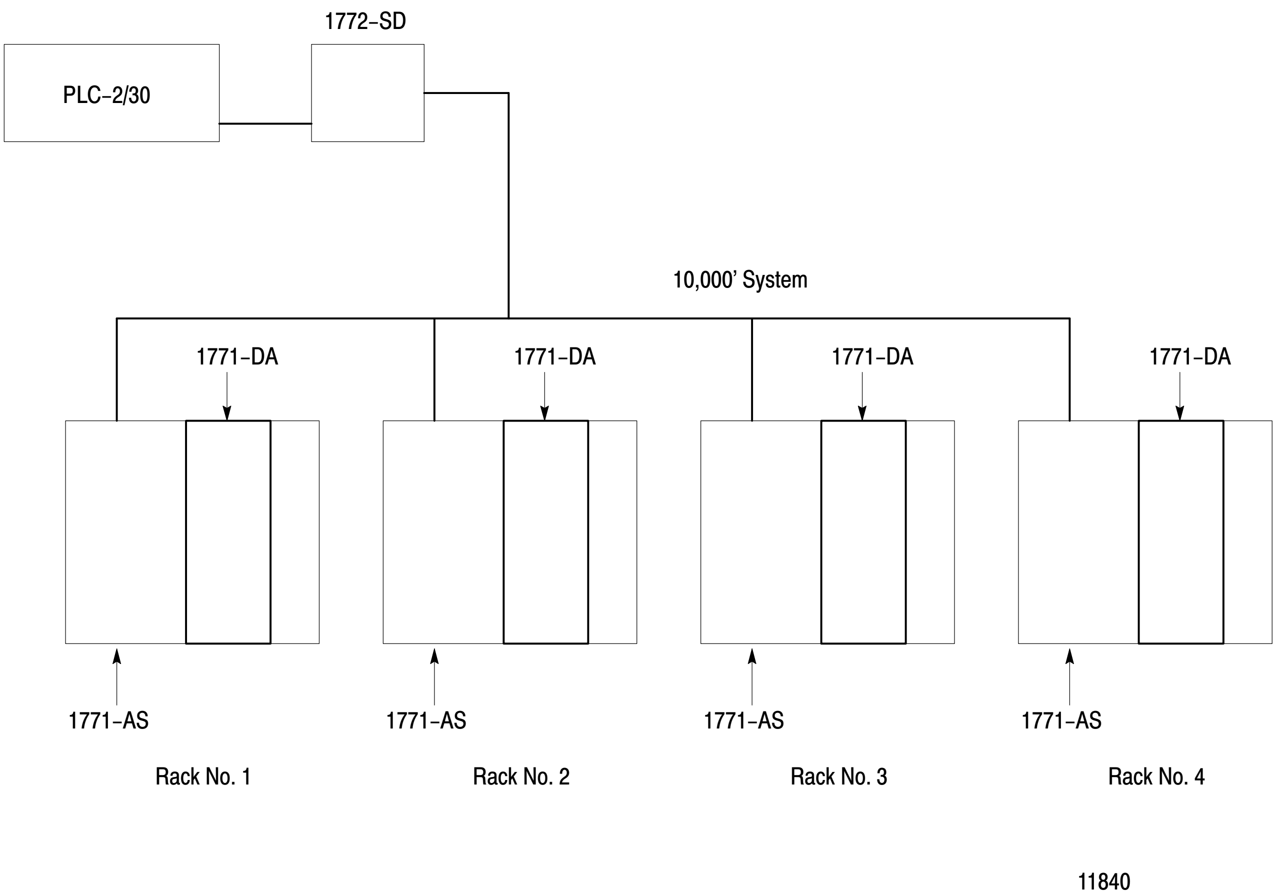
3. Calculate the worst case system time ST between transfers.

ST = Sum of transfer times of all block transfer modules in a system taken worst case (read or write).

Example Problem 1

A PLC-2/30 programmable controller is controlling 4 I/O racks in remote configuration (Figure A.4). An ASCII module is located in each rack. Assume that 64 words are transferred in each read and two words are transferred in each write operation and that the ladder diagram program contains 4K words (K=1024). There are no other block transfer modules in the system.

Figure A.4
Remote System Example



What is the worst case time between two consecutive read block transfers from the same module in this system?

Solution

The facts of the problem are:

Program length = 4K words
Number of chassis = 4 rack numbers
Number of block transfer words = 64 words (read), 2 words (write)

1. Calculate the system values.

Processor Scan Time PS = (5ms/1K words) x (4K words) = 20ms
Processor I/O Scan Time PIO = (0.5ms/rack number) x (4 rack numbers) = 2ms
Remote Distribution I/O Scan Time RIO = (7ms/chassis) x (4 chassis) = 28ms
Number of Words Transferred = 64 (read) or 2 (write)

2. Calculate the block transfer times, TW for a write and TR for a read operation.

TW = PS + IO + 2(RIO) + 0.5W + 13
TW = 20 + 2 + 2(28) + 0.5(2) + 13
TW = 92ms (write)

TR = PS + PIO + 2(RIO) + 0.5W + 4
TR = 20 + 2 + 2(28) + 0.5(64) + 4
TR = 114ms (read)

3. Calculate the worst case system time ST between 2 consecutive read block transfers.

ST = 4TW + 4TR
= 4(92) + 4(114)
= 368 + 456
824ms

This is the worst case time between two consecutive read block transfers in the 4-chassis remote configuration described in example problem 1 (enabled ASCII module in each chassis).

PLC-2/30 Local System

The system scan time for a local PLC-2/30 system is the program scan time plus the processor I/O scan time. Each block transfer module will be updated during a program scan.

The procedure for calculating the worst case time between transfers can be done in three steps.

1. Calculate the system values that are determined by the system configuration.

- Program Scan PS = (5ms/1K words) x (number of program words)
- Processor I/O Scan PIO = (1ms/rack number) x (number of declared rack numbers)
- Number of words transferred W = 64 (read) or a (write)

2. Calculate the block transfer time T for the read or write operation.

T = 0.1ms + (0.075ms/word x number of words transferred)

The same equation is used for either read or write transfer times.

3. Calculate the worst case system time ST between transfers.

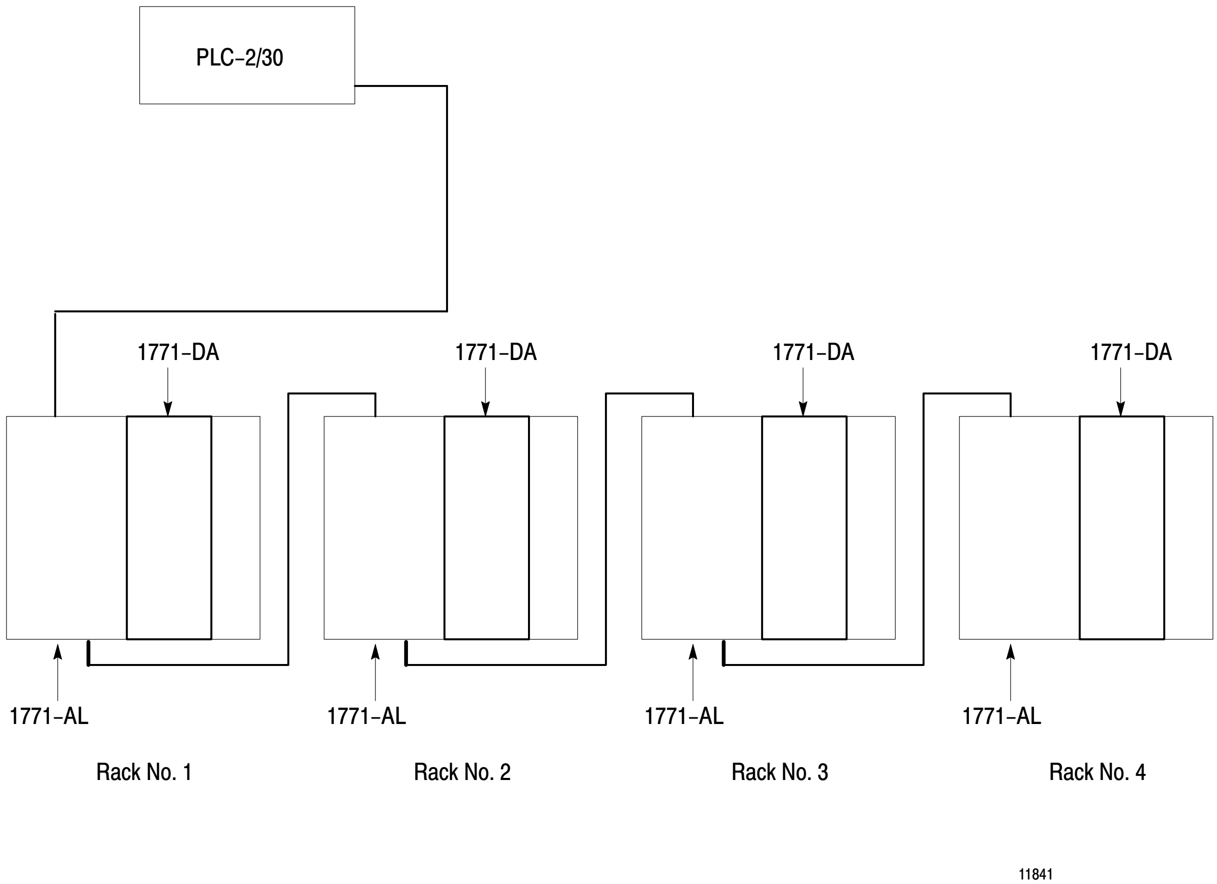
ST = PS + PIO + T(1)(read) + T(2)(read) + T(3)(read) + ...
PS + PIO + T(1)(write) + T(2)(write) + T(3)(write) + ...

= 2(PS +PIO) + T(1)(read) + T(2)(read) + T(3)(read) + ...
T(1)(write) + T(2)(write) + T(3)(write) + ...

Example Problem 2

A PLC-2/30 programmable controller is controlling four I/O racks in a local configuration (Figure A.5). Otherwise this example problem is identical to example problem 1.

Figure A.5
Local System Example



Solution:

The facts of the problem are:

Program length = 4K words
Number of chassis = 4 rack numbers
Number of block transfer words, W = 64 (read) or 2 (write)

1. Calculate the system values.

Processor Scan Time, PS = (5ms/1K words) x (4K words) = 20ms
Processor I/O Scan Time, PIO = (0.5ms/rack number) x(4 rack numbers) = 2ms
Number of Words Transferred, W = 64(read) or 2 (write)

2. Calculate the block transfer times T for the read and write operation.

T = 0.1 + (0.075ms/word x 64 words)
= 0.1 + 4.8
4.9ms (read)

T = 0.1 + (0.075ms/word x 2 words)
= 0.1 + 0.15
= 0.25ms (write)

3. Calculate the worst case system time ST between 2 consecutive read block transfers.

The module toggles to a read operation in the scan following completion of the write operation and vice versa.

ST = PS+ PIO + T(1) +T(2) + T(3) +T(4)(writes)
PS+ PIO + T(1) +T(2) + T(3) +T(4)(reads)

ST = 2PS + 2PIO + 4T(read) + 4T(write)
= 2(20) + 2(2) + 4(4.9) + 4(0.15)
= 40 + 4 + 19.6 + 0.6
= 64.2ms

This is the worst case time between two consecutive read block transfers in the 4-chassis local configuration described in example problem 2 (enabled ASCII module in each chassis).

Mini-PLC-2/15 Controller

The program scan and I/O scan are consecutive and are considered as a single processor scan. The Mini-PLC-2/15 scan time varies typically from 18 to 24ms for a 1K program and one I/O chassis. Each block transfer module will be updated during a program scan.

The procedure for calculating the worst case time between transfers can be done in two steps.

The facts of the problem are:

Processor Scan time, PS = 24ms
Number of Words Transferred, W = 64(read) or 2(write)

1. Calculate the block transfer time T for the read and write operation.

T = 0.1ms + (6.16ms/word x number of words transferred)

The same equation is used for either read or write transfer times.

2. Calculate the worst case system time ST between two read block transfers.

ST = PS + T(read) + PS + T(write)

Example Problem 3

A Mini-PLC-2/15 programmable controller is communicating with one ASCII module in its I/O chassis. The ladder diagram program contains 2K words. Otherwise, this example problem is identical to example problem 1.

Solution

The facts of the problem are:

Program length = 2K words
Processor Scan Time PS = (24ms/1K words) x (2K words) = 48ms
Number of words transferred W = 64(read), 2(write)

1. Calculate the block transfer time T for the read and write operation.

T = 0.1ms + (0.16ms/word x 64 words)(read)
= 0.1 + 10.24
= 10.34ms (read)

T = 0.1ms + (0.16ms/word x 2 words)(write)
= 0.1 + .32
= 0.42ms (write)

2. Calculate the worst case system time ST between two consecutive read block transfers.

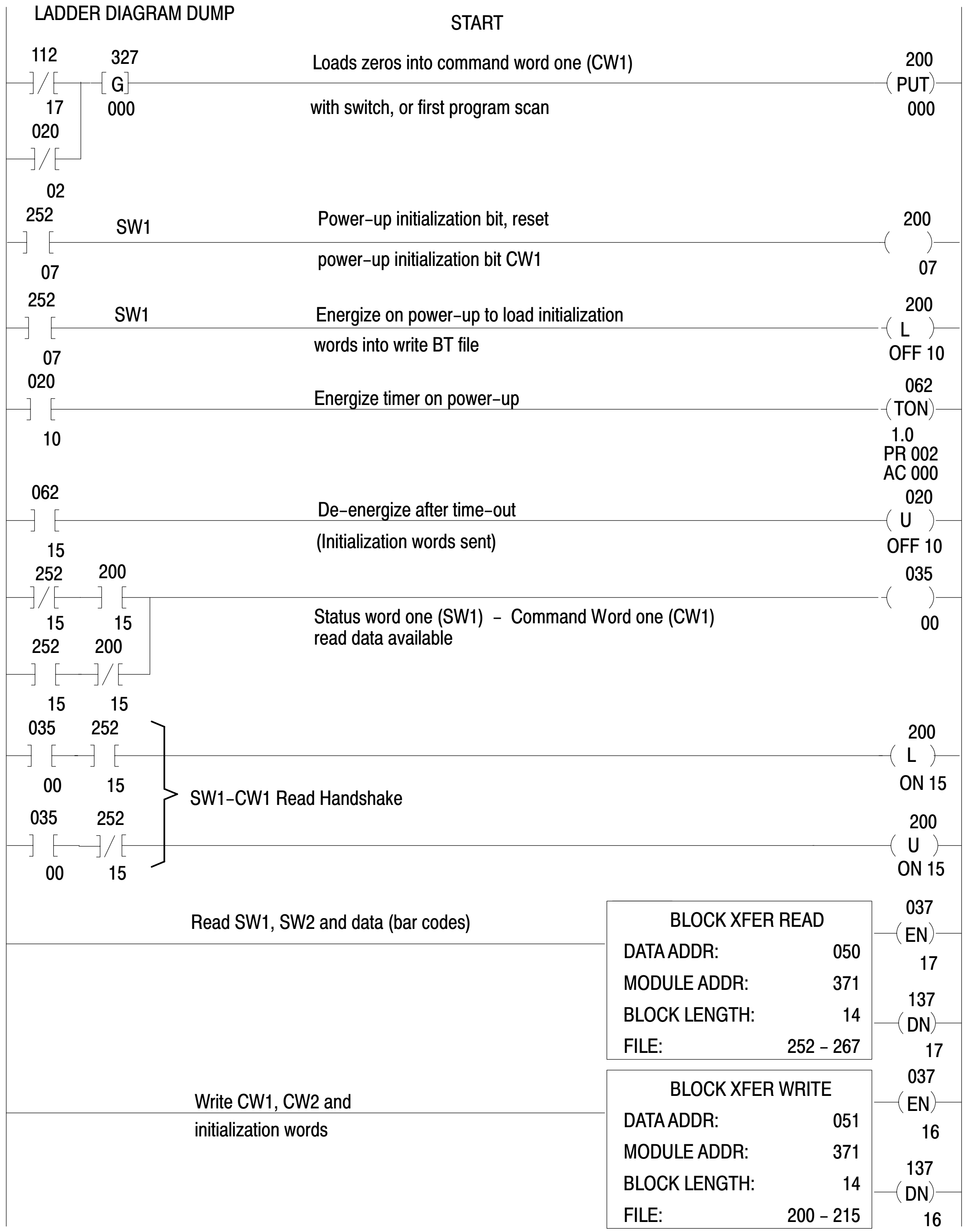
$$
\begin{aligned}
ST &= PS + T(read) + PS + T(write) \\
&= 48 + 10.34 + 48 + 0.42 \\
&= 107ms\ (rounded)
\end{aligned}
$$

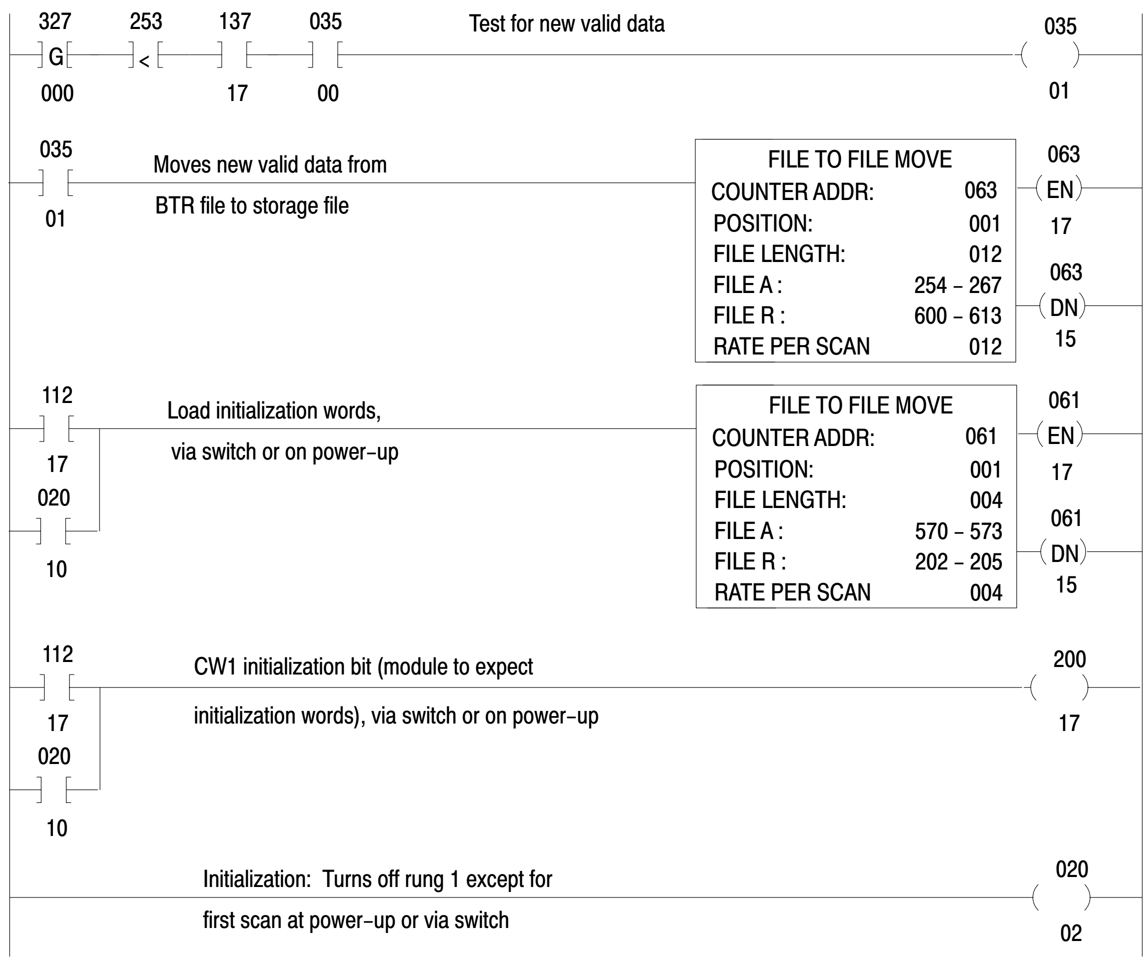
This is the worst case time between two consecutive read block transfers for the Mini-PLC-2/15 controller as described in example problem 3.

Example Read (Only) Program

A read (only) program for transferring data from your ASCII device into the data table of your processor is presented with rung descriptions (Figure A.6).

Figure A.6
Example Read (Only) Program



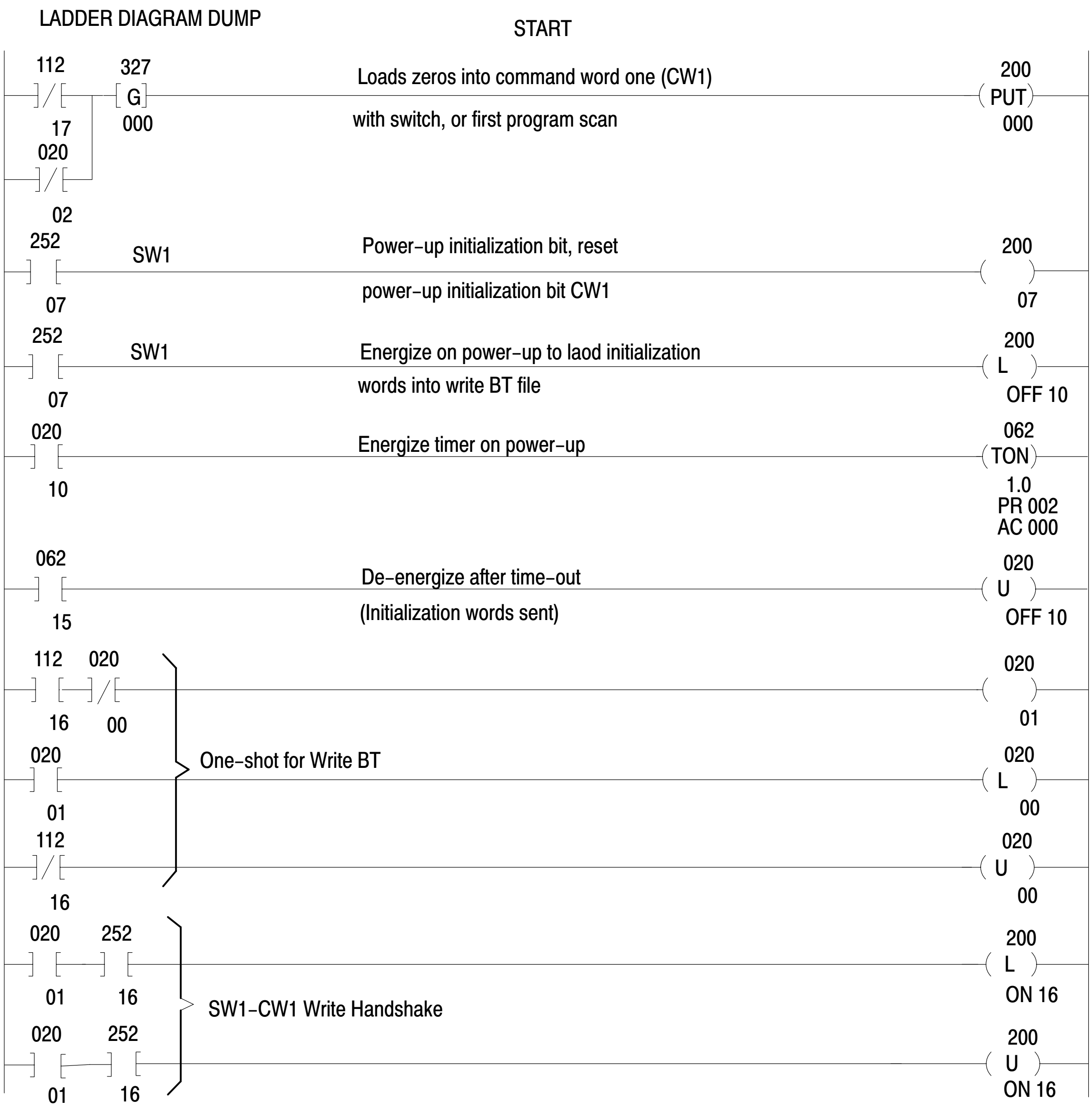

327
G
000
253
<
137
17
035
00
Test for new valid data
035
01
035
01
Moves new valid data from
BTR file to storage file
FILE TO FILE MOVE
COUNTER ADDR: 063
POSITION: 001
FILE LENGTH: 012
FILE A : 254 – 267
FILE R : 600 – 613
RATE PER SCAN 012
063
EN
17
063
DN
15
112
17
020
10
Load initialization words,
via switch or on power-up
FILE TO FILE MOVE
COUNTER ADDR: 061
POSITION: 001
FILE LENGTH: 004
FILE A : 570 – 573
FILE R : 202 – 205
RATE PER SCAN 004
061
EN
17
061
DN
15
112
17
020
10
CW1 initialization bit (module to expect
initialization words), via switch or on power-up
200
17
Initialization: Turns off rung 1 except for
first scan at power-up or via switch
020
02

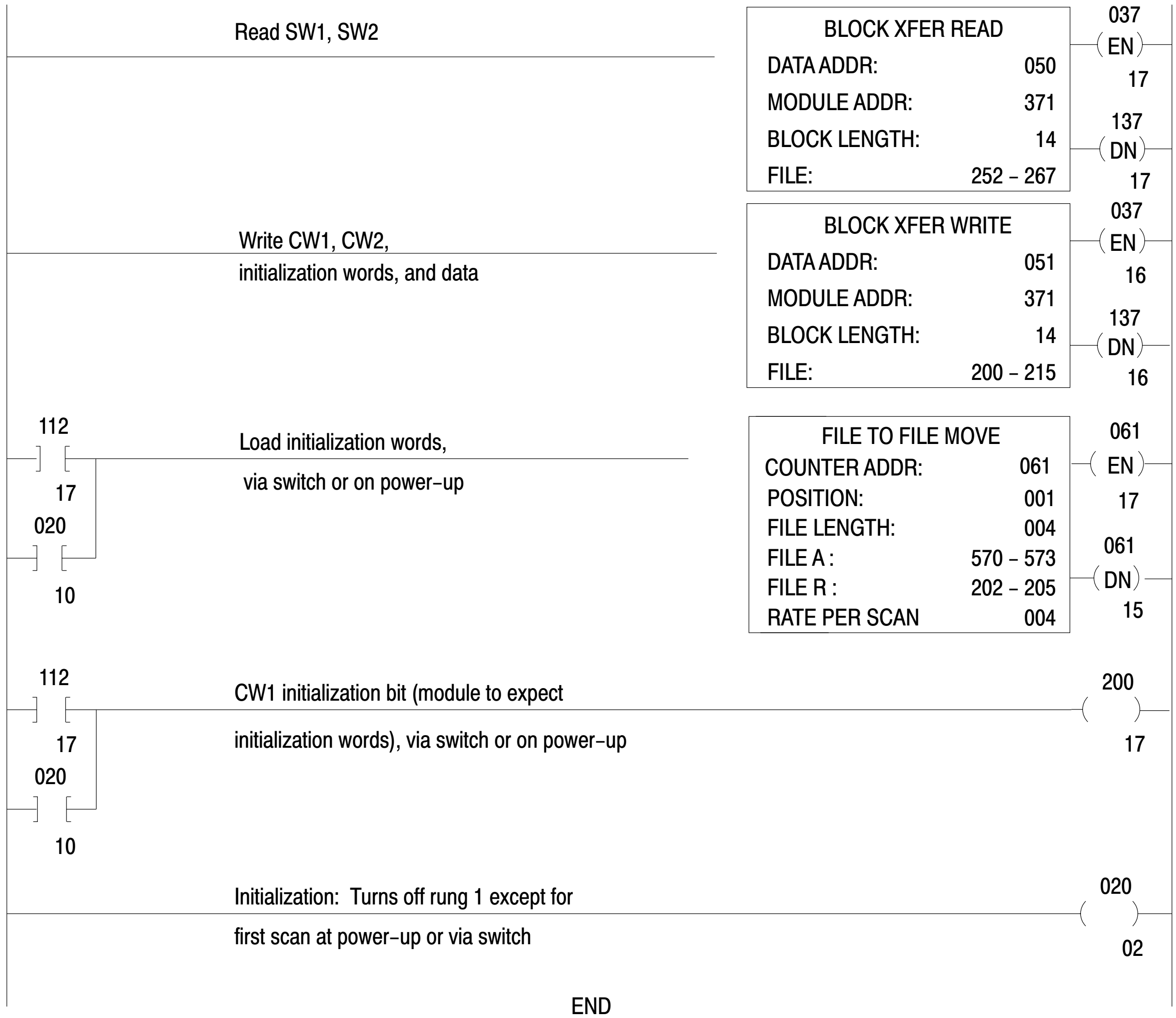
END

Example Write (Only) Program

A write (only) program for transferring data from your processor's data table to your ASCII device is presented with rung descriptions (Figure A.7).

Figure A.7
Example Write (Only) Program

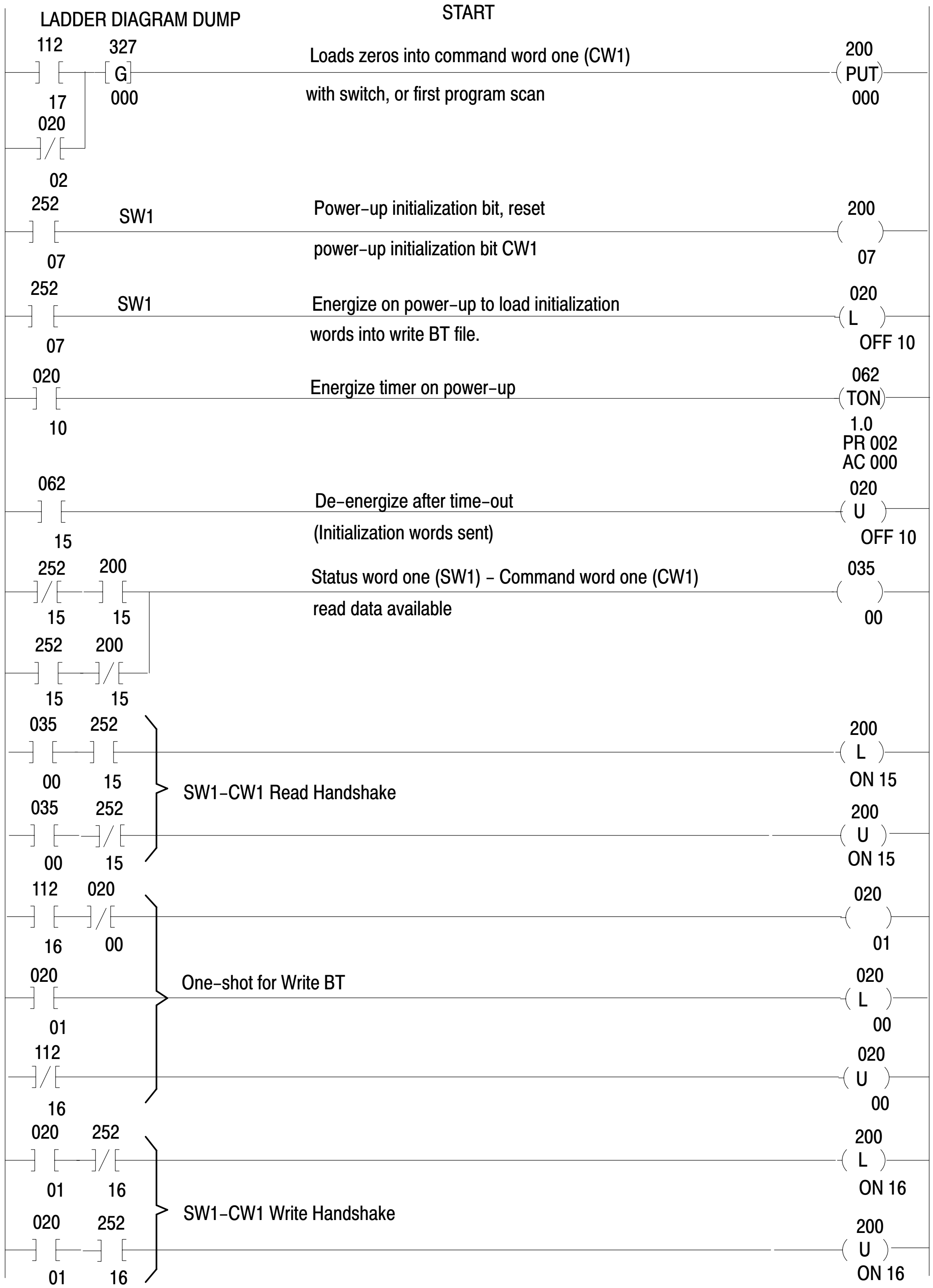


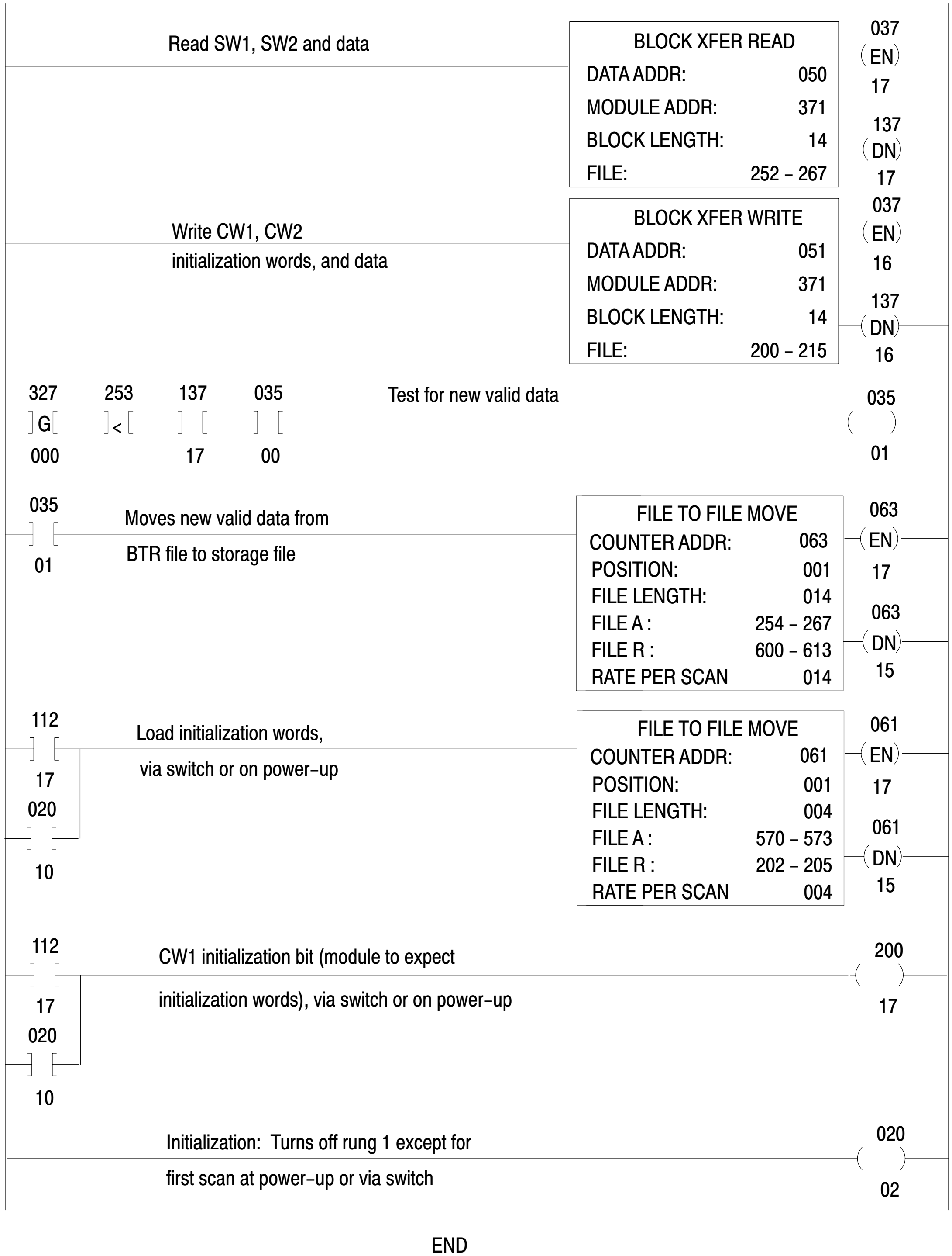


Example Read/Write Program

A read/write program that you can use to transfer data to and/or from your ASCII device is presented with rung descriptions (Figure A.8).

Figure A.8
Example Read/Write Program




Read SW1, SW2 and data
BLOCK XFER READ
DATA ADDR: 050
MODULE ADDR: 371
BLOCK LENGTH: 14
FILE: 252 – 267
037 EN 17
137 DN 17
Write CW1, CW2
initialization words, and data
BLOCK XFER WRITE
DATA ADDR: 051
MODULE ADDR: 371
BLOCK LENGTH: 14
FILE: 200 – 215
037 EN 16
137 DN 16
327 G 000
253 <
137 17
035 00
Test for new valid data
035 01
035 01
Moves new valid data from
BTR file to storage file
FILE TO FILE MOVE
COUNTER ADDR: 063
POSITION: 001
FILE LENGTH: 014
FILE A : 254 – 267
FILE R : 600 – 613
RATE PER SCAN 014
063 EN 17
063 DN 15
112 17
020 10
Load initialization words,
via switch or on power-up
FILE TO FILE MOVE
COUNTER ADDR: 061
POSITION: 001
FILE LENGTH: 004
FILE A : 570 – 573
FILE R : 202 – 205
RATE PER SCAN 004
061 EN 17
061 DN 15
112 17
020 10
CW1 initialization bit (module to expect
initialization words), via switch or on power-up
200 17
Initialization: Turns off rung 1 except for
first scan at power-up or via switch
020 02
END

Example Application Write Program

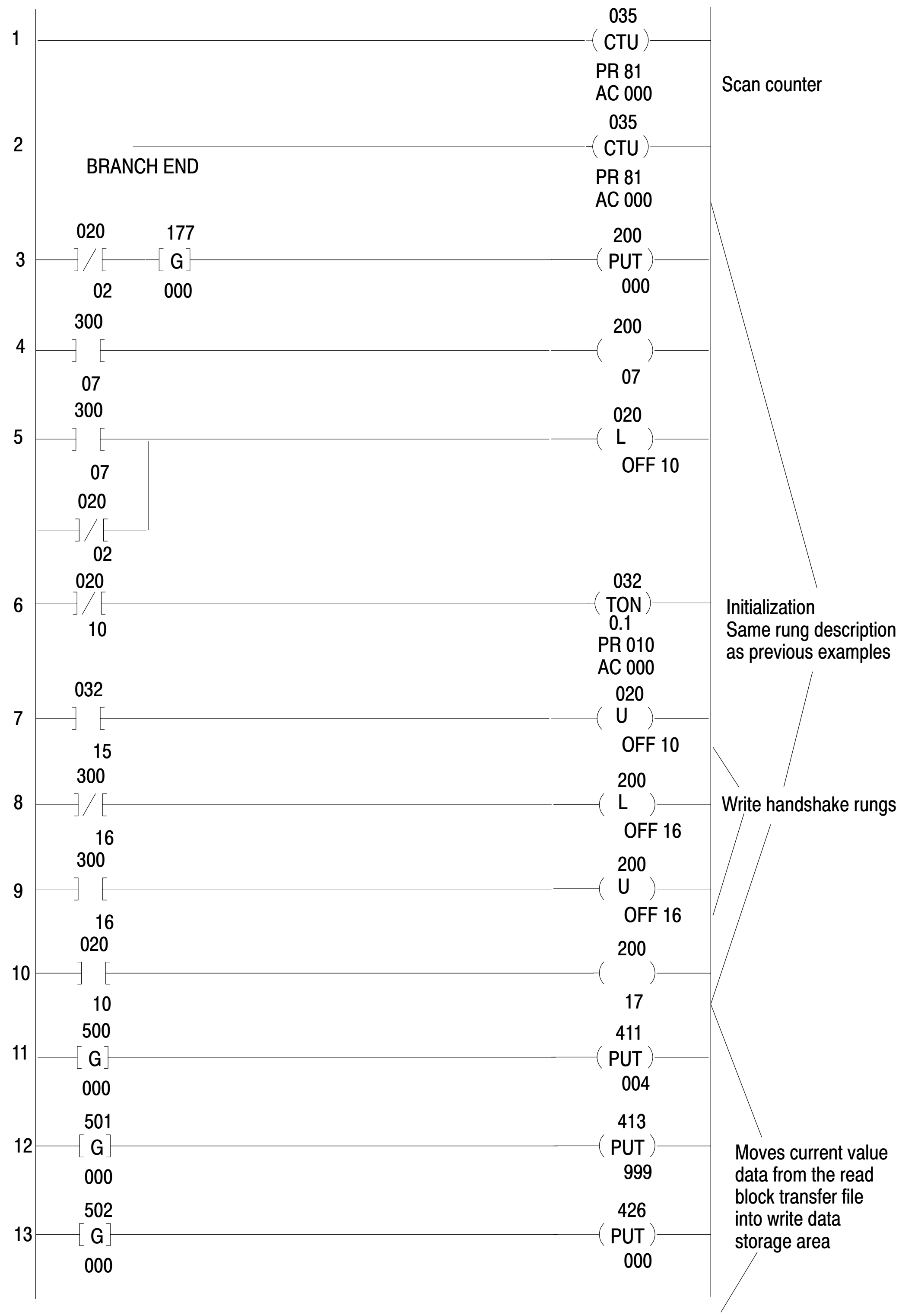
Use this application write program (Figure A.9) to display messages containing current values from an intelligent I/O module.

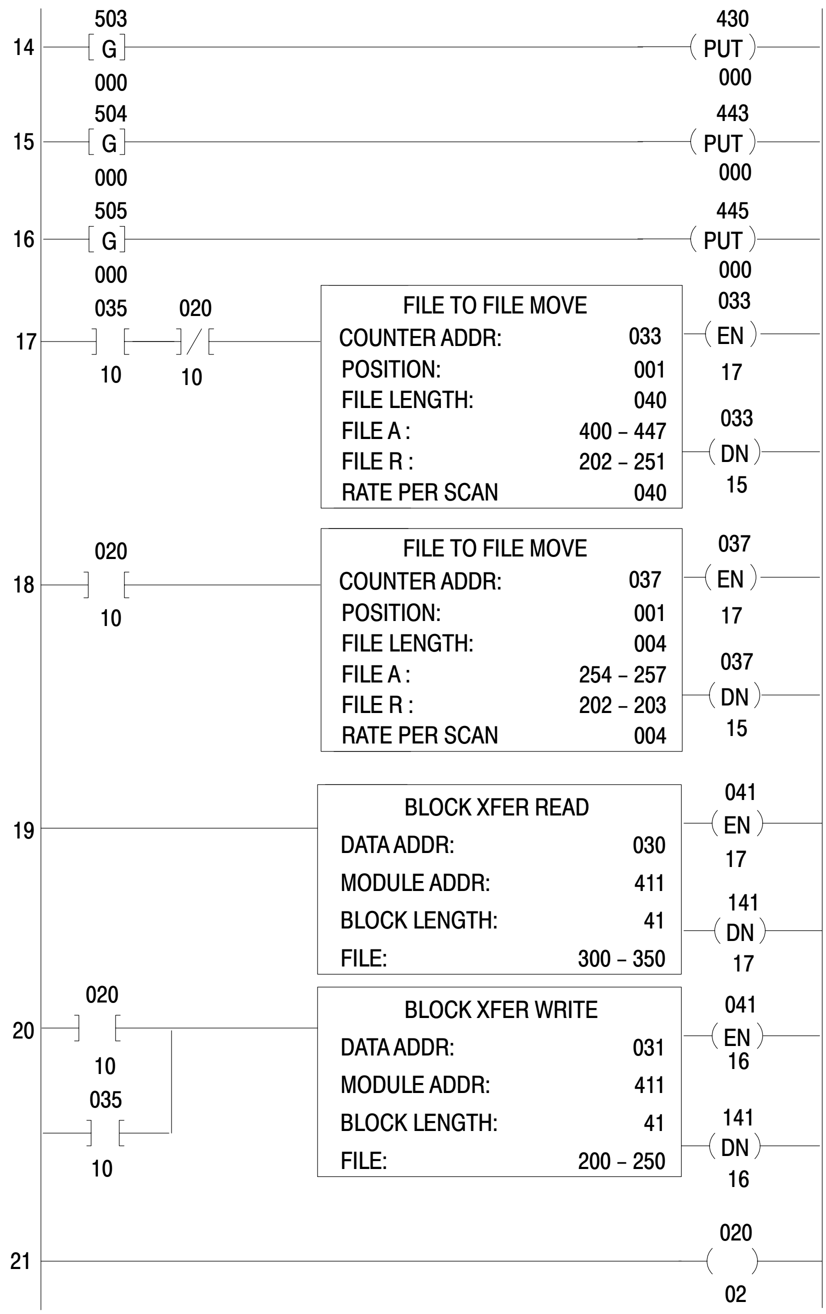
The processor stores current values in a file, 500-505. The source of the file could be read block transfers from an intelligent I/O module. The processor writes messages to the ASCII module for display on an industrial terminal using storage file 400-47, and write block transfer file 200-250. The storage file contains words for positioning current value data on the screen, and words which store ASCII characters of your message. The program moves current values, words 500 thru 505, into appropriate locations in the storage file. The scan counter controls the frequency at which write block transfers update the display.

If you want to demonstrate the use of this program to display messages, load data into storage file 400 (Table A.A). In this example, the message contains an 8-digit position number for each of three axes. Enter ASCII characters of your message, message positioning codes, and example 8-digit position numbers for each axis. Load initialization data into file 200 (Table A.B). Refer to section titled "Formatting a Multi-Line Message" (P. 3-24), for an explanation of data in the storage file.

This program will display current values if you add the source of current data. This could be a read block transfer instruction that transfers current value data from an intelligent I/O module into words 500 thru 505. Or, it could be a file move instruction that moves current values into words 500 thru 505 from elsewhere in the data table.

Figure A.9
Example Application Program





Moves updated current value data into write block transfer area once ever 100 program scans

Loads initialization words into write file.

ASCII block transfer rungs. Read occur unconditionally. Writes occur periodically, once every 100 scans after power–up.

Table A.A
Example Message Storage (File 400)

ADDR	CONTENTS			
400	1033			1033
1	303B	COLUMN 30, ROW 07	**NOTE:** This could be	303B
2	3037			3741
3	4100		instead of 4 words as shown.	
404	4185			
5	4953	AXIS 1 =		
6	2031			
7	203D			
10	203A			
411	(1234)	1234 5678*		
12	3A3A			
13	(5678)			
14	3A00			
415	1033			
16	303B	COLUMN 30, ROW 10		
17	3130			
20	4100			
421	4185			
22	4953	AXIS 2 =2032		
24	203D			
25	203A			
426	(ABCD)	ABCD 4321*		
27	3A3A			
30	(4321)			
31	3A00			
432	1033			
33	303B	COLUMN 30, ROW 13		
34	3133			
35	4100			
436	4158			
37	4953			
40	2033	AXIS 3 =		
41	203D			
42	203A			
443	(FACE)	FACE BAC2*		
44	3A3A			
45	(BAC2)			
56	3A0D			

*Message variable

Table A.B
Example Initialization Words (File 200) for Industrial Terminal

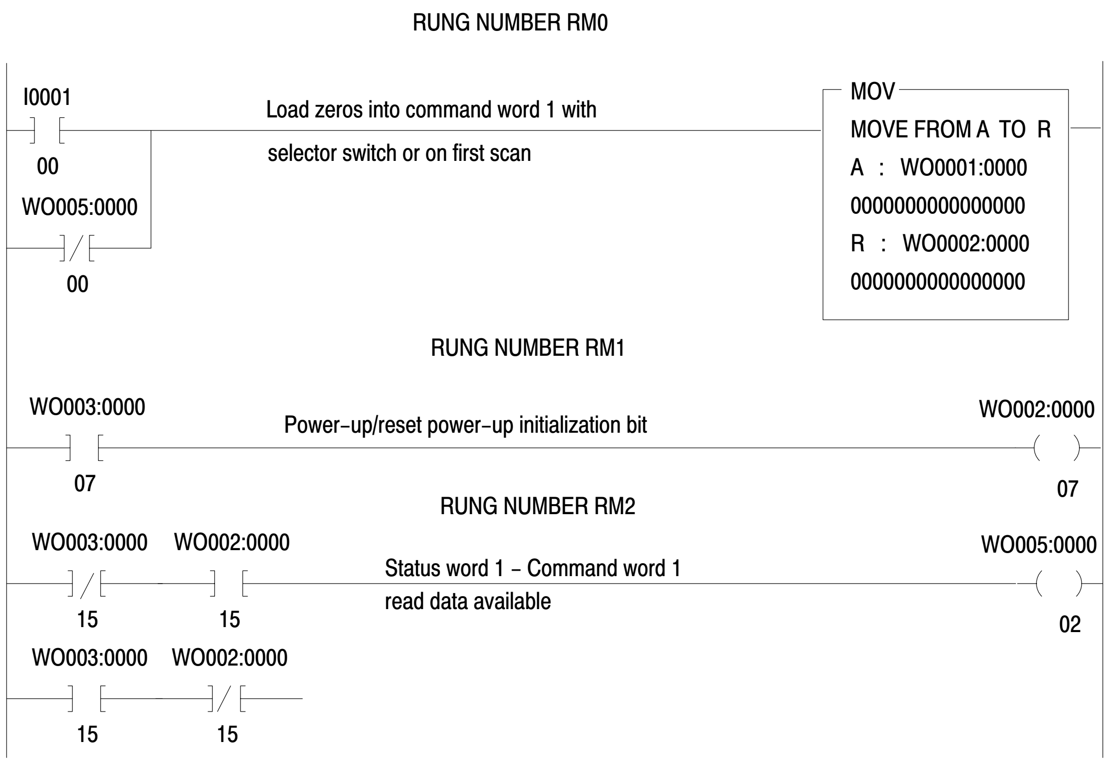
ADDR	Contents
254	0507
255	2000
256	0D04
257	3A00

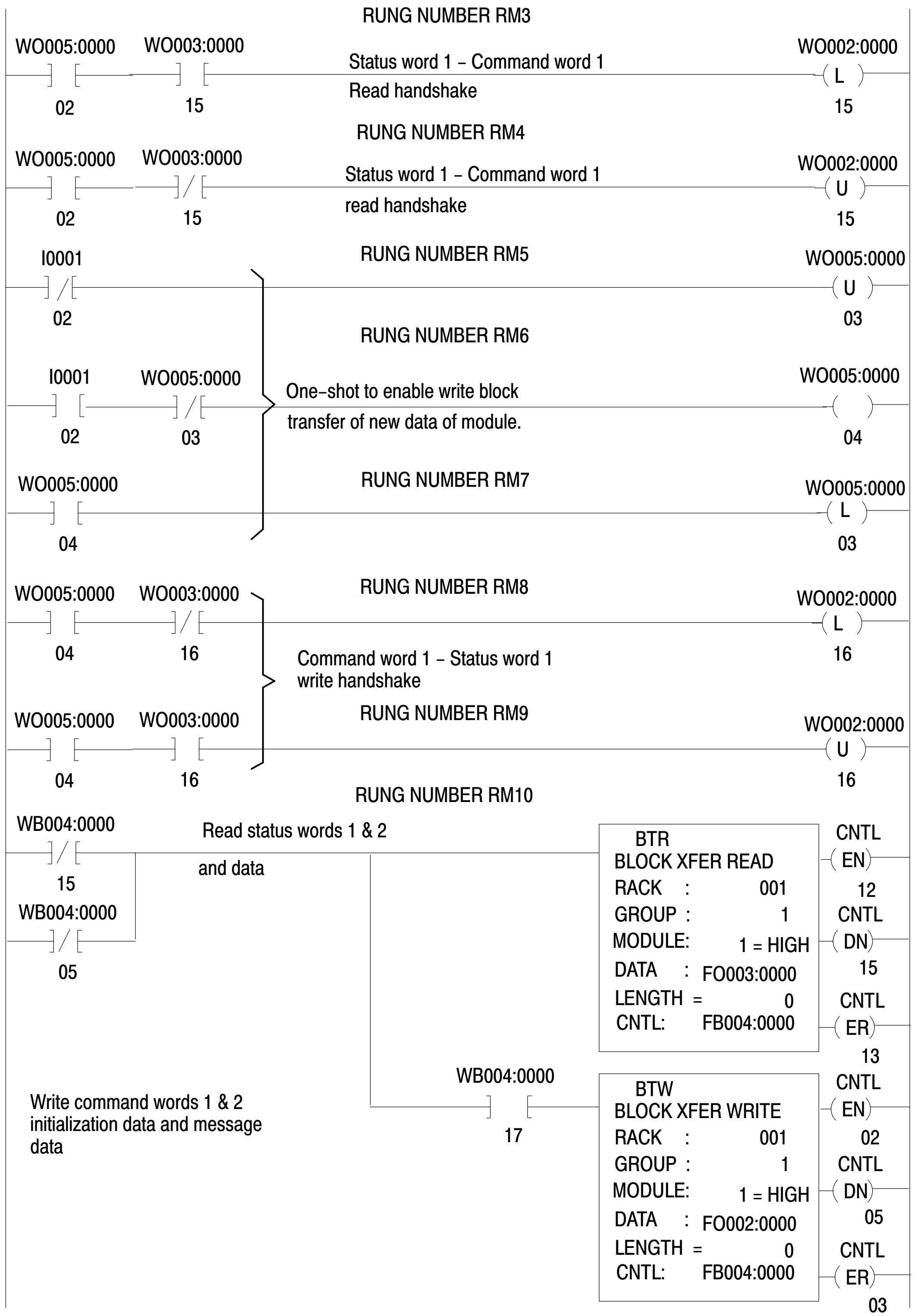
For PLC-3 Family Processor

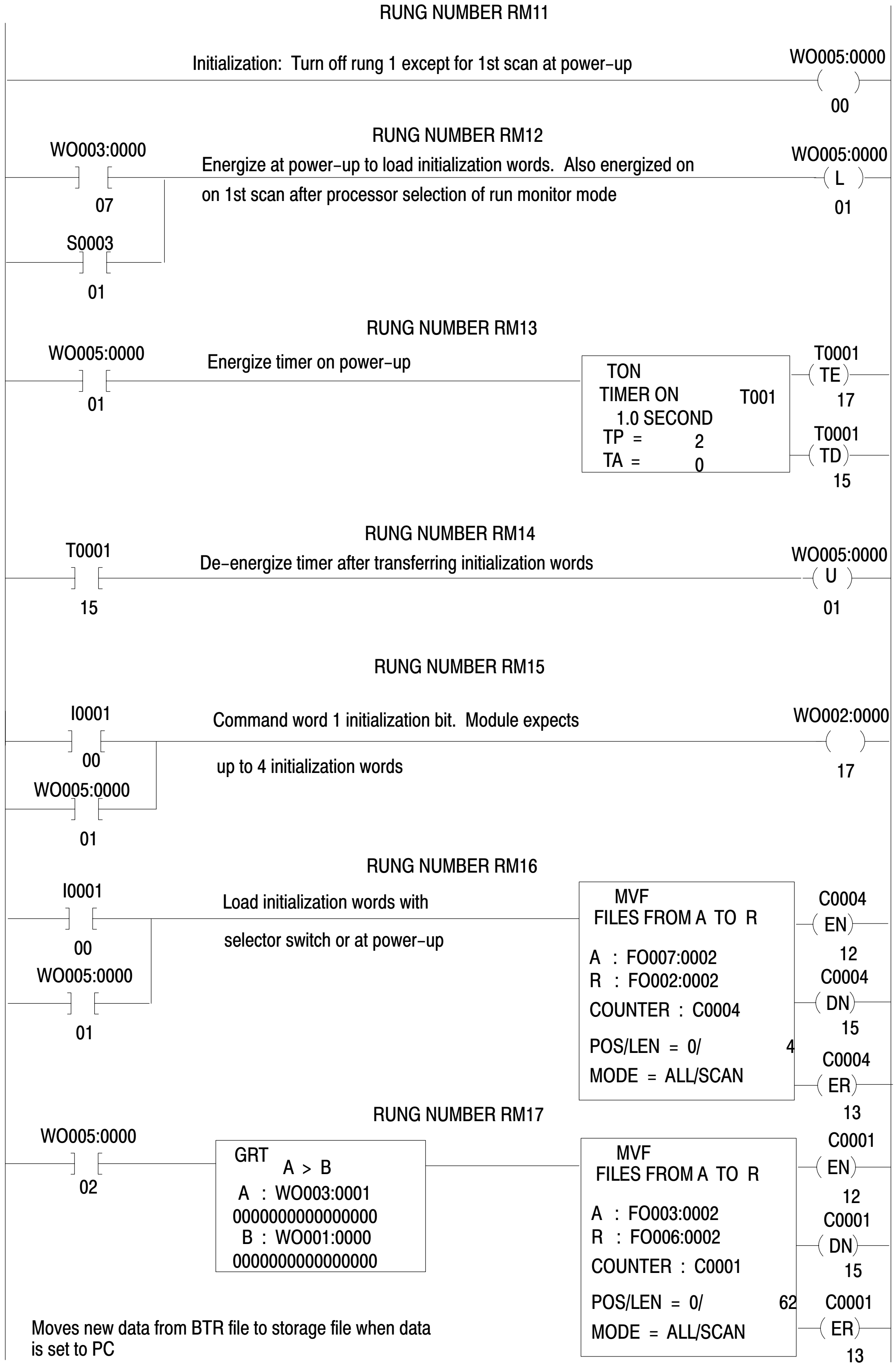
Complete Getting Started Program, PLC-3

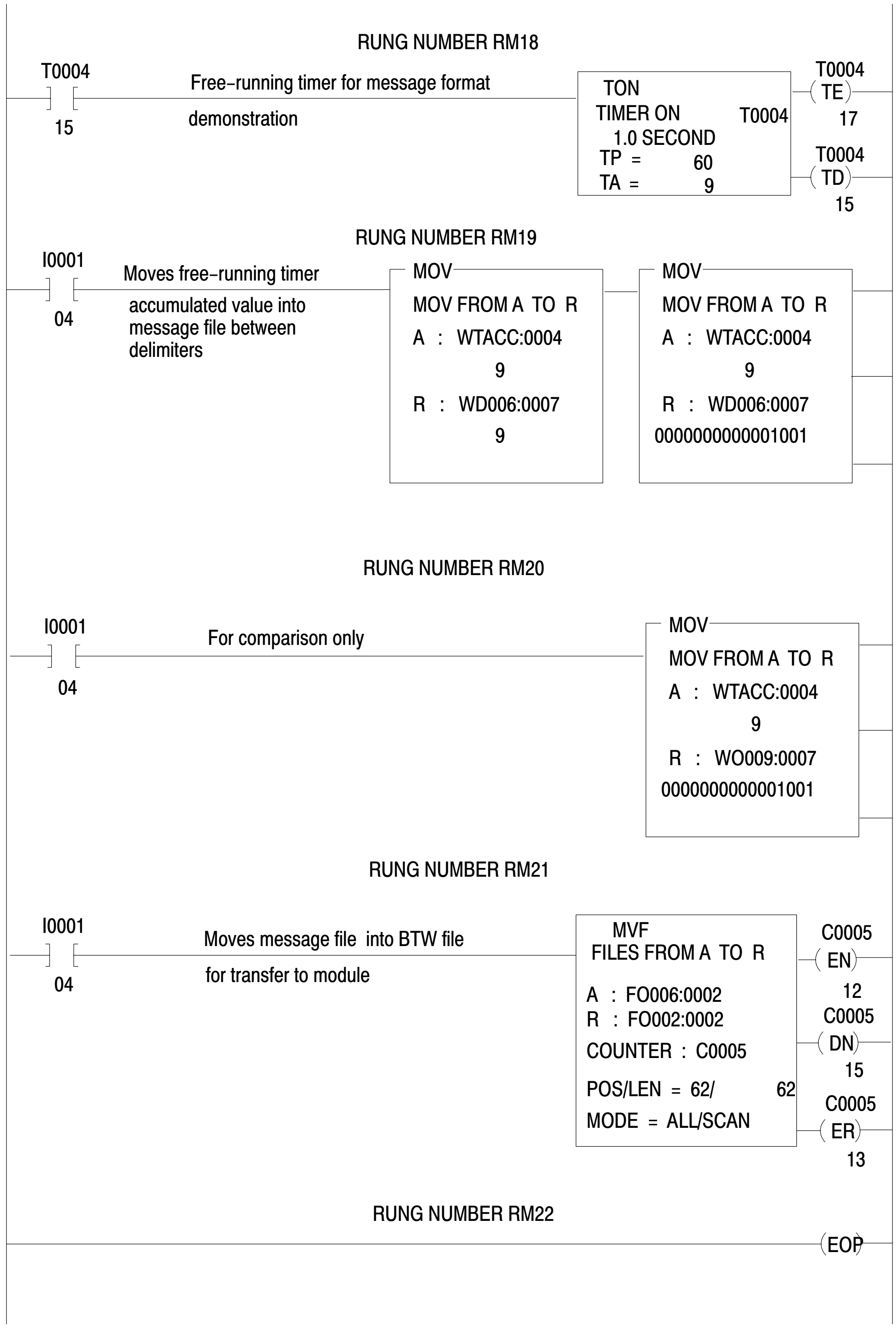
The complete Getting Started Program with rung descriptions is described in Figure B.1.

Figure A.10
Getting Started Program (PLC-3)




RUNG NUMBER RM3
WO005:0000
02
WO003:0000
15
Status word 1 – Command word 1
Read handshake
WO002:0000
L
15
RUNG NUMBER RM4
WO005:0000
02
WO003:0000
15
Status word 1 – Command word 1
read handshake
WO002:0000
U
15
RUNG NUMBER RM5
I0001
02
WO005:0000
U
03
RUNG NUMBER RM6
I0001
02
WO005:0000
03
One-shot to enable write block
transfer of new data of module.
WO005:0000
04
RUNG NUMBER RM7
WO005:0000
04
WO005:0000
L
03
RUNG NUMBER RM8
WO005:0000
04
WO003:0000
16
WO002:0000
L
16
Command word 1 – Status word 1
write handshake
RUNG NUMBER RM9
WO005:0000
04
WO003:0000
16
WO002:0000
U
16
RUNG NUMBER RM10
WB004:0000
15
WB004:0000
05
Read status words 1 & 2
and data
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03


RUNG NUMBER RM11
Initialization: Turn off rung 1 except for 1st scan at power–up
WO005:0000
00
RUNG NUMBER RM12
WO003:0000
07
S0003
01
Energize at power–up to load initialization words. Also energized on
on 1st scan after processor selection of run monitor mode
WO005:0000
L
01
RUNG NUMBER RM13
WO005:0000
01
Energize timer on power–up
TON
TIMER ON
T001
1.0 SECOND
TP = 2
TA = 0
T0001
TE
17
T0001
TD
15
RUNG NUMBER RM14
T0001
15
De–energize timer after transferring initialization words
WO005:0000
U
01
RUNG NUMBER RM15
I0001
00
WO005:0000
01
Command word 1 initialization bit. Module expects
up to 4 initialization words
WO002:0000
17
RUNG NUMBER RM16
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power–up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM17
WO005:0000
02
GRT
A > B
A : WO003:0001
0000000000000000
B : WO001:0000
0000000000000000
MVF
FILES FROM A TO R
A : FO003:0002
R : FO006:0002
COUNTER : C0001
POS/LEN = 0/ 62
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER
13
Moves new data from BTR file to storage file when data
is set to PC


RUNG NUMBER RM18
T0004
15
Free-running timer for message format
demonstration
TON
TIMER ON
T0004
1.0 SECOND
TP = 60
TA = 9
T0004
TE
17
T0004
TD
15
RUNG NUMBER RM19
I0001
04
Moves free-running timer
accumulated value into
message file between
delimiters
MOV
MOV FROM A TO R
A : WTACC:0004
9
R : WD006:0007
9
MOV
MOV FROM A TO R
A : WTACC:0004
9
R : WD006:0007
0000000000001001
RUNG NUMBER RM20
I0001
04
For comparison only
MOV
MOV FROM A TO R
A : WTACC:0004
9
R : WO009:0007
0000000000001001
RUNG NUMBER RM21
I0001
04
Moves message file into BTW file
for transfer to module
MVF
FILES FROM A TO R
A : FO006:0002
R : FO002:0002
COUNTER : C0005
POS/LEN = 62/ 62
MODE = ALL/SCAN
C0005
EN
12
C0005
DN
15
C0005
ER
13
RUNG NUMBER RM22
EOP

Block Transfer Programming

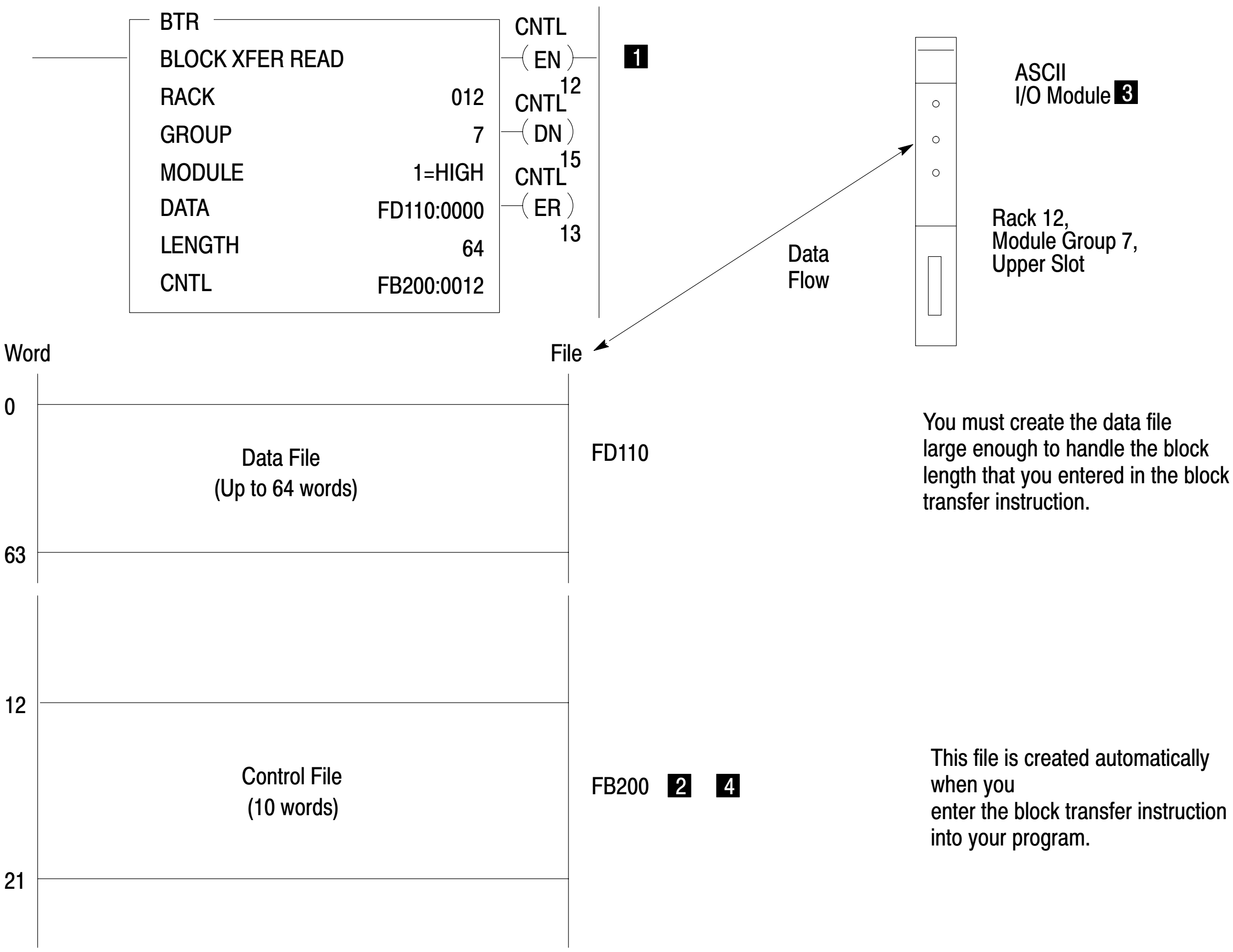
Overview

Block transfer is the method by which the PLC–3 processor communicates with the ASCII module. The PLC–3 controller can perform read, write, and bidirectional block transfer operations. During a block transfer read, data is read from the I/O module and is transferred to PLC–3 controller memory. During a block transfer write, data is transferred from memory and is written to the I/O module. Bidirectional block transfer requires both read and write operations. Each operation can transfer a maximum of 64 words.

Block Transfer Operation

Block transfer instructions use two files when transferring data and commands between the block transfer module and the PLC–3 processor: a data file that contains data to be transferred, and a control file that contains control bits, module location, data table address and length of the data file (Figure A.11). Communication between module and processor is directed by the 1775–S4A scanner. Once the instruction is enabled, the scanner directs the transfer of data to or from the enabled block transfer module according to the information contained in the instruction's control file. Once the instruction is enabled, it automatically sets and resets its control bits in accordance with the various steps required to execute the read or write operation.

Figure A.11
Example Block Transfer Operation



1 Block Transfer instruction goes true.

2 Appropriate status bits are set/reset, and the control file tells the I/O scanner module the address of the data file.

3 Data from the block transfer I/O module is transferred to the block transfer data file in the processor data table.

4 Upon completion of the block transfer, the appropriate status bits are set/reset.

NOTE: The direction of data flow is reversed for a write block transfer operation.

Block Transfer with the ASCII Module

Your ladder program must contain read and write handshake logic. This logic is separate from block transfer routines that use enable and done bits of block transfer instructions. Handshake logic uses control and status bits of the ASCII module.

Execution Time

The time required to complete a read or write block transfer depends on factors that include the number of:

- words of user program
- active I/O channels on the scanner
- I/O chassis entries in the rack list for the channel
- I/O channels on the scanner that contain block transfer modules
- block transfer modules on the channel (if the I/O chassis containing a block transfer module appears more than once in the I/O chassis rack list, count the module once each time the chassis appears in the rack list)

Typical time required to complete a read or write block transfer depends on the program scan and the scanner scan as follows:

Time (read or write)= Program scan + 2[Scanner scan]

Program Scan

The program scan is approximately 2.5ms per 1K words of user program when using a mix of examine on/off and block instructions.

Scanner Scan

The time required for the scanner to complete a read or write block transfer depends on the number of other block transfer modules on the same scanner channel that are enabled simultaneously. Use the following procedure to calculate the time required for the PLC–3 processor to perform all block transfers on the channel.

1. Determine the number of active I/O channels on the scanner.

2. Determine the number of I/O channels with block transfer modules.

3. Use this table to determine the nominal block transfer time using the numbers from steps 1 and 2.

Channels with Block Transfer Modules	1 Active Channel	2 Active Channels	3 Active Channels	4 Active Channels
1	40	52	54	58
2	–	67	68	76
3	–	–	98	99
4	–	–	–	123

Block transfer times typically are similar regardless of the type of block transfer module or the number of words transferred. Nominal read block transfer times typically are faster than nominal write block transfer times by approximately 10ms. In this example, consider them the same.

4. Count the number of block transfer modules on the channel. If a chassis containing block transfer modules is repeated in the rack list, count chassis and modules as often as listed.

5. Count the number of I/O chassis entries in the rack list for the channel.

6. Calculate the block transfer time for the scanner as follows:

$$\text{Scanner Time} = \left[\text{Nominal Time} \times \text{\# BT modules on the channel}\right] + \left[\text{\#I/O chassis in rack list} - 1\right] \text{X 9ms}$$

PLC–3 Example Computation

As an example, we will compute the read or write block transfer time between the supervisory processor and an ASCII module in an I/O channel with no other block transfer modules, and in an I/O channel with two other block transfer modules in the following system:

- User program contains 20K words
- Channel 1 contains four I/O chassis, with a total of three block transfer modules including one ASCII module
- Channel 2 contains two I/O chassis with no block transfer modules
- Channel 3 contains two I/O chassis with one ACII module
- Channel 4 is made inactive through processor LIST

You can compute the read or write block transfer times for the supervisory processor in this example in four steps. Each of the following steps is explained by an accompanying figure.

1. Diagram the I/O channels of your PC system (Figure B.3), showing the number of:

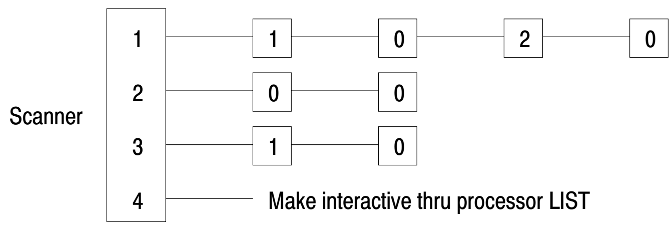
- block transfer modules in each I/O chassis
- block transfer I/O channels
- I/O chassis entries in the rack list for each block transfer I/O channel
- active I/O channels per scanner

A block transfer I/O channel is a channel that contains one or more block transfer modules located in any chassis connected to the channel.

An I/O chassis can appear more than once in a rack list of I/O chassis. Count it and the block transfer module(s) that it contains as often as it is listed.

Figure A.12
Diagramming I/O Channels

Step 1 – Diagram the chassis connected in series to each channel (up to four) of your scanner module. Then, fill in the information called for below. Example values have been added.



☐ = I/O Chassis
n= number of block–transfer modules in chassis

Description	Number	Ch 1	Ch 2	Ch 3	Ch 4
Active I/O channels	3				
Block Transfer I/O channels	2				
Block Transfer modules on each I/O block transfer channel		3	0	1	0
I/O chassis on each block–transfer I/O channel (I/O chassis in rack list)		4	0	2	0

12828

2. Using information from the diagram of I/O channels (Figure A.12), look up the nominal time from the table in Figure A.13.

Figure A.13
Nominal Time Table

Step 2 –Determine a time from the table. Example values have been added.

		Number of Active I/O Channels			
		1	**2**	**3**	**4**
Active I/O channels containing one or more block transfer modules	**1**	40	52	54	58
	2		67	68	76
	3			98	99
	4				123
		Time (ms)			

Number of active I/O channels: 3

Number of active I/O channels containing one or more block transfer module: 2

Time, from table: 68ms

12829

3. Compute the approximate transfer time for each block transfer I/O channel. Use values from your channel diagram (Figure A.12), a value from the table (Figure A.13), and the formula from step 6 above. We make these calculations for you in Figure A.14.

Figure A.14
Computing Channel Times

Step 3 – Compute the scanner time for each block transfer channel. Example values have been added.

CT = Channel Time

CT = [Nominal Time x #BT modules on BT channel] + [#I/O chassis on BT channel –1] X 9

CT1 = [68ms] x [3] + [4–1] x 9ms
204ms + 3 x 9ms
231ms

CT2 = Not a block transfer channel

CT3 = [68ms] x [1] + [2–1} x 9ms
68ms + 9ms
77ms

CT4 = Not an active channel

4. Compute the approximate read or write block transfer time for channel 1 and channel 3 (Figure A.15).

Figure A.15
Computing Block Transfer for Each Channel

Step 4 Compute the read or write block transfer time. Example values have been added.

Program Scan

Time (program) = 2.5ms/K words x 20K words
= 2.5ms x 20
= 50ms

Scanner Scan

Time (read or write) = 231ms for channel 1 and
77ms for channel 3 (from step 3)

Block Transfer Timer per Channel

Channel 1 = Program Scan + 2[Scanner Scan]
50ms + 2[231ms]
50ms + 462ms
512ms

Channel 3 = Program Scan + 2[Scanner Scan]
50ms + 2[77ms]
50ms + 154ms
204ms

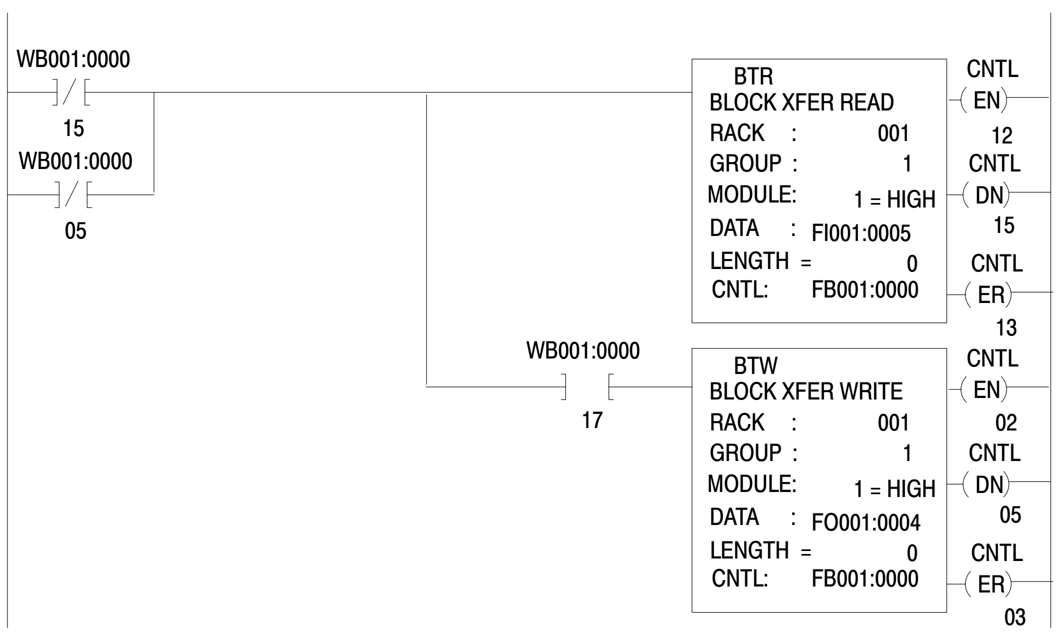
Reducing Scan Time

Due to the asychronous scan relationship between program and scanner, and the serial operation of each channel in the scanner, we suggest that you optimize the overall scan time. Although recommendations are application dependent, we make the following recommendations as general guidelines:

- Whenever possible, control the manner in which block transfer instructions are enabled. For example, if only a few block transfer modules require frequent transfer of data, program them to run continually. Inhibit block transfer instructions of those modules that require less frequent transfer until enabled by a timer and/or some application dependent condition.

- Program the read and write block transfer instructions of your ASCII module in the same rung (Figure A.16).
- Distribute your block transfer modules equally between all four scanner channels.
- Distribute block transfer instructions equally throughout your program. Place an equal number of non–block transfer rungs between block transfer rungs.
- For large numbers of block transfer instructions, distribute groups of block transfer rungs equally throughout your program. Place no more than four block transfer rungs consecutively in one group. Within each group, condition the next rung using the done bit of the previous block transfer instruction.
- Consider an additional I/O scanner module (cat. no. 1775–S4A) if you cannot otherwise reduce the block transfer times to meet your timing requirements.
- During a write handshake, the processor also can transfer write data to the ASCII module; and during a read handshake, the processor also can transfer read data.

Figure A.16
Example Block Transfer Programming



Special Considerations

When using one 1775–S4A I/O scanner with thumbwheel switch set to 1, only part of its data handling capacity is available for handling block transfers. This scanner can store and transfer a maximum of 72 words at any one time, from up to four block transfer modules, across any of the active channels.

If a block transfer read instruction is enabled but the scanner's buffer cannot accept the instruction's block length (the scanner is processing other blocks of data), the block transfer instruction must wait for a subsequent scan when the scanner's buffer can accept all the words that the module has to transfer. The same applies for a write block transfer instruction. We suggest that you add an additional scanner if necessary.

Block Transfer Errors

Once enabled, a block transfer instruction in a PLC–3 ladder program will set either a done bit or an error bit. The instruction indicates an error when it illuminates the –(ER)– symbol. Typical block transfer errors occur when:

- You do not correctly enter the instruction
  - The rack, group, and module numbers do not match the location of the installed module
  - You entered a file length greater than 64
  - You did not create the data file, or the address that you entered does not match the file you created

Read and write error bits illuminate at the same time when the error source is the module address entry or the file length entry in the instruction block.

- You have a communication problem
- You did not correctly connect the twinaxial cable to the scanner
- You did not connect a terminator resistor to each end of the twinaxial cable

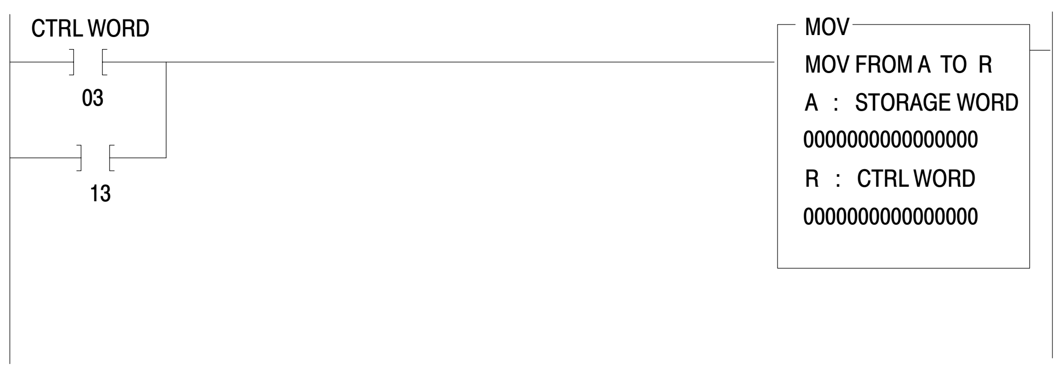
When the scanner encounters a communication fault, it tries twice to complete the transfer. It sets the error bit after the second unsuccessful try.

When the scanner encounters a communication fault, it tries twice to complete the transfer. It sets the error bit after the second unsuccessful try.

When the scanner and/or processor detects a block transfer error, the transfer is halted. Transfers from the module are prevented until:

- Your program clears the instruction's control word (clears the error, Figure A.17)
- You locate and correct the error

Figure A.17
Resetting the Control Word after a Block Transfer Error



Detecting Faults

Block transfer error detection and resulting processor shutdown are safety features of Allen–Bradley programmable controllers. We recommend that you adapt such safety features to your application. However, you may want your program to reset block transfer instructions whenever an error is detected. Block transfer errors can occur intermittently due to electrical noise in the environment, and may not be critical to system operation. This allows your system to continue operation, and allows you to observe the frequency and location of such errors.

The processor can record where faults are occurring in the I/O chassis, and the frequency of occurrence. To observe this information you must create the following files. Refer to section titled "Entering the Getting Started Program," step 7 (P. 1-26), for the procedure.

- I/O Adapter Status, Status file 2, S2:0

  This file records I/O faults occuring in each I/O chassis in your system. It identifies the location by rack number to within a quarter I/O rack (32 I/O points or four module slots). The file length is application dependent: one word for assigned rack numbers 0–3, two words for 0–7, three words for 0–11 and so forth. Each displayed bit represents a fault detected within the quarter rack. The display format is:

Bit Number			
17 – 13	**12 – 10**	**07 – 04**	**03 – 00**
rack 3 rack 7 :	rack 2 rack 6 :	rack 1 rack 5 :	rack 0 rack 4 :

For example, bit 00 indicates a fault at rack 0, first quarter chassis; bit 01 at rack 0, second quarter chassis, and so forth.

- Adapter Re–try, Status file, 3, S3:0

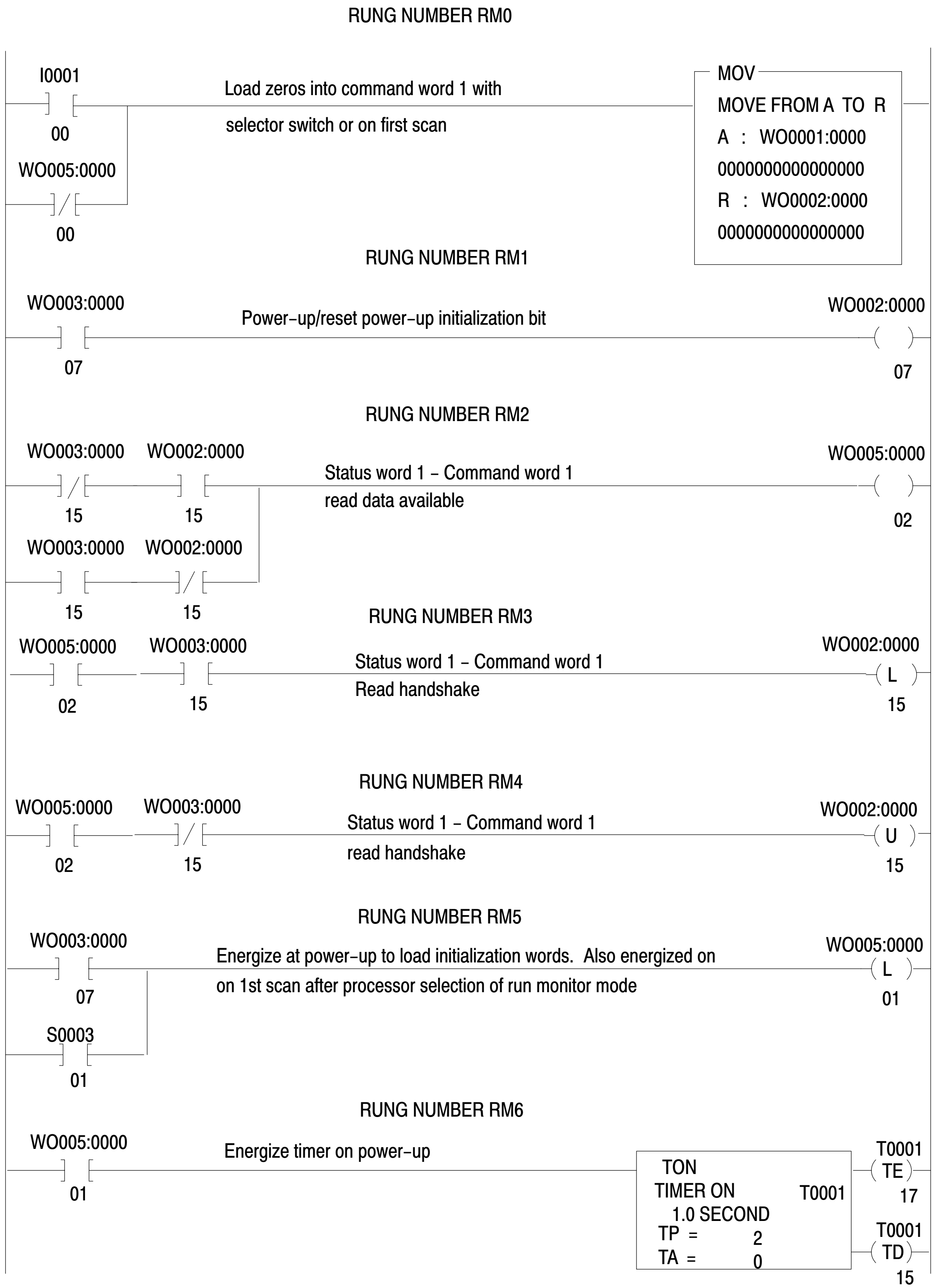
This file counts the number of transmissions attempted between the scanner and each I/O chassis in the system. The file records the re–tries occurring in each quarter rack. Frequent re–tries indicate I/O communication problems. The file length is application dependent, four words per assigned rack number. The display format is:

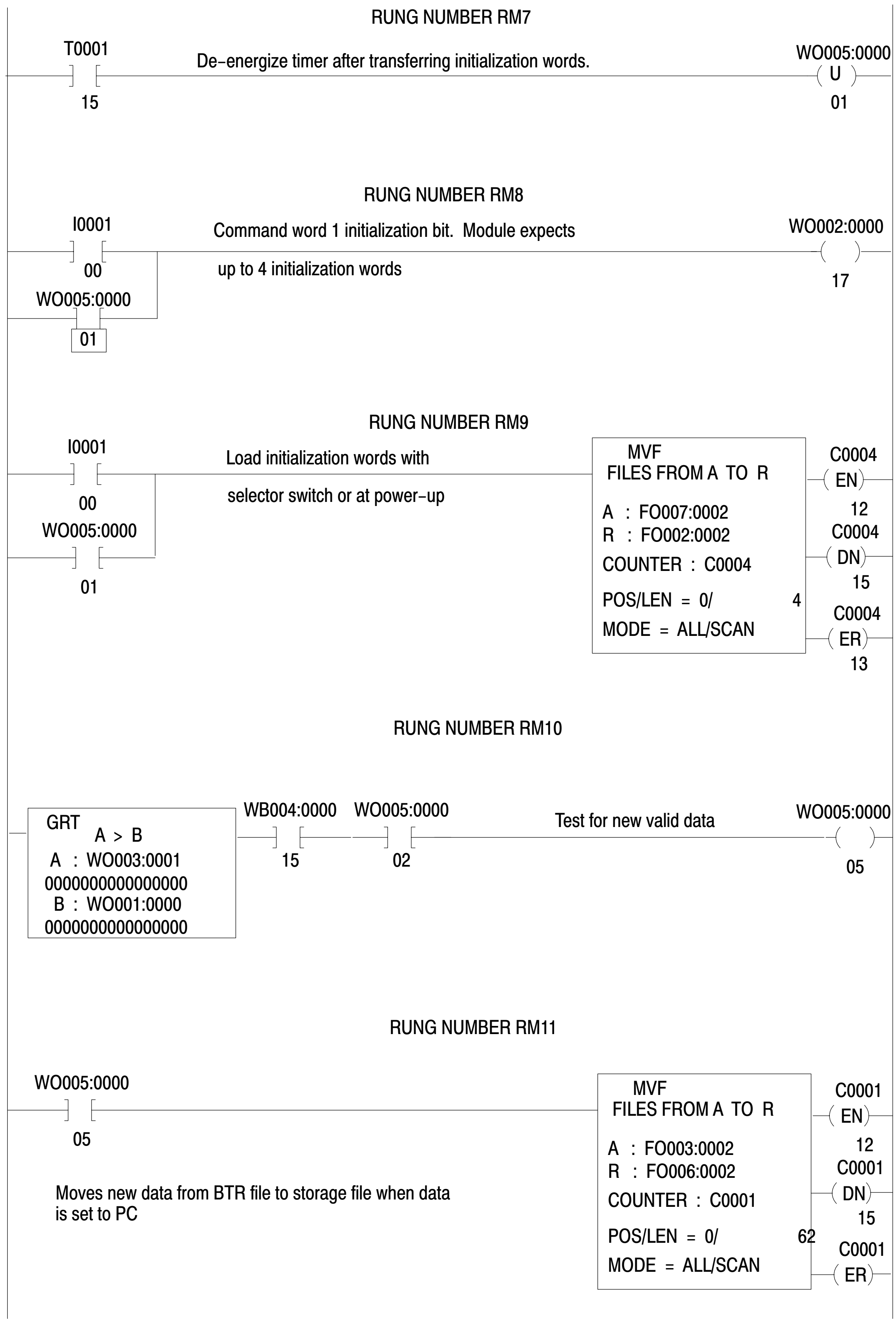
		Bit Number			
Word	**Rack**	**17 – 13**	**12 – 10**	**07 – 04**	**03 – 00**
0000	0	binary count, first quarter rack			
0001	0	binary count, second quarter–rack			
0002	0	binary count, third quarter–rack			
0003	0	binary count, fourth quarter–rack			
0004	1	binary count, first quarter–rack			
0005	1	binary count, second quarter–rack			
:	:	:			

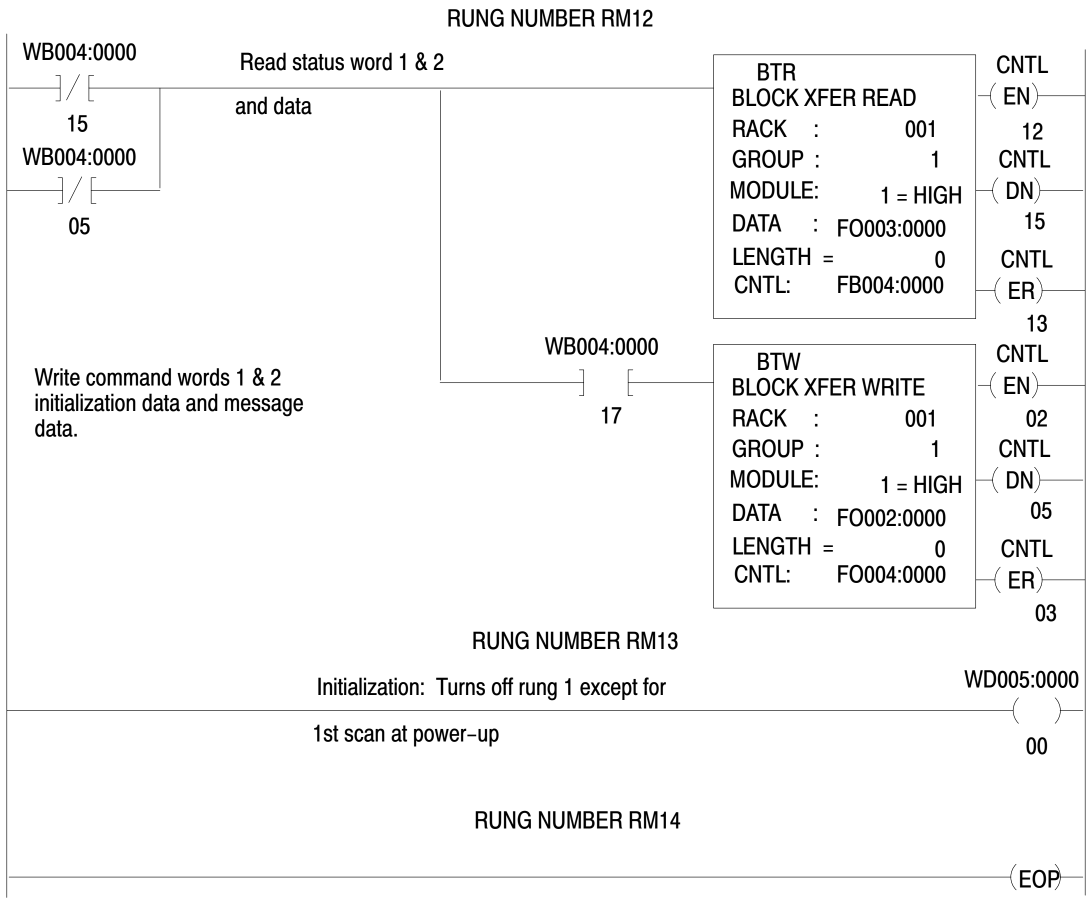
Example Read (Only) Program

A read (only) program for transferring data from your ASCII device into the data table of your processor is presented with rung descriptions in Figure A.18.

Figure A.18
Example Read (Only) Program



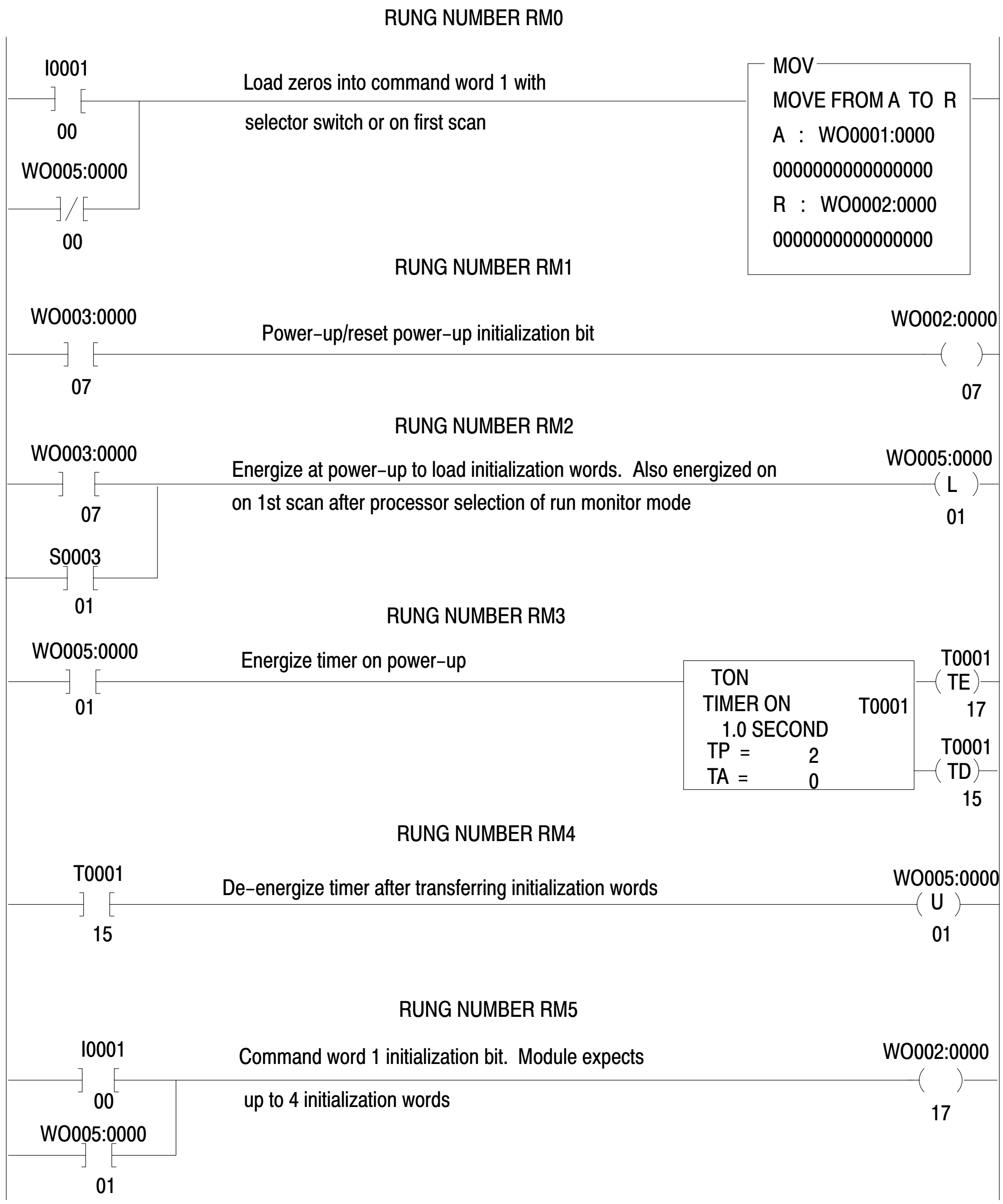

RUNG NUMBER RM7
T0001
15
De-energize timer after transferring initialization words.
WO005:0000
U
01
RUNG NUMBER RM8
I0001
00
WO005:0000
01
Command word 1 initialization bit. Module expects
up to 4 initialization words
WO002:0000
17
RUNG NUMBER RM9
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power-up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM10
GRT
A > B
A : WO003:0001
0000000000000000
B : WO001:0000
0000000000000000
WB004:0000
15
WO005:0000
02
Test for new valid data
WO005:0000
05
RUNG NUMBER RM11
WO005:0000
05
Moves new data from BTR file to storage file when data
is set to PC
MVF
FILES FROM A TO R
A : FO003:0002
R : FO006:0002
COUNTER : C0001
POS/LEN = 0/ 62
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER

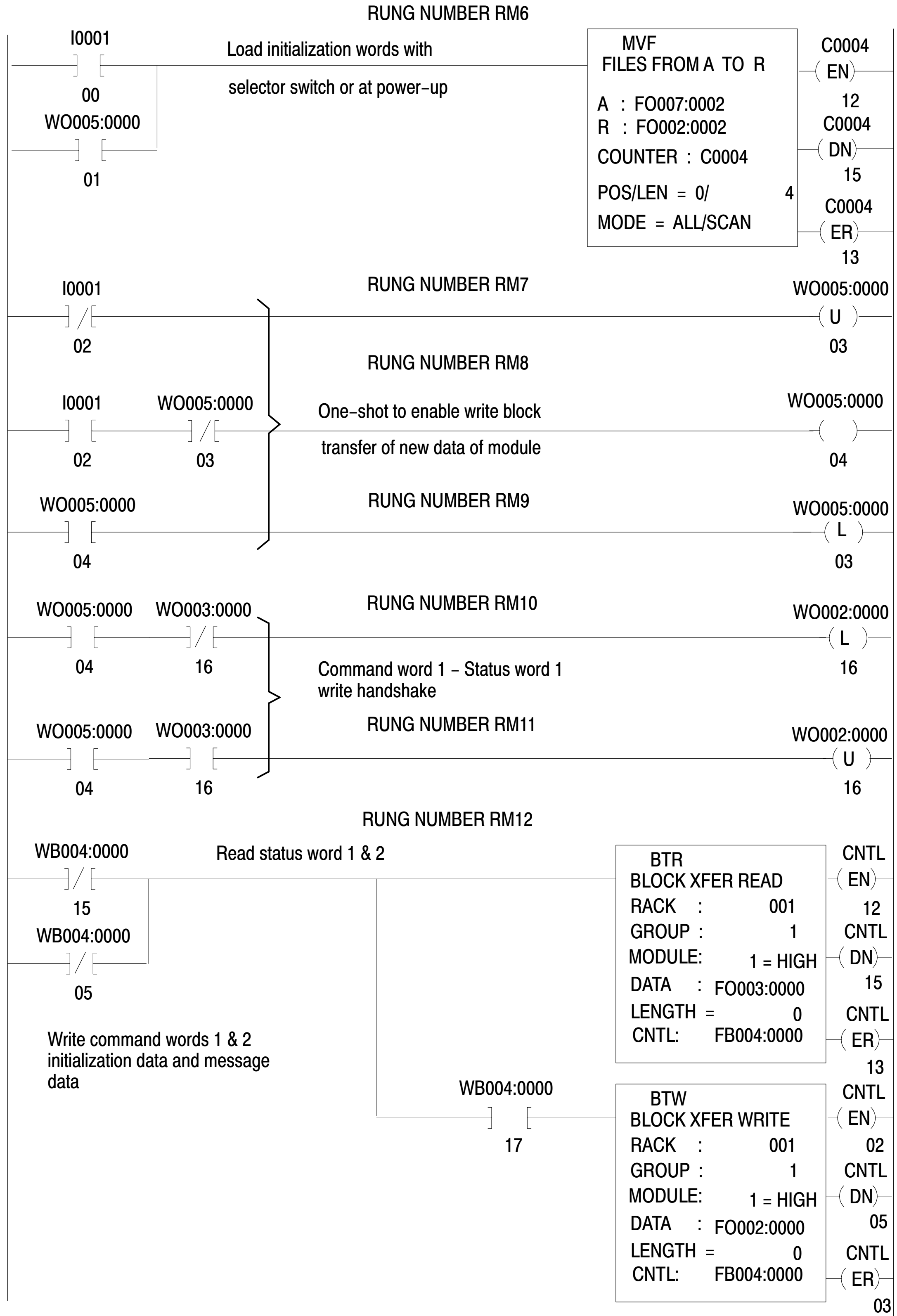

RUNG NUMBER RM12
WB004:0000
15
WB004:0000
05
Read status word 1 & 2
and data
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data.
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FO004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03
RUNG NUMBER RM13
Initialization: Turns off rung 1 except for
1st scan at power-up
WD005:0000
00
RUNG NUMBER RM14
EOP

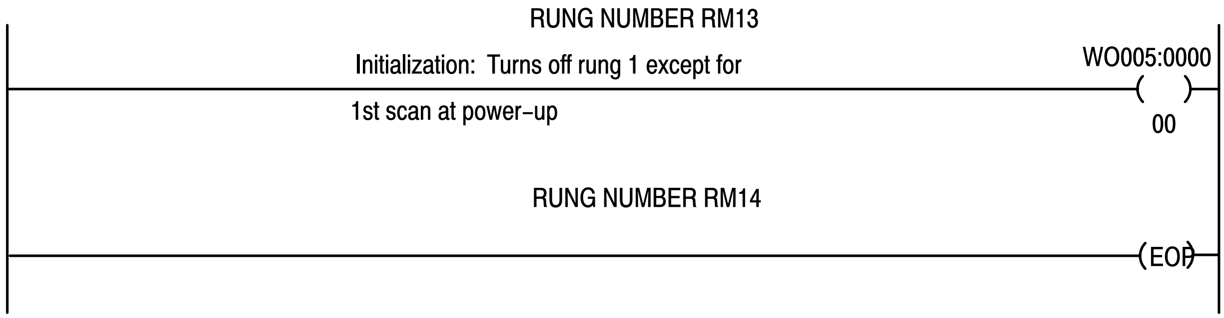
Example Write (Only) Program

A write (only) program for transferring data from your processor's data table to your ASCII device is presented with rung descriptions in Figure A.19.

Figure A.19
Example Write (Only) Program



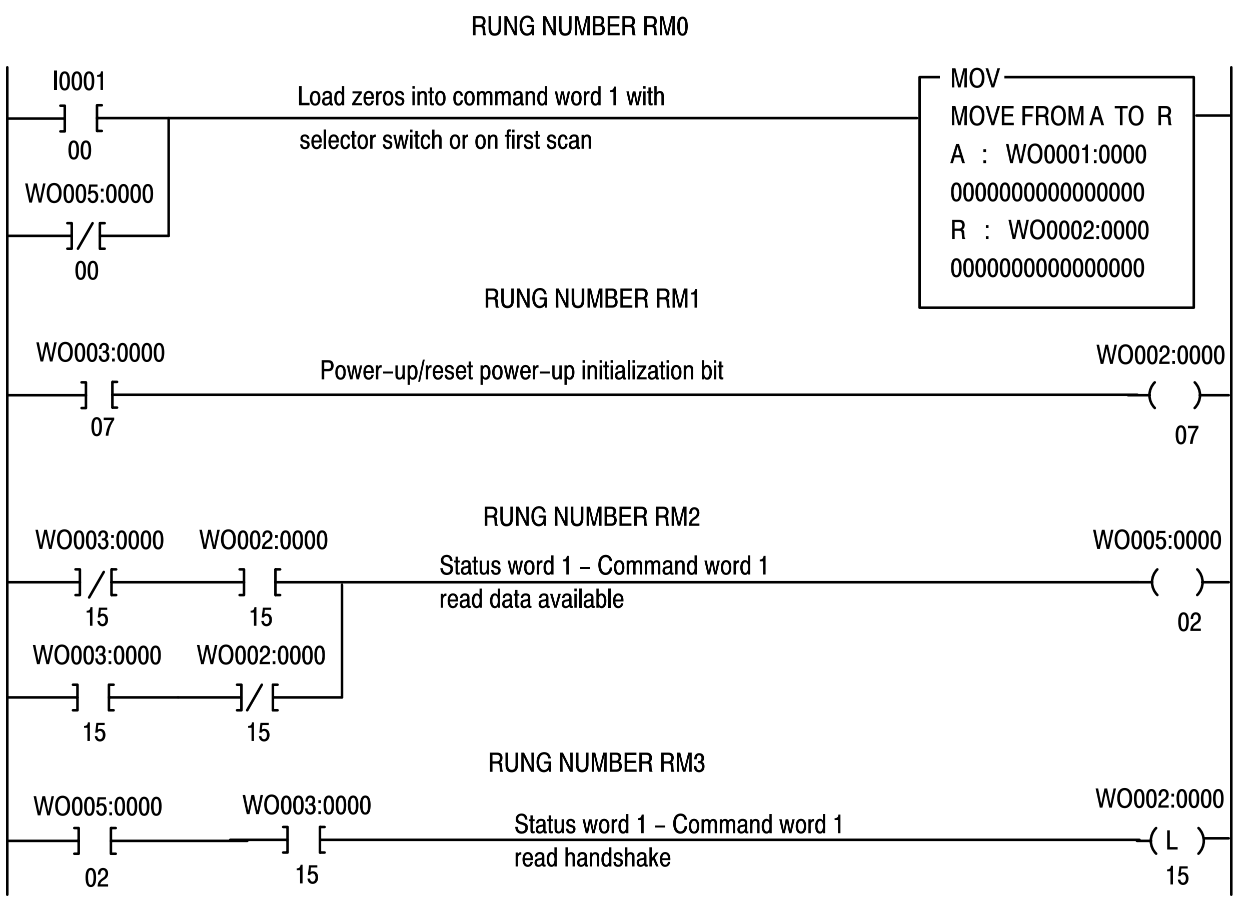

RUNG NUMBER RM6
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power-up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM7
I0001
02
WO005:0000
U
03
RUNG NUMBER RM8
I0001
02
WO005:0000
03
One-shot to enable write block
transfer of new data of module
WO005:0000
04
RUNG NUMBER RM9
WO005:0000
04
WO005:0000
L
03
RUNG NUMBER RM10
WO005:0000
04
WO003:0000
16
Command word 1 - Status word 1
write handshake
WO002:0000
L
16
RUNG NUMBER RM11
WO005:0000
04
WO003:0000
16
WO002:0000
U
16
RUNG NUMBER RM12
WB004:0000
15
WB004:0000
05
Read status word 1 & 2
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03

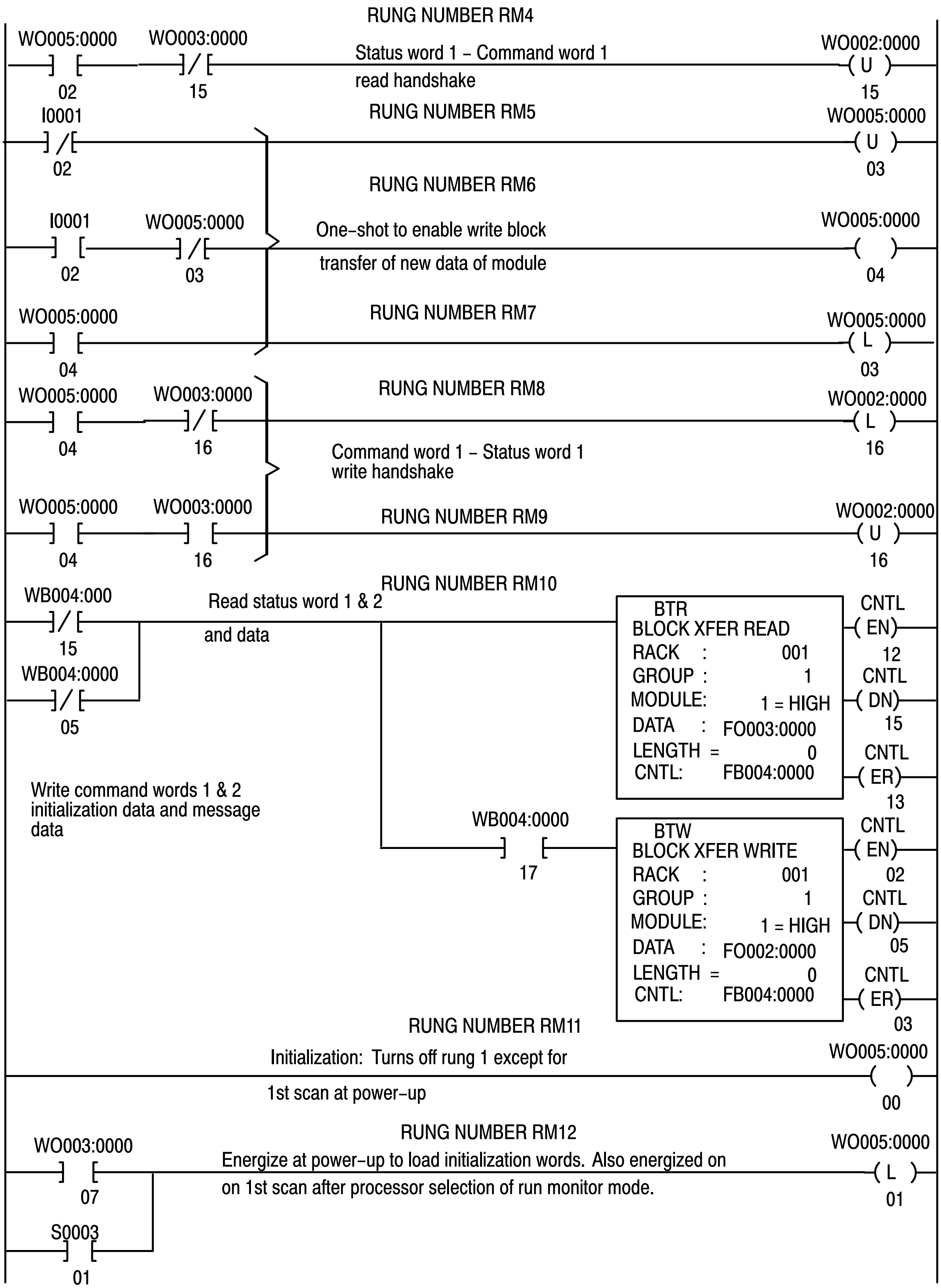


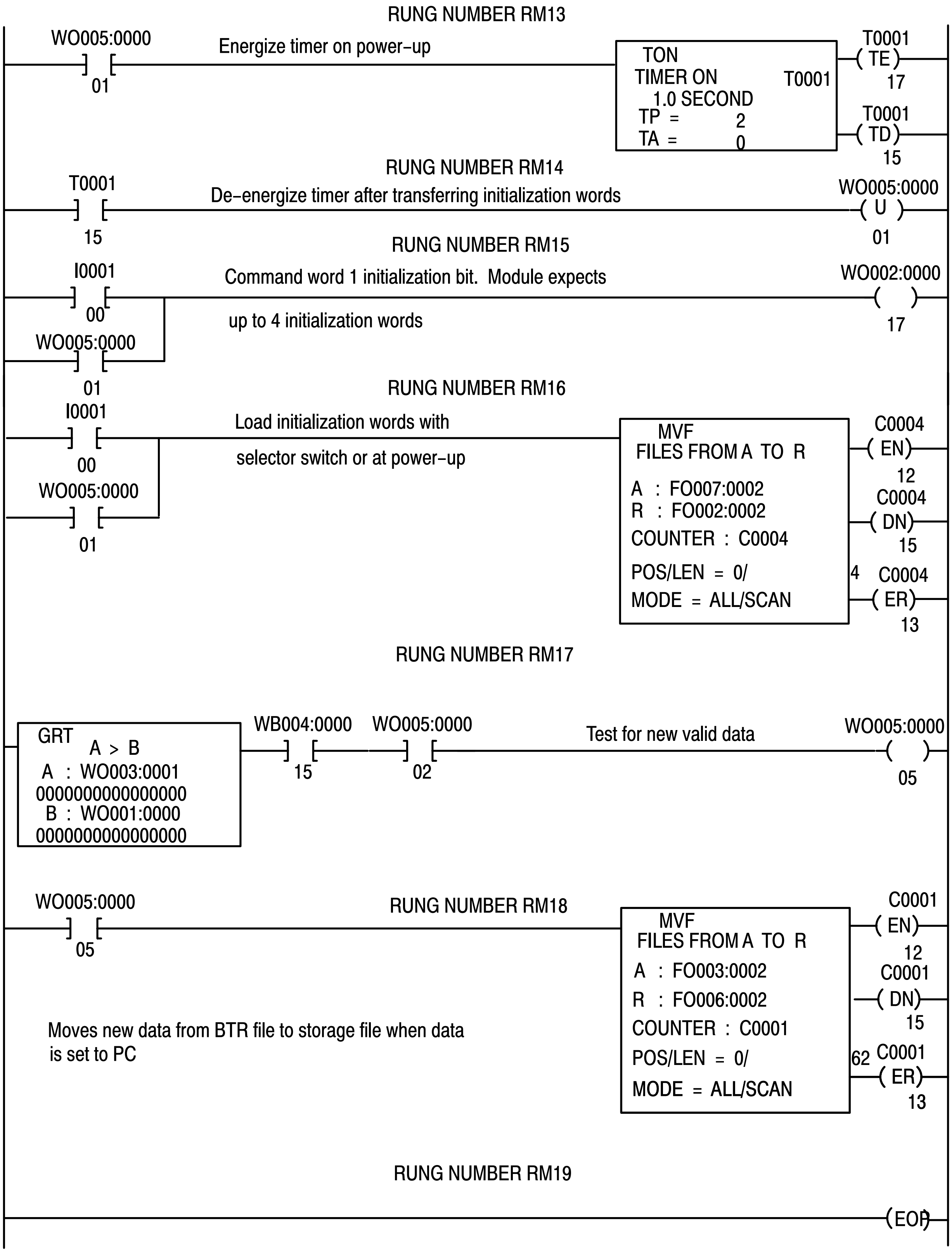
Example Read/Write Program

A read/write program that you can use to transfer data to and/or from your ASCII device is presented with rung descriptions in NO TAG.

Figure A.20
Example Read/Write Program




RUNG NUMBER RM4
WO005:0000
WO003:0000
Status word 1 – Command word 1
read handshake
WO002:0000
U
02
15
15
I0001
RUNG NUMBER RM5
WO005:0000
U
02
03
RUNG NUMBER RM6
I0001
WO005:0000
One-shot to enable write block
transfer of new data of module
WO005:0000
02
03
04
WO005:0000
RUNG NUMBER RM7
WO005:0000
L
04
03
WO005:0000
WO003:0000
RUNG NUMBER RM8
WO002:0000
L
04
16
16
Command word 1 – Status word 1
write handshake
WO005:0000
WO003:0000
RUNG NUMBER RM9
WO002:0000
U
04
16
16
RUNG NUMBER RM10
WB004:000
Read status word 1 & 2
and data
15
WB004:0000
05
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03
RUNG NUMBER RM11
Initialization: Turns off rung 1 except for
1st scan at power-up
WO005:0000
00
RUNG NUMBER RM12
WO003:0000
Energize at power-up to load initialization words. Also energized on
on 1st scan after processor selection of run monitor mode.
WO005:0000
L
07
01
S0003
01

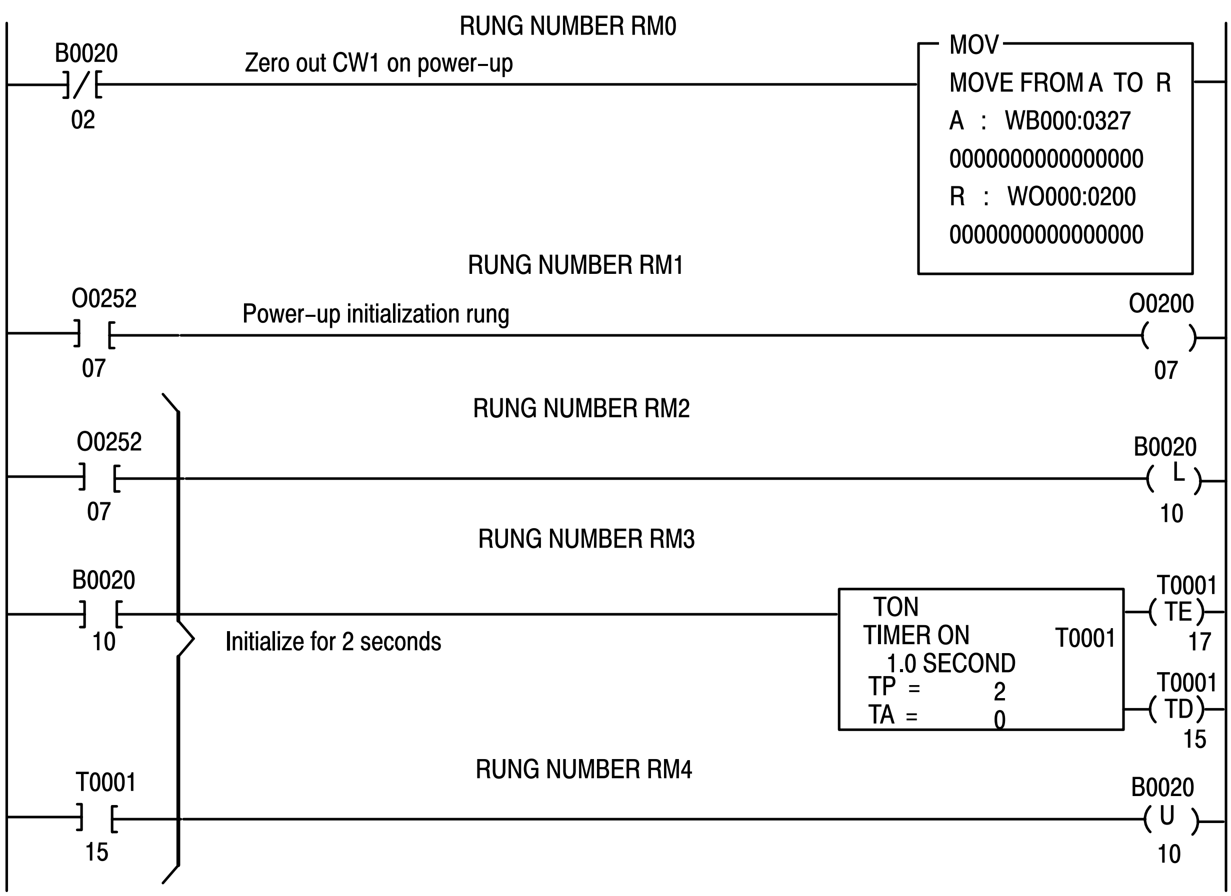

RUNG NUMBER RM13
WO005:0000
01
Energize timer on power–up
TON
TIMER ON
1.0 SECOND
TP = 2
TA = 0
T0001
T0001
TE
17
T0001
TD
15
RUNG NUMBER RM14
T0001
15
De–energize timer after transferring initialization words
WO005:0000
U
01
RUNG NUMBER RM15
I0001
00
WO005:0000
01
Command word 1 initialization bit. Module expects
up to 4 initialization words
WO002:0000
17
RUNG NUMBER RM16
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power–up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM17
GRT
A > B
A : WO003:0001
0000000000000000
B : WO001:0000
0000000000000000
WB004:0000
15
WO005:0000
02
Test for new valid data
WO005:0000
05
WO005:0000
05
RUNG NUMBER RM18
Moves new data from BTR file to storage file when data
is set to PC
MVF
FILES FROM A TO R
A : FO003:0002
R : FO006:0002
COUNTER : C0001
POS/LEN = 0/62
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER
13
RUNG NUMBER RM19
EOP

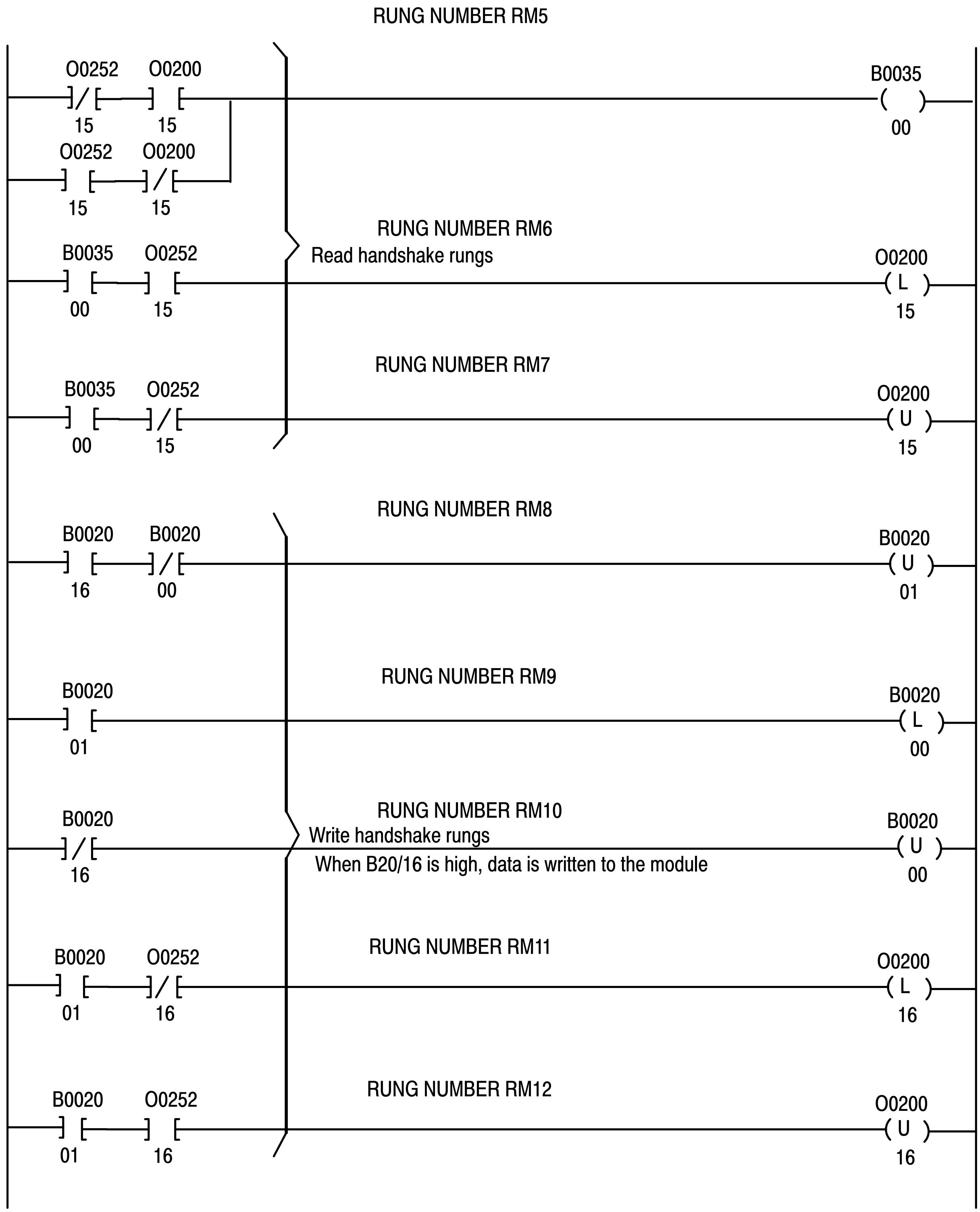
Example Application Read/Write Program

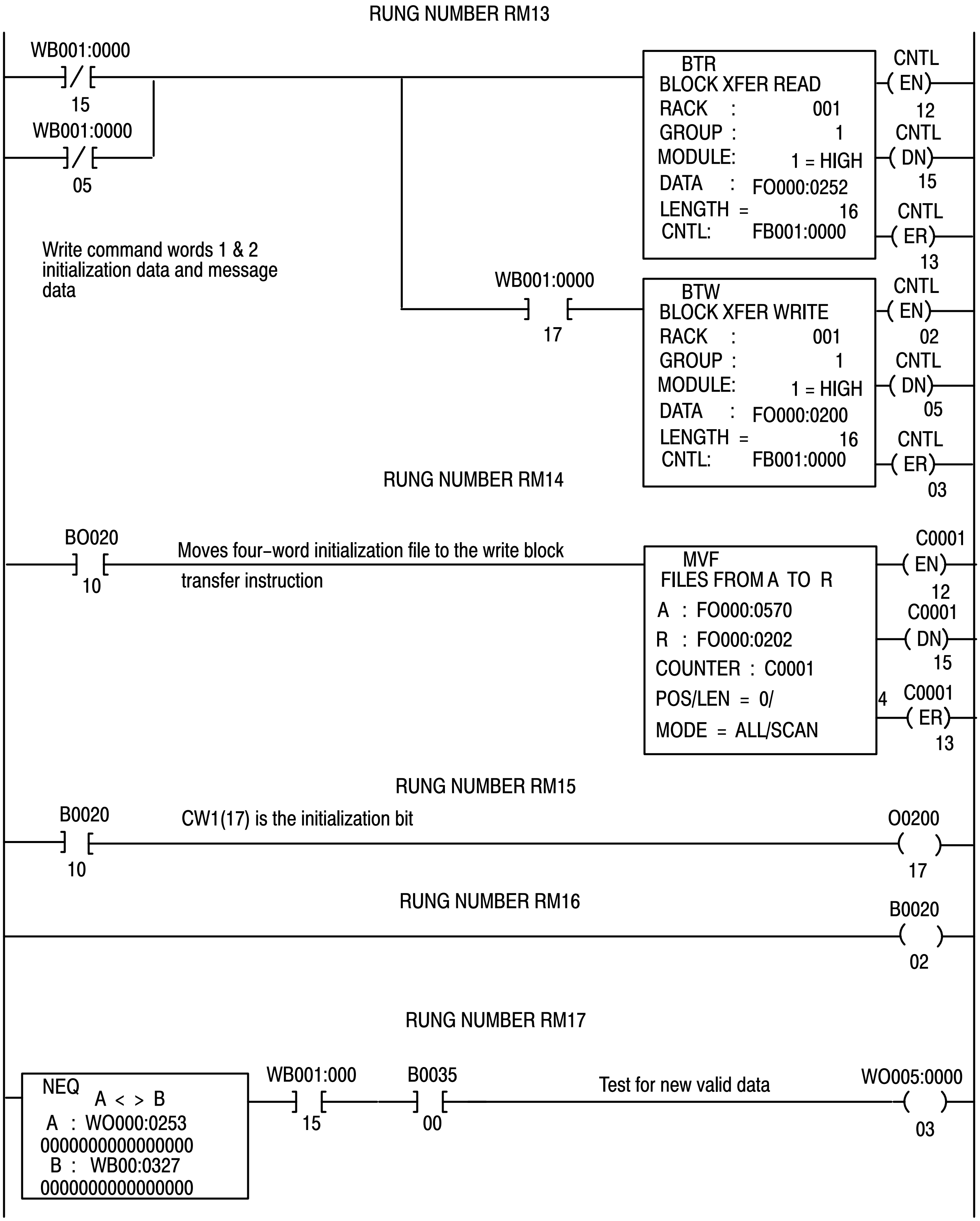
This program allows you to display two messages files on demand (NO TAG). One message file contains a message variable (timer accumulated value). When you enter the word GO from the keyboard of the peripheral device, your program starts a five–second write block transfer one–shot routine that transfers message files 1 and 2 to the peripheral device.

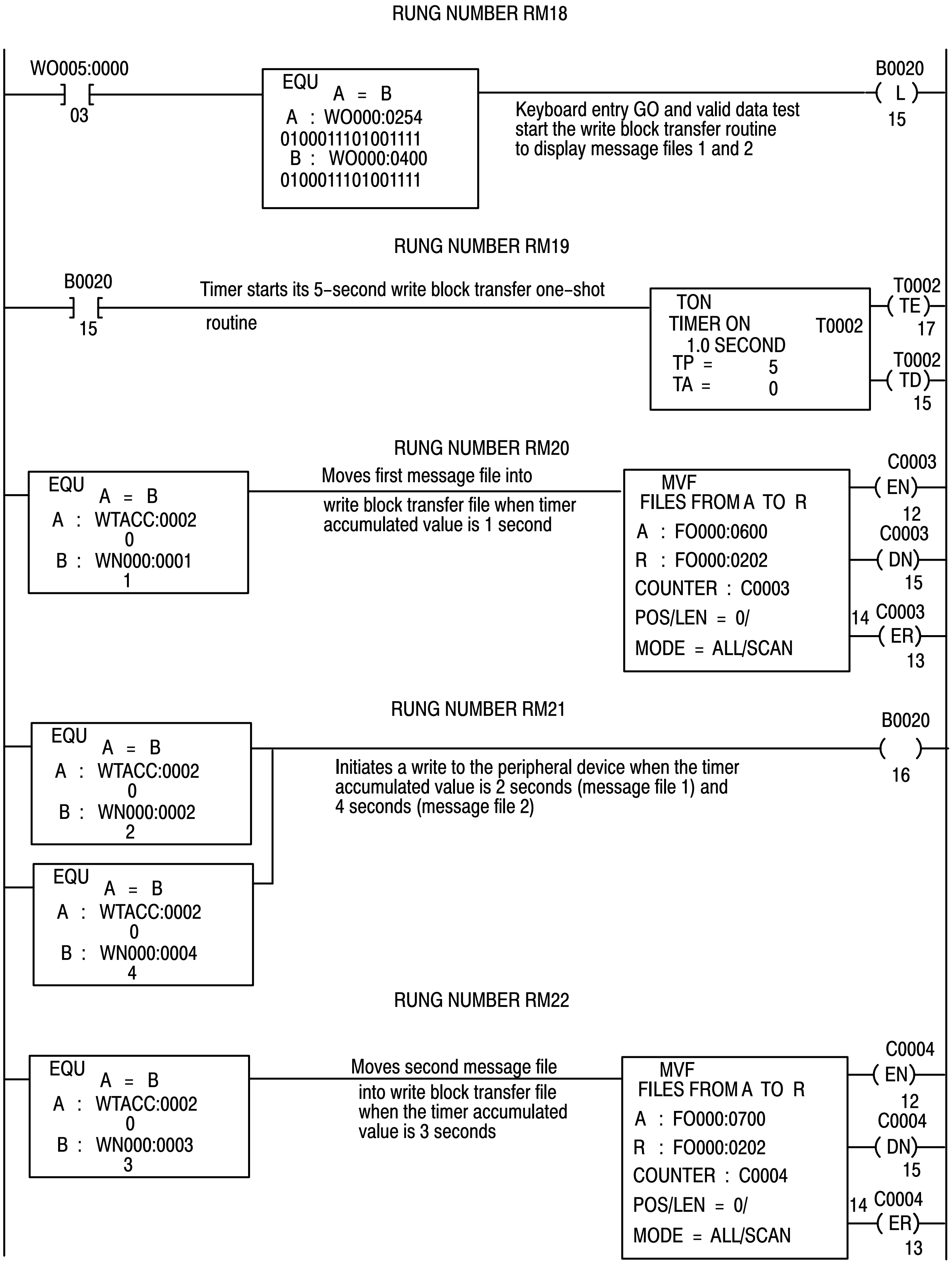
When the string of data containing GO is transmitted to the ASCII module's input buffer, the module sets the new data flag (SW2>0), and transfers data and the new data flag to the processor data table.

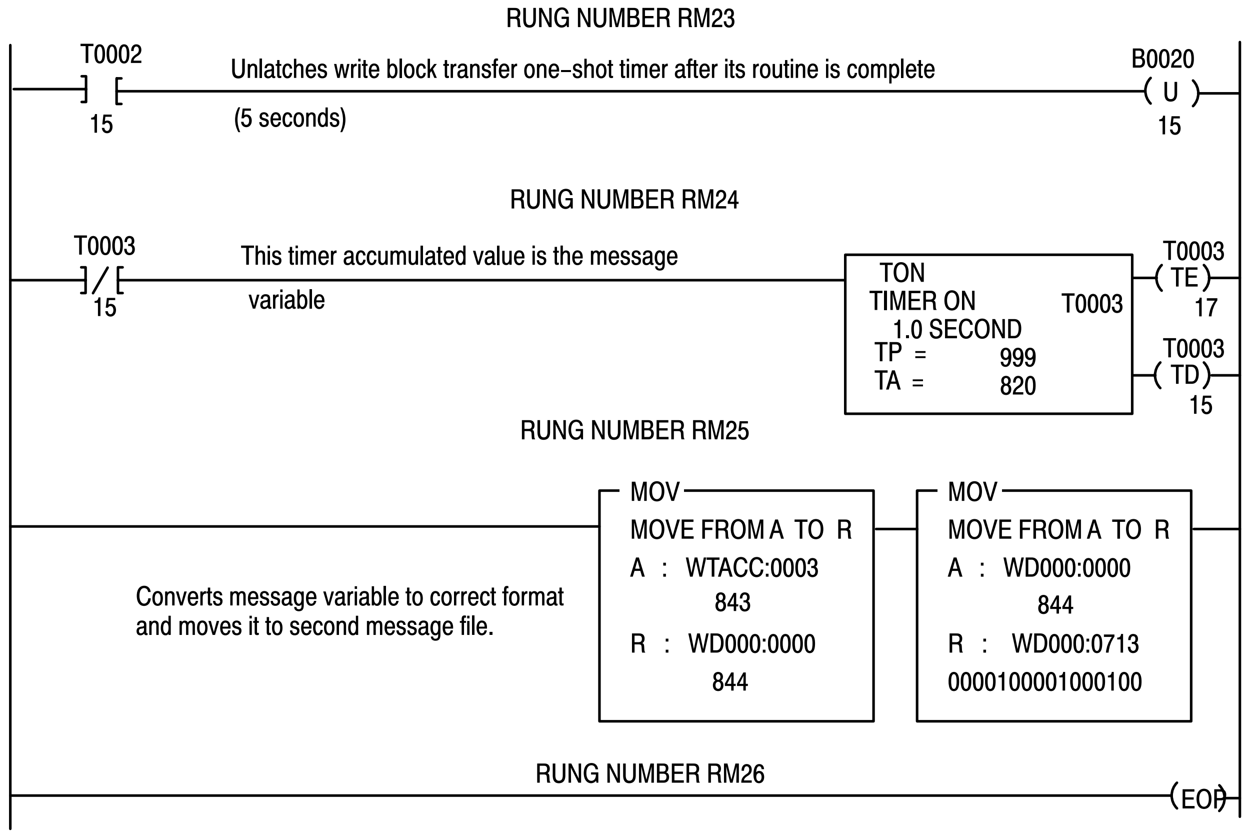
Figure A.21
Example Application Program




RUNG NUMBER RM5
O0252
15
O0200
15
O0252
15
O0200
15
B0035
00
RUNG NUMBER RM6
Read handshake rungs
B0035
00
O0252
15
O0200
L
15
RUNG NUMBER RM7
B0035
00
O0252
15
O0200
U
15
RUNG NUMBER RM8
B0020
16
B0020
00
B0020
U
01
RUNG NUMBER RM9
B0020
01
B0020
L
00
RUNG NUMBER RM10
Write handshake rungs
When B20/16 is high, data is written to the module
B0020
16
B0020
U
00
RUNG NUMBER RM11
B0020
01
O0252
16
O0200
L
16
RUNG NUMBER RM12
B0020
01
O0252
16
O0200
U
16


RUNG NUMBER RM13
WB001:0000
15
WB001:0000
05
Write command words 1 & 2 initialization data and message data
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO000:0252
LENGTH = 16
CNTL: FB001:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
WB001:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO000:0200
LENGTH = 16
CNTL: FB001:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03
RUNG NUMBER RM14
BO020
10
Moves four-word initialization file to the write block transfer instruction
MVF
FILES FROM A TO R
A : FO000:0570
R : FO000:0202
COUNTER : C0001
POS/LEN = 0/
4
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER
13
RUNG NUMBER RM15
B0020
10
CW1(17) is the initialization bit
O0200
17
RUNG NUMBER RM16
B0020
02
RUNG NUMBER RM17
NEQ
A < > B
A : WO000:0253
0000000000000000
B : WB00:0327
0000000000000000
WB001:000
15
B0035
00
Test for new valid data
WO005:0000
03


RUNG NUMBER RM18
WO005:0000
03
EQU
A = B
A : WO000:0254
0100011101001111
B : WO000:0400
0100011101001111
Keyboard entry GO and valid data test start the write block transfer routine to display message files 1 and 2
B0020
L
15
RUNG NUMBER RM19
B0020
15
Timer starts its 5-second write block transfer one-shot routine
TON
TIMER ON
1.0 SECOND
TP = 5
TA = 0
T0002
T0002
TE
17
T0002
TD
15
RUNG NUMBER RM20
EQU
A = B
A : WTACC:0002
0
B : WN000:0001
1
Moves first message file into write block transfer file when timer accumulated value is 1 second
MVF
FILES FROM A TO R
A : FO000:0600
R : FO000:0202
COUNTER : C0003
POS/LEN = 0/
MODE = ALL/SCAN
C0003
EN
12
C0003
DN
15
14
C0003
ER
13
RUNG NUMBER RM21
EQU
A = B
A : WTACC:0002
0
B : WN000:0002
2
EQU
A = B
A : WTACC:0002
0
B : WN000:0004
4
Initiates a write to the peripheral device when the timer accumulated value is 2 seconds (message file 1) and 4 seconds (message file 2)
B0020
16
RUNG NUMBER RM22
EQU
A = B
A : WTACC:0002
0
B : WN000:0003
3
Moves second message file into write block transfer file when the timer accumulated value is 3 seconds
MVF
FILES FROM A TO R
A : FO000:0700
R : FO000:0202
COUNTER : C0004
POS/LEN = 0/
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
14
C0004
ER
13



Addresses Used in Example Application Program

The following addresses are used in NO TAG for files, the message variable, and timers. Initialization data is also shown.

Message file 1	FO000:0600–0615	Initialization Words
Message file 2	FO000:0700–0715	
Message variable	FO000:0713	
Write block transfer file	FO000:0200–0217	IW1 0007
Read block transfer file	FO000:0252–0271	IW2 1028
Initialization file	FO000:0570–0573	IW3 OD08
Write block transfer timer	T0002	IW4 2A00
Message variable timer	T0003	

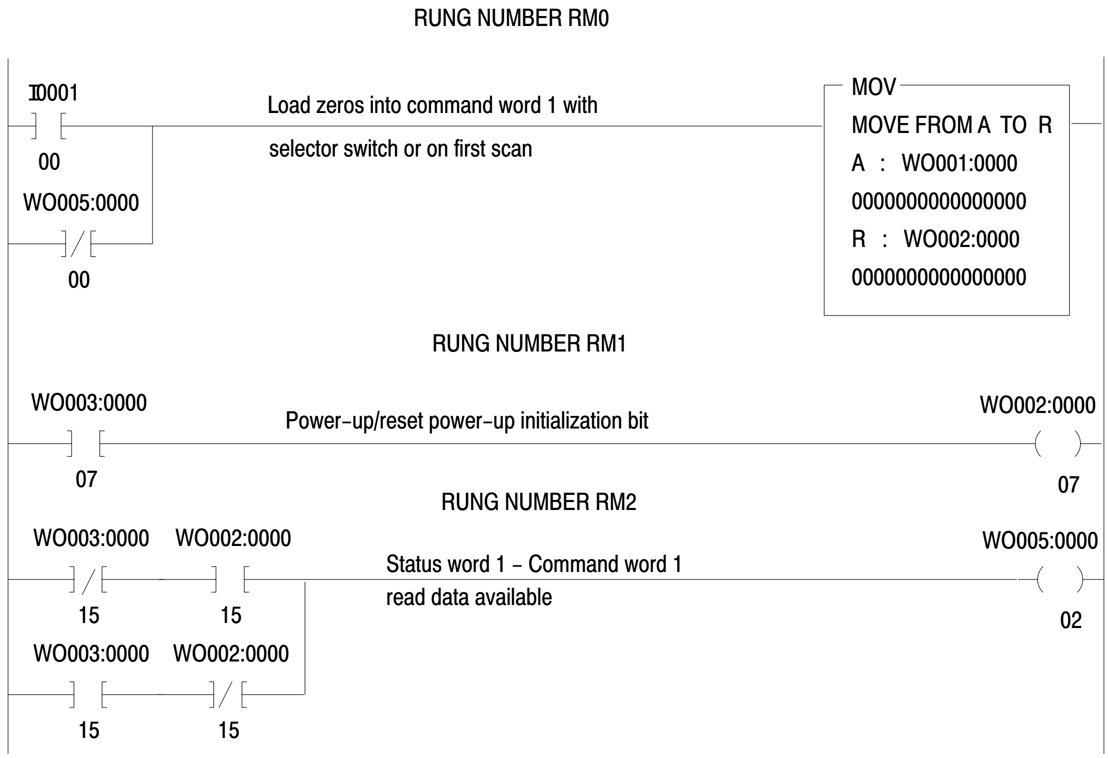
Appendix **B**

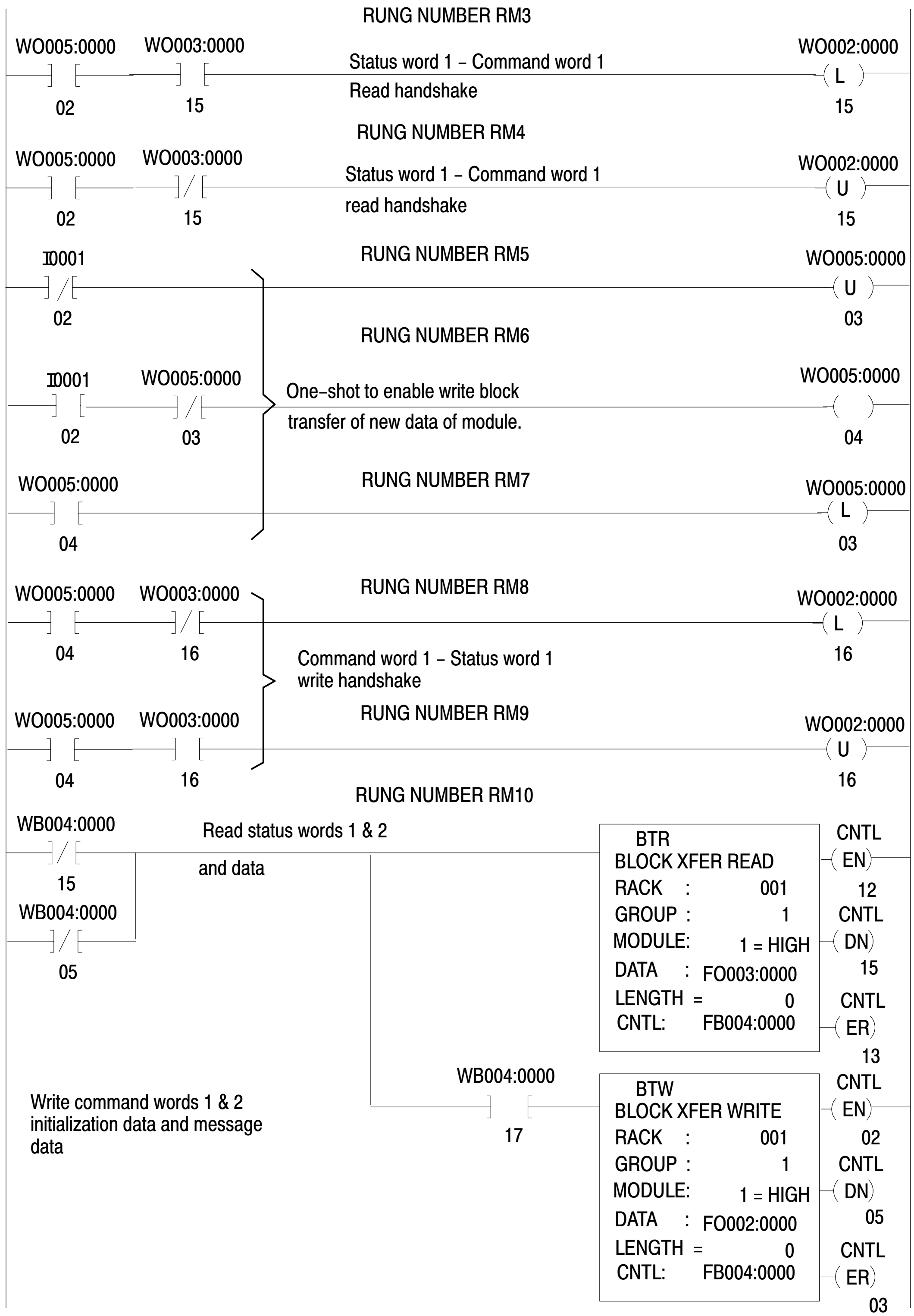
For PLC-3 Family Processor

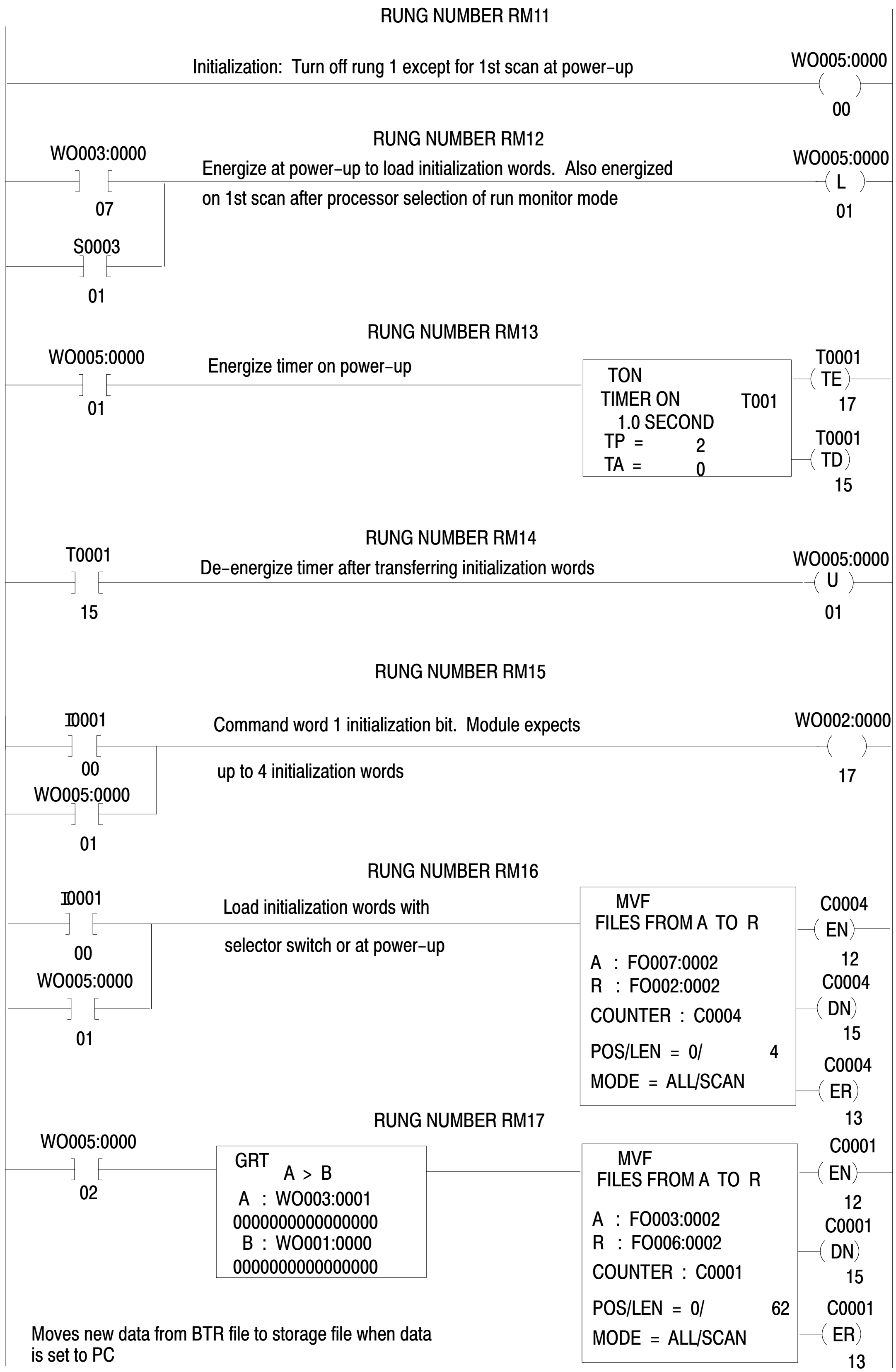
Complete Getting Started Program, PLC-3

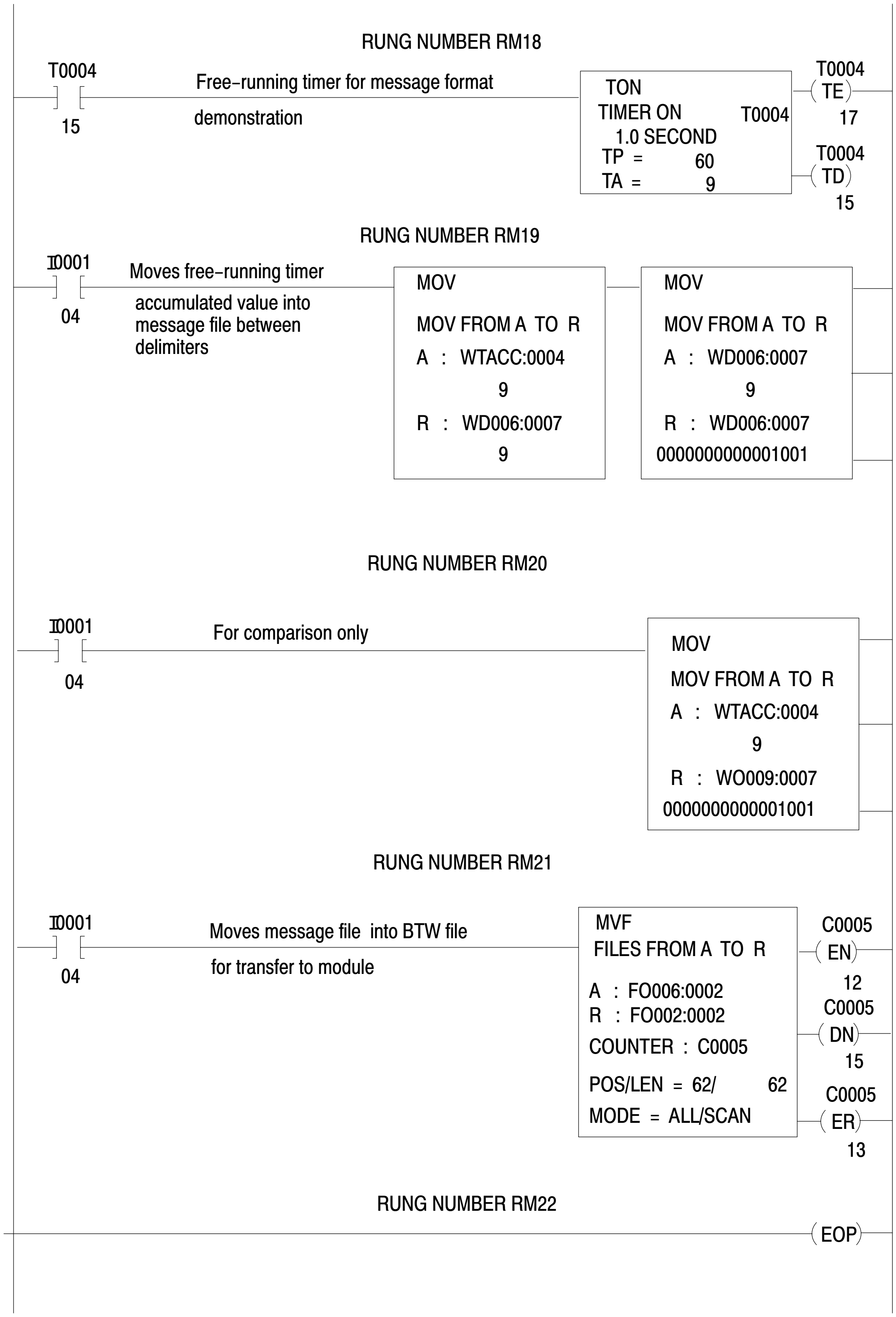
The complete Getting Started Program with rung descriptions is described in Figure B.1.

Figure B.1
Getting Started Program (PLC-3)




RUNG NUMBER RM3
WO005:0000
02
WO003:0000
15
Status word 1 – Command word 1
Read handshake
WO002:0000
L
15
RUNG NUMBER RM4
WO005:0000
02
WO003:0000
15
Status word 1 – Command word 1
read handshake
WO002:0000
U
15
RUNG NUMBER RM5
I0001
02
WO005:0000
U
03
RUNG NUMBER RM6
I0001
02
WO005:0000
03
One–shot to enable write block
transfer of new data of module.
WO005:0000
04
RUNG NUMBER RM7
WO005:0000
04
WO005:0000
L
03
RUNG NUMBER RM8
WO005:0000
04
WO003:0000
16
WO002:0000
L
16
Command word 1 – Status word 1
write handshake
RUNG NUMBER RM9
WO005:0000
04
WO003:0000
16
WO002:0000
U
16
RUNG NUMBER RM10
WB004:0000
15
WB004:0000
05
Read status words 1 & 2
and data
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03


RUNG NUMBER RM11
Initialization: Turn off rung 1 except for 1st scan at power-up
WO005:0000
00
RUNG NUMBER RM12
WO003:0000
07
S0003
01
Energize at power-up to load initialization words. Also energized
on 1st scan after processor selection of run monitor mode
WO005:0000
L
01
RUNG NUMBER RM13
WO005:0000
01
Energize timer on power-up
TON
TIMER ON
T001
1.0 SECOND
TP = 2
TA = 0
T0001
TE
17
T0001
TD
15
RUNG NUMBER RM14
T0001
15
De-energize timer after transferring initialization words
WO005:0000
U
01
RUNG NUMBER RM15
I0001
00
WO005:0000
01
Command word 1 initialization bit. Module expects
up to 4 initialization words
WO002:0000
17
RUNG NUMBER RM16
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power-up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM17
WO005:0000
02
GRT
A > B
A : WO003:0001
0000000000000000
B : WO001:0000
0000000000000000
MVF
FILES FROM A TO R
A : FO003:0002
R : FO006:0002
COUNTER : C0001
POS/LEN = 0/ 62
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER
13
Moves new data from BTR file to storage file when data
is set to PC


RUNG NUMBER RM18
T0004
15
Free–running timer for message format
demonstration
TON
TIMER ON
T0004
1.0 SECOND
TP = 60
TA = 9
T0004
TE
17
T0004
TD
15
RUNG NUMBER RM19
I0001
04
Moves free–running timer
accumulated value into
message file between
delimiters
MOV
MOV FROM A TO R
A : WTACC:0004
9
R : WD006:0007
9
MOV
MOV FROM A TO R
A : WD006:0007
9
R : WD006:0007
0000000000001001
RUNG NUMBER RM20
I0001
04
For comparison only
MOV
MOV FROM A TO R
A : WTACC:0004
9
R : WO009:0007
0000000000001001
RUNG NUMBER RM21
I0001
04
Moves message file into BTW file
for transfer to module
MVF
FILES FROM A TO R
A : FO006:0002
R : FO002:0002
COUNTER : C0005
POS/LEN = 62/ 62
MODE = ALL/SCAN
C0005
EN
12
C0005
DN
15
C0005
ER
13
RUNG NUMBER RM22
EOP

Block Transfer Programming

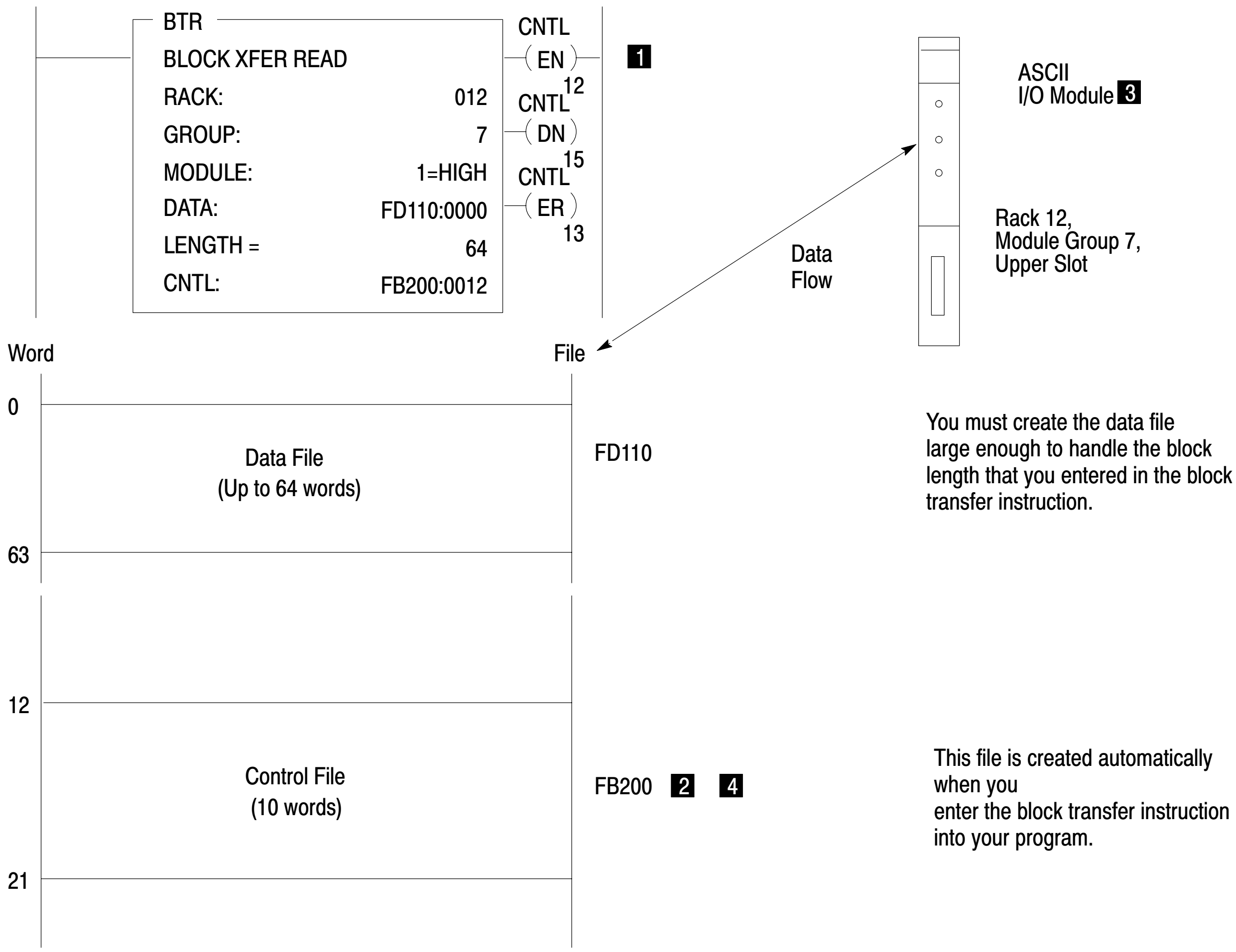
Overview

Block transfer is the method by which the PLC-3 processor communicates with the ASCII module. The PLC-3 controller can perform read, write, and bidirectional block transfer operations. During a block transfer read, data is read from the I/O module and is transferred to PLC-3 controller memory. During a block transfer write, data is transferred from memory and is written to the I/O module. Bidirectional block transfer requires both read and write operations. Each operation can transfer a maximum of 64 words.

Block Transfer Operation

Block transfer instructions use two files when transferring data and commands between the block transfer module and the PLC-3 processor: a data file that contains data to be transferred, and a control file that contains control bits, module location, data table address and length of the data file (Figure A.11). Communication between module and processor is directed by the 1775-S4A scanner. Once the instruction is enabled, the scanner directs the transfer of data to or from the enabled block transfer module according to the information contained in the instruction's control file. Once the instruction is enabled, it automatically sets and resets its control bits in accordance with the various steps required to execute the read or write operation.

Figure B.2
Example Block Transfer Operation



1. Block Transfer instruction goes true.

2. Appropriate status bits are set/reset, and the control file tells the I/O scanner module the address of the data file.

3. Data from the block transfer I/O module is transferred to the block transfer data file in the processor data table.

4. Upon completion of the block transfer, the appropriate status bits are set/reset.

NOTE: The direction of data flow is reversed for a write block transfer operation.

Block Transfer with the ASCII Module

Your ladder program must contain read and write handshake logic. This logic is separate from block transfer routines that use enable and done bits of block transfer instructions. Handshake logic uses control and status bits of the ASCII module.

Execution Time

The time required to complete a read or write block transfer depends on factors that include the number of:

- words of user program
- active I/O channels on the scanner
- I/O chassis entries in the rack list for the channel
- I/O channels on the scanner that contain block transfer modules
- block transfer modules on the channel (if the I/O chassis containing a block transfer module appears more than once in the I/O chassis rack list, count the module once each time the chassis appears in the rack list)

Typical time required to complete a read or write block transfer depends on the program scan and the scanner scan as follows:

Time (read or write)= Program scan + 2[Scanner scan]

Program Scan

The program scan is approximately 2.5ms per 1K words of user program when using a mix of examine on/off and block instructions.

Scanner Scan

The time required for the scanner to complete a read or write block transfer depends on the number of other block transfer modules on the same scanner channel that are enabled simultaneously. Use the following procedure to calculate the time required for the PLC-3 processor to perform all block transfers on the channel.

1. Determine the number of active I/O channels on the scanner.

2. Determine the number of I/O channels with block transfer modules.

3. Use this table to determine the nominal block transfer time using the numbers from steps 1 and 2.

Channels with Block Transfer Modules	1 Active Channel	2 Active Channels	3 Active Channels	4 Active Channels
1	40	52	54	58
2	-	67	68	76
3	-	-	98	99
4	-	-	-	123

Block transfer times typically are similar regardless of the type of block transfer module or the number of words transferred. Nominal read block transfer times typically are faster than nominal write block transfer times by approximately 10ms. In this example, consider them the same.

4. Count the number of block transfer modules on the channel. If a chassis containing block transfer modules is repeated in the rack list, count chassis and modules as often as listed.

5. Count the number of I/O chassis entries in the rack list for the channel.

6. Calculate the block transfer time for the scanner as follows:

$$\text{Scanner Time} = \left[\text{Nominal Time} \times \#\text{ BT modules on the channel}\right] + \left[\#\text{I/O chassis in rack list} - 1\right] \text{ X 9ms}$$

PLC-3 Example Computation

As an example, we will compute the read or write block transfer time between the supervisory processor and an ASCII module in an I/O channel with no other block transfer modules, and in an I/O channel with two other block transfer modules in the following system:

- User program contains 20K words
- Channel 1 contains four I/O chassis, with a total of three block transfer modules including one ASCII module
- Channel 2 contains two I/O chassis with no block transfer modules
- Channel 3 contains two I/O chassis with one ACII module
- Channel 4 is made inactive through processor LIST

You can compute the read or write block transfer times for the supervisory processor in this example in four steps. Each of the following steps is explained by an accompanying figure.

1. Diagram the I/O channels of your PC system (Figure B.3), showing the number of:

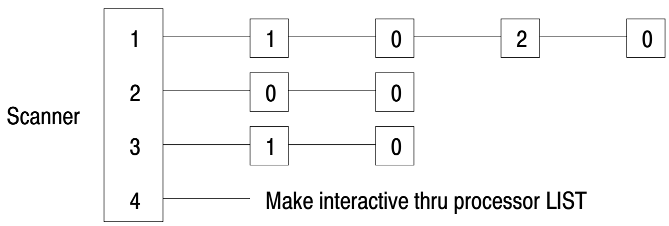
- block transfer modules in each I/O chassis
- block transfer I/O channels
- I/O chassis entries in the rack list for each block transfer I/O channel
- active I/O channels per scanner

A block transfer I/O channel is a channel that contains one or more block transfer modules located in any chassis connected to the channel.

An I/O chassis can appear more than once in a rack list of I/O chassis. Count it and the block transfer module(s) that it contains as often as it is listed.

Figure B.3
Diagramming I/O Channels

Step 1 - Diagram the chassis connected in series to each channel (up to four) of your scanner module. Then, fill in the information called for below. Example values have been added.



☐ = I/O Chassis
n = number of block-transfer modules in chassis

Description	Number	Ch 1	Ch 2	Ch 3	Ch 4
Active I/O channels	3				
Block Transfer I/O channels	2				
Block Transfer modules on each I/O block transfer channel		3	0	1	0
I/O chassis on each block-transfer I/O channel (I/O chassis in rack list)		4	0	2	0

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2. Using information from the diagram of I/O channels (Figure A.12), look up the nominal time from the table in Figure A.13.

Figure B.4
Nominal Time Table

Step 2 -Determine a time from the table. Example values have been added.

Number of Active I/O Channels

		1	2	3	4
Active I/O channels containing one or more block transfer modules	1	40	52	54	58
	2		67	68	76
	3			98	99
	4				123
		Time (ms)			

Number of active I/O channels: 3

Number of active I/O channels containing one or more block transfer module: 2

Time, from table: 68ms

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3. Compute the approximate transfer time for each block transfer I/O channel. Use values from your channel diagram (Figure A.12), a value from the table (Figure A.13), and the formula from step 6 above. We make these calculations for you in Figure A.14.

Figure B.5
Computing Channel Times

Step 3 – Compute the scanner time for each block transfer channel. Example values have been added.

CT = Channel Time

CT = [Nominal Time x #BT modules on BT channel] + [#I/O chassis on BT channel −1] x 9

CT1 = [68ms] x [3] + [4−1] x 9ms
204ms + 3 x 9ms
231ms

CT2 = Not a block transfer channel

CT3 = [68ms] x [1] + [2−1] x 9ms
68ms + 9ms
77ms

CT4 = Not an active channel

4. Compute the approximate read or write block transfer time for channel 1 and channel 3 (Figure A.15).

Figure B.6
Computing Block Transfer for Each Channel

Step 4 Compute the read or write block transfer time. Example values have been added.

Program Scan

Time (program) = 2.5ms/K words x 20K words
= 2.5ms x 20
= 50ms

Scanner Scan

Time (read or write) = 231ms for channel 1 and
77ms for channel 3 (from step 3)

Block Transfer Timer per Channel

Channel 1 = Program Scan + 2[Scanner Scan]
50ms + 2[231ms]
50ms + 462ms
512ms

Channel 3 = Program Scan + 2[Scanner Scan]
50ms + 2[77ms]
50ms + 154ms
204ms

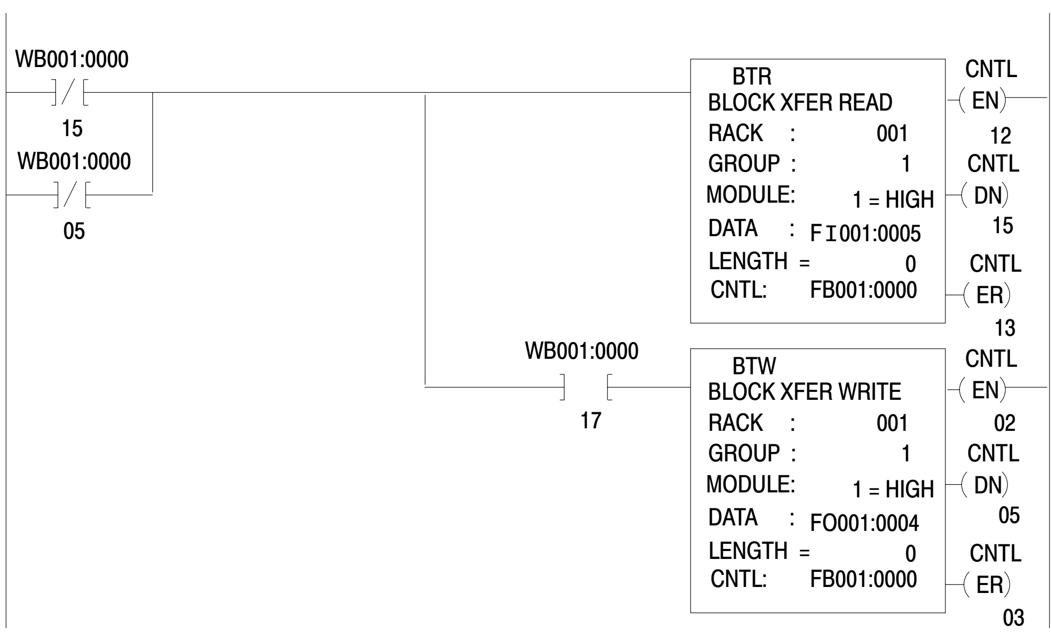
Reducing Scan Time

Due to the asychronous scan relationship between program and scanner, and the serial operation of each channel in the scanner, we suggest that you optimize the overall scan time. Although recommendations are application dependent, we make the following recommendations as general guidelines:

- Whenever possible, control the manner in which block transfer instructions are enabled. For example, if only a few block transfer modules require frequent transfer of data, program them to run continually. Inhibit block transfer instructions of those modules that require less frequent transfer until enabled by a timer and/or some application dependent condition.

- Program the read and write block transfer instructions of your ASCII module in the same rung (Figure A.16).
- Distribute your block transfer modules equally between all four scanner channels.
- Distribute block transfer instructions equally throughout your program. Place an equal number of non-block transfer rungs between block transfer rungs.
- For large numbers of block transfer instructions, distribute groups of block transfer rungs equally throughout your program. Place no more than four block transfer rungs consecutively in one group. Within each group, condition the next rung using the done bit of the previous block transfer instruction.
- Consider an additional I/O scanner module (cat. no. 1775-S4A) if you cannot otherwise reduce the block transfer times to meet your timing requirements.
- During a write handshake, the processor also can transfer write data to the ASCII module; and during a read handshake, the processor also can transfer read data.

Figure B.7
Example Block Transfer Programming



Special Considerations

When using one 1775-S4A I/O scanner with thumbwheel switch set to 1, only part of its data handling capacity is available for handling block transfers. This scanner can store and transfer a maximum of 72 words at any one time, from up to four block transfer modules, across any of the active channels.

If a block transfer read instruction is enabled but the scanner's buffer cannot accept the instruction's block length (the scanner is processing other blocks of data), the block transfer instruction must wait for a subsequent scan when the scanner's buffer can accept all the words that the module has to transfer. The same applies for a write block transfer instruction. We suggest that you add an additional scanner if necessary.

Block Transfer Errors

Once enabled, a block transfer instruction in a PLC-3 ladder program will set either a done bit or an error bit. The instruction indicates an error when it illuminates the -(ER)- symbol. Typical block transfer errors occur when:

- You do not correctly enter the instruction
  - The rack, group, and module numbers do not match the location of the installed module
  - You entered a file length greater than 64
  - You did not create the data file, or the address that you entered does not match the file you created

Read and write error bits illuminate at the same time when the error source is the module address entry or the file length entry in the instruction block.

- You have a communication problem
- You did not correctly connect the twinaxial cable to the scanner
- You did not connect a terminator resistor to each end of the twinaxial cable

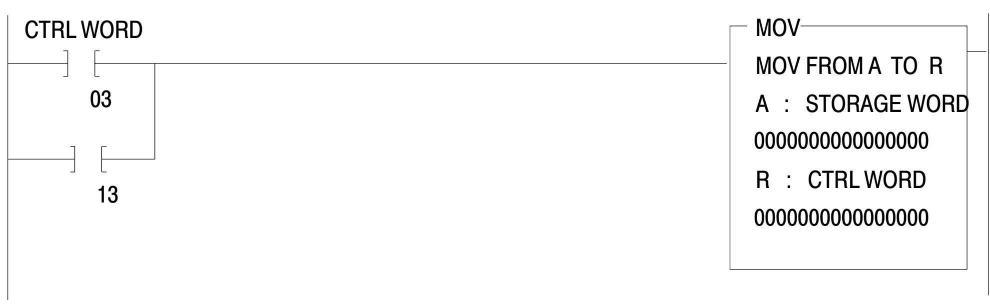
When the scanner encounters a communication fault, it tries twice to complete the transfer. It sets the error bit after the second unsuccessful try.

When the scanner encounters a communication fault, it tries twice to complete the transfer. It sets the error bit after the second unsuccessful try.

When the scanner and/or processor detects a block transfer error, the transfer is halted. Transfers from the module are prevented until:

- Your program clears the instruction's control word (clears the error, Figure A.17)
- You locate and correct the error

Figure B.8
Resetting the Control Word after a Block Transfer Error



Detecting Faults

Block transfer error detection and resulting processor shutdown are safety features of Allen-Bradley programmable controllers. We recommend that you adapt such safety features to your application. However, you may want your program to reset block transfer instructions whenever an error is detected. Block transfer errors can occur intermittently due to electrical noise in the environment, and may not be critical to system operation. This allows your system to continue operation, and allows you to observe the frequency and location of such errors.

The processor can record where faults are occurring in the I/O chassis, and the frequency of occurrence. To observe this information you must create the following files. Refer to section titled "Entering the Getting Started Program," step 7 (P. 1-26), for the procedure.

- I/O Adapter Status, Status file 2, S2:0

  This file records I/O faults occuring in each I/O chassis in your system. It identifies the location by rack number to within a quarter I/O rack (32 I/O points or four module slots). The file length is application dependent: one word for assigned rack numbers 0-3, two words for 0-7, three words for 0-11 and so forth. Each displayed bit represents a fault detected within the quarter rack. The display format is:

Bit Number			
17 - 13	**12 - 10**	**07 - 04**	**03 - 00**
rack 3 rack 7 :	rack 2 rack 6 :	rack 1 rack 5 :	rack 0 rack 4 :

For example, bit 00 indicates a fault at rack 0, first quarter chassis; bit 01 at rack 0, second quarter chassis, and so forth.

- Adapter Re-try, Status file, 3, S3:0

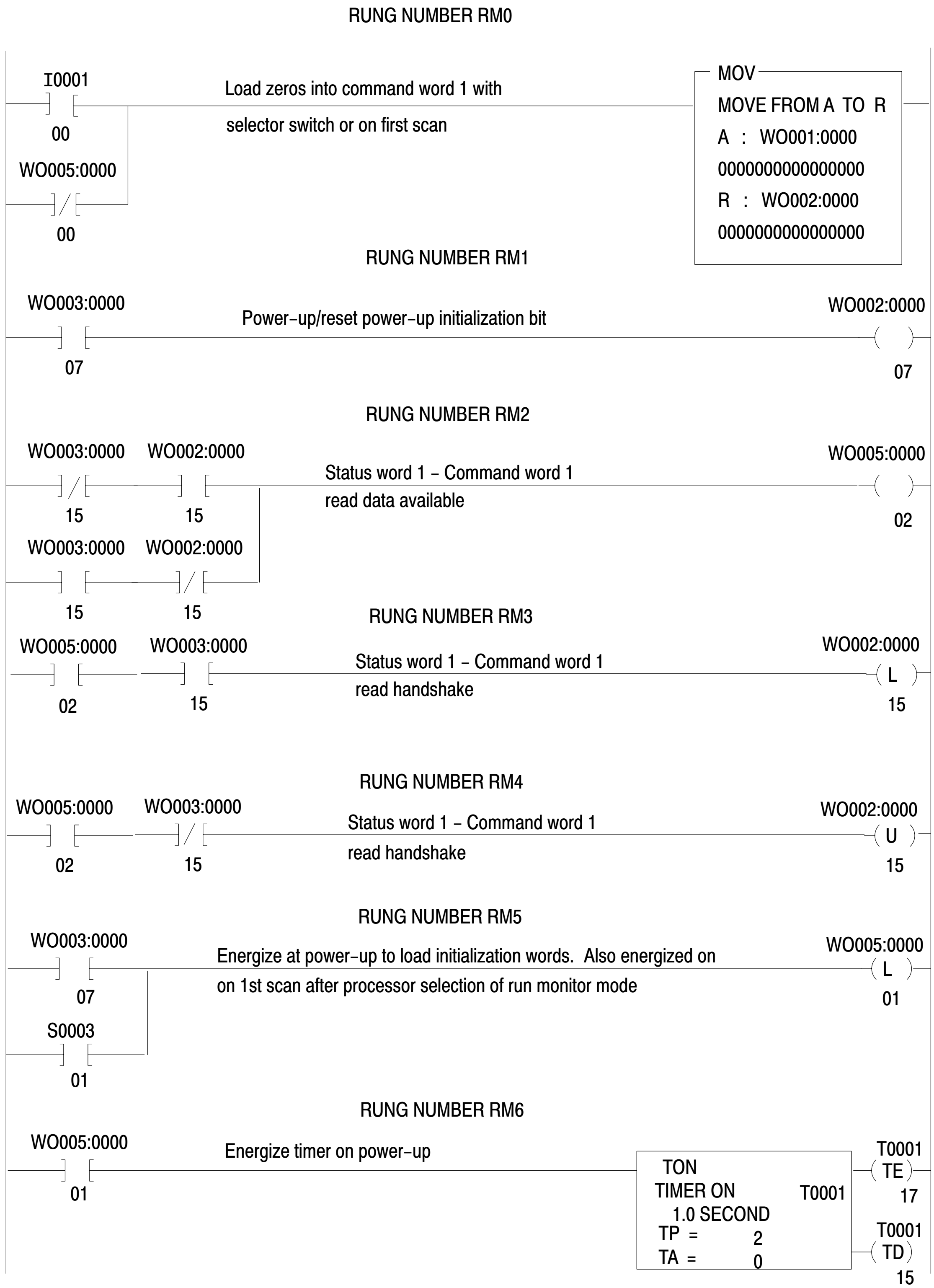
This file counts the number of transmissions attempted between the scanner and each I/O chassis in the system. The file records the re-tries occurring in each quarter rack. Frequent re-tries indicate I/O communication problems. The file length is application dependent, four words per assigned rack number. The display format is:

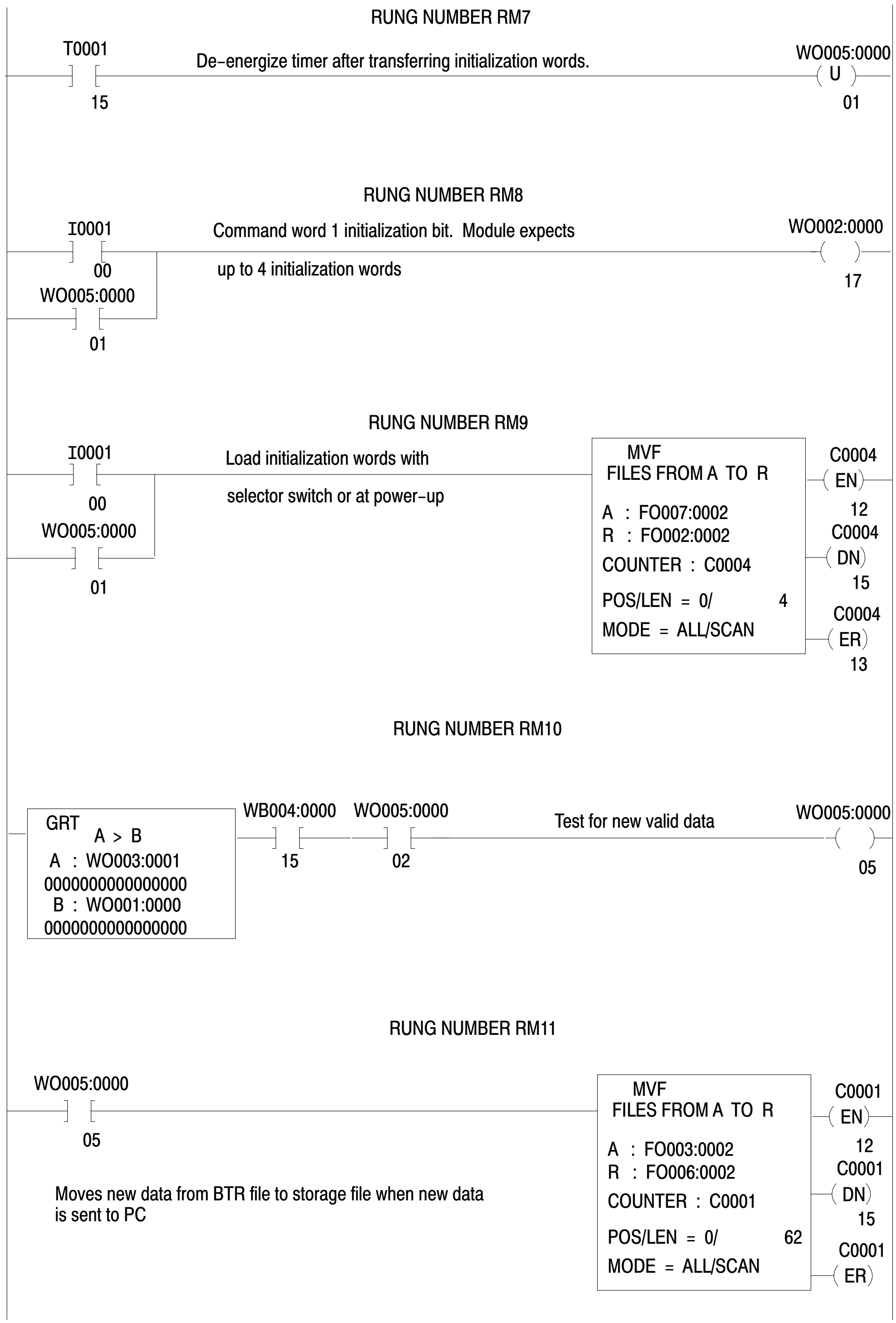
		Bit Number			
Word	**Rack**	**17 - 13**	**12 - 10**	**07 - 04**	**03 - 00**
0000	0	binary count, first quarter rack			
0001	0	binary count, second quarter-rack			
0002	0	binary count, third quarter-rack			
0003	0	binary count, fourth quarter-rack			
0004	1	binary count, first quarter-rack			
0005	1	binary count, second quarter-rack			
:	:	:			

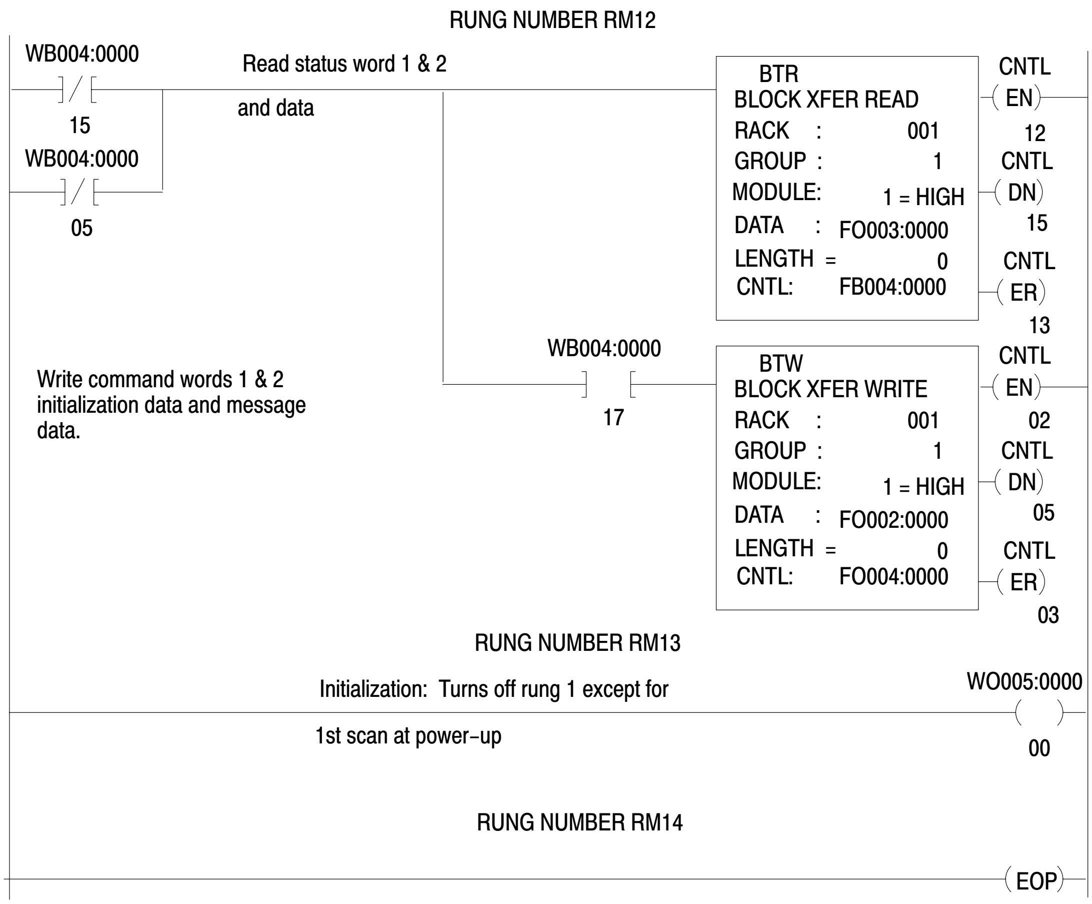
Example Read (Only) Program

A read (only) program for transferring data from your ASCII device into the data table of your processor is presented with rung descriptions in Figure A.18.

Figure B.9
Example Read (Only) Program



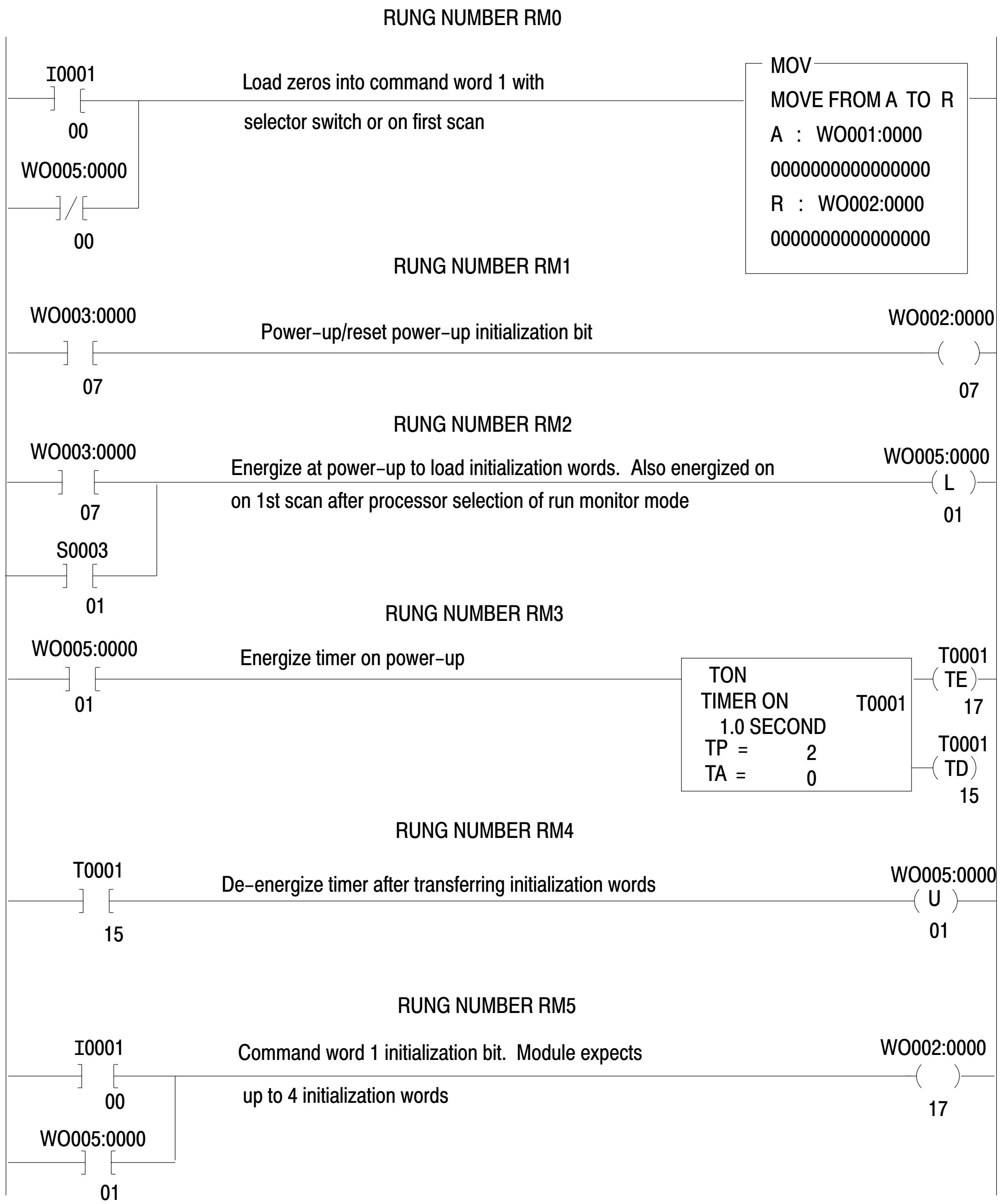

RUNG NUMBER RM7
T0001
15
De–energize timer after transferring initialization words.
WO005:0000
U
01
RUNG NUMBER RM8
I0001
00
WO005:0000
01
Command word 1 initialization bit. Module expects
up to 4 initialization words
WO002:0000
17
RUNG NUMBER RM9
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power–up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM10
GRT
A > B
A : WO003:0001
0000000000000000
B : WO001:0000
0000000000000000
WB004:0000
15
WO005:0000
02
Test for new valid data
WO005:0000
05
RUNG NUMBER RM11
WO005:0000
05
Moves new data from BTR file to storage file when new data
is sent to PC
MVF
FILES FROM A TO R
A : FO003:0002
R : FO006:0002
COUNTER : C0001
POS/LEN = 0/ 62
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER

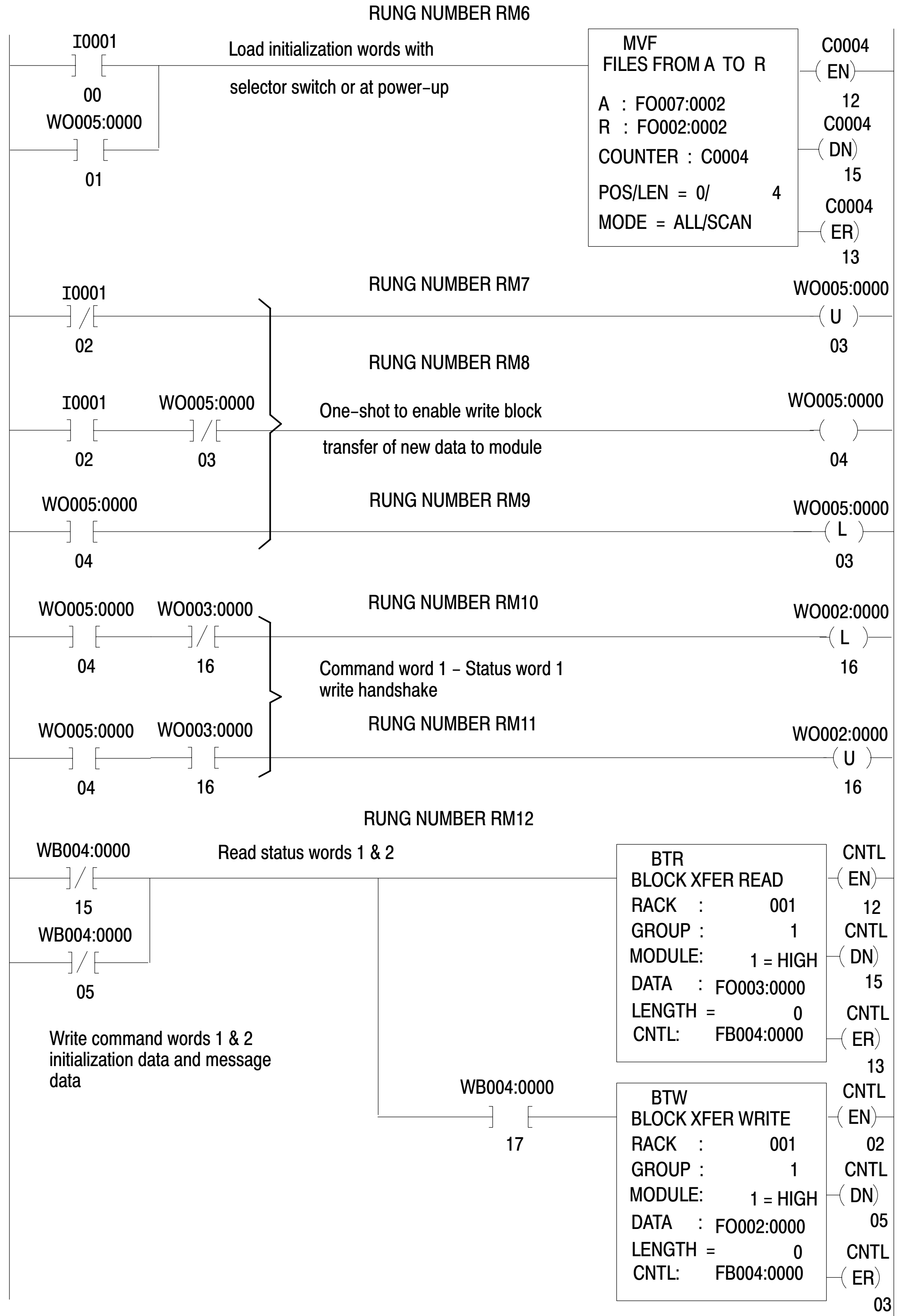

RUNG NUMBER RM12
WB004:0000
15
WB004:0000
05
Read status word 1 & 2
and data
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data.
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FO004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03
RUNG NUMBER RM13
Initialization: Turns off rung 1 except for
1st scan at power–up
WO005:0000
00
RUNG NUMBER RM14
EOP

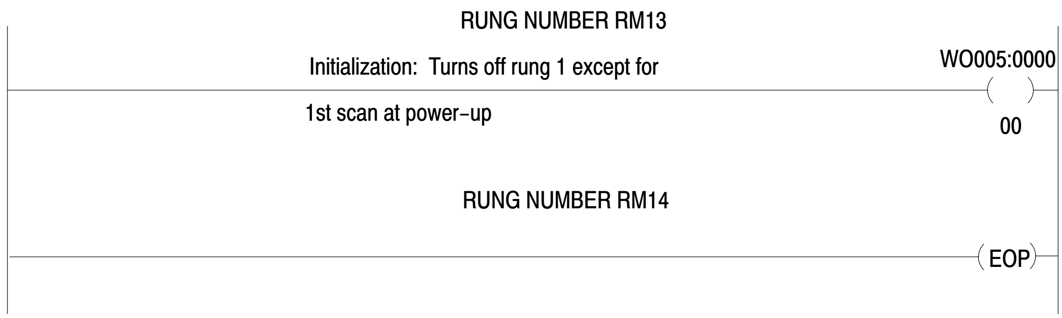
Example Write (Only) Program

A write (only) program for transferring data from your processor's data table to your ASCII device is presented with rung descriptions in Figure A.19.

Figure B.10
Example Write (Only) Program



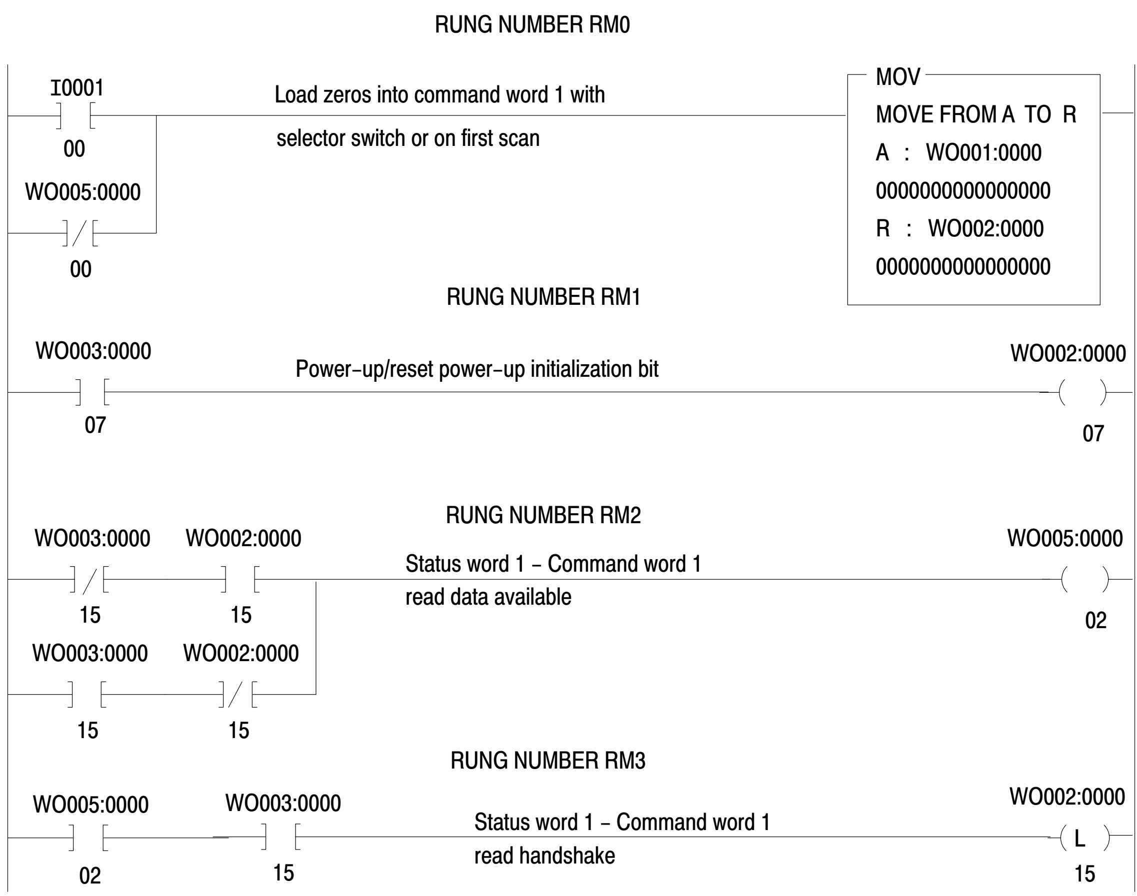

RUNG NUMBER RM6
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power–up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM7
I0001
02
WO005:0000
U
03
RUNG NUMBER RM8
I0001
02
WO005:0000
03
One–shot to enable write block
transfer of new data to module
WO005:0000
04
RUNG NUMBER RM9
WO005:0000
04
WO005:0000
L
03
RUNG NUMBER RM10
WO005:0000
04
WO003:0000
16
WO002:0000
L
16
Command word 1 – Status word 1
write handshake
RUNG NUMBER RM11
WO005:0000
04
WO003:0000
16
WO002:0000
U
16
RUNG NUMBER RM12
WB004:0000
15
WB004:0000
05
Read status words 1 & 2
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03

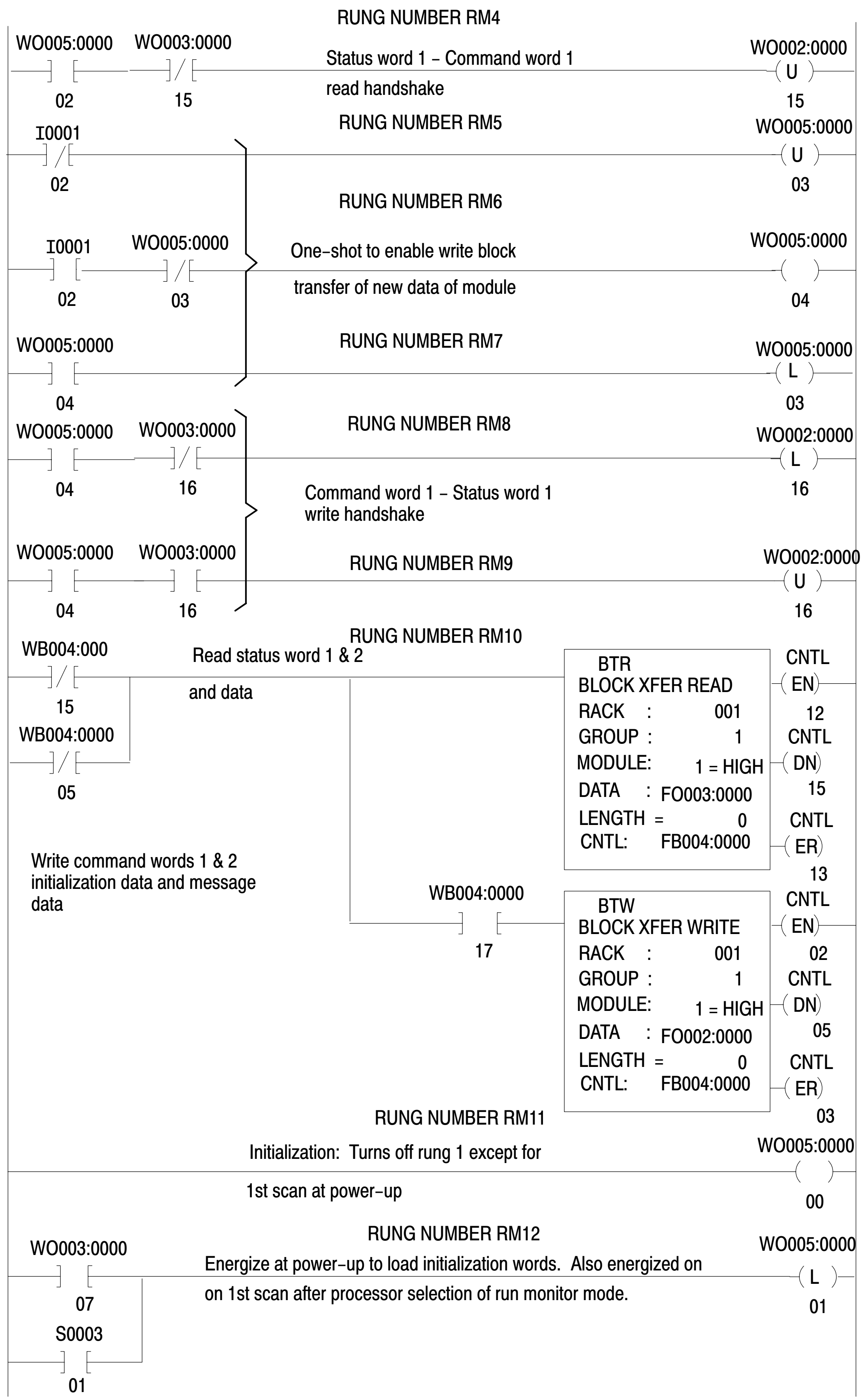


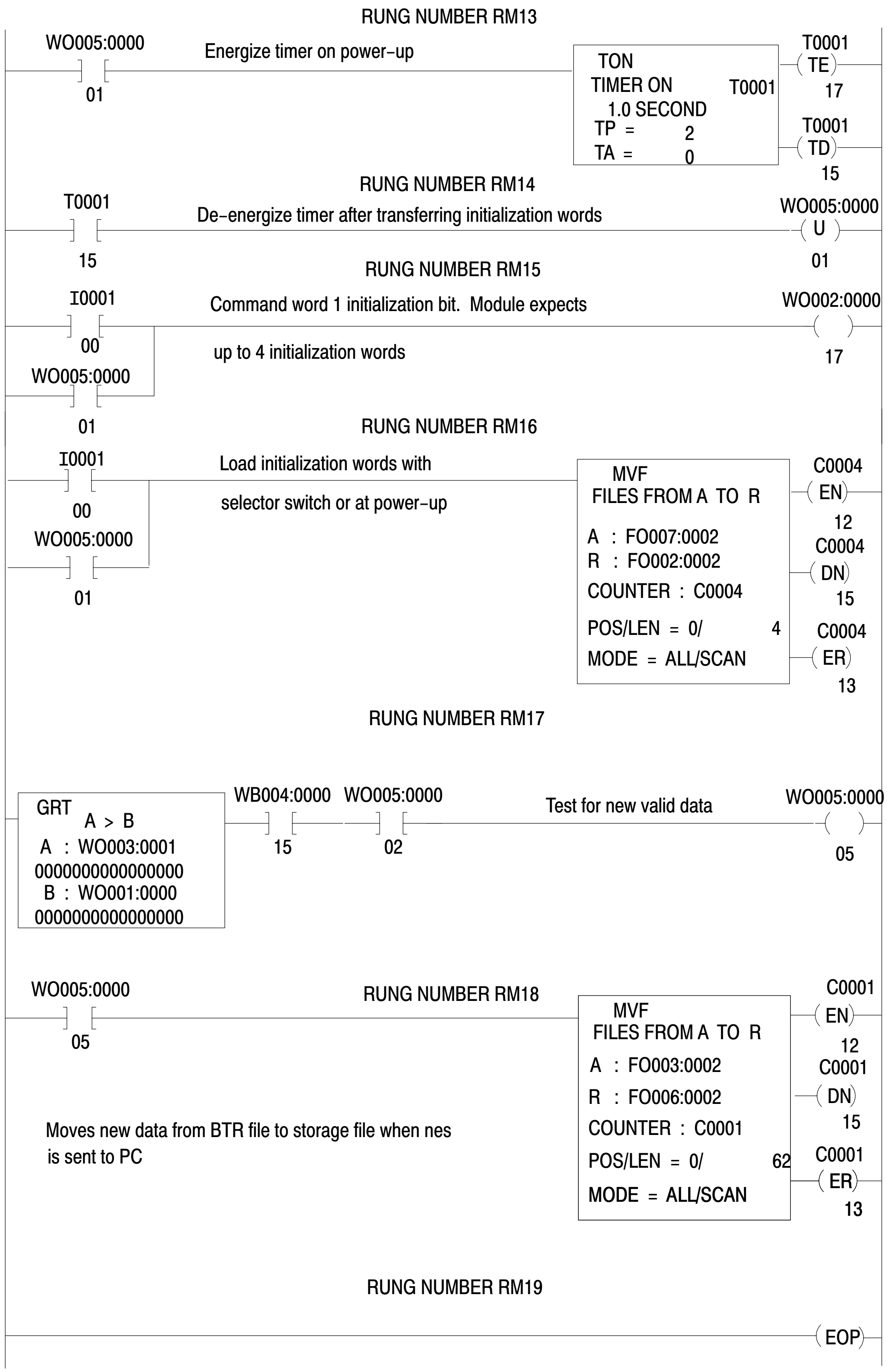
Example Read/Write Program

A read/write program that you can use to transfer data to and/or from your ASCII device is presented with rung descriptions in Figure B.11.

Figure B.11
Example Read/Write Program




RUNG NUMBER RM4
WO005:0000
02
WO003:0000
15
Status word 1 – Command word 1
read handshake
WO002:0000
U
15
RUNG NUMBER RM5
I0001
02
WO005:0000
U
03
RUNG NUMBER RM6
I0001
02
WO005:0000
03
One-shot to enable write block
transfer of new data of module
WO005:0000
04
RUNG NUMBER RM7
WO005:0000
04
WO005:0000
L
03
RUNG NUMBER RM8
WO005:0000
04
WO003:0000
16
Command word 1 – Status word 1
write handshake
WO002:0000
L
16
RUNG NUMBER RM9
WO005:0000
04
WO003:0000
16
WO002:0000
U
16
RUNG NUMBER RM10
WB004:000
15
WB004:0000
05
Read status word 1 & 2
and data
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO003:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
Write command words 1 & 2
initialization data and message
data
WB004:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO002:0000
LENGTH = 0
CNTL: FB004:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03
RUNG NUMBER RM11
Initialization: Turns off rung 1 except for
1st scan at power-up
WO005:0000
00
RUNG NUMBER RM12
WO003:0000
07
S0003
01
Energize at power-up to load initialization words. Also energized on
on 1st scan after processor selection of run monitor mode.
WO005:0000
L
01

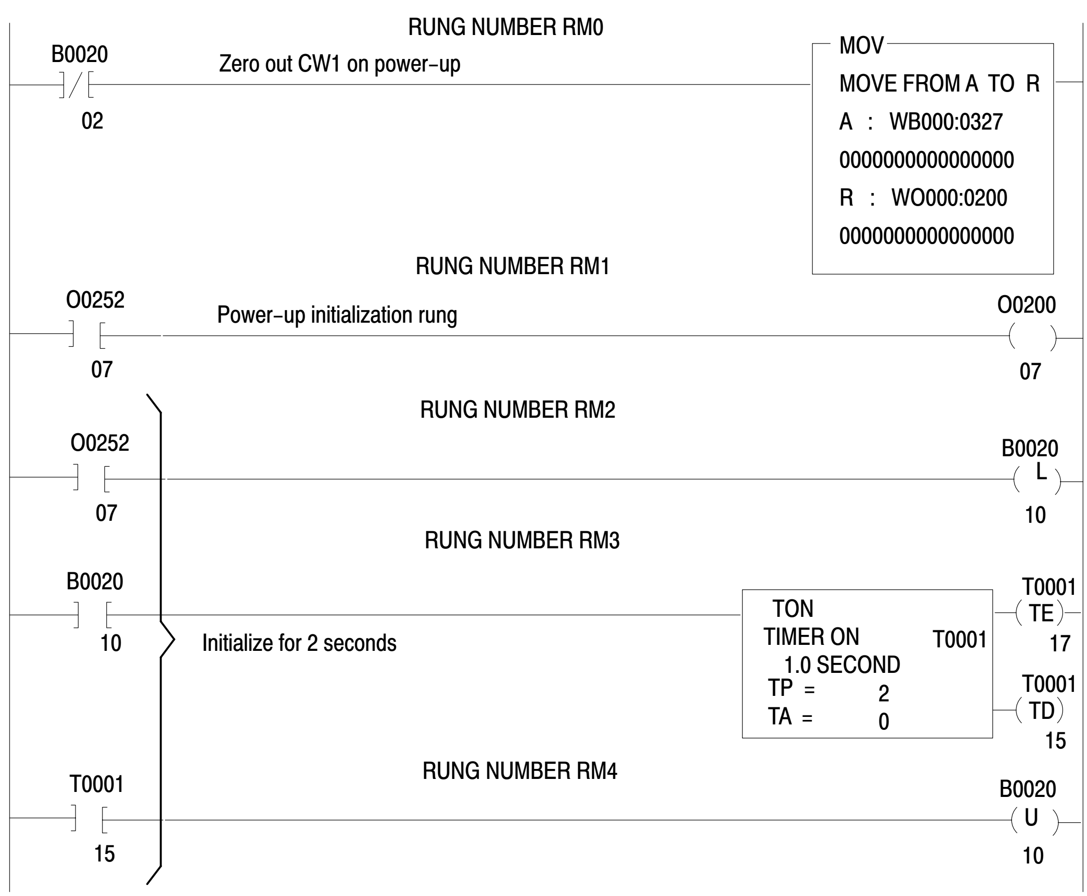

RUNG NUMBER RM13
WO005:0000
01
Energize timer on power-up
TON
TIMER ON
1.0 SECOND
TP = 2
TA = 0
T0001
T0001
TE
17
T0001
TD
15
RUNG NUMBER RM14
T0001
15
De-energize timer after transferring initialization words
WO005:0000
U
01
RUNG NUMBER RM15
I0001
00
WO005:0000
01
Command word 1 initialization bit. Module expects
up to 4 initialization words
WO002:0000
17
RUNG NUMBER RM16
I0001
00
WO005:0000
01
Load initialization words with
selector switch or at power-up
MVF
FILES FROM A TO R
A : FO007:0002
R : FO002:0002
COUNTER : C0004
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13
RUNG NUMBER RM17
GRT
A > B
A : WO003:0001
0000000000000000
B : WO001:0000
0000000000000000
WB004:0000
15
WO005:0000
02
Test for new valid data
WO005:0000
05
WO005:0000
05
RUNG NUMBER RM18
Moves new data from BTR file to storage file when nes
is sent to PC
MVF
FILES FROM A TO R
A : FO003:0002
R : FO006:0002
COUNTER : C0001
POS/LEN = 0/ 62
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER
13
RUNG NUMBER RM19
EOP

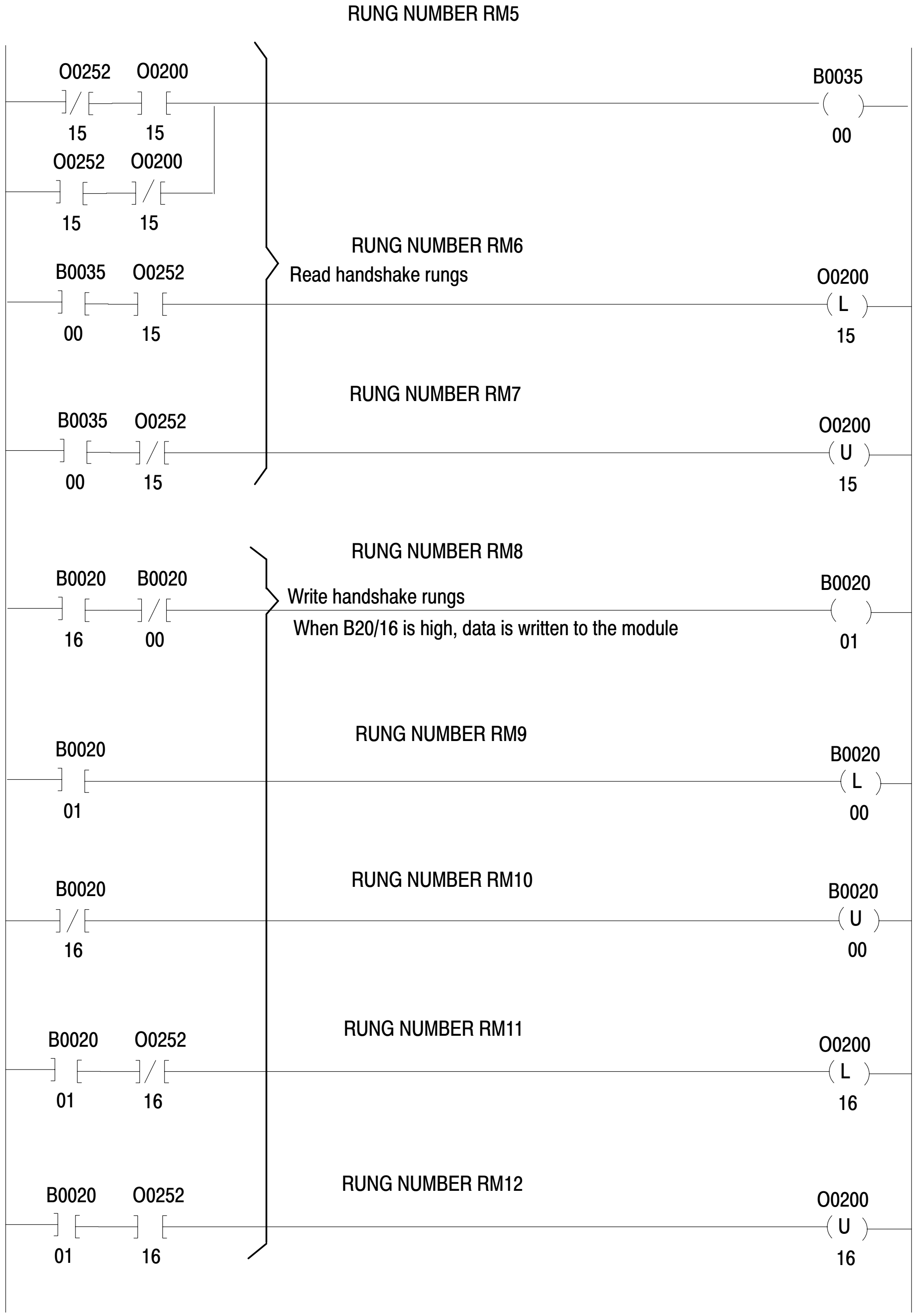
Example Application Read/Write Program

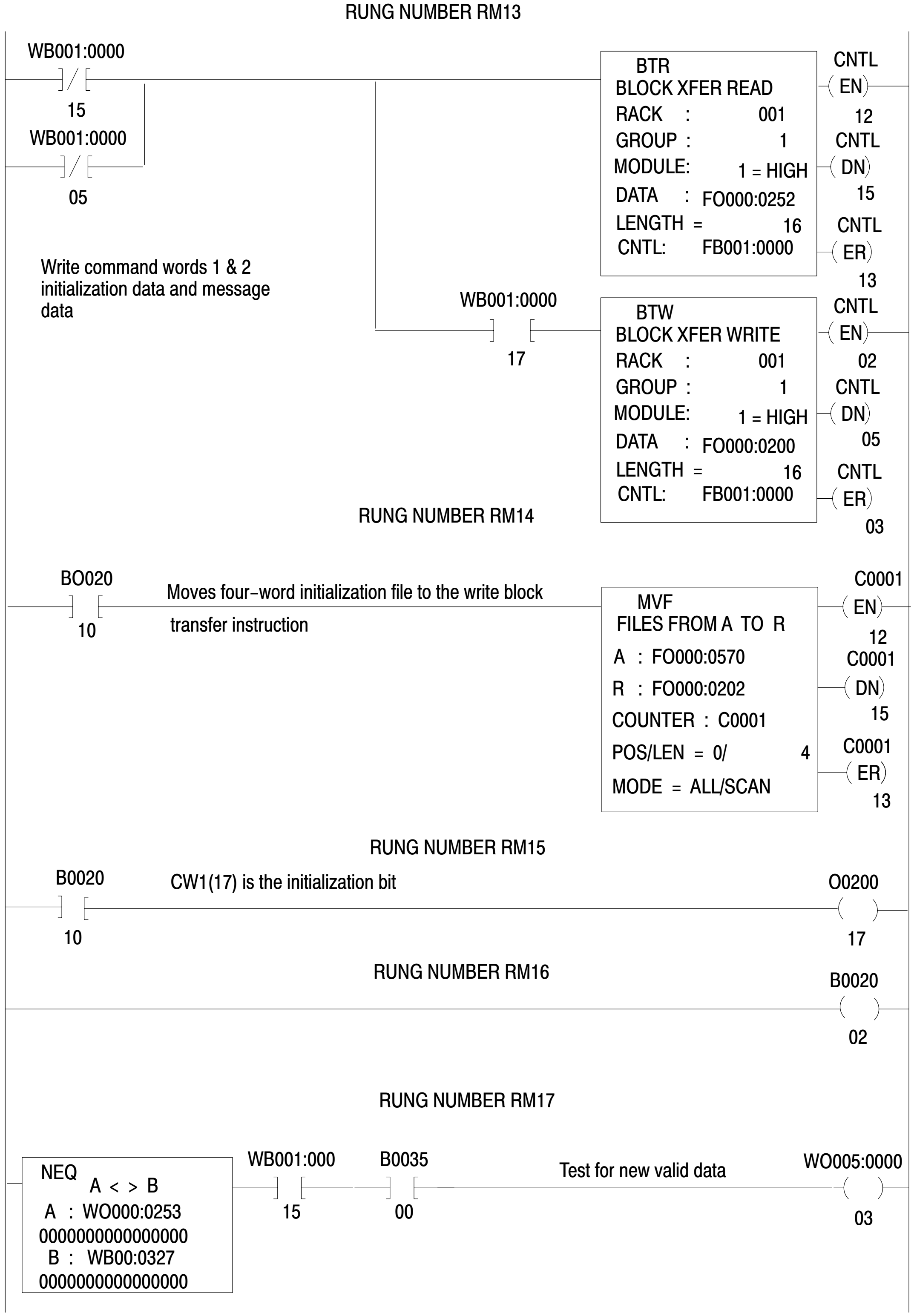
This program allows you to display two messages files on demand (NO TAG). One message file contains a message variable (timer accumulated value). When you enter the word GO from the keyboard of the peripheral device, your program starts a five-second write block transfer one-shot routine that transfers message files 1 and 2 to the peripheral device.

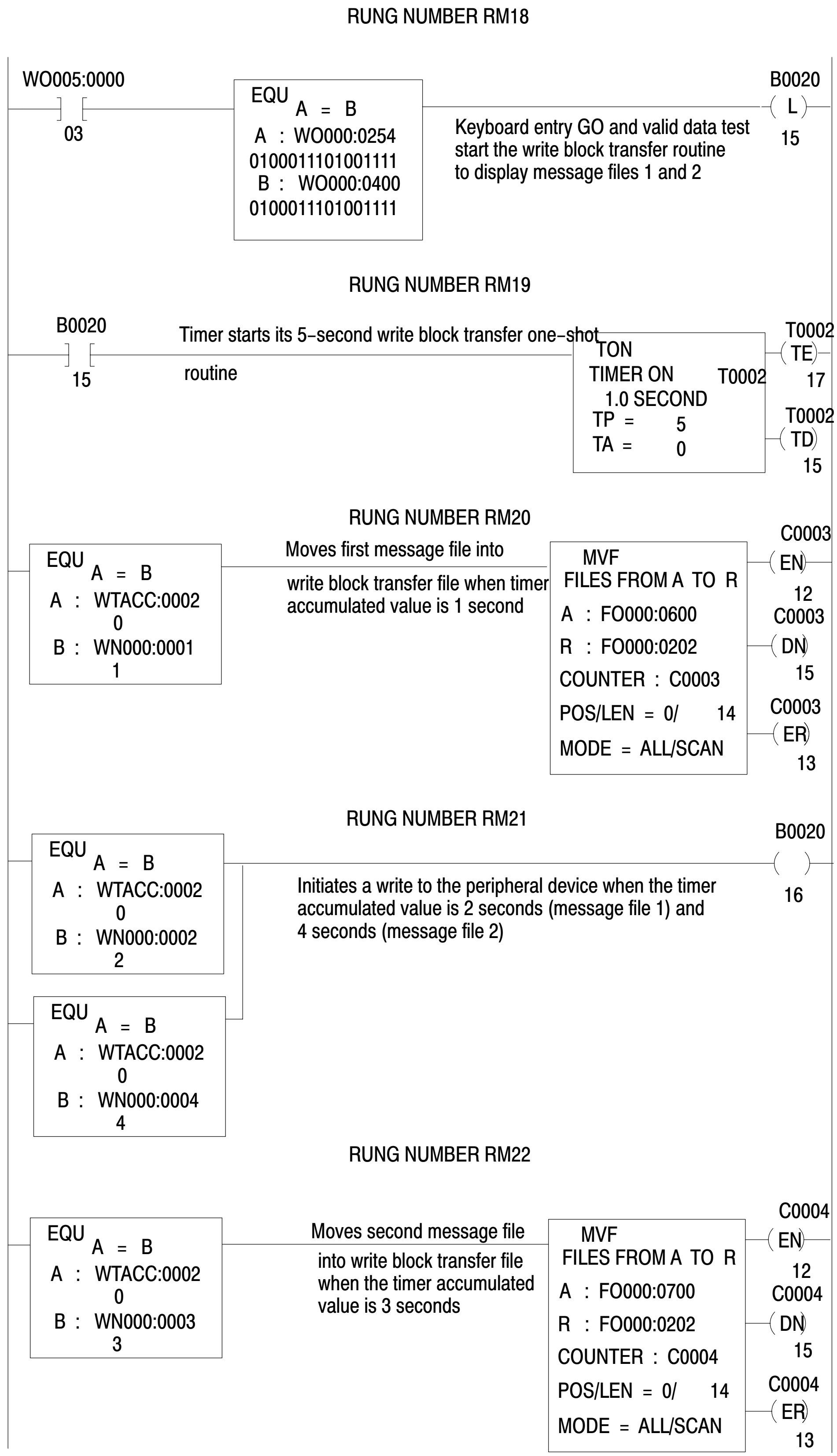
When the string of data containing GO is transmitted to the ASCII module's input buffer, the module sets the new data flag (SW2>0), and transfers data and the new data flag to the processor data table.

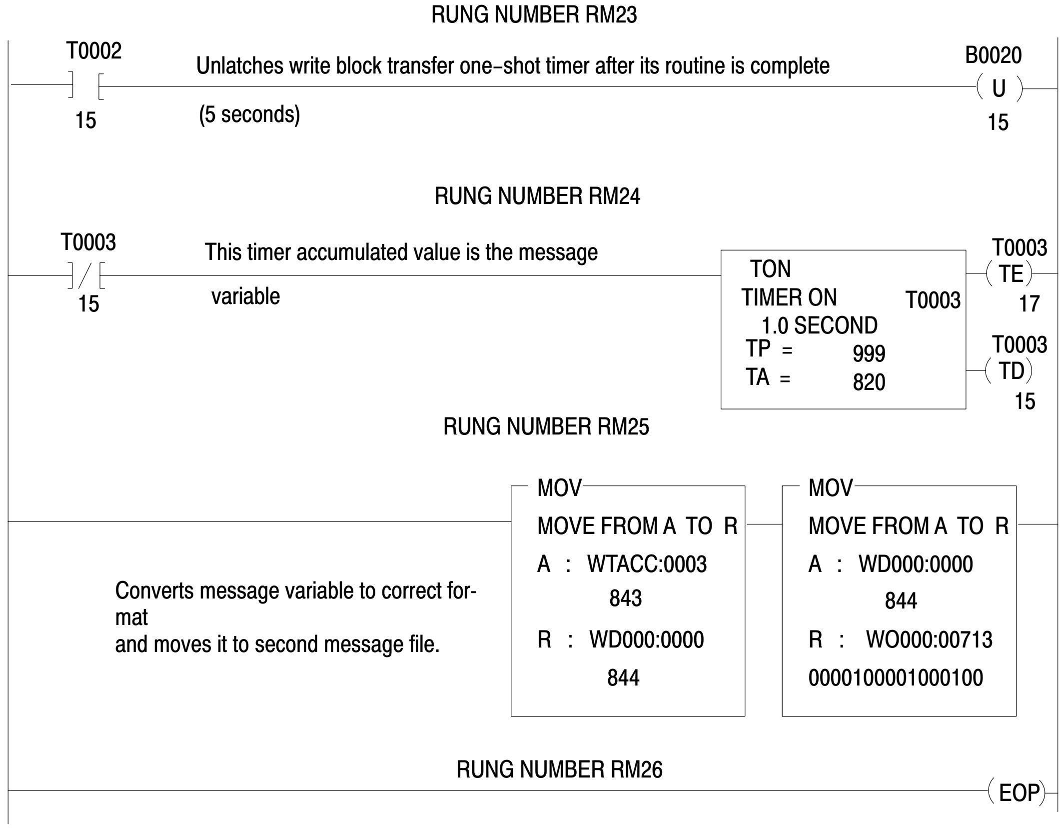
Figure B.12
Example Application Program




RUNG NUMBER RM5
O0252
O0200
15
15
O0252
O0200
15
15
B0035
00
RUNG NUMBER RM6
Read handshake rungs
B0035
O0252
00
15
O0200
L
15
RUNG NUMBER RM7
B0035
O0252
00
15
O0200
U
15
RUNG NUMBER RM8
Write handshake rungs
When B20/16 is high, data is written to the module
B0020
B0020
16
00
B0020
01
RUNG NUMBER RM9
B0020
01
B0020
L
00
RUNG NUMBER RM10
B0020
16
B0020
U
00
RUNG NUMBER RM11
B0020
O0252
01
16
O0200
L
16
RUNG NUMBER RM12
B0020
O0252
01
16
O0200
U
16


RUNG NUMBER RM13
WB001:0000
15
WB001:0000
05
Write command words 1 & 2 initialization data and message data
BTR
BLOCK XFER READ
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO000:0252
LENGTH = 16
CNTL: FB001:0000
CNTL
EN
12
CNTL
DN
15
CNTL
ER
13
WB001:0000
17
BTW
BLOCK XFER WRITE
RACK : 001
GROUP : 1
MODULE: 1 = HIGH
DATA : FO000:0200
LENGTH = 16
CNTL: FB001:0000
CNTL
EN
02
CNTL
DN
05
CNTL
ER
03
RUNG NUMBER RM14
BO020
10
Moves four–word initialization file to the write block transfer instruction
MVF
FILES FROM A TO R
A : FO000:0570
R : FO000:0202
COUNTER : C0001
POS/LEN = 0/ 4
MODE = ALL/SCAN
C0001
EN
12
C0001
DN
15
C0001
ER
13
RUNG NUMBER RM15
B0020
10
CW1(17) is the initialization bit
O0200
17
RUNG NUMBER RM16
B0020
02
RUNG NUMBER RM17
NEQ
A < > B
A : WO000:0253
0000000000000000
B : WB00:0327
0000000000000000
WB001:000
15
B0035
00
Test for new valid data
WO005:0000
03


RUNG NUMBER RM18
WO005:0000
03
EQU
A = B
A : WO000:0254
0100011101001111
B : WO000:0400
0100011101001111
Keyboard entry GO and valid data test start the write block transfer routine to display message files 1 and 2
B0020
L
15
RUNG NUMBER RM19
B0020
15
Timer starts its 5-second write block transfer one-shot routine
TON
TIMER ON
1.0 SECOND
TP = 5
TA = 0
T0002
T0002
TE
17
T0002
TD
15
RUNG NUMBER RM20
EQU
A = B
A : WTACC:0002
0
B : WN000:0001
1
Moves first message file into write block transfer file when timer accumulated value is 1 second
MVF
FILES FROM A TO R
A : FO000:0600
R : FO000:0202
COUNTER : C0003
POS/LEN = 0/ 14
MODE = ALL/SCAN
C0003
EN
12
C0003
DN
15
C0003
ER
13
RUNG NUMBER RM21
EQU
A = B
A : WTACC:0002
0
B : WN000:0002
2
EQU
A = B
A : WTACC:0002
0
B : WN000:0004
4
Initiates a write to the peripheral device when the timer accumulated value is 2 seconds (message file 1) and 4 seconds (message file 2)
B0020
16
RUNG NUMBER RM22
EQU
A = B
A : WTACC:0002
0
B : WN000:0003
3
Moves second message file into write block transfer file when the timer accumulated value is 3 seconds
MVF
FILES FROM A TO R
A : FO000:0700
R : FO000:0202
COUNTER : C0004
POS/LEN = 0/ 14
MODE = ALL/SCAN
C0004
EN
12
C0004
DN
15
C0004
ER
13



Addresses Used in Example Application Program

The following addresses are used in NO TAG for files, the message variable, and timers. Initialization data is also shown.

Message file 1	FO000:0600-0615	Initialization
Message file 2	FO000:0700-0715	Words
Message variable	FO000:0713	
Write block transfer file	FO000:0200-0217	IW1 0007
Read block transfer file	FO000:0252-0271	IW2 1028
Initialization file	FO000:0570-0573	IW3 OD08
Write block transfer timer	T0002	IW4 2A00
Message variable timer	T0003	

ASCII Conversion Tables

Table C.A
Hex/Binary/ASCII Conversion

Hex	Binary	ASCII	Hex	Binary	ASCII	Hex	Binary	ASCII
00	0000000	NUL	2A	0101010	*	55	1010101	U
01	0000001	SOH	2B	0101011	+	56	1010110	V
02	000010	STX	2C	0101100	,	57	1010111	W
03	0000011	ETX	2D	0101101	–	58	1011000	X
04	0000100	EOT	2E	0101110	.	59	1011001	Y
05	0000101	ENQ	2F	0101111	/	5A	1011010	Z
06	0000110	ACK	30	0110000	0	5B	1011011	[
07	0000111	BEL	31	0110001	1	5C	1011100	\
08	0001000	BS	32	0110010	2	5D	1011101	]
09	0001001	HT	33	0110011	3	5E	1011110	^
0A	0001010	LF	34	0110100	4	5F	1011111	_
0B	0001011	VT	35	0110101	5	60	1100000	\
0C	0001000	FF	36	0110110	6	61	1100001	a
0D	0001101	CR	37	0110111	7	62	1100010	b
0E	0001110	SO	38	0111000	8	63	1100011	c
0F	0001111	SI	39	0111001	9	64	1100100	d
10	0010000	DLE	3A	0111010	:	65	1100101	e
11	0010001	DC1	3B	0111011	;	66	1100110	f
12	0010010	DC2	3C	0111100	<	67	1100111	g
13	0010011	DC3	3D	0111101	=	68	1101000	h
14	0010100	DC4	3E	0111110	>	69	1101001	i
15	0010101	NAK	3F	0111111	?	6A	1101010	j
16	0010110	SYN	40	1000000	@	6B	11010111	k
17	0010111	EB	41	1000001	A	6C	1101100	l
18	0011000	CAN	42	1000010	B	6D	1101101	m
19	0011001	EM	43	1000011	C	6E	1101110	n
1A	0011010	SUB	44	1000100	D	6F	1101111	o
1B	0011011	ESC	45	1000101	E	70	1110000	p
1C	0011100	FS	46	1000110	F	71	1110001	q
1D	0011101	GS	47	1000111	G	72	1110010	r
1E	0011110	RS	48	1001000	H	73	1110011	s
1F	0011111	US	49	1001001	I	74	1110100	t
20	0100000	SP	4A	1001010	J	75	1110101	u
21	0100001	!	4B	1001011	K	76	1110110	v
22	0100010	“	4C	1001100	L	77	1110111	w
23	0100011	#	4D	1001101	M	78	1111000	x
24	0100100	$	4E	1001110	N	79	1111001	y
25	0100101	%	4F	1001111	O	7A	1111010	z
26	0100110	&	50	1010000	P	7B	1111011	{
27	0100111	’	51	1010001	Q	7C	1111100	|
28	0101000	(	52	1010010	R	7D	111101	}
29	0101001	)	53	1010011	S	7E	111110	~
			54	1010100	T	7F	1111111	DEL

Table C.B
Decimal/Octa/Hex ASCII Conversion

DECIMAL	OCTAL	HEX	ASCII CHARACTER OR CONTROL
0	0	0	CONTROL SHIFT P, NULL
1	1	1	CONTROL A
2	2	2	CONTROL B
3	3	3	CONTROL C
4	4	4	CONTROL D
5	5	5	CONTROL E
6	6	6	CONTROL F
7	7	7	CONTROL G, RINGS BELL
8	10	8	CONTROL H, BACKSPACE ON SOME TERMINALS
9	11	9	CONTROL I, HORIZONTAL TAB ON SOME TERMINALS
10	12	A	CONTROL J, LINE FEED
11	13	B	CONTROL K
12	14	C	CONTROL L, FORM FEED ON SOME TERMINALS
13	15	D	CONTROL M, CARRIAGE RETURN
14	16	E	CONTROL N
15	17	F	CONTROL O
16	20	10	CONTROL P
17	21	11	CONTROL Q
18	22	12	CONTROL R
19	23	13	CONTROL S
20	24	14	CONTROL T
21	25	15	CONTROL U
22	26	16	CONTROL V
23	27	17	CONTROL W
24	30	18	CONTROL X
25	31	19	CONTROL Y
26	32	1A	CONTROL Z
27	33	1B	CONTROL SHIFT K, ESCAPE
28	34	1C	CONTROL SHIFT L
29	35	1D	CONTROL SHIFT M
30	36	1E	CONTROL SHIFT N
31	37	1F	CONTROL SHIFT O
32	40	20	SPACE
33	41	21	!
34	42	22	“
35	43	23	#
36	44	24	$
37	45	25	%
38	46	26	&
39	47	27	’
40	50	28	(
41	51	29	)
42	52	2A	*
43	53	2B	+
44	54	2C	,
45	55	2D	–
46	56	2E	.
47	57	2F	/
48	60	30	0
49	61	31	1
50	62	32	2
51	63	33	3

DECIMAL	OCTAL	HEX	ASCII CHARACTER OR CONTROL
52	64	34	4
53	65	35	5
54	66	36	6
55	67	37	7
56	70	38	8
57	71	39	9
58	72	3A	:
59	73	3B	;
60	74	3C	<
61	75	3D	=
62	76	3E	>
63	77	3F	?
64	100	40	@
65	101	41	A
66	102	42	B
68	103	43	C
69	104	44	D
60	105	45	E
70	106	46	F
71	107	47	G
72	110	48	H
73	111	49	I
74	112	4A	H
75	113	4B	J
76	114	4C	K
77	115	4D	M
78	116	4E	N
79	117	4F	O
80	120	50	P
81	121	51	Q
82	122	52	R
83	123	53	S
84	124	54	T
85	125	55	U
86	126	56	V
87	127	67	W
88	130	68	X
89	131	69	Y
90	132	5A	Z
91	133	5B	[
92	134	5C	\
93	135	5D	]
94	136	5E	^
95	137	5F	_
96	140	60	\
97	141	61	a
98	142	62	b
99	143	63	c
100	144	64	d

DECIMAL	OCTAL	HEX	ASCII CHARACTER OR CONTROL
101	145	65	e
102	146	66	f
103	147	67	g
104	150	68	h
105	151	69	i
106	152	6A	j
107	153	6B	k
108	154	6C	l
109	155	6D	m
110	156	6E	n
111	157	6F	o
112	160	70	p
113	161	71	q
114	162	72	r
115	163	73	s
116	164	74	t
117	165	75	u
118	166	76	v
119	167	77	w
120	170	78	x
121	171	79	y
122	172	7A	z
123	173	7B	{
124	174	7C	|
125	175	7D	}
126	176	7E	~
127	177	7F	DEL

Table C.C
ASCII Control Codes

Control Code (1)	Display(2)	ASCII	Name
CTRL 0	NU	NUL	NULL
CTRL A	SH	SOH	START OF HEADER
CTRL B	SX	STX	START OF TEXT
CTRL C	EX	ETX	END OF TEXT
CTRL D	ET	EOT	END OF TRANSMISSION
CTRL E	EQ	ENQ	ENQUIRE
CTRL F	AK	ACK	ACKNOWLEDGE
CTRL G	BL	BEL	BELL
CTRL H	BS	BS	BACKSPACE
CTRL I	HT	HT	HORIZONTAL TAB
CTRL J	LF	LF	LINE FEED
CTRL K	VT	VT	VERTICAL TAB
CTRL L	FF	FF	FORM FEED
CTRL M	CR	CR	CARRIAGE RETURN
CTRL N	SO	SO	SHIFT OUT
CTRL O	SI	SI	SHIFT IN
CTRL P	DL	DLE	DATA LINK ESCAPE
CTRL Q	D1	DC1	DEVICE CONTROL 1
CTRL R	D2	DC2	DEVICE CONTROL 2
CTRL S	D3	DC3	DEVICE CONTROL 3
CTRL T	D4	DC4	DEVICE CONTROL 4
CTRL U	NK	NAK	NEGATIVE ACKNOWLEDGE
CTRL V	SY	SYN	SYNCHRONOUS IDLE
CTRL W	EB	ETB	END OF TRANSMISSION BLOCK
CTRL X	CN	CAN	CANCEL
CTRL Y	EM	EM	END OF MEDIUM
CTRL Z	SB	SUB	SUBSTITUTE
ESCAPE	EC	ESC	ESCAPE
CTRL ,	FS	FS	FILE SEPARATOR
CTRL D	GS	GS	GROUP SEPARATOR
CTRL .	RS	RS	RECORD SEPARATOR
CTRL /	US	US	UNIT SEPARATOR
DELETE OR RUBOUT	+	DEL	DELETE

(1) Some ASCII control codes are generated using non-standard keystrokes.
(2) Will be displayed when Control Code Display option is set on.

Appendix D

Specifications

General Specifications
Function Interfaces a programmable controller with block transfer capability and an ASCII device For use as a Data Communications Equipment (DCE) **Available Interfaces** RS–232–C Current Loop, 20mA A–B Long Line **Communication Rates** User selectable: 110, 300, 600, 1200, 2400, 4800, 9600 baud **Buffer Memory** 1.5K words (3K bytes) **Module Location** 1771 I/O Chassis **Backplane Current Requirement** 1.3A **Environmental Conditions** Operational Temperature 32° to 140° F (0° to 60°C) Storage Temperature –40° to 185° F (–40° to 85° C) Relative Humidity 5% to 95% (without condensation) **Keying** Between 8 and 10 Between 30 and 32

Current Loop Specifications

Passive Receive CIrcuit
(pins 12 and 24)

Isolation:
3000Vdc between customer and PC system circuitry

500V/us common mode transient immunity

Input Current Range:
4.0mA to 20.0mA for mark state

0.0mA to 0.5mA for space state

Nominal Input Voltage Range:
1.51V @ 4mA to 2.05V @ 20mA for mark state

0.0V to 1.10V @ 0.5mA for space state

Reverse Input Voltage Limit:
5.0V between pins 12 and 24

No reverse voltage protection

Active Transmitter Circuit
(pins 13 and 11)

Isolation:
500Vdc between customer and PC system circuitry

Input Current Range:
23.0mA max for mark state (load must exceed 300 ohms)

0mA for space state

Passive Transmitter Circuit
(pins 11 and 18)

Isolation:
500Vdc between customer and PC system circuitry

Device and power supply must float referenced to module ground

Input Current Range:
55.0mA max for mark state (max voltage across pins 11 and l8 is 2.29, nominal is 1V@20mA)

0mA for space state

Reverse Voltage Limit:
2.7V across pins 11 and 18

RS-232-C Specifications
Receiver Circuit, Control: (pins 4, 7, and 20) **Isolation:** 500Vdc between customer and PC system circuitry **Typical Input Voltage Range**: +3 to +25Vdc for Request to Send or Data Terminal Ready –3 to –25Vdc for signal inhibit **Typical Input Impedance:** 3k to 7k ohms for +3 to +25Vdc, and –3 to –25Vdc
Receiver Circuit, Data: (pins 2 and 7) **Isolation:** 500Vdc between customer and PC system circuitry **Typical Input Voltage Range:** +3 to +25Vdc for space state –3 to –25Vdc for mark state **Typical Input Impedance:** 3k to 7k ohms for +3 to +25Vdc, and –3 to –25Vdc
Transmitter Circuit: (pins 3, 5, 6, and 7) **Isolation:** 500Vdc between customer and PC system circuitry **Output Voltage Range:** +5 to +15Vdc for space state –5 to –15Vdc for mark state

Symbols

A

B

C

D

E

F

H

I

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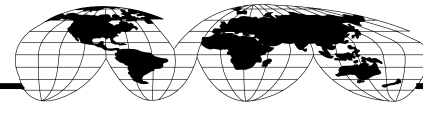

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