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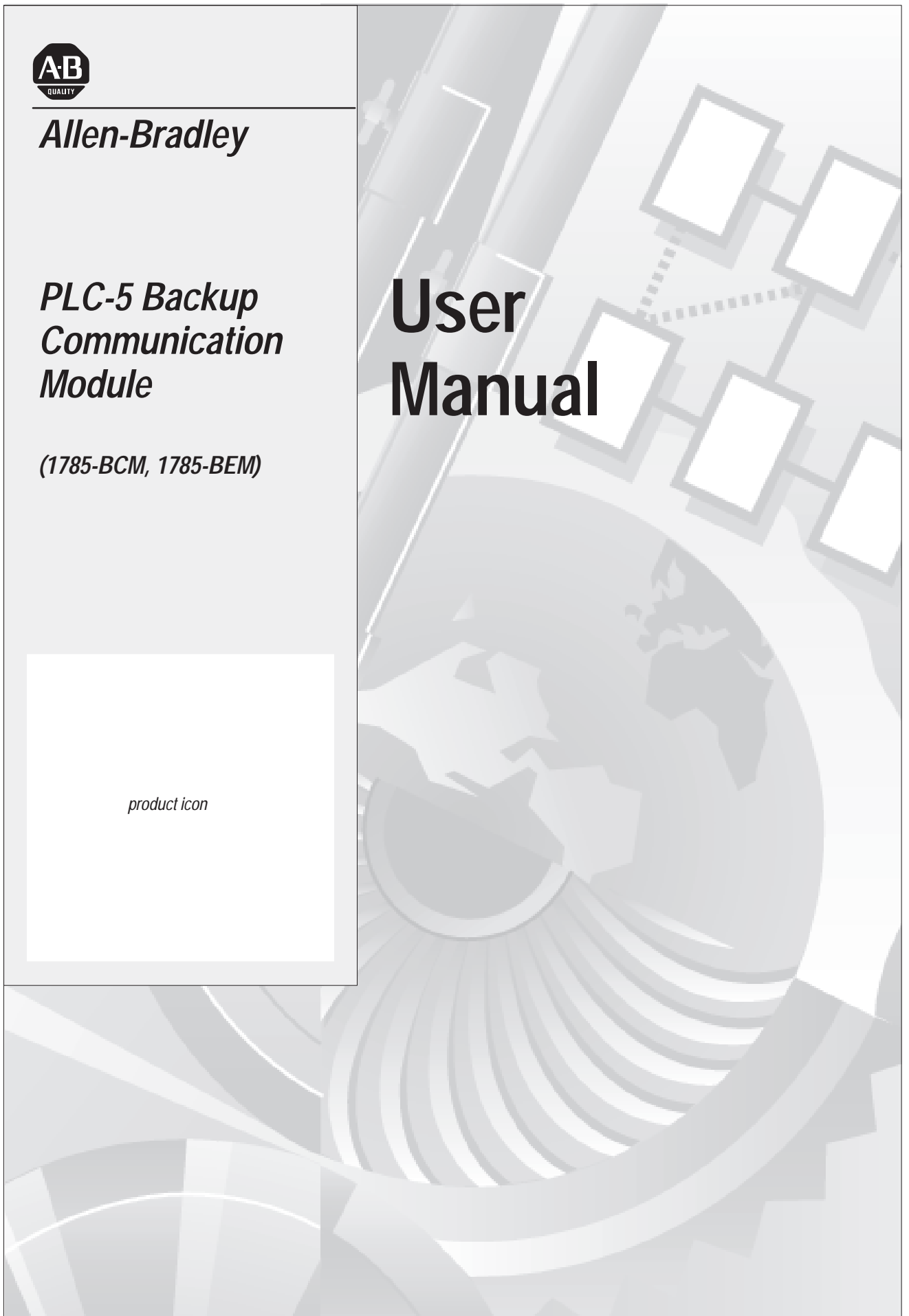
***PLC-5 Backup
Communication
Module***

(1785-BCM, 1785-BEM)



product icon

User Manual



Important User Information

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

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

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Throughout this manual we make notes to alert you to possible injury to people or damage to equipment under specific circumstances.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention helps you:

- Identify a hazard
- Avoid the hazard
- recognize the consequences

Important: Identifies information that is critical for successful application and understanding of the product.

Summary of Changes

Summary of Changes

This release of the publication contains new updated information.

To help you find updated information in this release of the manual, we have included change bars as shown to the left of this paragraph.

Using This Manual

Manual Objectives

This manual shows you how to use 1785-BCM series B backup communication modules with a PLC-5 programmable controller (PLC-5/15 series B, -5/20, -5/25, -5/30, -5/40, and -5/60 processors). These modules enable high-speed communication transfer between two PLC-5 processors and provide system backup should the processor or other equipment in the system fail.

In this manual we describe:

- backup system concepts
- procedures for installing and operating your modules
- various programming techniques

Audience

Before you read this manual or attempt to use 1785-BCM modules, you should be familiar with PLC-5 programmable controllers. In addition, you need to be familiar with:

- 6200 Series Software
- remote I/O system
- Data Highway Plus™ network
- block-transfer instructions

What this Manual Contains

The following table lists each chapter of this manual and describes the contents of each.

If you want to read about:	Refer to chapter:
an overview of backup concepts; description of backup system that uses 1785-BCM module.	1 – Backup Concepts for the PLC-5 System
a description of 1785-BCM module hardware.	2 – Understanding the 1785-BCM Module Hardware Components
procedures for installing the 1785-BCM module; procedures for connecting the backup system.	3 – Installing Your 1785-BCM Series B Backup System
description of 1785-BEM backup expansion module and procedures for installing	4 – Installing Your 1785-BEM Module
an overview of how the 1785-BCM module and the backup system operate; procedures for starting, powering-up, disconnecting, and restarting a repaired system.	5 – Operating Your PLC-5 Backup System
considerations for timing, divergence, I/O forces, Data Highway Plus switching, Remote I/O switching, special sections of the data table, and data integrity.	6 – Switchover Considerations

If you want to read about:	Refer to chapter:
two methods you can use to program your backup system; considerations for using instructions that can cause problems in your backup system.	7 – Programming Techniques
1785-BCM module faults (as indicated by the module's status indicators and bits of the system status word) and procedures for correcting faults.	8 – Diagnosing Faults
specifications for the 1785-BCM module.	9 – Specifications
sample Programs for method 1 (transferring one block of data at a time) and method 2 (transferring multiple blocks of data at a time); data table transfer times for both programming methods.	Appendix A – Sample Programs
answers to common PLC-5 backup system questions; delay times between the primary and the secondary processor for both programming methods and formulas for determining delay times.	Appendix B – Reference Information
describes differences between a 1785-BCM series A backup module and a 1785-BCM series B backup module	Appendix C – Using a Series A 1785-BCM Module

PLC-5 Processor Reference

In this manual, the term PLC-5 processor refers to the following processors:

- PLC-5/11
- PLC-5/15
- PLC-5/20
- PLC-5/25
- PLC-5/30
- PLC-5/40
- PLC-5/60
- PLC-5/80

Contact your Allen-Bradley Sales Office or your Allen-Bradley distributor for additional PLC-5 processors that can be configured with the 1785-BCM modules.

Terms and Conventions

Some terms used in this manual may be unfamiliar to you. We list these terms with a brief definition of each.

- **HSSL** is the 1785-BCM module's High-Speed Serial Link. It is a dedicated communication link between the primary and secondary 1785-BCM modules and is used to pass I/O, status, and data table information.
- **Primary System** is the PLC-5 processor that controls the I/O and the other equipment associated with that processor.
- **Secondary System** is the PLC-5 processor that is ready to assume control of the I/O and the equipment associated with that processor.
- **Backup System** is the primary and secondary systems.

- **Switchover** is the transfer of I/O control from the primary processor to the secondary processor.
- **Bumpless switchover** is the transfer of I/O control from the primary processor to the secondary processor where the operation of the process being controlled is not affected.
- **Asynchronous processing** is processing where the ladder program scan and the block-transfer scan operate independently of each other within the same scan time.
- **BTW** is block-transfer write; transfer of up to 64 words from the processor to the block-transfer module.
- **BTR** is block transfer read; transfer of up to 64 words from the block transfer module to the processor.
- **Smart Switch Interface** is a remote I/O interface in the 1785-BCM module that responds to secondary scanner poll commands with actual input values from the remote I/O link, making the scanner think it is talking with remote I/O.

Related Publications

For more information about components used with the 1785-BCM module in a PLC-5 backup system, refer to the following publications:

Publication Title	Publication Number
Enhanced and Ethernet PLC-5 Programmable Controllers User Manual	1785-6.5.12
Classic 1785 PLC-5 Family Programmable Controllers Hardware Installation Manual	1785-6.6.1
PLC-5 Programming Software Documentation Set	6200-N8.001
PLC-5 Programming Software: Installing and Configuring the Software	6200-6.4.6
PLC-5 Programming Software: Programming	6200-6.4.7
PLC-5 Programming Software: Instruction Set Reference	6200-6.4.11
PLC-5 Programming Software: I/O Configuration Software	6200-6.4.12
Remote I/O Adapter Module (cat. no. 1771-ASB) Installation Data	1771-2.162

Table of Contents

Backup Concepts for the PLC-5 System

Chapter 1
Chapter Objectives 1-1
Why Use a Backup System? 1-1
Applying 1785-BCM Backup Communication Modules to the PLC-5 Programmable Controller 1-2
What to do Next 1-7

Understanding the 1785-BCM Hardware Components

Chapter 2
Chapter Objectives 2-1
Status Indicators 2-1
Wiring Arm 2-2
Communication Links 2-2
Customer Relay 2-5
Switch Assemblies 2-6
I/O Backplane Interface 2-7
What to Do Next 2-7

Installing Your PLC-5 Backup System

Chapter 3
Chapter Objectives 3-1
PLC-5 Backup System Installation Overview 3-1
Determining Power Supply Requirements 3-3
Setting the I/O Chassis Switches 3-4
Terminating the Data Highway Plus and Remote I/O Links 3-4
Installing the 1785-BCM Module 3-5
Connecting Your PLC-5 Backup System 3-9
What to Do Next 3-19

Installing Your 1785-BEM Module

Chapter 4
Chapter Objectives 4-1
Backup Expansion Module 4-1
Hardware Components 4-1
Determining Power Supply Requirements 4-6
Installing the 1785-BEM Module 4-7
Connecting Your 1785-BEM Module 4-13
What to Do Next 4-21

Table of Contents

Operating Your PLC-5 Backup System	Chapter 5	
	Chapter Objectives	5-1
	How the 1785-BCM Module Operates	5-1
	How the Backup System Operates	5-13
	Starting the Backup System	5-17
	Powering Up the Backup System	5-18
	Disconnecting/Repairing a Faulted Backup System	5-18
	Restarting a Repaired Backup System	5-19
	Switching the Processor's Operating Mode	5-19
	Editing or Programming On-line	5-20
What to Do Next	5-20	
Switchover Considerations	Chapter 6	
	Chapter Objectives	6-1
	Timing Requirements	6-1
	Divergence	6-3
	Forcing I/O	6-4
	Data Highway Plus Switching	6-4
	Remote I/O Switching	6-6
	Data Table Considerations	6-9
	Data Integrity	6-10
	What to Do Next	6-12
Programming Techniques	Chapter 7	
	Chapter Objectives	7-1
	Getting Started	7-1
	Programming Methods to Transfer Data Table Values	7-3
	Accounting for Instructions That Could Cause Problems During Switchover	7-9
	Summary of Programming Considerations	7-13
Diagnosing Faults	Chapter 8	
	Chapter Objectives	8-1
	Diagnosing Faults with the Status Indicators	8-1
	Diagnosing Faults with Bits of the System Status Word	8-4
Specifications	Chapter 9	
	Specifications	9-1

Table of Contents

Sample Programs

Appendix A

Appendix Objectives A-1
Method 1 Sample – Transferring Data One Block at a Time A-1
Method 2 Sample – Transferring Data Multiple Blocks at a Time A-13

Reference Information

Appendix B

Appendix Objectives B-1
Answers to PLC-5 Backup Configuration Questions B-1
Determining Data Table Transfer Time B-5

**Using a Series A 1785-BCM
Module**

Appendix C

Appendix Objectives C-1
1785-BCM Series A Backup Module Characteristics C-1

Backup Concepts for the PLC-5 System

Chapter Objectives

This chapter describes concepts for using a backup system with your programmable controller. In addition, this chapter provides an overview of a PLC-5 processor backup system that uses 1785-BCM backup communication modules and a system that also uses 1785-BEM backup expansion modules.

Why Use a Backup System?

The objective of any redundant system (backup system) is to improve the amount of up-time of a machine or process by ensuring consistent availability of that machine, and by reducing costs associated with equipment failure. By using this backup system, you can guard your application against shutdowns caused by the programmable controller.



ATTENTION: Backup does not protect you from faults caused by programming errors or system timeouts because such an error or timeout will also occur in the secondary processor.

The backup option is used where you must transfer the control of the process to a secondary system, without thereby interrupting the machine/process operation.

To guard against system shutdown, a backup system must provide:

- equipment with exceptional reliability
- automatic fault isolation
- minimal disturbance of the process when switching from the primary to the secondary system

Applying 1785-BCM Backup Communication Modules to the PLC-5 Programmable Controller

A PLC-5 system configured with 1785-BCM modules provides high speed backup communication and switchover of the Data Highway Plus and remote I/O links. In this section we:

- show a typical PLC-5 backup configuration
- explain how the backup system works
- describe the role of the 1785-BCM module (including 1785-BEM module)

A Typical PLC-5 Backup Configuration

You must use BCM series B, revision C or later if you are using PLC-5/20, -5/30, -5/40, or -5/60 processors.

A PLC-5 backup system contains two of each of the following hardware components:

- PLC-5 processor module

Processor: [*]	Catalog Number:
PLC-5/11 series A, revision B or later	1785-L11B
PLC-5/15 series B, any revision	1785-LT series B
PLC-5/20 series A, revision B or later	1785-L20B
PLC-5/25 any revision	1785-LT2
PLC-5/30 series A, revision C or later	1785-L30B
PLC-5/40 series A, revision F or later or series B, revision C or later	1785-L40B
PLC-5/60 series A, revision F or later or series B, revision C or later	1785-L60B
PLC-5/80 series C, revision A or later	1785-L80B

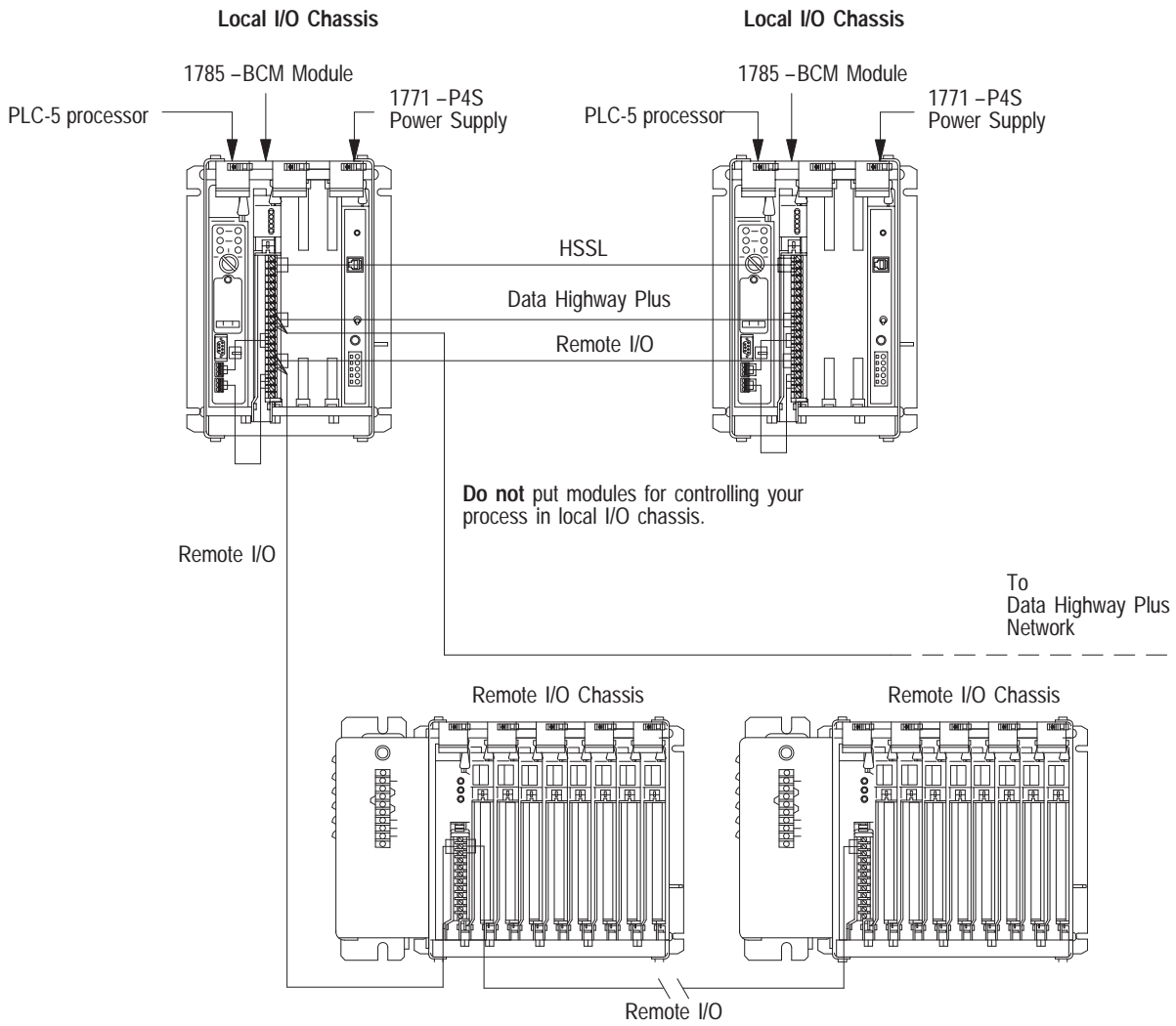
^{*} Contact your Allen-Bradley Sales Office or your Allen-Bradley distributor for additional PLC-5 processors that can be configured with the 1785-BCM modules.

- 1785-BCM module
- 1785-BEM module (when applicable)
- power supply
- local chassis

Figure 1.1 shows a typical PLC-5 backup configuration using PLC-5/15 processors and 1785-BCM modules. Figure 1.2 shows a typical PLC-5 backup configuration using PLC-5/40 or PLC-5/60 processors, 1785-BCM modules, and 1785-BEM modules.

Chapter 1 Backup Concepts for the PLC-5 System

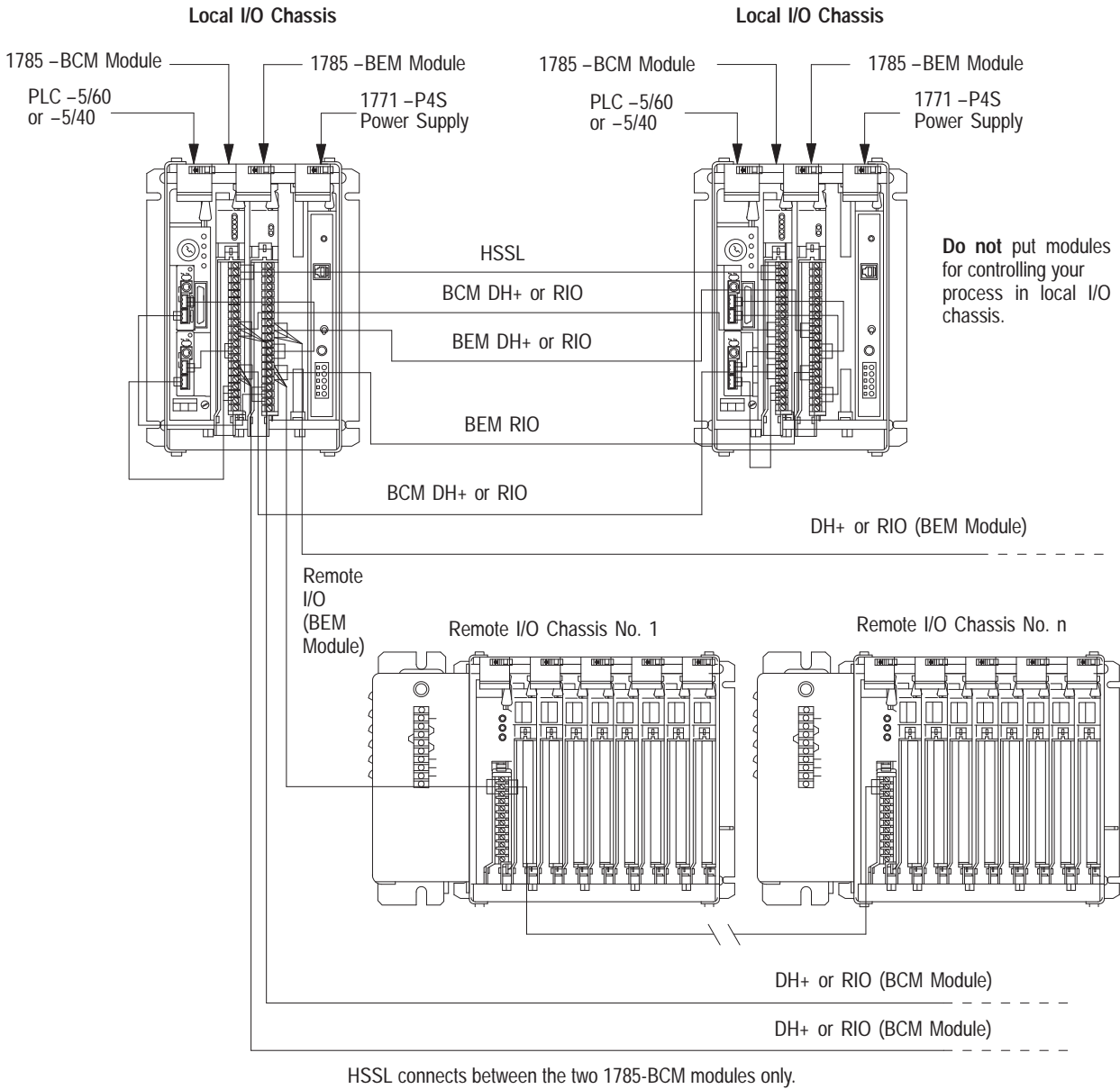
Figure 1.1
PLC-5 Backup System Configuration Using 1785-BCM Module Only



Applications that use more than two ports (PLC-5/40, or PLC-5/60 processors) may require a 1785-BEM module (not shown).

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Figure 1.2
PLC-5 Backup System Configuration Using 1785-BCM and 1785-BEM Modules



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How the PLC-5 Backup System Works

In the PLC-5 backup configuration, one system (consisting of one PLC-5 processor, 1785-BCM module, power supply, and chassis) controls the operation of the remote I/O. This system is referred to as the **primary system**. The other system is ready to take control of the remote I/O in the event of a fault in the primary system. This is referred to as the **secondary system**. The PLC-5 backup system does not back up local I/O; therefore, do not install I/O in the local chassis.

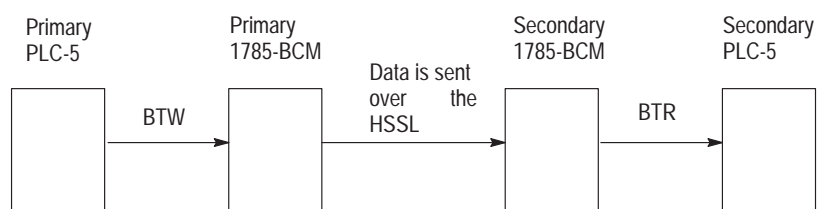
Data Transfer

During normal operation, the primary system sends remote input and data table data to the secondary system so that in the event of a switchover, the secondary system (which becomes the new primary system) has the same data.

Remote I/O data is automatically transferred over the High-Speed Serial Link (see Figure 1.1). This transfer is independent of the application program.

Data table values are transferred from the primary to the secondary system with block transfer instructions that you include in your ladder program. You do not have to transfer data table values if not necessary for your application. Figure 1.3 shows how data table data is transferred from the primary to the secondary system.

Figure 1.3
Transfer of Data Table Data From the Primary to Secondary System



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For detailed information about data transfer from the primary to the secondary system, refer to Chapter 5, “Operating Your PLC-5 Backup System.”

Switchover

Should a fault occur in the primary processor, control switches to the secondary system in less than 50 ms (maximum). When a switchover occurs, the outputs in the remote I/O maintain their last state until they come under the control of the secondary processor.

However, keep in mind that the program scans of the two processors are not synchronized. This means that the secondary processor may be scanning all, none, or only part of the program (at your discretion). This manual explains the switchover process, and provides guidelines for developing programs for your PLC-5 backup system. (For more information about switchover, refer to Chapter 6, “Switchover Considerations.”)

Role of the 1785-BCM Series B Module

As an integral part of the backup system, the 1785-BCM modules enable high speed communication between the two PLC-5 processors, and permit the secondary processor to assume control of the process. In addition, the 1785-BCM module provides:

- high speed transfer of the data table values from the primary to the secondary system, to ensure that the secondary system’s data table is a copy of the primary system’s
- a buffer of 4K words for data table values
- exchange of information on the status of the primary and secondary systems
- automatic transfer to the secondary system of the remote input and block transfer read values (analog values, etc.)
- transfer of control from the primary processor to the secondary processor when one of the following conditions occur:
 - power failure
 - processor fault
 - 1785-BCM module fault
 - change in the primary processor’s mode from:
 - RUN to PROGRAM (manual switchover)
 - REM RUN to REM PROG
 - REM RUN to REM TEST

- transfer of control from the primary processor to the secondary when one of the following conditions is detected by the secondary processor:
 - communication timeout in the High Speed Serial Link (HSSL) between the two 1785-BCM modules and primary system is not updating the remote I/O
 - transfer of control command from the primary 1785-BCM module
- substitution of equipment without interruption of the process; that is, the faulted system can be repaired while the other system is controlling the process
- connections for remote I/O and Data Highway Plus network (the 1785-BCM module routes the remote I/O network and the Data Highway Plus network to the active processor)
- isolation of the systems, in order to guarantee that a fault in one system does not affect the other
- diagnostics information
- remote programming capability for secondary processor
- capability of switching up to four configurable communication channels when using the 1785-BEM backup expansion module

Backup Expansion

The 1785-BCM module has two channels. The PLC-5/40 and PLC-5/60 processors have four communication channels. You can provide the backup of the other two processor channels by adding the 1785-BEM backup expansion module. For more information about the 1785-BEM backup expansion module, refer to Chapter 4.

Compatibility

The 1785-BCM series B backup module is compatible with the 1785-BCM series A backup module when you properly configure switch assembly SW1 and switch assembly SW2 of the series B module.

What to do Next

This chapter provided an overview of backup concepts and the PLC-5 backup system. Read chapter 2 to understand the 1785-BCM module hardware components.

Understanding the 1785-BCM Hardware Components

Chapter Objectives

This chapter describes the major components that make up the 1785-BCM module. These components include:

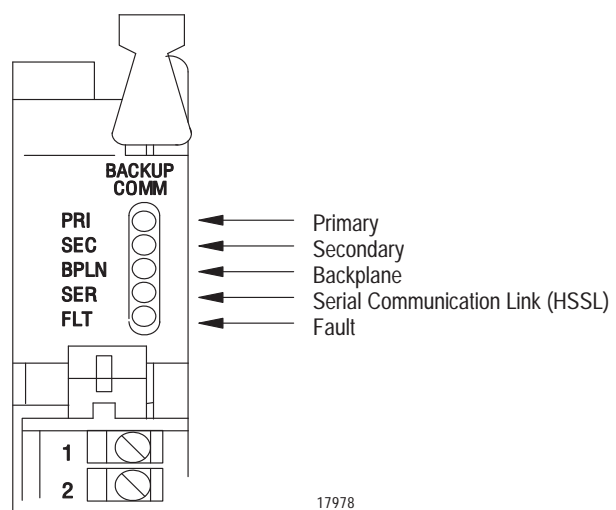
- status indicators
- 1771-WG wiring arm
- 1785-BCM communication links
 - high-speed serial link (HSSL)
 - Data Highway Plus link (DH+)
 - remote I/O link (RIO)
- customer relay (contact)
- switch assemblies
- backplane interface

Refer to Chapter 4 for information about the 1785-BEM backup expansion module.

Status Indicators

The 1785-BCM module has five status indicators on the front panel of the module (Figure 2.1). The indicators show both normal operation and error conditions of your PLC-5 backup system.

Figure 2.1
1785-BCM Module Status Indicators



All indicators light at power up or when a hardware fault occurs in the 1785-BCM module. With the exception of the FLT indicator, all of the 1785-BCM module's indicators are related to individual bits of the system status word. For more information on the system status word, refer to Chapter 5, "Operating Your PLC-5 Backup System."

For information about locating faults using the status indicators, refer to Chapter 8, "Diagnosing Faults".

Wiring Arm

You make connections to your communication links with the 1771-WG wiring arm, which is shipped with the module.

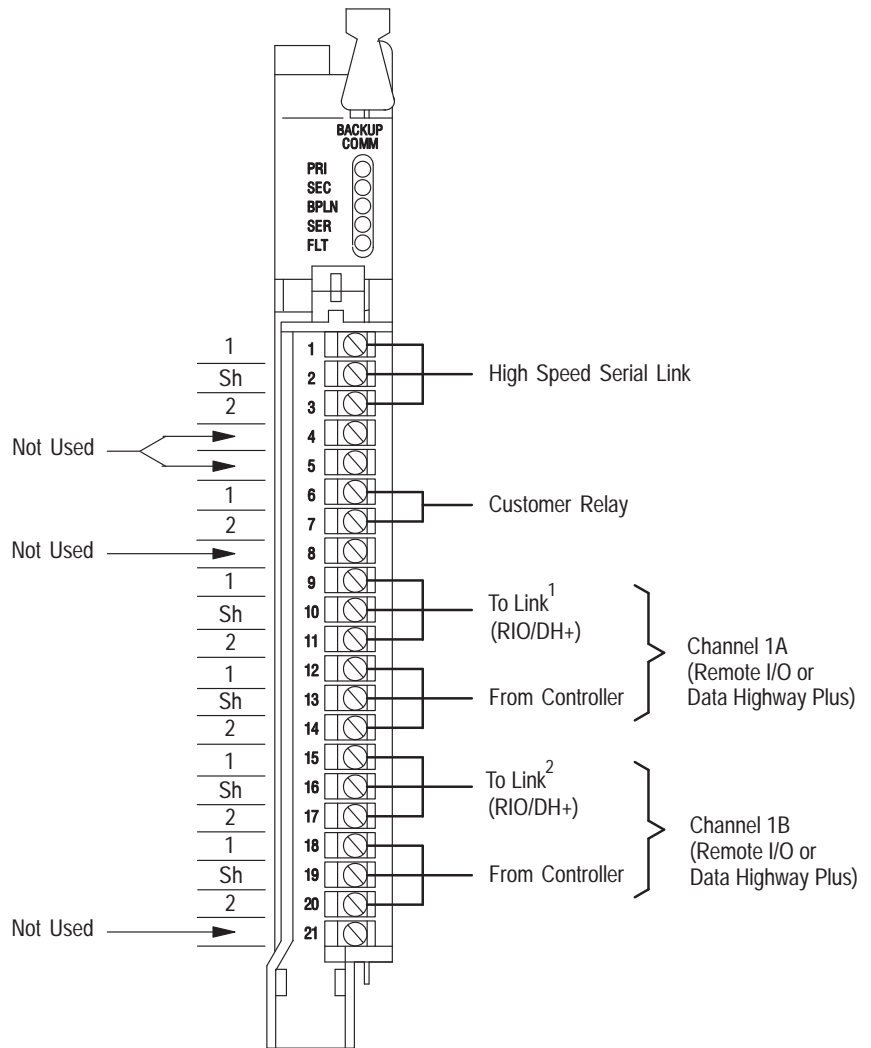
Your wiring arm attaches to the pivot bar on the bottom of the I/O chassis. It pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.

Communication Links

The 1785-BCM module has ports for three communication links for connection with the Remote I/O, Data Highway Plus network, and the other 1785-BCM module (Figure 2.2). In addition, the module has a relay for customer connection.

As shown in Figure 2.2, there are two user-configurable ports (Channels 1A and 1B) that support remote I/O or Data Highway Plus modes. Table 2.A lists the communication ports and describes how the system uses each one.

Figure 2.2
1785-BCM Module Communication Links



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- ¹ Terminals 9, 10, and 11 are connected between the 1785-BCM modules in the backup system; in addition terminals 9, 10, and 11 of one of the 1785 BCM modules are connected to the DH+ network or to the remote I/O link.
- ² Terminals 15, 16, and 17 are connected between the 1785-BCM modules in the backup system; in addition terminals 15, 16, and 17 of one of the 1785 BCM modules are connected to the DH+ network or to the remote I/O link.

Table 2.A
Communication Ports

Communication Port:	This link is used to:
High Speed Serial Link (HSSL)	permit two-way alternating communication (half-duplex) between the two 1785-BCM modules of the backup system at a distance of up to 15 feet.
Channel 1A	connect the primary PLC-5 processor to the Data Highway Plus network or to the remote I/O link; the secondary processor is isolated from this link.
Channel 1B	connect the primary PLC-5 processor to the Data Highway Plus network or to the remote I/O link; the secondary processor is isolated from this link.

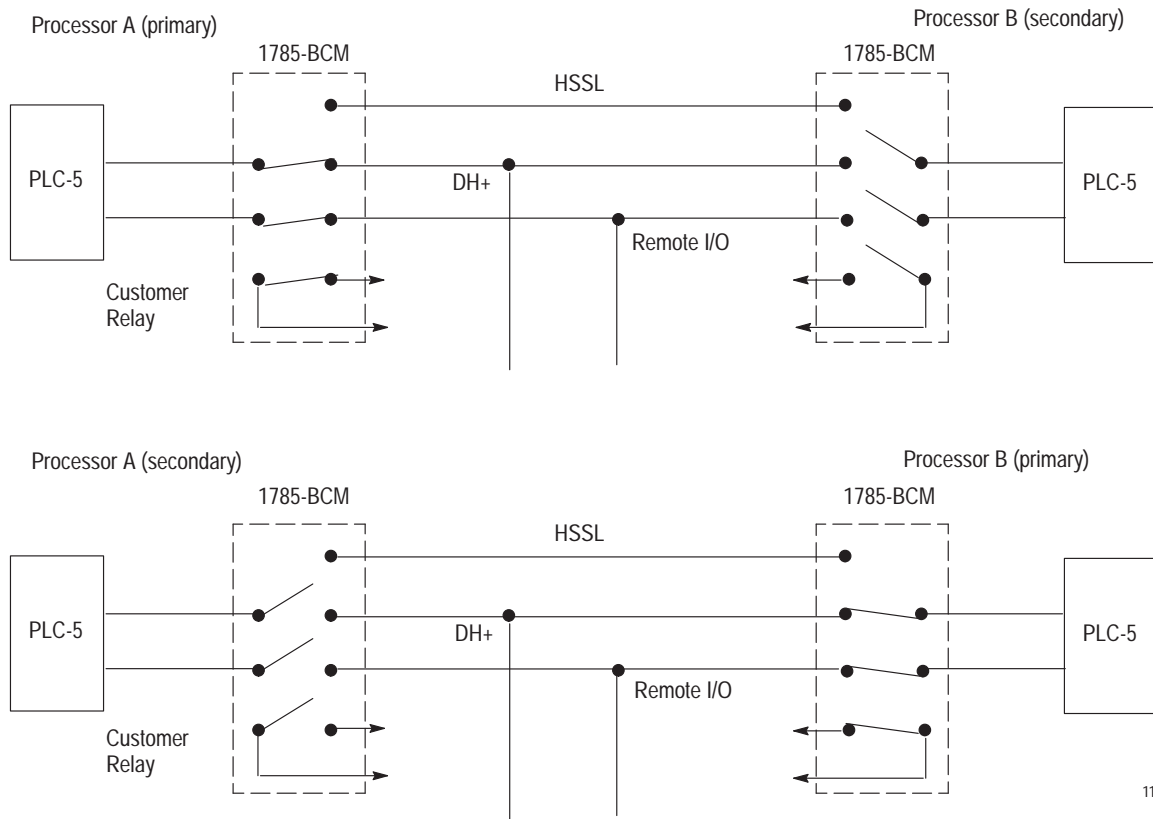
Channels 1A and 1B have a default communication mode which can be changed by resetting switches, if necessary. Table 2.B describes the default communication mode for each of the two channels.

Table 2.B
Default Communication Modes

Channel	Default Communication Mode
1A	Data Highway Plus
1B	Remote I/O – Scanner mode at 57.6 kbaud

With the exception of the HSSL, all of the connections in the 1785-BCM module have an internal relay whose contacts are closed when the controller is primary and open when the processor is secondary. Figure 2.3 shows these relays for processor A and processor B of a PLC-5 backup system.

Figure 2.3
Relays for Processor A and Processor B



Important: When using a 1785-BCM module with a PLC-5/40, PLC-5/60, or PLC-5/80 processor, you can add a 1785-BEM backup expansion module to provide backup for all processor communication channels. The channels of the 1785-BEM module, like the 1785-BCM module, can be configured for Data Highway Plus or remote I/O. For more information on the 1785-BEM backup expansion module, refer to Chapter 4.

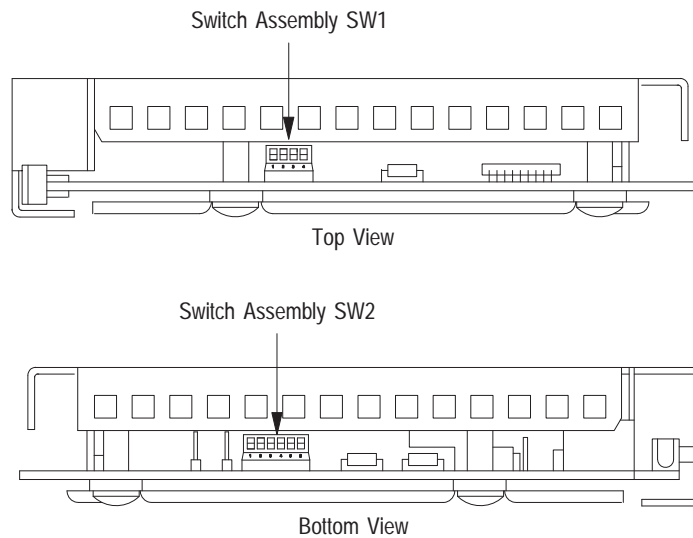
Customer Relay

The customer relay connection on the 1785-BCM module is used to switch external devices. Relay contacts are rated at .25A @ 24V dc **resistive**. Loads with inductive characteristics will require additional suppression devices.

Switch Assemblies

There are two switch assemblies located at the top and at the bottom of the 1785-BCM module. Refer to Figure 2.4 for locations of the switch assemblies. Refer to Table 2.C for a description of the function of the 1785-BCM module switch assemblies.

Figure 2.4
1785-BCM Module Switch Assemblies



19084

Table 2.C
1785-BCM Module Switch Assembly Functions

Use this switch assembly:	To:
SW1	<ul style="list-style-type: none"> establish communication between the 1785-BCM series B module and a 1785-BCM series A module. establish the fast data transfer mode from the secondary module to the secondary processor.
SW2	<ul style="list-style-type: none"> specify if Channels 1A and 1B are going to establish communication with Data Highway Plus network or with the remote I/O link. With the remote I/O link, determine the baud rate as well as the mode of operation of the processor (scanner or adapter).

To set the switches described above, refer to Chapter 5, “Operating Your PLC-5 Backup System.”

I/O Backplane Interface

Through its connection with the I/O chassis backplane, the 1785-BCM module can execute block transfer read (BTR) and block transfer write (BTW) instructions from a PLC-5 processor. With the inherent block-transfer queuing capabilities of the PLC-5 processor, multiple block-transfer instructions per program scan can be executed to the same 1785-BCM module.

What to Do Next

This chapter described the hardware components of the 1785-BCM module. Now that you are familiar with the module and some of the backup concepts for the PLC-5 backup system as described in chapter 1, you are ready to install the backup system. Chapters 3 and 4 describes installation procedures for the PLC-5 backup system (1785-BCM and 1785-BEM modules, respectively).

Installing Your PLC-5 Backup System

Chapter Objectives

This chapter provides an overview of an installed PLC-5 backup system and describes procedures for installing your PLC-5 backup system (1785-BCM series B module only). These procedures are:

- determining power supply requirements
- setting the I/O chassis switches
- setting the module switches
- installing the 1785-BCM module
- connecting the PLC-5 backup system

When installing a backup system for a PLC-5/40, PLC-5/60, or PLC-5/80 processor, you may choose to use a 1785-BEM backup expansion module to provide backup for the two additional channels of the processor. Refer to Chapter 4 for installation procedures for the 1785-BEM backup expansion module.

PLC-5 Backup System Installation Overview

Figure 3.1 shows a typical configuration of a PLC-5 backup system. In this system, communication between the controllers is accomplished through the two 1785-BCM modules. All of the cable connections between the primary and backup system require a 1770-CD (Belden 9463) cable.

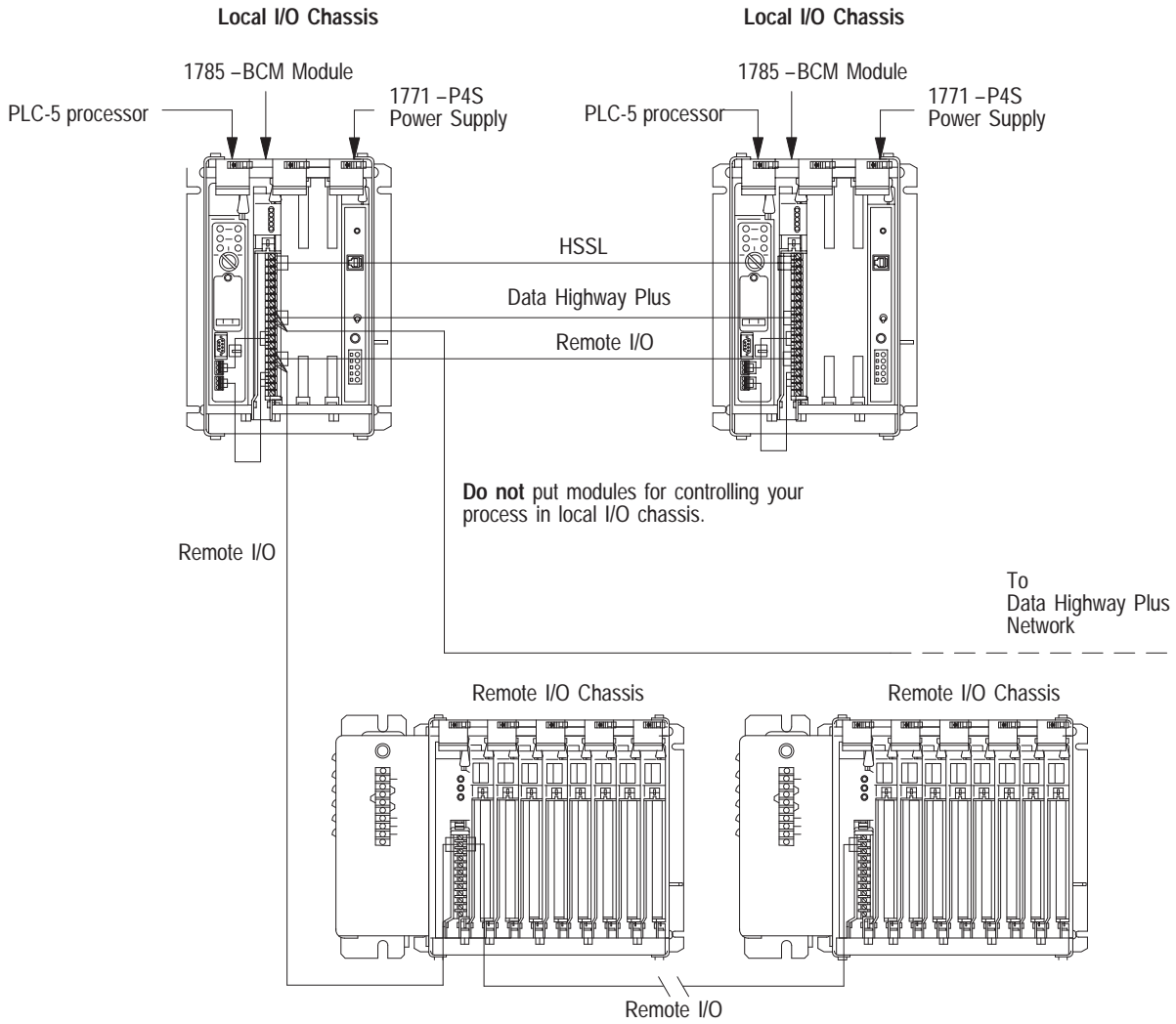
Important: Do not install I/O modules for controlling your process in the local chassis. Only the I/O modules residing in the remote chassis will be backed up. Local chassis are necessary for housing the processor, 1785-BCM backup communication module, 1785-BEM backup expansion module, and power supply for the backup system. Local I/O is **not** backed up.

When a coprocessor is in the same chassis (standalone mode) or directly connected to a PLC-5 processor (direct-connect mode), place the 1785-BCM and 1785-BEM modules in any other available I/O module group in that chassis

Important: Do not place the 1785-BCM module in the same module group (as defined by 2-slot addressing) as the coprocessor. The 1785-BCM module can reside in an adjacent slot, but not in the same module group (under the same chassis locking tab).

Chapter 3
Installing Your PLC-5 Backup System

Figure 3.1
PLC-5 Backup System Configuration



Some applications that use more than two ports (PLC-5/40, PLC-5/60, or PLC-5/80 processors) may require a 1785-BEM module (not shown).

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Determining Power Supply Requirements

The logic circuit of the 1785-BCM module is driven by a power supply through the backplane of the I/O chassis. Determine the power supply requirements for your PLC-5 backup system:

1. Add these values to determine output current needed from the power supply.
 - 1.0A at 5V for a 1785-BCM module **and**
 - 2.5A for the PLC-5/15 or PLC-5/25 processor **or**
3.3A for PLC-5/11, -5/20, -5/30, -5/40, -5/60, or -5/80 processor
2. Refer to Table 3.A to choose the power supply that provides sufficient power for all modules in your backup system.

Important: Refer to Chapter 4 to select your power supply when you add a 1785-BEM module in your backup system.

Table 3.A
Power Supplies for a PLC-5 Backup System

Power Supply	Output Current (in amps)	Power Supply Location
1771-P4	8	slot
1771-P4R ¹	8	slot
1771-P4S	8	slot
1771-P4S1	8	slot
1771-P5	8	slot
1771-P6S	8	slot
1771-P6S1	8	slot
1771-P6R	8	slot
1771-P7	16	external ²
1771-PS7	16	external ²

¹ A P4R redundant power supply can prevent system switchover due to power supply failures or incoming power failures.

² You cannot use an external power supply and a power supply module to power the same chassis; they are not compatible.

3. Use separate power sources for the primary and secondary processors. Connect the power supplies through different power sources to take precautions against interruptions and incoming power failures.

Setting the I/O Chassis Switches

The I/O chassis switch assembly is located on the left side of the chassis backplane. Table 3.B lists the settings we recommend for the local chassis of your PLC-5 backup system. (Local refers to the chassis with the PLC-5 processor and the 1785-BCM module.) You can set remote system switches for your specific application. For more information about setting your I/O chassis backplane switches refer to the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual (publication 1785-6.5.12).

Important: The addressing mode and local chassis size you select can affect the number of remote racks available. Refer to the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual (publication 1785-6.5.12) for the maximum number of remote racks that can be addressed by the PLC-5 processor(s) in your system.

Table 3.B
Recommended I/O Chassis Switch Settings for Local Chassis

Set switch(es)	To this position:
1	OFF – to turn off outputs in the chassis when a fault is detected.
2 and 3	both OFF – these switches are not used
4 and 5	4 – ON configure for 1/2-slot addressing* 5 – OFF configure for 1/2-slot addressing*
6 and 7	as required for your application
8	as required for your application

Important: * The 1785-BCM module appears to the PLC-5 processor as a 32-point input module. You must configure switches 4 and 5 for 1/2-slot addressing or 1-slot addressing. If not configured as 1/2- or 1-slot addressing, a PLC-5 processor fault will occur. If you are installing a 1785-BEM module, you must select 1/2-slot addressing.

Terminating the Data Highway Plus and Remote I/O Links

If your processor is an end device on the Data Highway Plus or remote I/O link, a terminator must be connected to the processor. In the PLC-5 backup system, you should set each PLC-5 processor in the backup system as if the other PLC-5 processor does not exist and no 1785-BCM modules are present. Terminate both links (DH+ and remote I/O):

- for a **PLC-5/15 or PLC-5/25 processor** using switch assembly SW3 on the PLC-5 processor. See Table 3.C.
- for a **PLC-5/11, -5/20, -5/30, -5/40, -5/60, or -5/80 processor** by installing an external resistor on the PLC-5 processor. See Table 3.D.

Table 3.C
Terminate PLC-5/15 or -5/25 Backup System DH+ and Remote I/O Links

Set SW3 switch	To this position:
1	ON – indicating that the PLC-5 processor is on the end of the remote I/O link
1	OFF – indicated that PLC-5 processor is not on the end of the remote I/O link
2	ON – indicating that PLC-5 processor is on the end of the DH+ link
2	OFF – indicating that PLC-5 processor is not on the end of the DH+ link

Table 3.D
Terminate PLC-5/11, -5/20, -5/30, -5/40, -5/60, or -5/80 Backup System DH+ and Remote I/O Links

For this kbaud:	Install this terminating resistor:
57.6 or 115.2 ¹	150 ohm, 1/2 watt resistor
230.4 ¹	82 ohm

¹ Refer to the Enhanced and Ethernet PLC-5 Programmable Controllers User Manual to install the terminating resistor.

Installing the 1785-BCM Module

To install the 1785-BCM module, you:

- key the I/O chassis
- set the switches of the module
- insert the module into the chassis

Electrostatic Discharge Damage



ATTENTION: Under some conditions, electrostatic discharge can degrade performance or damage the module. Observe the following precautions to guard against electrostatic damage.

- Wear an approved grounded wrist strap or touch a grounded object to discharge potential before handling the module.
- Do not touch the backplane connector or connector pins.
- If you configure or replace internal components, do not touch other circuit components inside the module. If available, use a static-free work station.
- When not in use, keep the module in a static-shielded bag.

Keying Your I/O Chassis

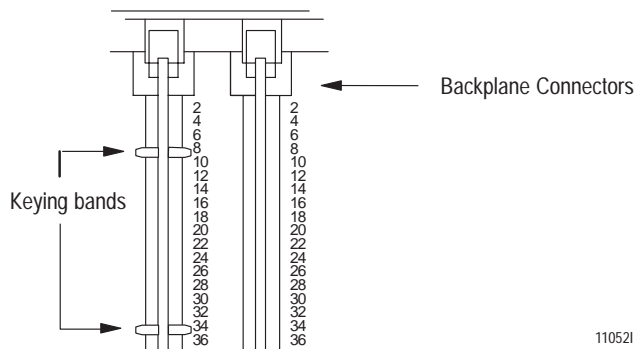
Use the plastic keying bands, shipped with each I/O chassis, to key the chassis slot to accept only the 1785-BCM module.

The module circuit board is slotted in two places on the rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. You can key any connector in an I/O chassis to receive this module except for the left-most connector reserved for the processor modules.

Place keying bands between the following numbers labeled on the backplane connector (Figure 3.2):

- Between 8 and 10
- Between 34 and 36

Figure 3.2
Keying Positions



Setting the 1785-BCM Series B Switch Assemblies

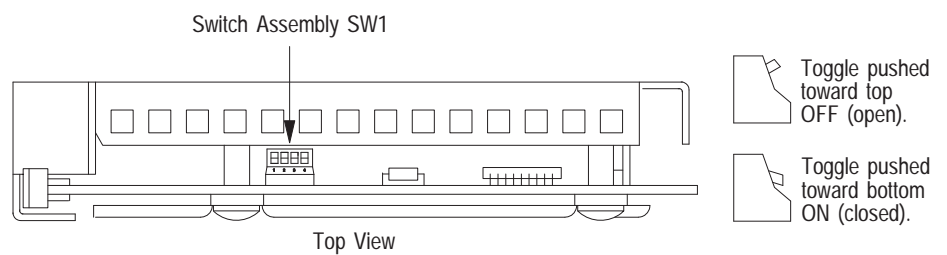
The **switch assembly SW1**, located at the top of the 1785-BCM module, has four switches as shown in Figure 3.3. Refer to Table 3.E for instructions on setting the four switches. The functions of the four switches are:

- **Switch 1** indicates to the 1785-BCM series B module whether the other 1785-BCM module is a series A or a series B module. If it is a series A module, functions of switches 2 through 4 will not apply.
- **Switch 2** selects the Fast Data-Transfer mode from the secondary module to the secondary processor (1785-BCM series B module only).
- **Switch 3** is not used.
- **Switch 4** is not used.

The 1785-BCM series B module switch assembly SW1 is preset at the factory to operate:

- with another 1785-BCM series B module
- in the Fast Data-Transfer mode. Fast data-transfer mode means that when the secondary module receives a data block, it immediately enables it to be read by the secondary processor.

Figure 3.3
1785-BCM Series B Switch Assembly SW1



19085

Table 3.E
Setting 1785-BCM Series B SW1 Switches

When:	Set this switch:	To this position:
the other 1785-BCM module is a series A	1 ¹	ON (closed)
		OFF (opened)
		OFF (opened)
		OFF (opened)
	2 ¹	OFF (opened)
		ON (closed)
		ON (closed)
		OFF (opened)
		ON (closed)
		OFF (opened)
the other 1785-BCM module is a series B	1	OFF (opened)
you want fast data transfer	2 ²	ON (closed)
you want the secondary BCM module to enable BTRs to the secondary PLC-5 processor only when all blocks of a multi-block segment have been received	2 ²	OFF (opened)

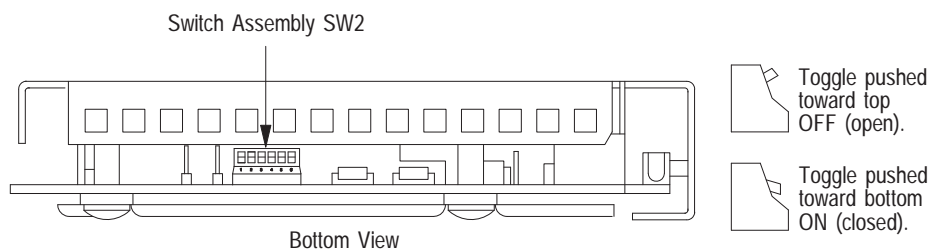
When:	Set this switch:	To this position:
switch 3 is always unused	3	OFF (opened)
switch 4 is always unused	4	OFF (opened)

¹ To be compatible with 1785-BCM series A modules, you must set these switches as shown. If you use this module with a series A module and do not set switch assembly SW2 as shown, the LEDs on the series B module will flash.

² This switch applies when both modules are 1785-BCM series B modules only.

The **switch assembly SW2**, located at the bottom of the 1785-BCM series B module, has six switches. The function of the six switches is to establish the configuration of Channels 1A and 1B of the module. Refer to Figure 3.4 for the location of SW2.

Figure 3.4
1785-BCM Series B Switch Assembly SW2



19086

Switches 1, 2, and 3 determine the configuration of Channel 1A. Switches 4, 5, and 6 determine the configuration of Channel 1B. These channels can be configured for Data Highway Plus or Remote I/O mode, either with the PLC-5 processor operating in adapter mode or in scanner mode.

The 1785-BCM series B module is shipped with Channel 1A configured for Data Highway Plus and Channel 1B configured for Remote I/O (to be used with a processor in scanner mode set at 57.6 kbaud).

Refer to Table 3.F to configure Channels 1A and 1B using switch assembly SW2 switches.

Table 3.F
Configuring 1785-BCM Series B Channels 1A and 1B using SW2

Configure Channel 1A switches ¹ Configure Channel 1B switches ² for:	1	2	3
	4	5	6
Data Highway Plus network at 57.6 kbaud (refer to Chapter 5, section "Secondary Processor Remote Programming")	ON	ON	ON
Remote I/O – adapter mode using 57.6 kbaud	ON	ON	OFF
Remote I/O – adapter mode using 115.2 kbaud	ON	OFF	ON
Remote I/O – adapter mode using 230.4 kbaud	ON	OFF	OFF
Relay switching or unused Channel ³	OFF	ON	ON
Remote I/O – scanner mode with 57.6 kbaud	OFF	ON	OFF
Remote I/O – scanner mode with 115.2 kbaud	OFF	OFF	ON
Remote I/O – scanner mode with 230.4 kbaud	OFF	OFF	OFF

¹ Switches 1, 2, and 3 determine configuration for Channel 1A.

² Switches 4, 5, and 6 determine configuration for Channel 1B.

³ Does not function as a smart switch but as a relay with contacts either opened or closed. Also, set the switches in this configuration if you are not going to use this channel.

Important: The positions of the switches are read at the module power-up. If the position of the switches is changed after module power-up, the 1785-BCM module does not recognize the new position.

Inserting the 1785-BCM Module into the I/O Chassis

To insert the 1785-BCM module in your I/O chassis, perform the following steps. We recommend that you insert your 1785-BCM module into the left-most slot of the first I/O module group in the I/O chassis.



ATTENTION: Remove power from the 1771 I/O chassis backplane and wiring arm before removing or installing an I/O module.

- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

1. Turn off power to the I/O chassis.
2. Place the module in the plastic tracks on the top and bottom of the slot that guides the module into position.
3. Do not force the module into its backplane connector. Apply firm, even pressure on the module to seat it properly.
4. Snap the chassis latch over the top of the module to secure its position.
5. Connect the wiring arm to the module.
6. Make wiring connections to the wiring arm as indicated in the next sections.

Connecting Your PLC-5 Backup System

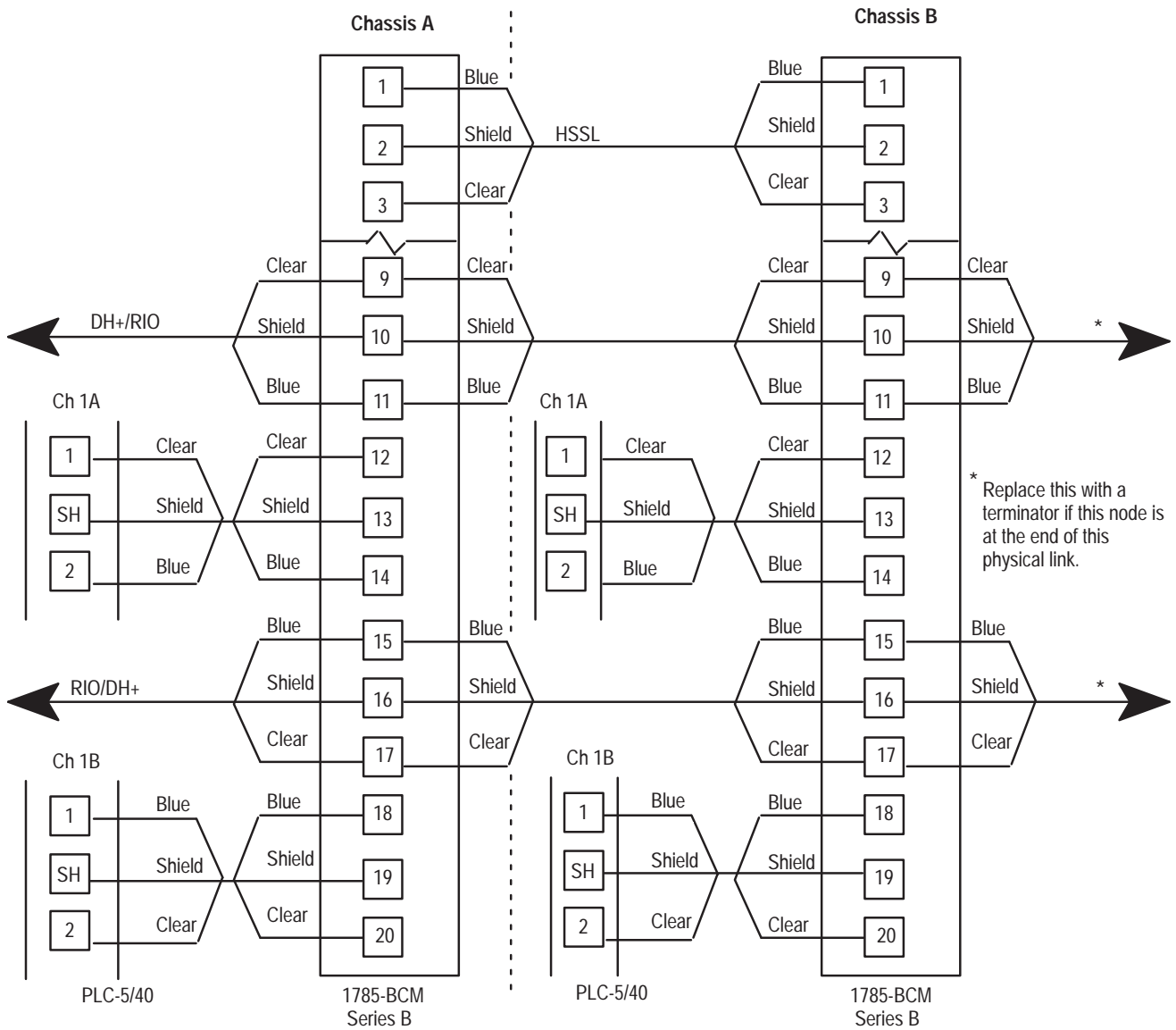
To connect your PLC-5 backup system, you:

- connect the 1785-BCM modules
- make remote I/O connections
- make Data Highway Plus network connections

You make the connections to the 1785-BCM module's wiring arm (cat. no. 1771-WG). Figure 3.5 shows an overview of the connections.

Important: Note that the connections described in the following paragraphs refer to the 1785-BCM module default configuration, that is Channel 1A is configured for Data Highway Plus and Channel 1B is configured for Remote I/O scanner mode.

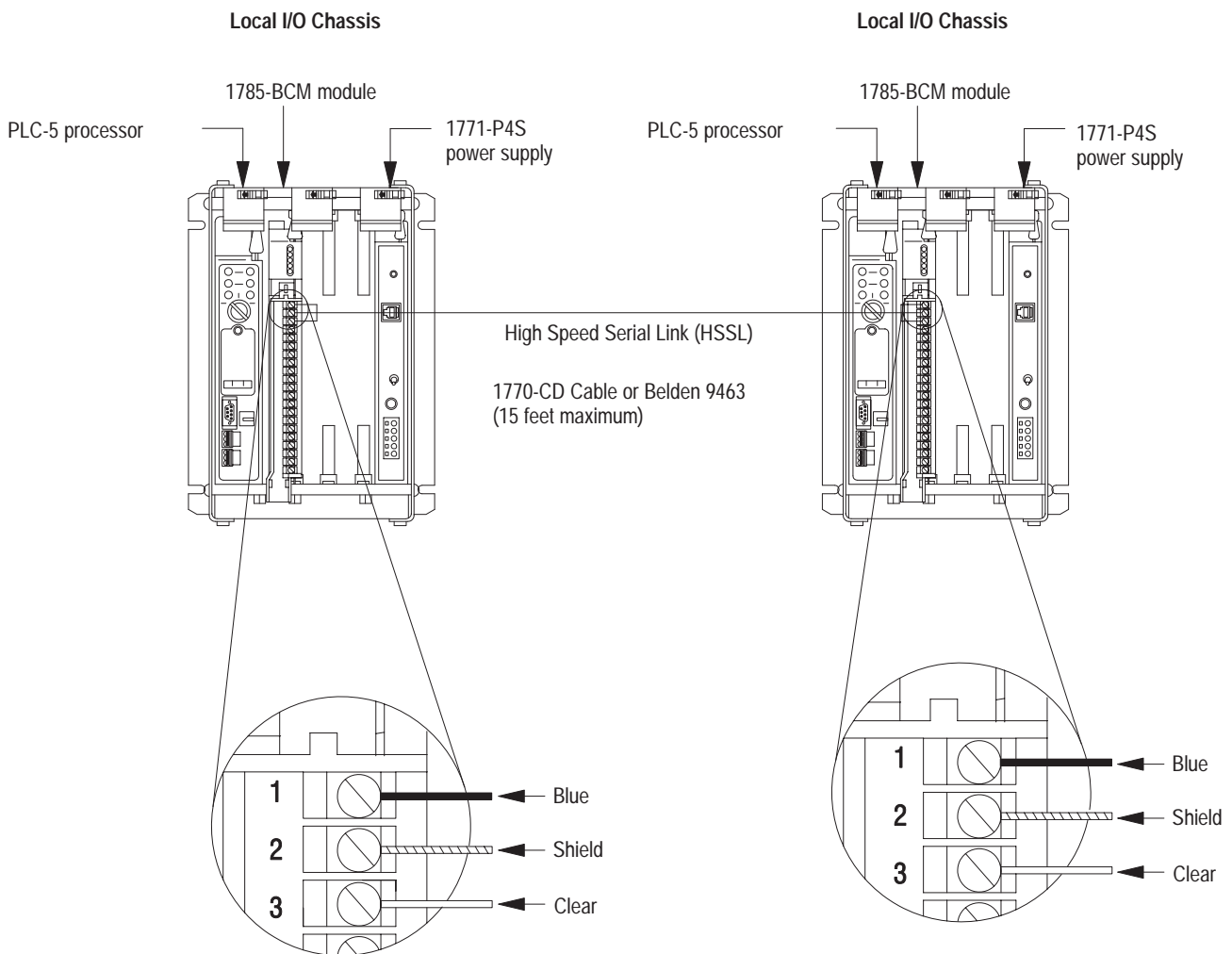
Figure 3.5
1785-BCM Module Connections



Connecting the 1785-BCM Modules

Connect the High Speed Serial Link (HSSL) to establish communication between the 1785-BCM modules of the primary system and the secondary system. The cable for these connections can be a maximum of 15 feet. To do this, connect a 1770-CD or Belden 9463 cable to terminals **1, 2, and 3** on the wiring arm of each 1785-BCM module as shown in Figure 3.6.

Figure 3.6
1785-BCM Module Connections for High-Speed Serial Link



Connections show default configuration with Channel 1A as Data Highway Plus and Channel 1B as Remote I/O Scanner.

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ATTENTION: The 1785-BCM series B module communicates with the 1785-BCM series A module only if switch 1 of the SW1 switch assembly is set to ON and if SW2 switch assembly is properly configured.

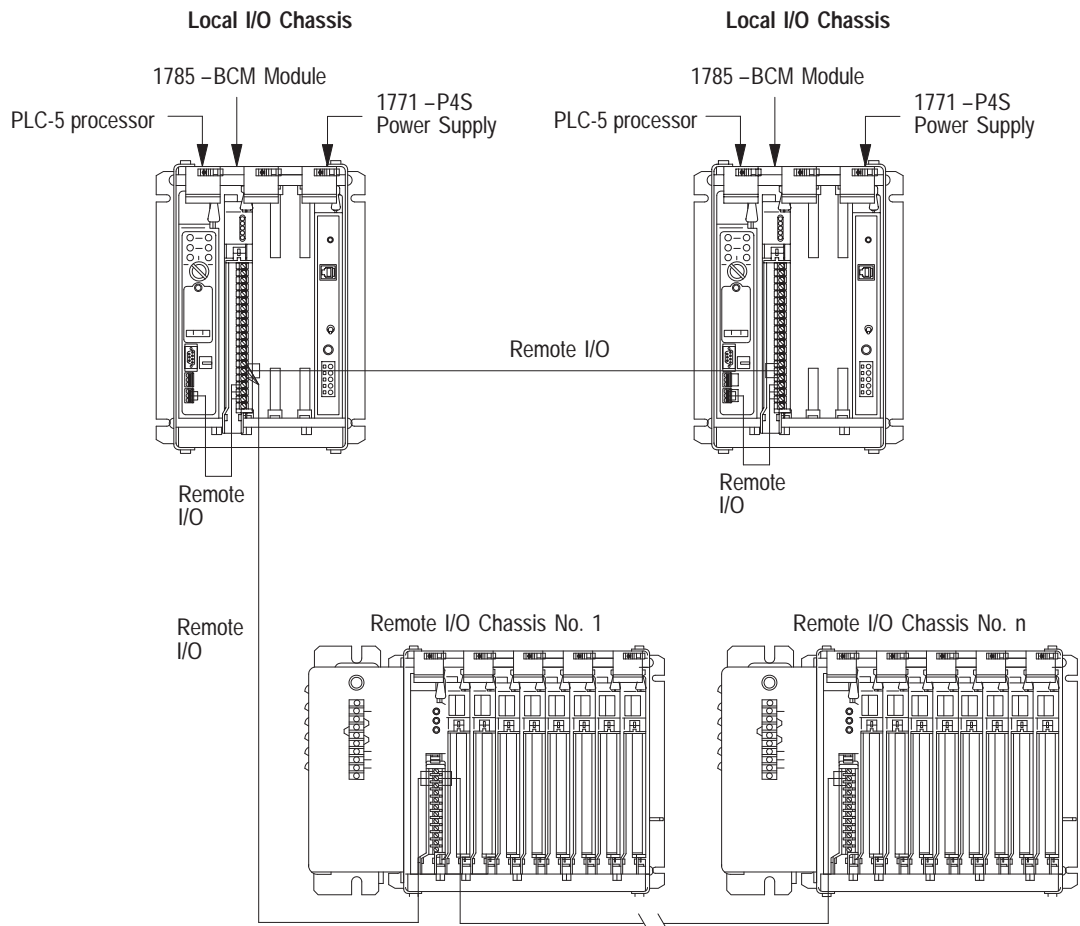
Making Remote I/O Connections

Figure 3.7 shows Channel 1B configured to establish communication with the remote I/O scanner mode (default configuration). The connections you must make for your PLC-5 backup system are between the:

- PLC-5 and the 1785-BCM module
- two 1785-BCM modules
- 1785-BCM module and Remote I/O Adapter module

Steps to make these connections follow the figure.

Figure 3.7
Remote I/O Connections

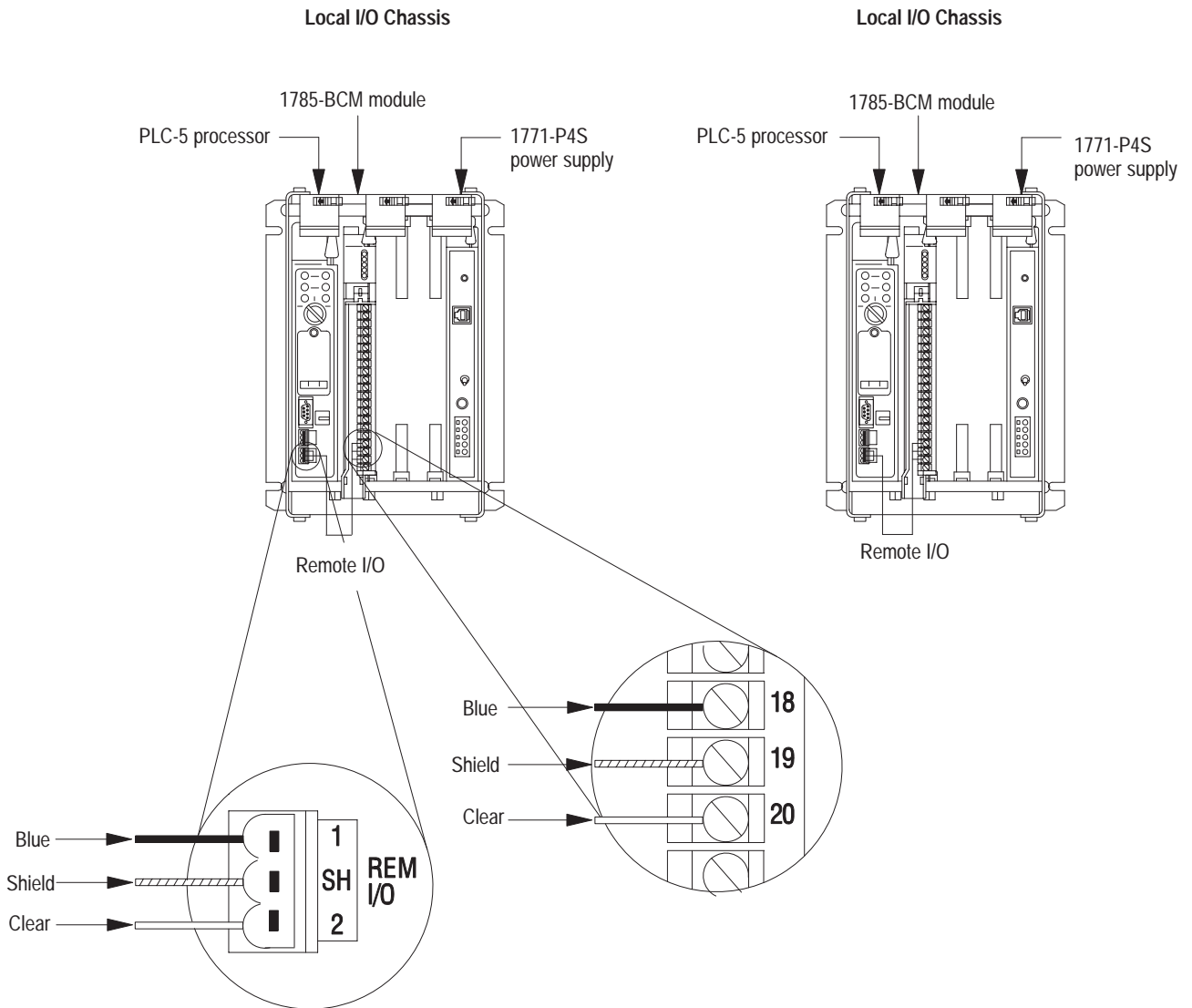


Connections show default configuration with Channel 1A as Data Highway Plus and Channel 1B as Remote I/O Scanner.

HSSL was previously connected but is not shown for clarity.
Make all connections with 1770-CD cable.

1. Connect one end of a 1770-CD cable to the **REM I/O** connector on one of the PLC-5 programmable controllers as shown in Figure 3.8.

Figure 3.8
Remote I/O Connections Added Between PLC-5 and 1785-BCM Module



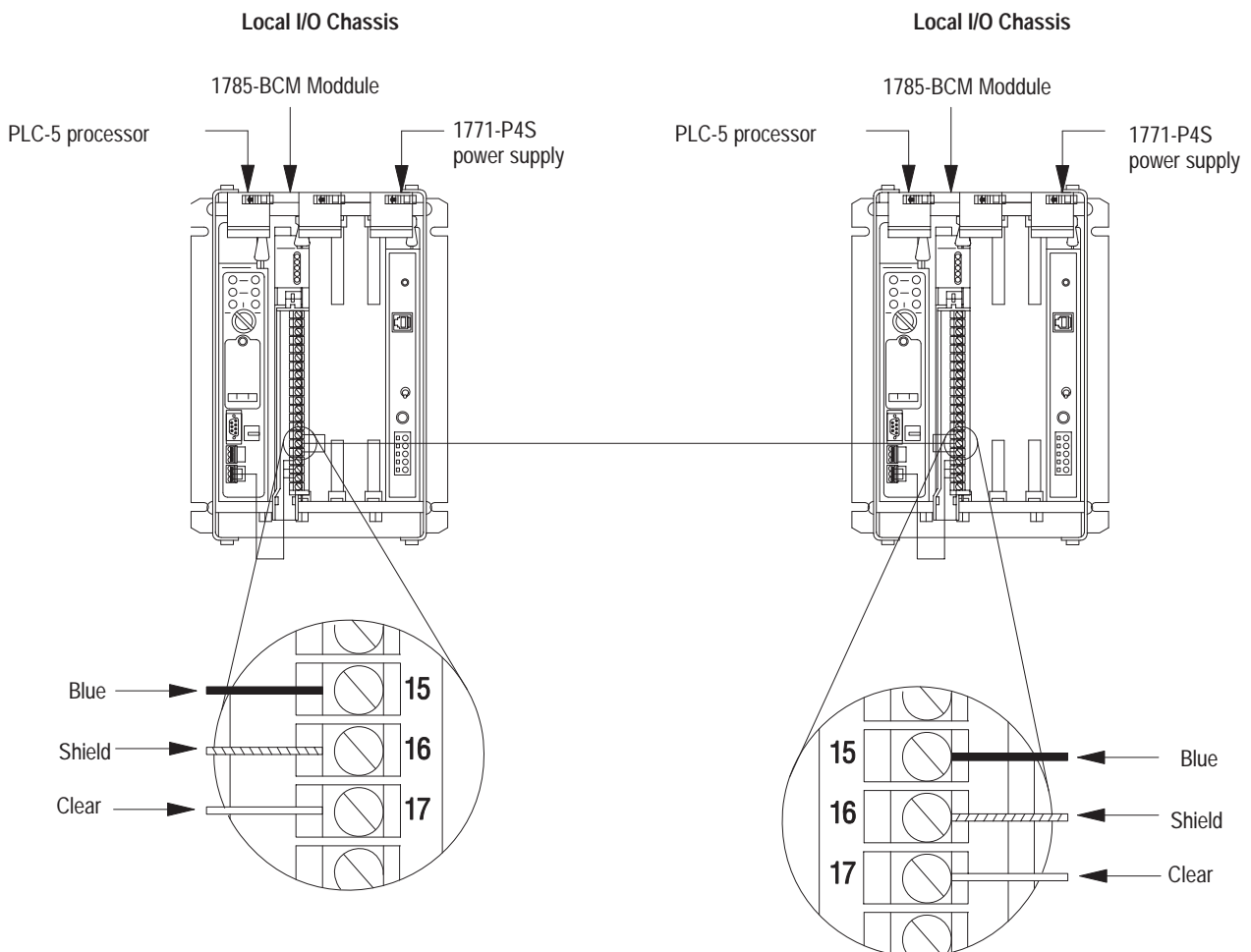
HSSL was previously connected but is not shown for clarity.
Connections show default configuration with Channel 1A as Data Highway Plus and Channel 1B as Remote I/O scanner.

17982

2. Connect the other end of the 1770-CD cable to terminals **18, 19, and 20** on the wiring arm of the 1785-BCM module in the same chassis as shown in Figure 3.8.

3. Perform steps 1 and 2 for the other PLC-5 programmable controller and 1785-BCM module.
4. Connect a 1770-CD cable to terminals **15, 16, and 17** on each of the 1785-BCM wiring arms as shown in Figure 3.9.

Figure 3.9
Remote I/O Connections Added Between 1785-BCM Modules



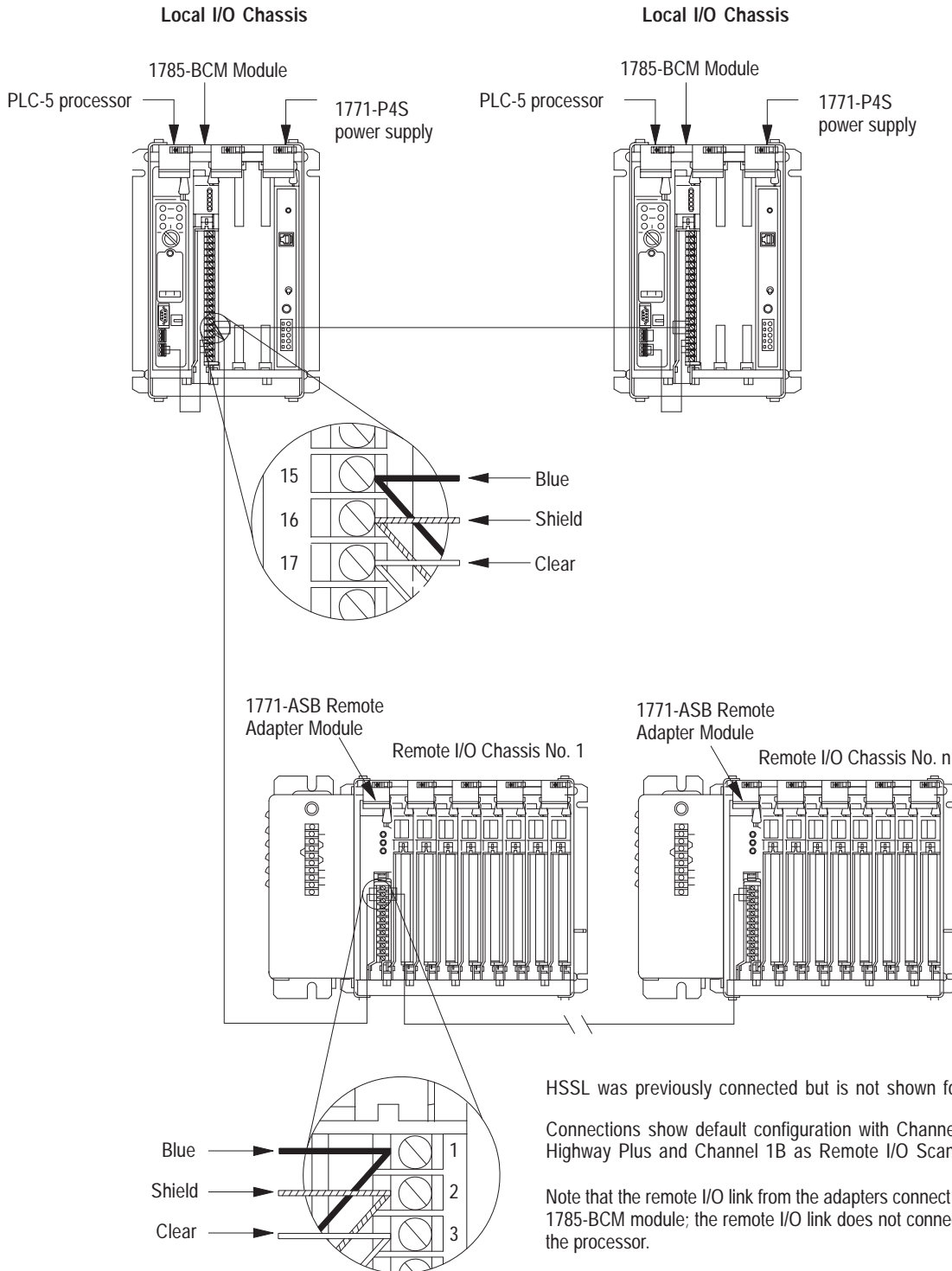
HSSL was previously connected but is not shown for clarity.

Connections show default configuration with Channel 1A as Data Highway Plus and Channel 1B as Remote I/O scanner.

17983

5. Connect one end of a 1770-CD cable to terminals **15, 16, and 17** on the wiring arm of one of the 1785-BCM modules as shown in Figure 3.10.

Figure 3.10
Remote I/O Connections Added Between 1785-BCM Module and Remote I/O Adapter Module



17984

6. Connect the other end of the 1770-CD cable to terminals **1, 2, and 3** on the wiring arm of the Remote I/O Adaptor module as shown in Figure 3.10.

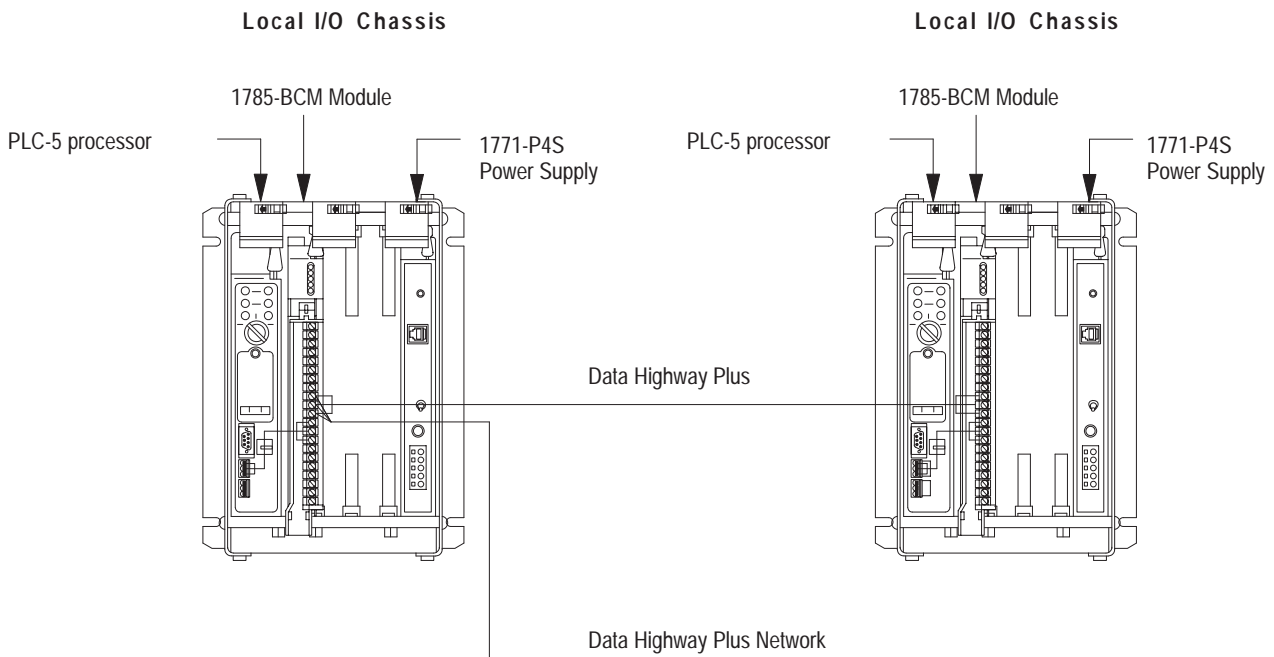
Making Data Highway Plus Connections

Figure 3.11 shows Channel 1A configured to establish communication with Data Highway Plus network (default configuration). The connections you must make for your PLC-5 backup system are between the:

- PLC-5 and the 1785-BCM module
- two 1785-BCM modules
- 1785-BCM module and Data Highway Plus network

Steps to make these connections follow the figure.

Figure 3.11
Data Highway Plus Connections



HSSL and Remote I/O link were previously connected but are not shown for clarity.

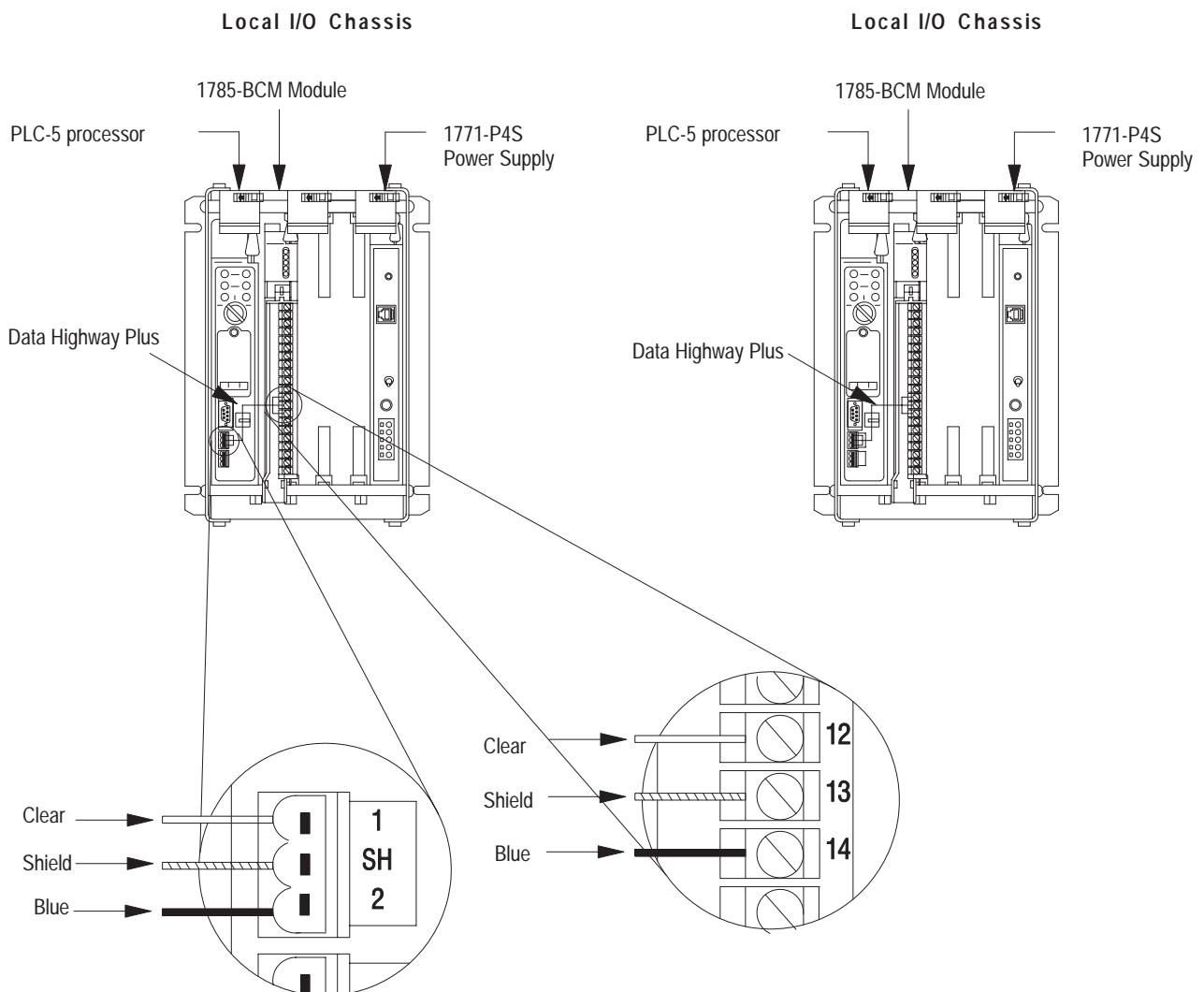
Connections show default configuration with Channel 1A as Data Highway Plus and Channel 1B as Remote I/O Scanner.

Make all connections with 1770-CD cable.

Chapter 3 Installing Your PLC-5 Backup System

1. Connect one end of a 1770-CD cable to the **PEER COMM INTFC** connector on one of the PLC-5 programmable controllers, as shown in Figure 3.12.

Figure 3.12
Data Highway Plus Connections Added Between PLC-5
and 1785-BCM Module



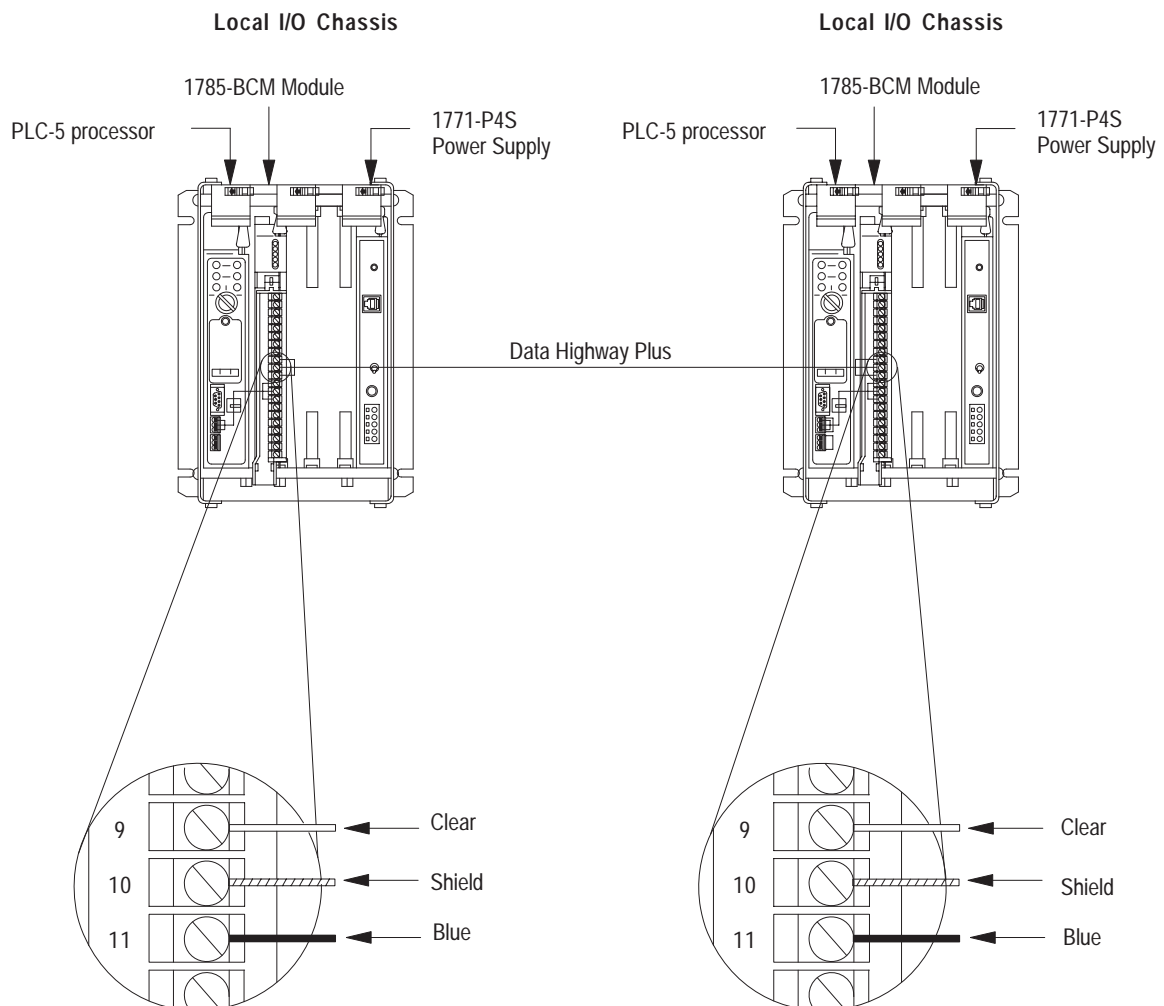
HSSL and Remote I/O link were previously connected but are not shown for clarity.

Connections show default configuration with Channel 1A as Data Highway Plus and Channel 1B as Remote I/O Scanner.

17985

2. Connect the other end of the 1770-CD cable to terminals **12, 13, and 14** on the wiring arm of the 1785-BCM module in the same chassis as shown in Figure 3.12.
3. Perform steps 1 and 2 for the other PLC-5 programmable controller and 1785-BCM module.
4. Connect a 1770-CD cable to terminals **9, 10, and 11** on the wiring arm of each 1785-BCM module as shown in Figure 3.13.

Figure 3.13
Data Highway Plus Connections Added Between 1785-BCM Modules

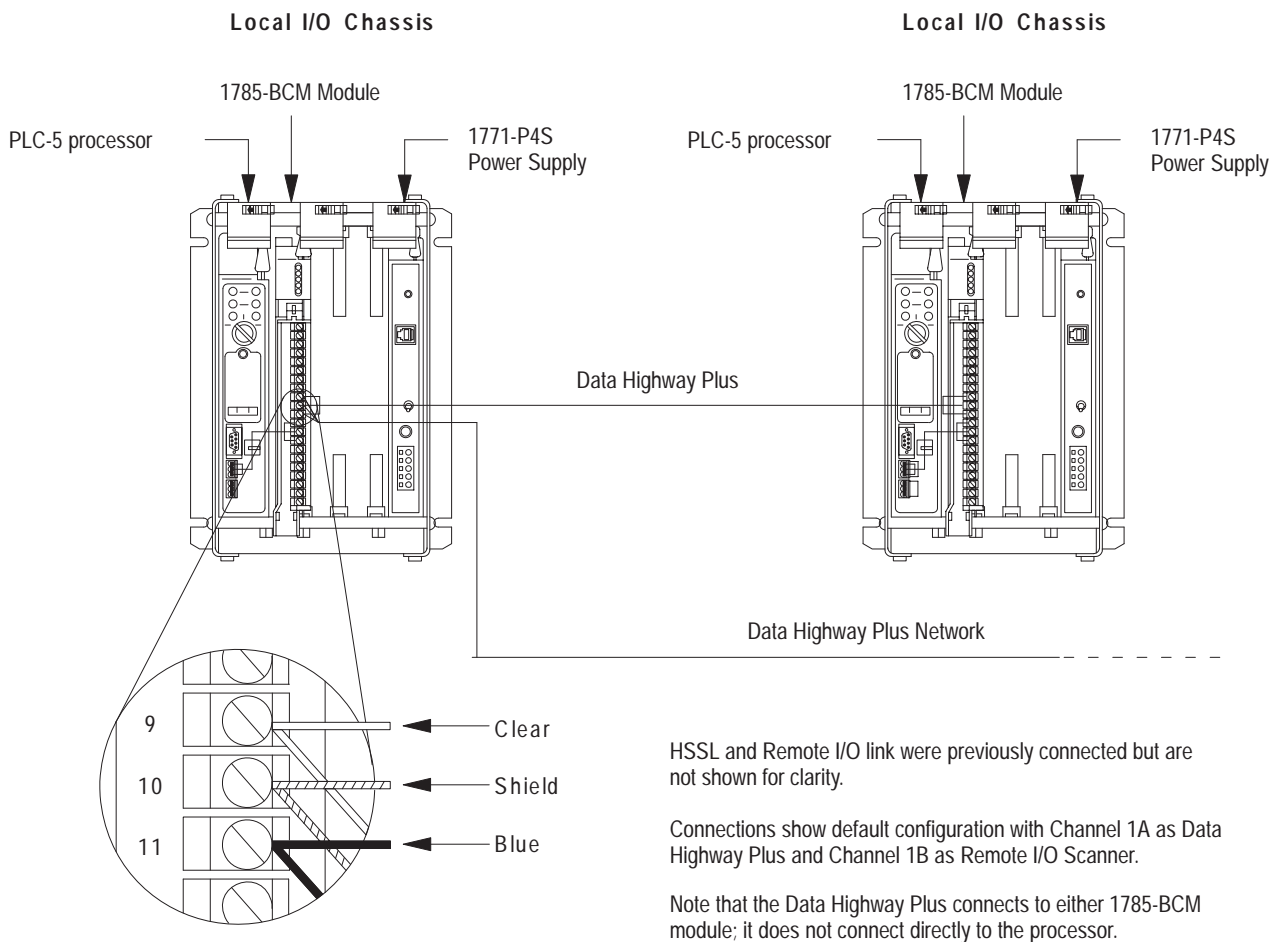


HSSL and Remote I/O link were previously connected but are not shown for clarity.

Connections show default configuration with Channel 1A as Data Highway Plus and Channel 1B as Remote I/O Scanner.

5. Connect the 1770-CD cable from the Data Highway Plus network to **9, 10, and 11** on the wiring arm of one of the 1785-BCM modules as shown in Figure 3.14.

Figure 3.14
Data Highway Plus Connections Added Between 1785-BCM Module and Data Highway Plus Network



What to Do Next

Now that you've installed your PLC-5 backup system and made connections, you are ready to start up your system. Before doing so, double check all connections against the procedures described in this chapter. If your backup systems requires the use of a 1785-BEM module, refer to Chapter 4 for a description of the module and installation procedures. Chapter 5 describes the operation of the 1785-BCM module and the backup system and shows procedures for starting up and operating your system.

Installing Your 1785-BEM Module

Chapter Objectives

This chapter:

- describes the 1785-BEM backup expansion module
- identifies major components of the 1785-BEM module
- provides an overview of an installed PLC-5/40, -5/60, or -5/80 backup system
- provides procedures for determining power supply requirements
- provides procedures for installing your 1785-BEM modules
- provides procedures for connecting the 1785-BEM modules in the PLC-5 backup system

Backup Expansion Module

The 1785-BEM is the backup expansion module for the 1785-BCM series B module. It has the capability of switching two additional configurable communication channels when you are using a 1785-BCM series B module with a PLC-5/40, -5/60, or PLC-5/80 processor.

Hardware Components

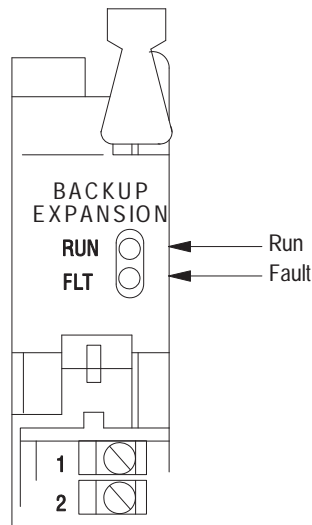
The major components of a 1785-BEM module are:

- status indicators
- 1771-WG wiring arm
- 1785-BEM communication links
 - Data Highway Plus (DH+)
 - remote I/O (RIO)
- customer relay (contact)
- switch assembly
- I/O backplane interface

Status Indicators

The 1785-BEM module has two status indicators on the front panel of the module (Figure 4.1).

Figure 4.1
1785-BEM Module Status Indicators



19087

RUN (green) indicator is on to show normal operation of the 1785-BEM module.

FLT (red) indicator is on when a hardware fault is detected in the 1785-BEM module.

Note that these indicators light at power up or when a hardware fault occurs in the 1785-BEM module.



ATTENTION: If the **RUN** indicator is blinking on the secondary 1785-BEM module, it means that there is a switch setting error. Note that switches of switch assembly SW2 must be in the same position in both 1785-BEM modules. (If the blinking RUN indicator goes unnoticed, it could prevent a switchover.)

Wiring Arm

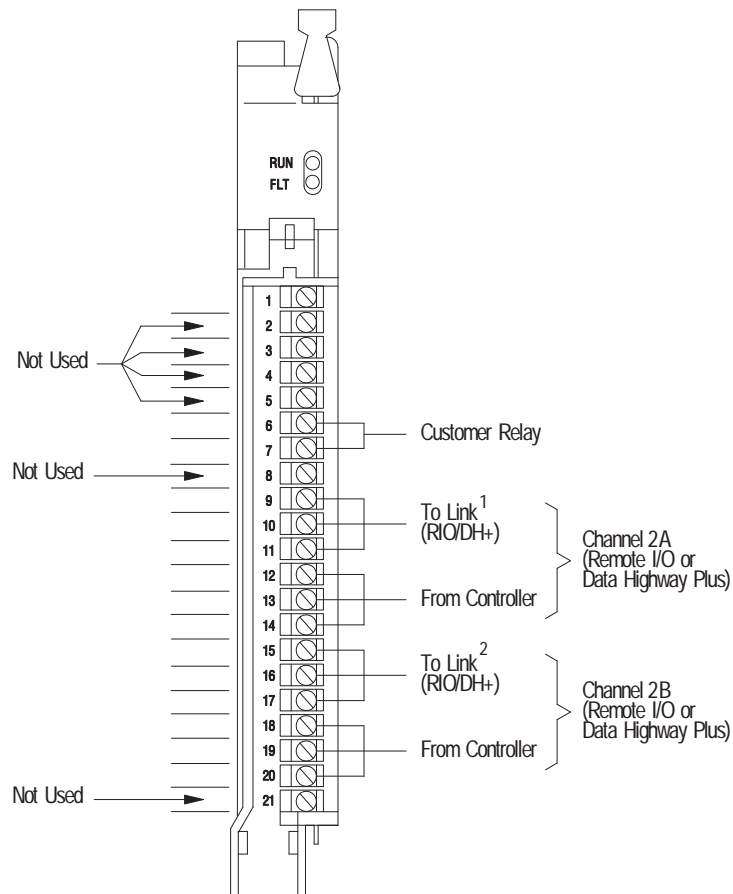
You make connections to your communication links with the 1771-WG wiring arm, which is shipped with the module.

Your wiring arm attaches to the pivot bar on the bottom of the I/O chassis. It pivots upward and connects with the module so that you can install or remove the module without disconnecting the wires.

Communication Links

The 1785-BEM module has ports for two communication links that connect with remote I/O and Data Highway Plus network (Figure 4.2). In addition, the module has a relay for customer connection.

Figure 4.2
1785-BEM Module Communication Links



¹ Terminals 9, 10, and 11 are connected between the 1785-BEM modules in the backup system; in addition terminals 9, 10, and 11 of one of the 1785-BEM modules are connected to the DH+ network or to the Remote I/O link.

² Terminal 15, 16, and 17 are connected between the 1785-BEM modules in the backup system; in addition, terminals 15, 16 and 17 of one of the 1785-BEM modules are connected to the DH+ network or to the Remote I/O link.

As shown in Figure 4.2, there are two user-configurable ports (Channels 2A and 2B) that support remote I/O or Data Highway Plus modes.

Table 4.A lists the communication ports and describes how the system uses each port.

Table 4.A
Communication Ports

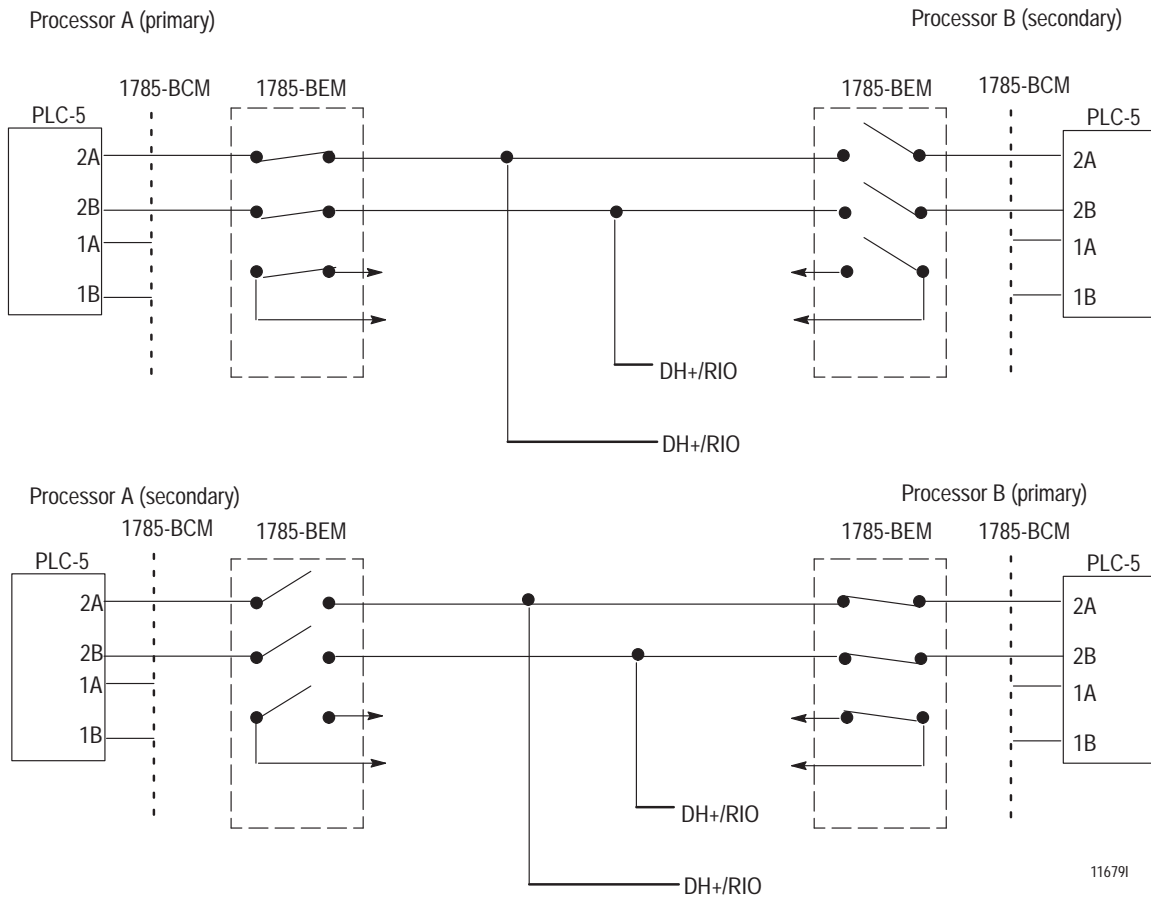
Communication Port	This link is used to:
Channel 2A	connect the primary PLC-5/40, -5/60, or PLC-5/80 processor to the Data Highway Plus network or to the Remote I/O link; the secondary PLC-5/40 or PLC-5/60 processor is isolated from this link.
Channel 2B	connect the primary PLC-5/40, -5/60, or PLC-5/80 processor to the Data Highway Plus network or to the Remote I/O link; the secondary PLC-5/40 or PLC-5/60 processor is isolated from this link.

The 1785-BEM module is shipped with Channel 2A configured for Data Highway Plus mode and Channel 2B configured for Remote I/O scanner mode at 57.6 kbaud (default configuration).

Important: Note that I/O, status, and data table communication between the primary and secondary backup systems is accomplished over the HSSL, which is connected between the primary and secondary 1785-BCM modules only. Each 1785-BEM module communicates with the 1785-BCM series B module, in its same rack, via a secondary backplane bus. Remote I/O or Data Highway Plus is connected between the primary and secondary 1785-BEM modules through Channels 2A and 2B.

Channels 2A or 2B have an internal relay whose contacts are closed when the controller is primary and are open when the processor is secondary. Figure 4.3 shows these relays for processor A and processor B of a PLC-5 backup system.

Figure 4.3
Relays for Processor A and Processor B



Customer Relay

The customer relay connection on the 1785-BEM module is used to switch external devices. Relay contacts are rated at .25A at 24V DC **resistive**. Loads with inductive characteristics will require additional suppression devices.

Switch Assembly

The 1785-BEM module has a switch assembly which specifies if Channels 2A and 2B are going to establish communication with Data Highway Plus network or with the remote I/O link. When the module establishes communication with the remote I/O link, the switch also determines the baud rate and the mode of operation of the processor (scanner or adapter). To set these switches, refer to the section on “Setting the Switch Assembly.”

I/O Backplane Interface

The 1785-BEM module communicates with the 1785-BCM module through its connection with the I/O chassis backplane.

Determining Power Supply Requirements

The logic circuit of the 1785-BEM module is driven by the power supply through the backplane of the I/O chassis. Use the following guidelines to determine the power supply requirements for your PLC-5 backup system.

1. Add these values to determine output current needed from the power supply for all the modules in that chassis.
 - 0.6A at 5V for the 1785-BEM module **and**
 - 1.0A at 5V for the 1785-BCM module **and**
 - 3.3A for the PLC-5/40 or PLC-5/60 processor
2. Refer to table 3.A, Power Supplies for a PLC-5 Backup System, to select your power supply.
3. Use separate power sources for the primary and secondary processors. Connect the power supplies through different power sources to take precautions against interruptions and incoming power failures.

Installing the 1785-BEM Module

The installation procedures for the 1785-BEM backup expansion module are:

- determining power supply requirements
- setting the 1785-BEM module switches
- keying the I/O chassis
- inserting the module into the chassis



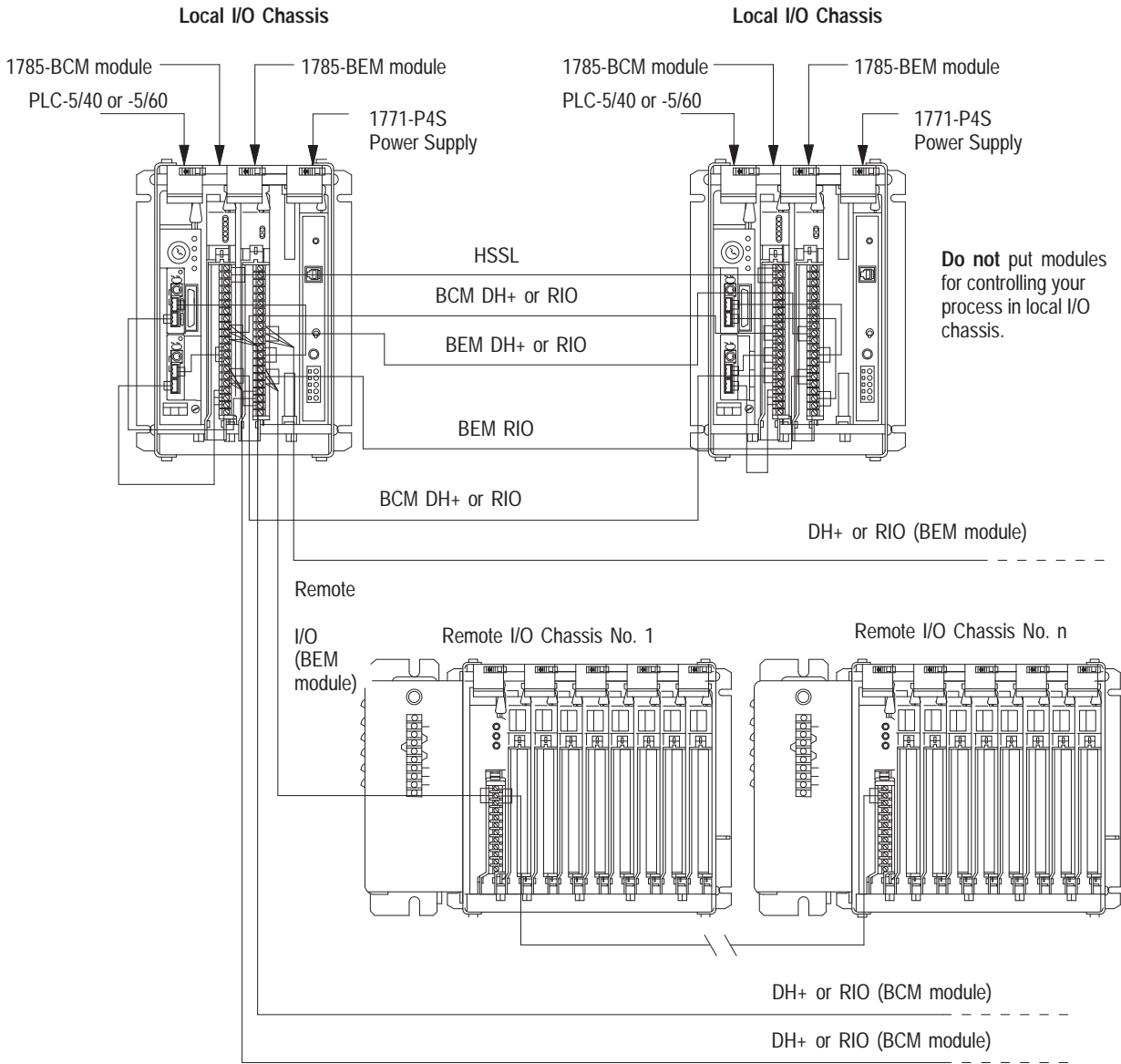
ATTENTION: In the backup system, switch 1 of the local I/O chassis should be in OFF position in order to allow the switchover when a fault is detected. In remote chassis, this switch should be positioned at the user's discretion.

Figure 4.4 shows a typical configuration of a PLC-5 backup system using the 1785-BEM module. In this system, all of the cable connections between the primary and backup system require a 1770-CD cable.

Important: Do not install I/O modules for controlling your process in the local chassis. Only the I/O modules residing in the remote chassis will be backed up. Local chassis are necessary for housing the processor, 1785-BEM module, 1785-BCM module, and power supply for the backup system.

Chapter 4
Installing Your 1785-BEM Module

Figure 4.4
PLC-5 Backup System Configuration (using a 1785-BEM module)



HSSL connects between the two 1785-BCM modules only.

19088

Electrostatic Discharge Damage



ATTENTION: Under some conditions, electrostatic discharge can degrade performance or damage the module. Observe the following precautions to guard against electrostatic damage.

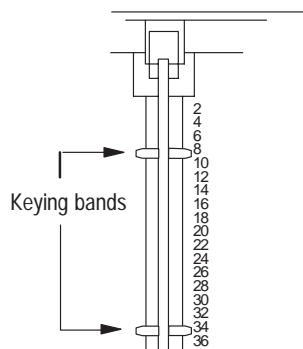
- Wear an approved grounded wrist strap or touch a grounded object to discharge potential before handling the module.
- Do not touch the backplane connector or connector pins.
- If you configure or replace internal components, do not touch other circuit components inside the module. If available, use a static-free work station.
- When not in use, keep the module in a static-shielded bag.

Keying the I/O Chassis

Use the plastic keying bands, shipped with each I/O chassis, to key the chassis slot to accept only the 1785-BEM module.

The module circuit board is slotted in two places on the rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. You can key any connector in an I/O chassis to receive this module except for the left-most connector which is reserved for processor modules. Place keying bands between the following numbers that are labeled on the backplane connector (Figure 4.5).

Figure 4.5
Keying Positions

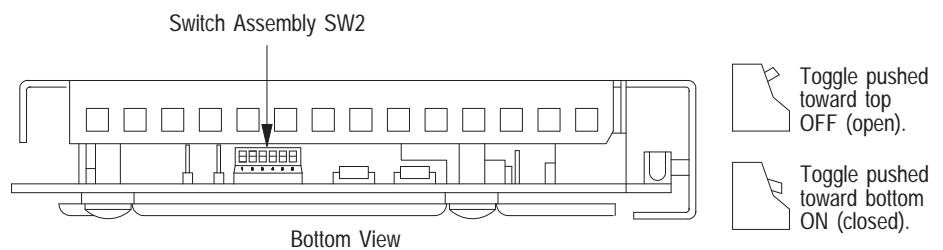


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Setting the 1785-BEM Module Switch Assembly

Switch assembly SW2, located at the bottom of the 1785-BEM module, has six switches. The function of the six switches is to establish the configuration of Channels 2A and 2B of the module. Figure 4.6 shows the location of SW2.

Figure 4.6
Switch Assembly SW2



19086

Switches 1, 2, and 3 determine the configuration of Channel 2A. Switches 4, 5, and 6 determine the configuration of Channel 2B.

These channels can be configured for Data Highway Plus (DH+) or for Remote I/O (RIO) mode with the PLC-5 processor operating either in adapter mode or in scanner mode.

The 1785-BEM module is shipped with Channel 2A configured for Data Highway Plus (DH+) and Channel 2B configured for Remote I/O (RIO) with the processor in scanner mode at 57.6 kbaud.

Refer to Table 4.B to configure Channels 2A and 2B using switch assembly SW2 switches.

Table 4.B
Configuring Channels 2A and 2B

Configure Channel 2A switches ¹ Configure Channel 2B switches ² for:	1	2	3
	4	5	6
Data Highway Plus network	ON	ON	ON
Remote I/O – adapter mode using 57.6 kbaud	ON	ON	OFF
Remote I/O – adapter mode using 115.2 kbaud	ON	OFF	ON
Remote I/O – adapter mode using 230.4 kbaud	ON	OFF	OFF
Relay switching or unused Channel ³	OFF	ON	ON
Remote I/O – scanner mode with 57.6 kbaud	OFF	ON	OFF
Remote I/O – scanner mode with 115.2 kbaud	OFF	OFF	ON
Remote I/O – scanner mode with 230.4 kbaud	OFF	OFF	OFF

¹ Switches 1, 2, and 3 determine configuration for Channel 2A.

² Switches 4, 5, and 6 determine configuration for Channel 2B.

³ Does not function as a smart switch but as a relay with contacts either opened or closed. Also, set the switches in this configuration if you are not going to use this channel.

Important: The positions of the switches are read at module power-up. If the position of the switches is changed after module power-up, the 1785-BEM module will not recognize the new position.

Inserting the 1785-BEM Module into the I/O Chassis

To insert the 1785-BEM module in your I/O chassis, perform the following steps. We recommend that you insert you 1785-BEM module into the right-most slot of the first I/O module group in the I/O chassis. The 1785-BEM module must be in the same module group (as defined by 2-slot addressing) with the 1785-BCM module.



ATTENTION: Remove power from the 1771 I/O chassis backplane and wiring arm before removing or installing an I/O module.

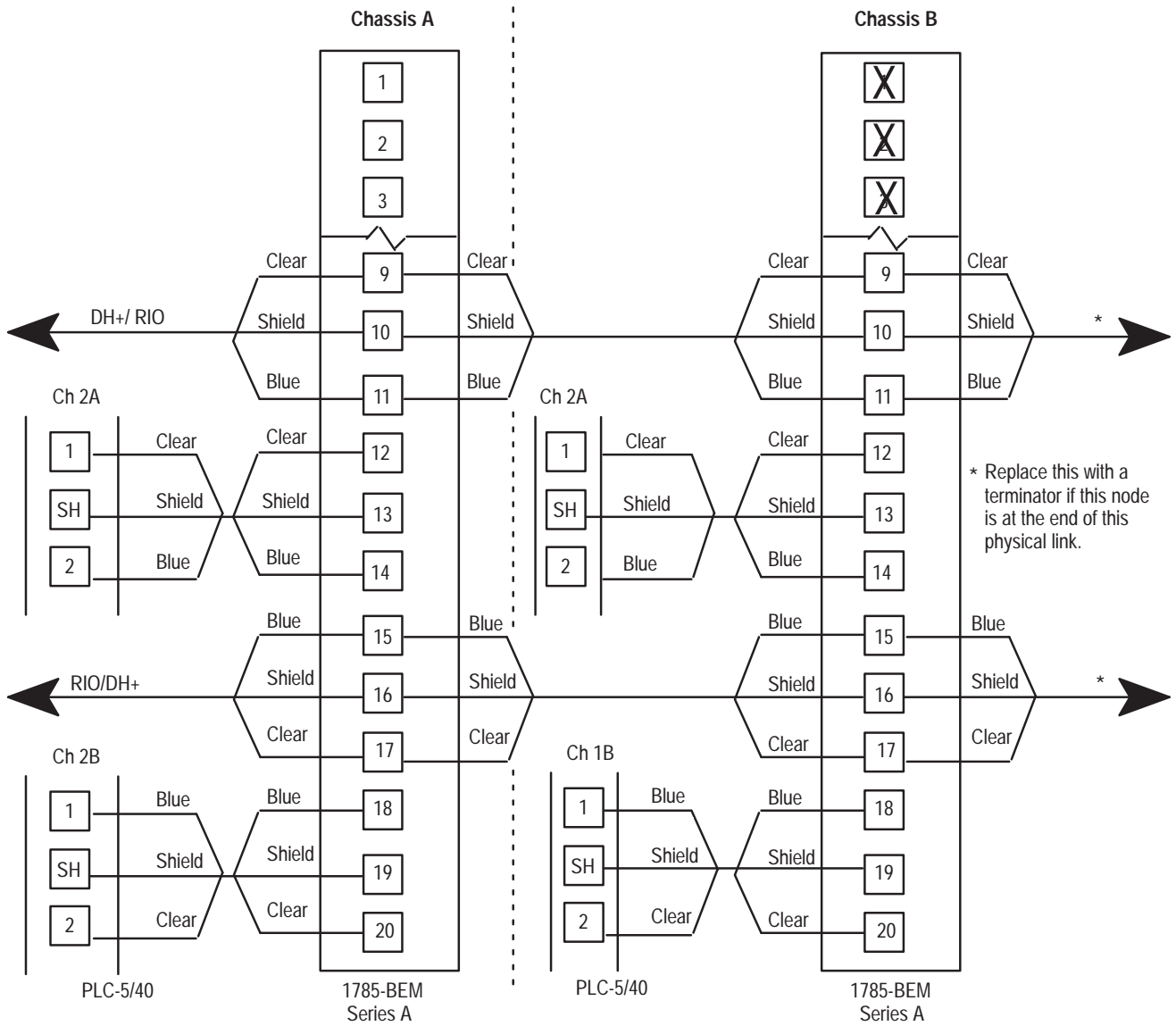
- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

1. Turn off power to the I/O chassis.
2. Place the module in the plastic tracks on the top and bottom of the slot that guides the module into position.
3. Do not force the module into its backplane connector. Apply firm, even pressure on the module to seat it properly.
4. Snap the chassis latch over the top of the module to secure it in position.
5. Connect the wiring arm to the module.
6. Make wiring connections to the wiring arm as indicated in the next section.

Connecting Your 1785-BEM Module

Make the Channel 2A and 2B connections to the 1785-BEM module wiring arm (cat. no. 1771-WG) as described in the following paragraphs. Figure 4.7 is an overview of the connections.

Figure 4.7
1785-BEM Module Connections

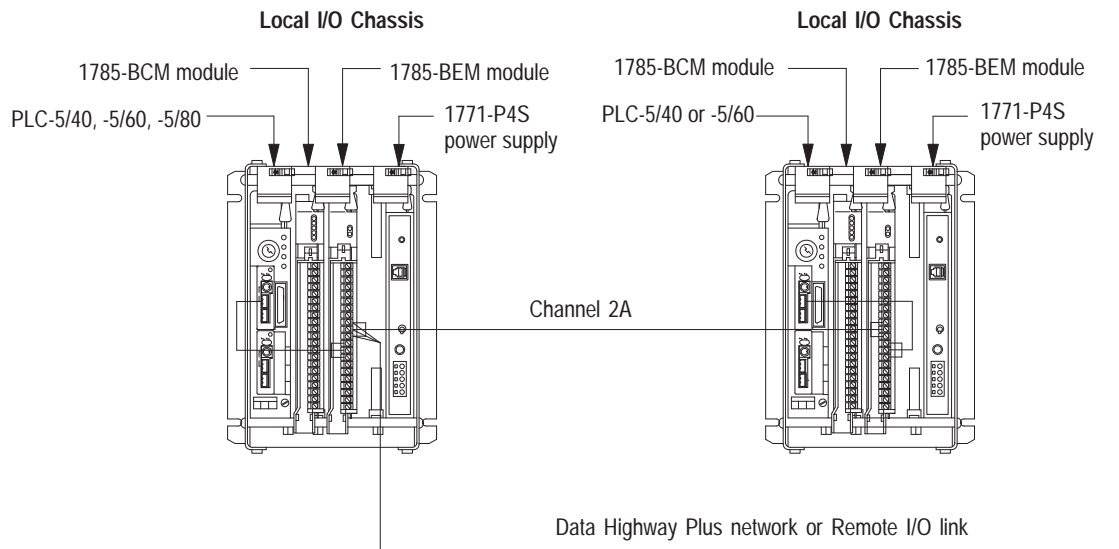


Making Channel 2A Connections

Figure 4.8 shows the Channel 2A connections you must make for your PLC-5 backup system. These connections are between the:

- PLC-5/40 or PLC-5/60 processor and the 1785-BEM module
- two 1785-BEM modules
- 1785-BEM module and Data Highway Plus network or remote I/O link

Figure 4.8
Channel 2A Connections

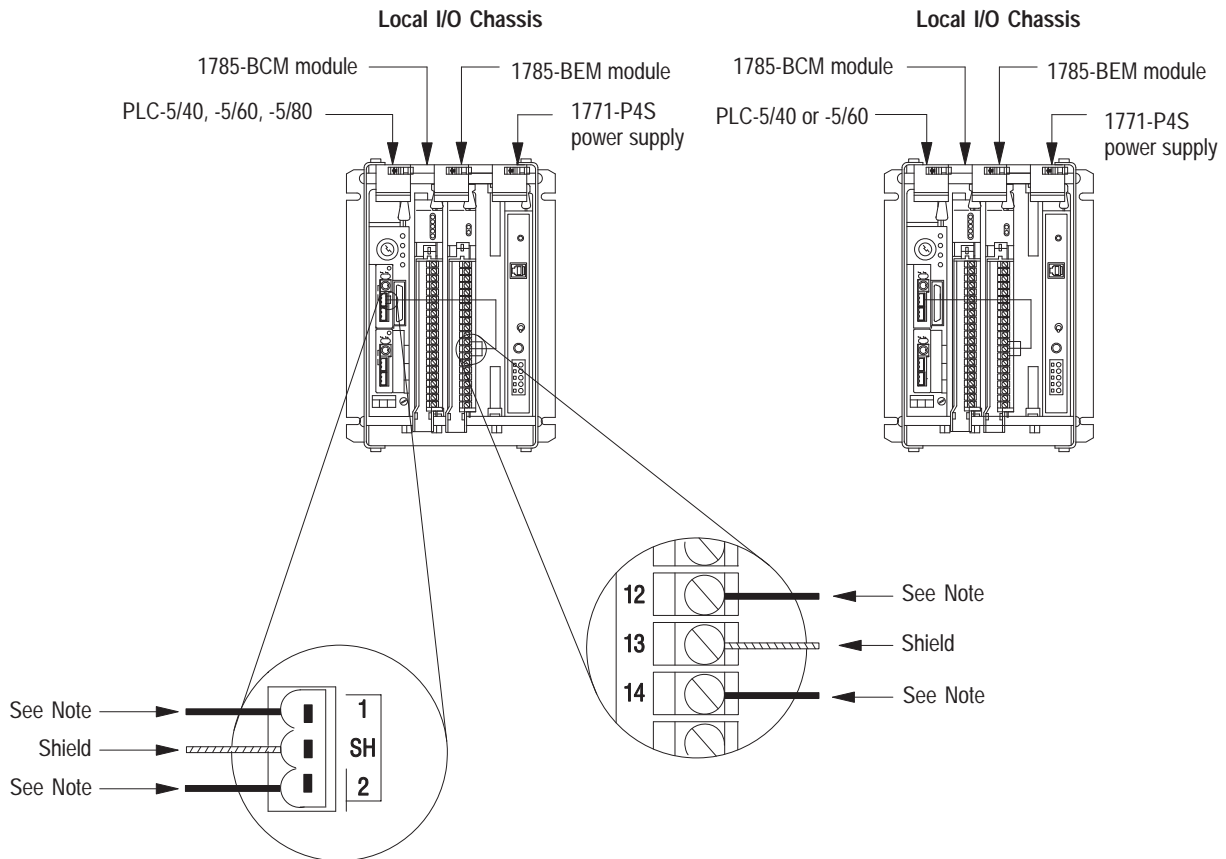


1785-BCM module was connected in Chapter 3 but is not shown for clarity.

19089

1. Connect one end of a 1770-CD cable to Channel 2A on one of the PLC-5/40 or PLC-5/60 programmable controllers, as shown in Figure 4.9.

Figure 4.9
Channel 2A Connections Added Between a PLC-5 Processor
and 1785-BEM Module



Wire channel for either Data Highway Plus or Remote I/O.

Data Highway Plus –connect the signal-conductors with **Clear, Shield, and Blue** insulation to terminals **1, SH, and 2** of PLC –5/40 or –5/60 processor respectively, as well as to terminals **12, 13 and 14** of 1785 –BEM module

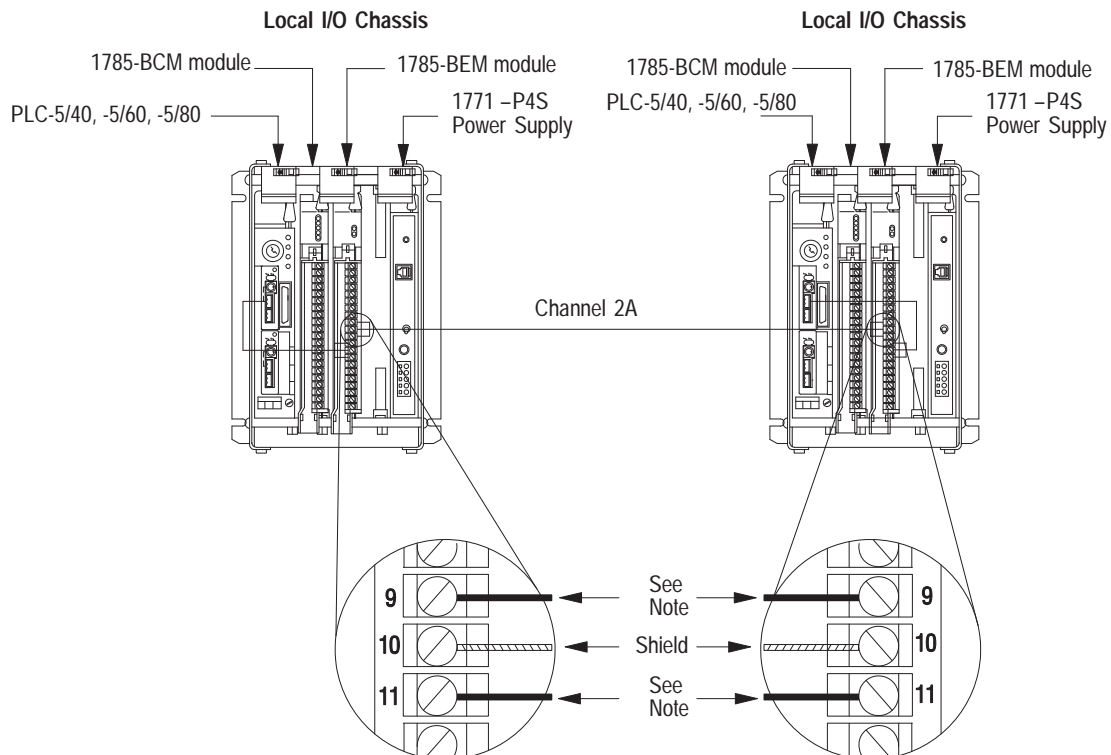
Remote I/O –connect the signal conductors with **Blue, Shield, and Clear** insulation to terminals **1, SH, and 2** of PLC –5/40 or –5/60 processor respectively, as well as to terminals **12, 13, and 14** of 1785 –BEM module.

2. Connect the other end of the 1770-CD cable to terminals **12, 13, and 14** on the wiring arm of the 1785-BEM module in the same chassis as shown in Figure 4.9.
3. Perform steps 1 and 2 for the other PLC-5/40 or PLC-5/60 processor and 1785-BEM module.

Chapter 4 Installing Your 1785-BEM Module

4. Connect a 1770-CD cable to terminals **9**, **10**, and **11** on each of the 1785-BEM wiring arms as shown in Figure 4.10.

Figure 4.10
Channel 2A Connections Added Between 1785-BEM Modules



Wire channel for either Data Highway Plus or Remote I/O.

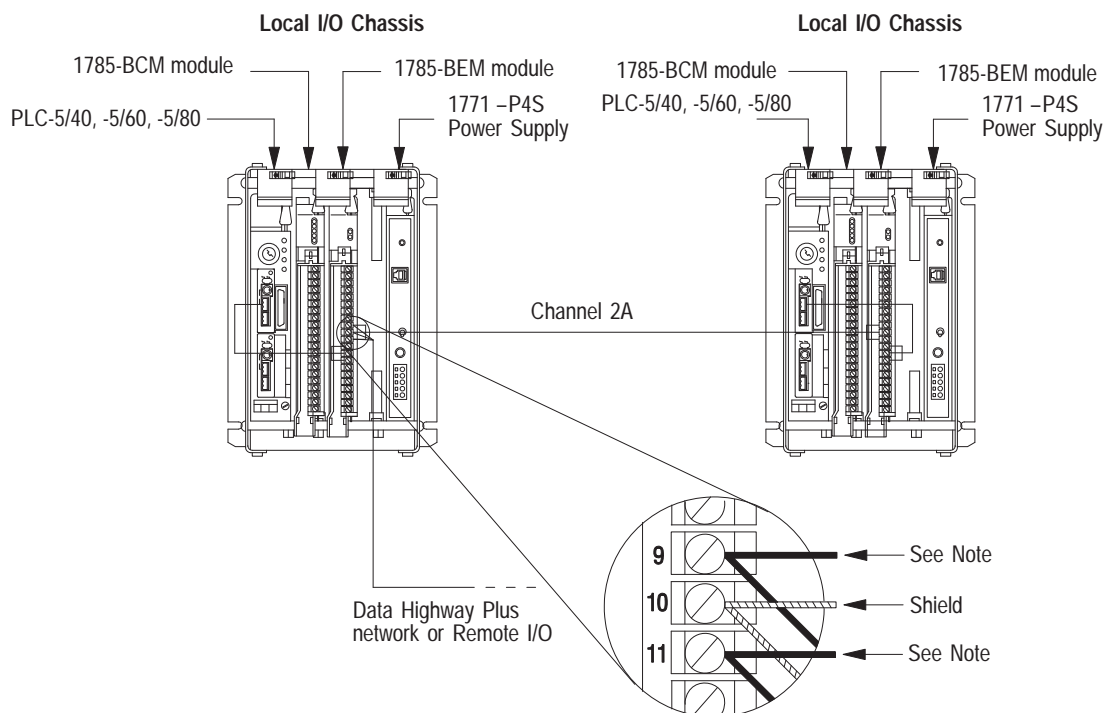
Data Highway Plus – connect the signal conductors with **Clear**, **Shield**, and **Blue** insulation to terminals **9**, **10**, and **11** of 1785-BEM modules respectively.

Remote I/O – connect the signal conductors with **Blue**, **Shield**, and **Clear** insulation to terminals **9**, **10**, and **11** of 1785-BEM modules respectively.

19091

5. Connect the 1770-CD cable from the Data Highway Plus network or Remote I/O link to **9, 10, and 11** on the wiring arm of one of the 1785-BEM modules as shown in Figure 4.11.

Figure 4.11
Channel 2A Connections Added Between a 1785-BEM Module and Data Highway Plus Network or Remote I/O Link



Wire channel for either Data Highway Plus or Remote I/O.

Data Highway Plus – connect the signal conductors with **Clear, Shield, and Blue** insulation to terminals **9, 10, and 11** of 1785-BEM modules respectively.

Remote I/O – connect the signal conductors with **Blue, Shield, and Clear** insulation to terminals **9, 10, and 11** of 1785-BEM modules respectively.

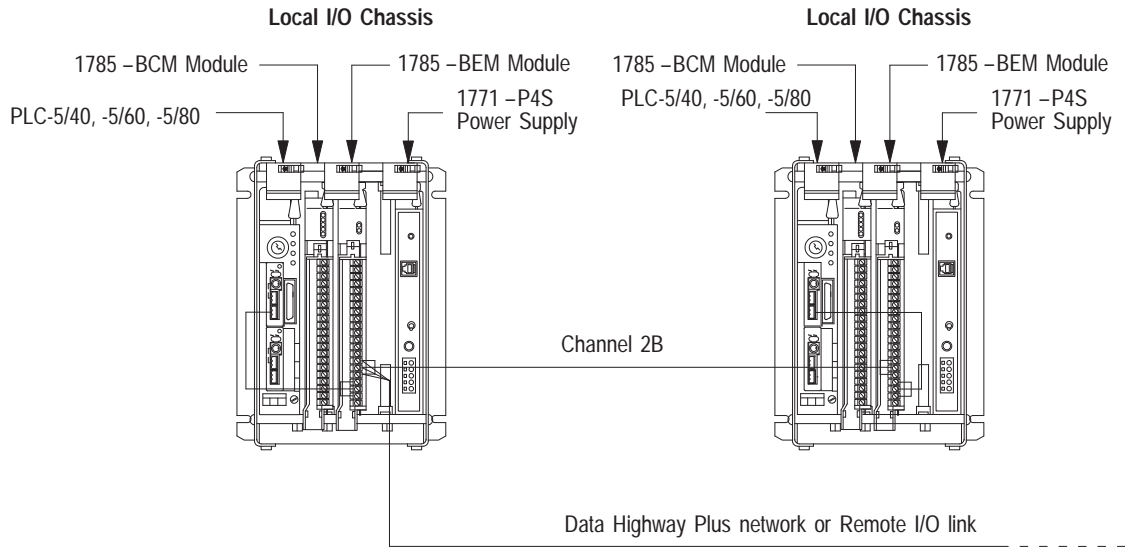
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Making Channel 2B Connections

Figure 4.12 shows the Channel 2B connections you must make for your PLC-5 backup system. These connections are between the:

- PLC-5/40, PLC-5/60, or PLC-5/80 processor and the 1785-BEM module
- two 1785-BEM modules
- 1785-BEM module and Data Highway Plus or Remote I/O link

Figure 4.12
Channel 2B Connections

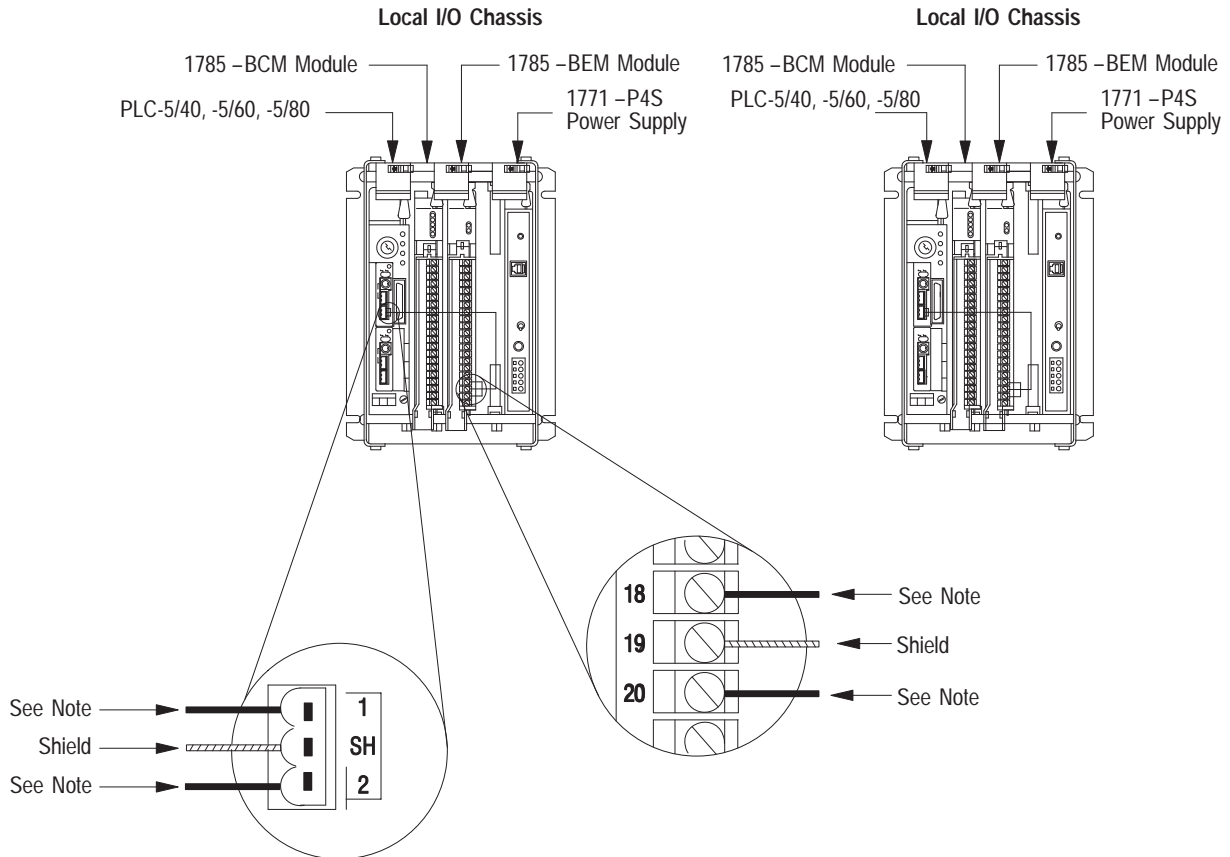


1785-BCM module was connected in Chapter 3 but is not shown for clarity. Also, 1785-BEM module Channel 2A was previously connected but is not shown for clarity.

19093

1. Connect one end of a 1770-CD cable to Channel 2B on one of the PLC-5/40, -5/60, or -5/80 processors as shown in Figure 4.13.

Figure 4.13
Channel 2B Connections Added Between a PLC-5 and a 1785-BEM Module



Wire channel for either Data Highway Plus or Remote I/O.

Data Highway Plus – connect the signal conductors with **Clear, Shield, and Blue** insulation to terminals **1, SH, and 2** of PLC -5/40 or -5/60 processor respectively, as well as to terminals **18, 19, and 20** of 1785-BEM module.

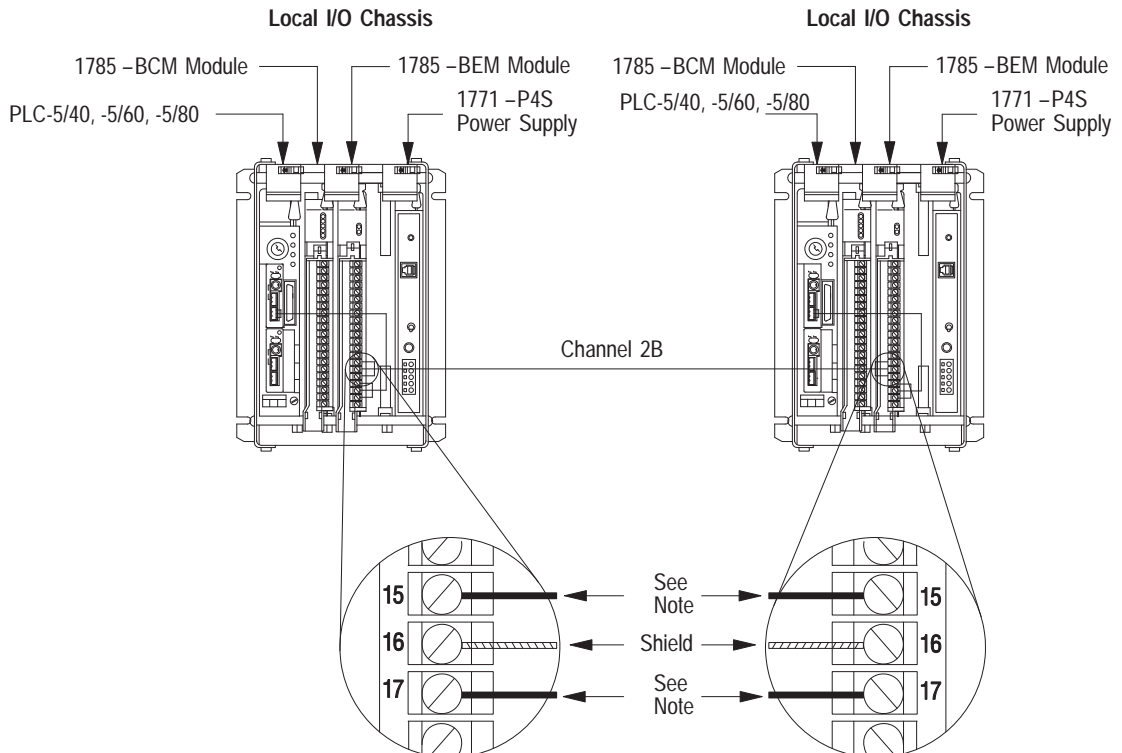
Remote I/O – connect the signal conductors with **Blue, Shield, and Clear** insulation to terminals **1, SH, and 2** of PLC -5/40 or -5/60 processor respectively, as well as to terminals **18, 19, and 20** of 1785-BEM module.

19094

2. Connect the other end of the 1770-CD cable to terminals **18, 19, and 20** on the wiring arm of the 1785-BEM module in the same chassis as shown in Figure 4.13.
3. Perform steps 1 and 2 for the other PLC-5/40, -5/60, or -5/80 processor and 1785-BEM module.

4. Connect a 1770-CD cable to terminals **15, 16, and 17** on each of the 1785-BEM wiring arms as shown in Figure 4.14.

Figure 4.14
Channel 2B Connections Added Between 1785-BEM Modules



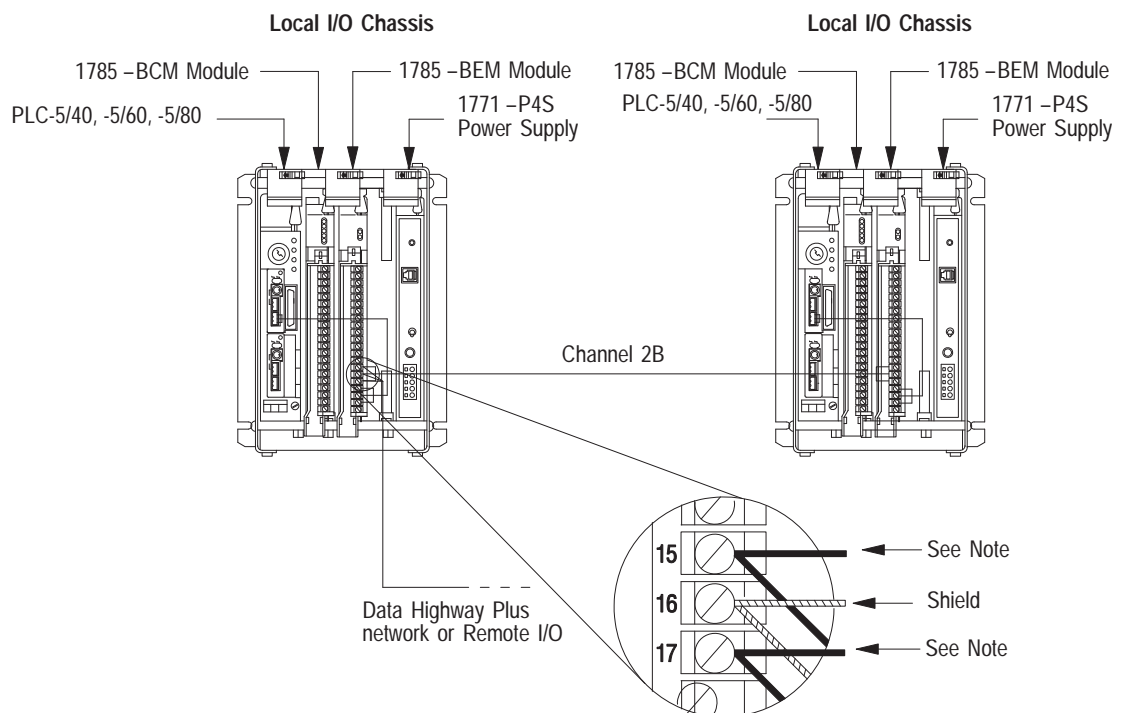
Wire channel for either Data Highway Plus or Remote I/O

Data Highway Plus – connect the signal conductors with **Clear, Shield, and Blue** insulation to terminals **15, 16, and 17** of 1785 –BEM module, respectively.

Remote I/O – connect the signal conductors with **Blue, Shield, and Clear** insulation to terminals **15, 16, and 17** of 1785 –BEM module, respectively.

- Connect one end of a 1770-CD cable to terminals **15, 16, and 17** on the wiring arm of one of the 1785-BEM modules as shown in Figure 4.15.

Figure 4.15
Channel 2B Connections Added Between a 1785-BEM Module and Data Highway Plus Network or Remote I/O Link



Wire channel for either Data Highway Plus or Remote I/O.

Data Highway Plus – connect the signal conductors with **Clear, Shield, and Blue** insulation to terminals **15, 16, and 17** of 1785-BEM modules respectively.

Remote I/O – connect the signal conductors with **Blue, Shield, and Clear** insulation to terminals **15, 16, and 17** of 1785-BEM modules respectively.

19096

- Connect the other end of the 1770-CD cable to terminals **1, 2, and 3** on the wiring arm of the Data Highway Plus network or remote I/O link as shown in Figure 4.15.

What to Do Next

Now that you've installed your 1785-BEM module, you are ready to start up your system. Before doing so, double check all connections against the procedures described in this chapter. Chapter 5 describes the operation of the 1785-BCM module and the backup system and shows procedures for starting up and operating your system.

Operating Your PLC-5 Backup System

Chapter Objectives

In this chapter we describe how the primary system transfers data to the secondary system. We do this by describing the operation of the:

- 1785-BCM module
- PLC-5 backup system

In addition, we provide procedures for:

- starting your system
- powering up your system
- disconnecting a faulted system
- restarting a repaired system
- changing the processor's operating mode
- editing a program on-line

How the 1785-BCM Module Operates

In a PLC-5 backup system, the 1785-BCM module performs three distinct functions:

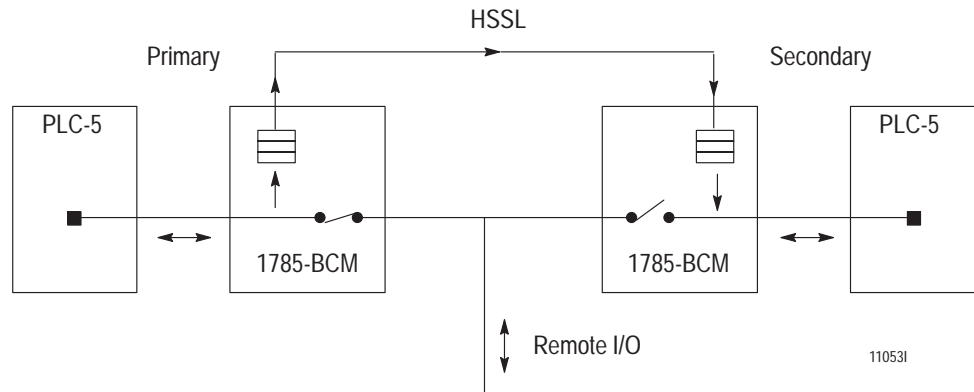
- automatic transfer of remote input data over the High-Speed Serial Link (HSSL)
- transfer of data in the data table by block-transfer instructions
- secondary processor remote programming capability

Automatic Transfer of Remote Input Data Over the HSSL

With automatic transfer, the primary 1785-BCM module is continually updating a copy of the remote input image table in an interface located in the secondary 1785-BCM module. This remote input data includes discrete data as well as block-transferred data. Automatic transfer is carried out over the High Speed Serial Link (HSSL) and is independent of the application program.

The secondary 1785-BCM module responds with current data to the remote I/O scan requests of the secondary processor, making the secondary processor “think” that it is communicating with remote I/O chassis. This response prevents remote I/O faults in the secondary processor, since the secondary processor is not physically connected to the remote I/O link (Figure 5.1).

Figure 5.1
Automatic Transfer of Data Over Remote I/O



In addition to providing the secondary processor a copy of the remote discrete input image table, the 1785-BCM modules in both systems work together to provide the secondary processor a copy of block transfer read (BTR) data from the remote I/O chassis.

The primary 1785-BCM module provides the secondary 1785-BCM module with information that a BTW command has been accomplished. The processor can store in memory up to 256 BTW done bits (16 racks x 16 slots=256, maximum) per channel. The primary 1785-BCM module has sufficient memory to store up to 92 BTR instructions of a possible 256 per channel. When the primary processor executes a BTR from any module in a remote I/O chassis, a copy of the data is stored. Should the secondary processor attempt to read that module, it will receive the same data. If the secondary processor attempts to read from a module that the primary processor has not read, the done bit (DN) will not turn on.

Transfer of Data with Block Transfer Instructions

Although not required to implement backup, you can transfer data in the data table by including block transfer instructions to the 1785-BCM module in your application program. We describe transfer of data in the data table by explaining the:

- sequence of transfer
- method of transfer
- words in the BTR and BTW instructions used by the PLC-5 backup system
- input image table auxiliary diagnostics/status words

Sequence of Transfer

The sequence of transfer from the primary to the secondary system is as follows:

1. The data from the primary processor’s data table is sent to the primary 1785-BCM module by means of a Block Transfer Write (BTW) instruction.
2. The data is sent to the secondary 1785-BCM module over the HSSL.
3. The secondary processor reads the data from the secondary 1785-BCM module by means of a Block Transfer Read (BTR) instruction.

Method of Transfer

Data table information is transferred from the primary processor to the secondary processor in a **segment** that is composed of 1-64 sequentially ordered **blocks**. Each block has 64 **words**. The first 2 words of each block are reserved for a system status word and block identification (block ID) word; the remaining 62 are reserved for data.

The content of the block transfer instruction’s first two words depends on the type of instruction (BTW or BTR), and also on the application program run in the primary and secondary processor. Table 5.A briefly describes block transfer instructions in the PLC-5 backup system. (For detailed information about words in the block transfer instructions, refer to the “Block Transfer Read Instruction” and “Block Transfer Write Instruction” sections of this chapter.)

Table 5.A
Block Transfer Instructions in the PLC-5 Backup System

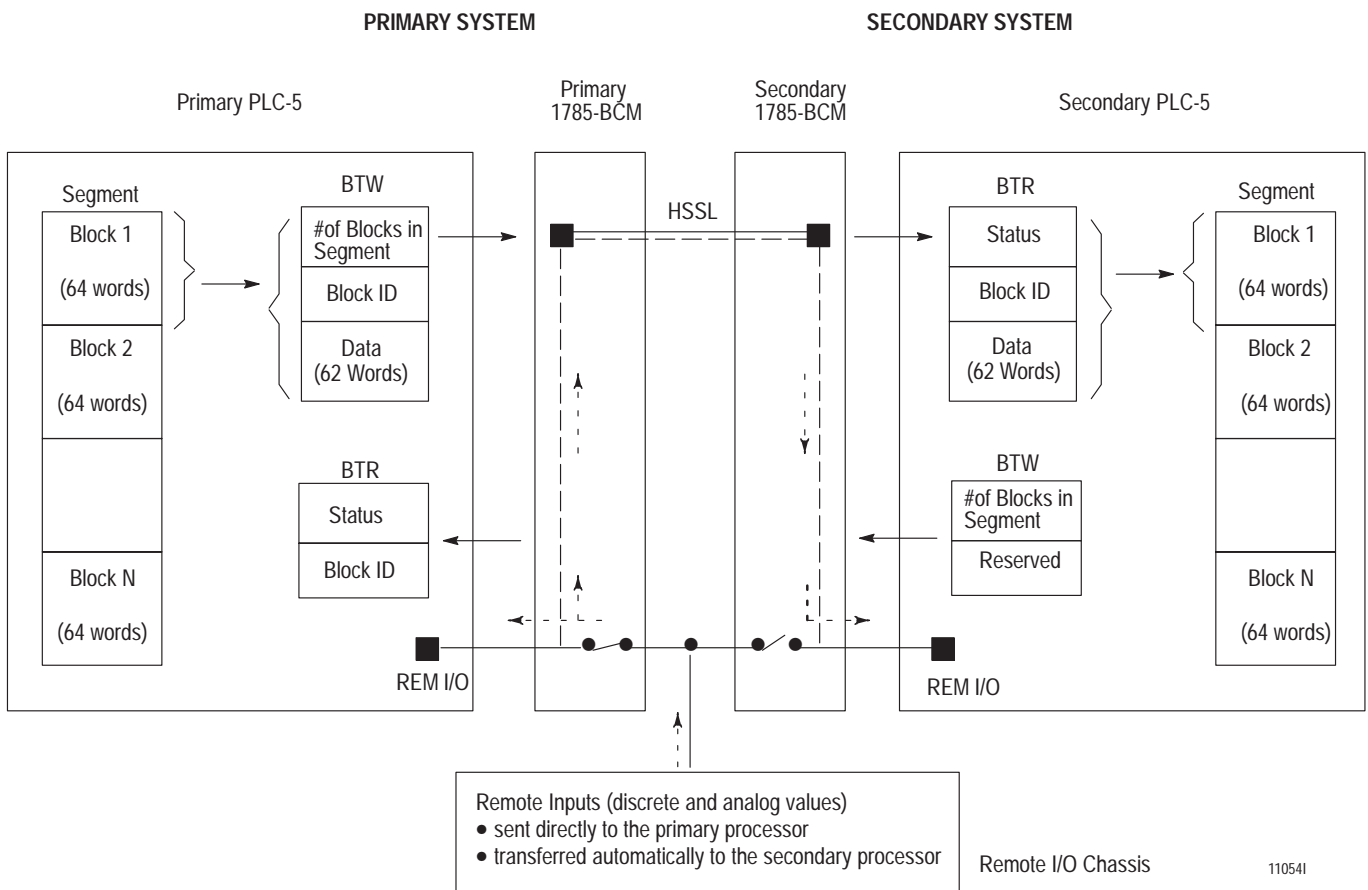
Instruction	Word	Function of word is to:	
		Primary System	Secondary System
Block-Transfer Read	1 – System Status	inform the processor about the status of the primary and secondary system	
	2 – Block Identification (block I/D)	indicate the number of the next block that should be transferred to the module	indicate the number of the block being transferred from the module
Block-Transfer Write	1 – Number of Blocks in Segment	indicate the number of data blocks within a segment being transferred from the processor to the primary 1785-BCM module (1–64). Must be same as secondary system.	indicate the number of data blocks within a segment being received by the secondary 1785-BCM module (1–64). Must be same as primary system.
	2 – Block Identification (block I/D)	indicate the number of the block that is being transferred from the primary processor to the primary 1785-BCM module	reserved for future use

This scheme, where status and block identification information are always present, permits continuous verification of the data transfer, and if necessary, the re-sending of a block of data if that block was not successfully transmitted.

In addition, the 1785-BCM modules exchange the status word over the HSSL continuously (even when the processors are not in RUN mode). This constant communication allows the modules to always have information about each other.

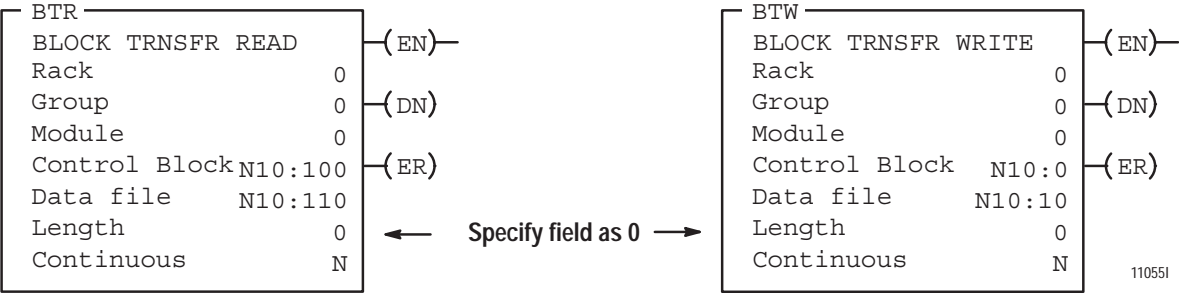
Figure 5.2 shows transfer of data from the primary processor to the secondary processor through the 1785-BCM modules. Note that the path of automatic transfer of remote input data is represented by a dotted line.

Figure 5.2
Transferring Data With Block Transfer Instructions
in the PLC-5 Backup System



Important: When programming block transfer instructions, you must specify the LENGTH field (Figure 5.3) as 0, since the 1785-BCM module determines that size in accordance with its status (primary or secondary) and type of instruction (BTW or BTR).

Figure 5.3
Block Transfer Instructions



Block Transfer Read (BTR) Instruction

The local 1785-BCM module provides information to the ladder logic to help coordinate the orderly exchange of information from the primary processor to the secondary processor. The local processor obtains this information by executing a BTR instruction. As shown in Table 5.A, the first two words of the block transfer read (BTR) instruction contain:

- status information
- the current block identification number (block ID)

The BTR in the primary processor transfers **only** these two words; the BTR in the secondary processor transfers 64 words — the system status and block ID words, plus 62 words of data. Figure 5.4 shows the words of the BTR instruction.

Figure 5.4
BTR Instruction Words

15	14	13	12	11	10	09	08	07	06	05	04	03	03	01	00
REMOTE STATUS								LOCAL STATUS							
BLOCK IDENTIFICATION															
62 WORDS OF DATA (IN SECONDARY PROCESSOR ONLY)															

Important: The lower byte of the status word is for the LOCAL status. These bits indicate status of the 1785-BCM module installed in the same chassis as the processor to which you are referring. The upper byte of the status word refers to REMOTE status. Its bits indicate the status of the 1785-BCM module installed in the other chassis of the backup system.

Word 1: System Status — Table 5.B lists the bits in the system status word and defines each.

Table 5.B
System Status Word Bits (BTR)

Status	Bit	Description
Local	0	Serial communication error; when on, this bit indicates a communication error in the high speed serial link (HSSL)
	1	I/O chassis backplane error; when on, this bit indicates a communication error in the transfer of data from the PLC-5 processor to its 1785-BCM module. Setting bits in the BCM output image table can set this bit.
	2	Buffer full; if on, this bit indicates that the primary module cannot accept writes, or it indicates that the secondary module has received a data block before the first data segment has been read.
	3	Programming error; this bit is on when an out-of-range block is detected between the primary 1785-BCM module and its PLC-5 processor. In the secondary system, this bit is on when the transmitted segment length does not match the received segment length. If there is a BTW or BTR to the BCM module with an invalid length, the module will not switch over, but this bit will not be on.
	4	Remote I/O communication fault; when on, this bit indicates that a communication fault exists on a remote I/O channel between the processor and the 1785-BCM module. Refer to section "Auxiliary Diagnostics/Status Words" to know which channel has a communication fault.
	5	Reserved – Always 0
	6	Primary/Secondary; when on, this bit indicates that the 1785-BCM module belongs to the primary system; if off, the bit indicates that the module belongs to the secondary system
	7	Data valid; this bit is used only by the secondary processor. If the Fast Data-Transfer mode is enabled, the bit is on when the 1785-BCM module contains one data block available to be read. If the Fast Data-Transfer mode is disabled, the bit is on when the 1785-BCM module contains one complete segment.

Status	Bit	Description
Remote	8	Serial communication error ; when on, this bit indicates a communication error in the high speed serial link (HSSL)
	9	I/O chassis backplane error ; when on, this bit indicates a communication error in the transfer of data from the PLC-5 processor to its 1785-BCM module. See bit 1.
	10	Buffer full ; if on, this bit indicates that the primary module cannot accept writes, or it indicates that the secondary module has received a data block before the first data segment has been read.
	11	Programming error ; this bit is on when an out of range block is detected between the primary 1785-BCM module and its PLC-5 processor. In the secondary system, this bit is on when the transmitted segment length does not match the received segment length. See bit 3.
	12	Remote I/O communication fault ; when on, this bit indicates that a communication fault exists on a remote I/O channel between the processor and the 1785-BCM module. Refer to section "Auxiliary Diagnostics/Status Words" to know which channel has a communication fault.
	13	Processor fault ; when on, the bit indicates that the local system detects a failure in the remote processor or the remote processor is in PROGRAM mode
	14	Primary/Secondary ; when on, this bit indicates that the 1785-BCM module belongs to the primary system; if off, the bit indicates that the module belongs to the secondary system
	15	Data valid ; this bit is used only by the secondary processor. If the Fast Data-Transfer mode is enabled, the bit is on when the 1785-BCM module contains one data block available to be read. If the Fast Data-Transfer mode is disabled, the bit is on when the 1785-BCM module contains one complete segment.

Important: If the fault is cleared and a successful BTR is executed, the five least significant bits (00, 01, 02, 03, 04) are automatically turned off.

Word 2: Block Identification (Block ID) — Word 2 of the BTR is the block identification word (block ID). Its meaning varies depending on whether it is the primary or secondary system.

In the primary system, word 2 of the BTR instruction indicates the number of the **next** block to be sent. To calculate this number, the 1785-BCM module adds 1 to the block ID number of the last block that was successfully transferred from the PLC-5 processor to the module through a BTW instruction. If the block is not received successfully, the 1785-BCM module does not increment the last block number. It, however, returns the number of the block in error so that the block can be automatically re-transmitted.

When the primary 1785-BCM module receives the last block (block ID = number of blocks in segment) through a BTW instruction, the module returns a block number equal to 1 in the next BTR instruction. This re-initializes the data transmission process.

The 1785-BCM module also specifies a block ID equal to 1 under the following conditions:

- power-up
- programming error
- switchover

In the secondary system, word 2 of the BTR instruction indicates the block number of the data just read, so that the data can be moved to the proper address in the data table. If the Fast Data-Transfer mode is enabled, as soon as the secondary module receives a block, the module sets the data valid bit and releases this block for reading.

If the Fast Data-Transfer mode is disabled, the module returns the data valid bit as a 1 (one) only when the secondary module receives the complete data segment. This means that the data valid bit remains **on** until the last block is read from the secondary 1785-BCM module. If no blocks are available to be read, the 1785-BCM module returns the block ID as 0 (zero) and the file contains only two words (status and block ID).

Block Transfer Write (BTW) Instruction

The local processor sends information to the 1785-BCM module using the BTW instruction. In the backup system, the block transfer write (BTW) instruction uses the first two words to indicate:

- the number of blocks in the segment being sent
- the block identification number (block ID)

The BTW in a primary system transfers these two words, plus 62 words of data; the BTW in the secondary system transfers only these two words of data. Figure 5.5 shows the words of the BTW instruction.

Figure 5.5
BTW Instruction Words

15	14	13	12	11	10	09	08	07	06	05	04	03	03	01	00	Bits
NUMBER OF BLOCKS IN SEGMENT															Word 1	
BLOCK IDENTIFICATION ¹															Word 2	
62 WORDS OF DATA (PRIMARY PROCESSOR ONLY)															Word 3 ... Word 64	

110571

¹ Reserved for future use

Word 1: Number of Blocks in Segment — In the BTW instruction, word 1 has different meanings depending on whether the system is primary or secondary. The number of blocks in a segment should be the same in both processors. (The secondary 1785-BCM module checks this word to make sure it matches the number of blocks specified in the primary.) If not, the programming error bit (local — bit 3, remote — bit 11) will be on in the system status word.

In the primary system, word 1 of the BTW instruction indicates the total number of blocks that make up the data package being transferred.

In the secondary system, word 1 of the BTW instruction indicates the number of blocks that make up the package to be received.

Word 2: Block Identification (Block ID) — Word 2 of this instruction is called the block identification (block ID) word. Its meaning varies depending on whether the system is primary or secondary.

In the primary system, the word is reserved for the identification number of the block being sent.

Important: It is your responsibility to make sure that each data block you want to send has its own unique identification number.

In the secondary system, word 2 is not used and is reserved.

Auxiliary Diagnostics/Status Words

The 1785-BCM module appears to the PLC-5 processor as a 32-point I/O module. This means that the I/O chassis physical slot in which the module is located corresponds to two input and two output image table words.

With 1785-BCM module, 32 input bits are available in the PLC-5 processor image table. (The 32 output bits in the output image table are unused and reserved.) These input words are called Auxiliary Diagnostics/Status Words and they provide further information about the 1785-BCM module and the 1785-BEM backup expansion module in both the primary and secondary systems. Refer to Figure 5.6.

Figure 5.6
Auxiliary Diagnostics/Status Words

	17 ¹		10 ¹	07 ¹		01 ¹	
W1	EXTENDED STATUS				RESERVED		1st Word
W2	Channel 1A Status	Channel 1B Status	Channel 2A Status ²	Channel 2B Status ²			2nd Word

W1 Bits:

- | | |
|---|--------------------------------|
| Bits 00 to 07 = Reserved for Block Transfer Communication | Bit 14 = Reserved |
| Bit 10 = 1785-BCM series A module | Bit 15 = Reserved |
| Bit 11 = Fast Data Transfer mode | Bit 16 = Switchover Diagnostic |
| Bit 12 = Reserved | Bit 17 = 1785-BEM module |
| Bit 13 = Reserved | |

W2 Bits:

- Bits 00 to 07 = 1785-BEM module communication channels status
- Bits 10 to 17 = 1785-BCM module communication channels status

¹ Note that these bits are in octal format because they correspond to the input image table.
² Bits 00 to 07 of the second word can be used or not, depending on whether the 1785-BEM module is in the backup system or not.

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The first word address corresponds to the module slot, that is, the location of the 1785-BCM module in the I/O chassis. The least-significant byte of this word is reserved to the 1785-BCM module usage and the most-significant byte shows extended status of the module. Refer to Table 5.C.

Table 5.C
Extended Status Bits (W1)

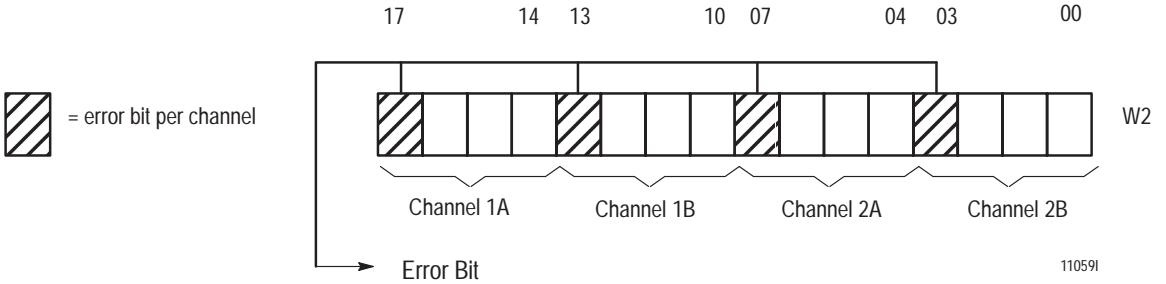
Bit ¹	Description
10	1785-BCM series A module ; when on, this bit indicates that the other 1785-BCM module is series A.
11	Fast Data Transfer mode ; when on, this bit indicates that the data valid bit is set to 1 (one) as soon as the secondary module receives a data block. When off, this bit indicates that the data valid bit is 1 (one) only when the secondary module receives the complete data segment.
12	Reserved – always 0
13	Reserved – always 0
14	Reserved – always 0
15	Reserved – always 0
16	Switchover Diagnostic ; this bit is always off, but if during a switchover condition this bit is on, it means that the module must be replaced.
17	1785-BEM module ; this bit is on when there is a 1785-BEM backup expansion module in the system.

¹ Bits 0 through 7 (least significant byte of W1) are unused and reserved. For W1, bit 0 is the least-significant bit and bit 17 is the most-significant bit.

The second auxiliary status word address corresponds to the right-most slot of the first I/O module group in the I/O chassis. This word shows the channel configurations of the 1785-BCM and 1785-BEM (if any) modules and also indicates an error condition in any of these channels.

The most-significant byte of this word corresponds to Channels 1A and 1B of the 1785-BCM module. The least-significant byte corresponds to Channels 2A and 2B of the 1785-BEM module. Refer to Figure 5.7.

Figure 5.7
Second Auxiliary Diagnostics/Status Word



Each byte of word W2 is divided into two groups of four bits corresponding to the module's channels (Figure 5.7). The three least-significant bits of each group corresponds to three switches of switch assembly SW2 which is used to specify the configuration of module channels. The most-significant bit corresponds to the error bit for the respective channel.

Refer to Chapter 8, Diagnosing Faults, for further information about these bits of the Auxiliary Diagnostics/Status Words.

Secondary Processor Remote Programming

Important: The programming device must be connected through the Data Highway Plus network and must not bypass the relay in the 1785-BCM module. If you were to connect the device directly to a processor, it must be connected to the primary processor. Therefore, if your system were to switch to the secondary system, you must then move your device to your new primary processor.

In the PLC-5 backup system, only the primary processor is connected to the link. The secondary processor is not physically connected, but it communicates with the secondary 1785-BCM module making this processor think that it is on the Data Highway Plus network. This separate link prevents Data Highway faults in the secondary processor.

The 1785-BCM series B backup module provides remote programming capability for your secondary processor. This means that even with the programming device directly connected to the primary processor, the secondary PLC-5 processor memory can be programmed and/or monitored.

Important: If you are communicating with the primary processor via a programming terminal, do not place it in Remote Program mode. If you do, a switchover will occur and the new primary can go into Remote Program mode, shutting the system down.

Important: As a guideline, you should connect over DH+ to only one programming terminal at a time on the secondary processor.

The primary 1785-BCM module provides an access point for a programming device to access the secondary processor. Using the 1785-BCM module, you can communicate from a programming device across the backup modules to the secondary processor. You must assign both the primary and the secondary processor the same node address (using either dipswitches or Channel Config screen in 6200 software) in the Data Highway Plus link. The 1785-BCM module reserves the subsequent node address as an access-point address to the secondary processor, that is, this address is accessed by a programming device in order to program the secondary processor.

This means that if you set both processors node addresses to **n**, the programming device can communicate with the secondary processor with the node address **n+1**.

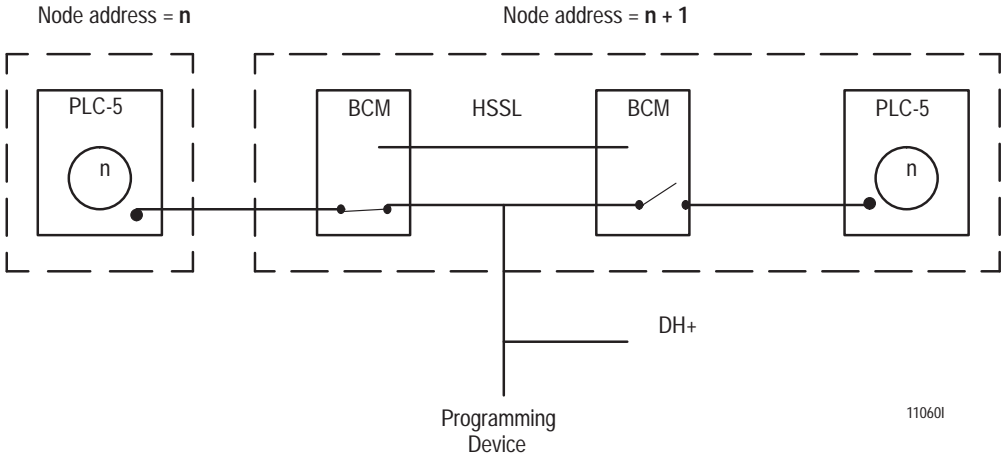
For example, a primary processor with node number 16 on Data Highway Plus network has the same address switch setting as the secondary processor node. However, in this situation, the terminal addressed to station 16 attaches to the primary processor and the terminal addressed to station 17 attaches to the secondary processor.

Important: It is recommended to assign the same node address (**n**) for both processors (primary and secondary) in a redundant system. You must also reserve the next node address (**n+1**) because this address is the access-point address to the secondary processor.

Figure 5.8 shows how the programming device sees the secondary processor which is not physically connected to the Data Highway Plus link.

Important: The DH+ connection to the secondary processor is meant for remote programming only. Also, only one terminal at a time may connect to the secondary processor. No DH+ messages can be sent to or from the secondary processor.

Figure 5.8
Access Point to the Secondary Processor (DH+)



How the Backup System Operates

When the system is started, each PLC-5 processor executes a BTR instruction to its 1785-BCM module to obtain the system status word, which will indicate whether it is in the primary or secondary mode. If the processor belongs to the primary system, it will execute the primary (transmitter) program; if the processor is secondary, it will execute the secondary (receiving) program.

To provide status information, or to pass additional block transfer values, you must provide support ladder programming. Refer to Chapter 7, “Programming Techniques” and Appendix A “Sample Programs” for information on developing ladder programs for the backup system.

Primary (Transmitter) Program

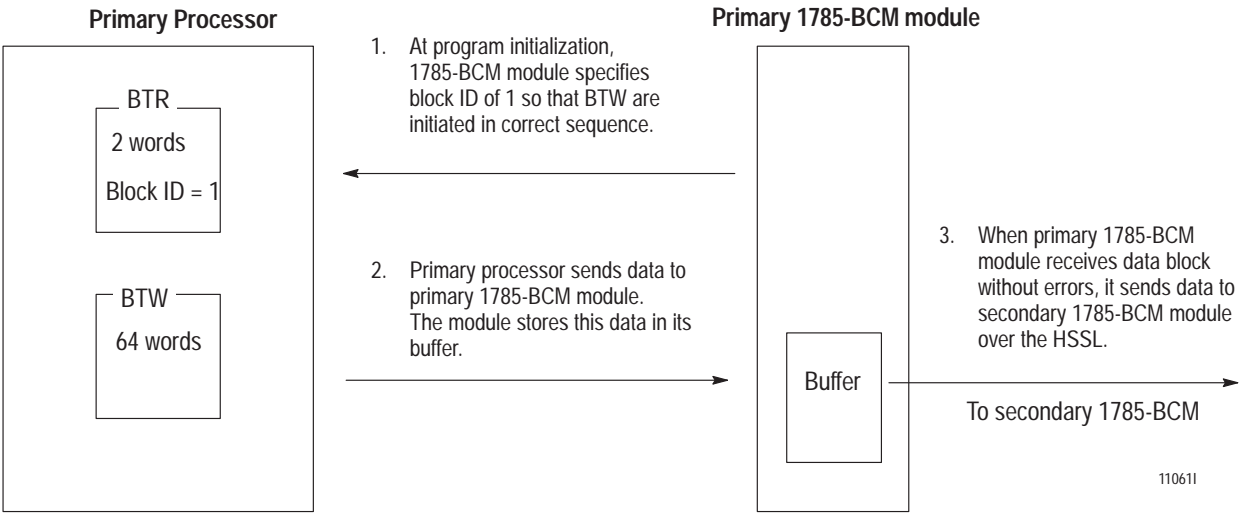
Upon initialization of the backup system, or when the secondary PLC-5 is not in operation, the primary 1785-BCM Module responds to the BTR instruction that the block number is one (block ID = 1). This assures the correct initiation of the block transfers, principally when the secondary PLC-5 is placed in RUN mode.

After execution of the first BTR instruction, the 1785-BCM module is ready to execute the necessary sequence of instructions to transfer the data table words from the primary system to the secondary.

Important: Remember that, in block transfer instructions, you must specify the LENGTH field as 0 (zero). This allows the 1785-BCM module to determine automatically the block size depending on if the module is in the primary or secondary system. In the primary system, the 1785-BCM module will return 2 words in the BTR instruction, while the processor will write 64 words to the 1785-BCM module.

Each word received by the primary 1785-BCM module is stored in its buffer. If the primary module receives the data block (of up to 64 words) without errors, it automatically sends the block to the secondary 1785-BCM module over the HSSL. Each block is checked for errors, and if no errors are pending, the primary module transmits the data after the current data block, one block at a time.

Figure 5.9
Execution of Primary Program



Secondary (Receiver) Program

In the secondary program, the BTR instruction is used to obtain the system status, the block ID word, and its respective data. The BTW instruction informs the secondary 1785-BCM module of the size of the segment to be received, that is, the number of blocks which must be accepted before turning on the data valid bit.

The number of blocks which must be accepted before turning on the data valid bit depends on the switch setting for Fast Data-Transfer mode and word 1 of the BTW segment length.

The secondary PLC-5 processor will read data from the secondary 1785-BCM module according to the Fast Data Transfer mode setting.

Fast Data-Transfer Mode Enabled

The secondary PLC-5 processor continuously executes BTR instructions to obtain the system status word and data from the secondary 1785-BCM module. With the Fast Data Transfer mode, as soon as the secondary 1785-BCM module correctly receives a data block, the data valid bit returned to its local processor through the BTR instruction will immediately turn on and the block is released for reading.

Fast Data Transfer Mode Disabled

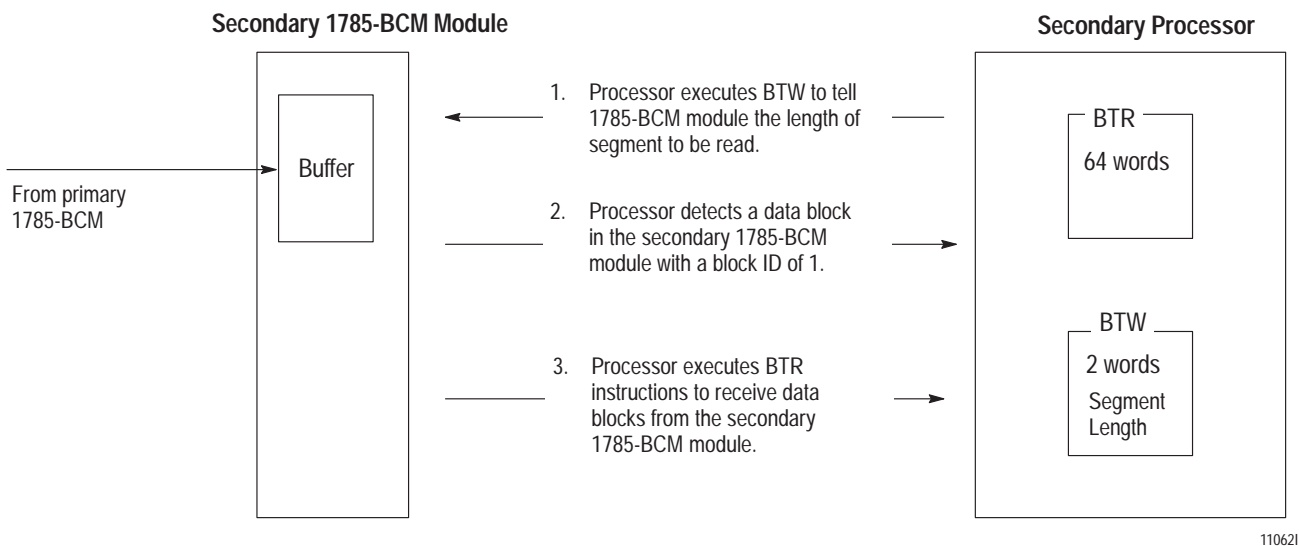
The secondary PLC-5 processor continuously executes BTR instructions to obtain the system status word and data from the secondary 1785-BCM module.

The primary 1785-BCM module sends several data blocks that make up a segment sent to the secondary 1785-BCM module. Until the secondary 1785-BCM module correctly receives all blocks of the segment, the data valid bit returned to its local processor through the BTR instruction will not turn on. This bit will turn on only when the complete segment is correctly received and the number of blocks in the segment match that sent by the primary 1785-BCM module. Transfer from the 1785-BCM and the secondary processor can now begin.

During transfer of the information from the 1785-BCM module to the secondary processor, the 1785-BCM module sets the block ID of the first block equal to one and increments it on each successive block.

In the BTR data, the block ID word always contains the number of the last block received from the buffer of the 1785-BCM module. If the buffer is empty, or if the 1785-BCM module cannot send a new segment, the block ID equals 0 (zero) and only the first two words are received. Figure 5.10 shows how the secondary program operates.

Figure 5.10
Execution of the Secondary Program



Important: It is up to you to:

- determine which parts of the data table must be shared by the processors
- develop a program that sequences all blocks to and from the 1785-BCM modules
- account for the asynchronous nature of queuing and moving of BTW and BTR data in the PLC-5 processor.

For example, if the primary processor is sending multiple blocks to the secondary processor, the data that was in block 2 when block 1 was sent may change by the time block 2 is sent. This is because the ladder program, which executes asynchronously to block transfer instructions, may have changed the information in block 2 before it was sent.

Starting the Backup System

After you have checked your program for proper data to be transferred, and have developed the transmitting and receiving programs, you can start the backup system.

To start the backup system:

1. Apply power to the primary system.
2. Apply power to the secondary system.
3. Load the application program and the remote I/O configuration in the primary PLC-5 processor by addressing node **n**.
4. Test the system.
5. Load the application program and the remote I/O configuration in the secondary PLC-5 processor through node **n+1**.
6. Test the system.
7. Switch the primary and the secondary PLC-5 processors to RUN mode.

Powering Up the Backup System

If a power loss occurs in both the primary and secondary systems once the backup system has been started up, use the following power-up sequence:



ATTENTION: When you connect a 1785-BCM series B module to a 1785-BCM series A module, ensure you have properly set switch 1 of switch assembly SW1. Otherwise, if you power up both systems, both modules will assume to be the primary.

1. Switch both PLC-5 processors to PROGRAM mode.
2. Re-apply power to the system that you intend to be primary.
3. Switch the primary PLC-5 processor to RUN mode.
4. After the primary PLC-5 processor begins operating correctly, re-apply power to the secondary system.
5. Switch the secondary PLC-5 processor to RUN mode.

If you power up both systems at the same time, the 1785-BCM modules decide which will be the primary and which the secondary. In this case, all of the relays of the modules remain open until one of the 1785-BCM modules arbitrarily assumes control of the process. This guarantees the existence of only one primary system.

Disconnecting/Repairing a Faulted Backup System

When a fault occurs in the primary system, the remote I/O, Data Highway Plus, and customer relay switches in the primary 1785-BCM module open immediately. When these switches open, the module interrupts the transmission of data and sends commands to transfer control to the secondary module.

Because the secondary PLC-5 processor's input image table has been loaded with actual data from the primary processor's remote I/O interface, the application program of the secondary processor does not need to wait for the complete execution of an remote I/O scan to use this input image table data.

After 50 ms maximum, the remote I/O, Data Highway Plus, and customer relay switches in the secondary 1785-BCM module close. When these switches close, the secondary PLC-5 processor is now controlling the system and becomes the primary processor.

To disconnect a faulted backup system, do the following:

1. Power-down the faulted system.
2. Troubleshoot and/or repair the faulted system as needed.

Restarting a Repaired Backup System

Once a faulted system has been repaired, you may restart it as described below. You do not need to power-down or change the mode of the operating system to restart the system.

1. Switch the repaired processor to PROGRAM mode and apply power. This way, the processor automatically becomes the secondary (backup).
2. Load the memory of the secondary processor and the I/O configuration through node **n+1** by using a programming device connected to the Data Highway Plus link.



ATTENTION: Ensure that key data table values are identical in both processors. If this is not accomplished, unpredicted machine motion could result when you transfer from primary to secondary processor.

3. Switch the backup processor to RUN mode.

Switching the Processor's Operating Mode

The 1785-BCM Backup Control Module does not control the operating mode (PROGRAM/RUN) of the primary and secondary PLC-5 processors. Thus, if it is necessary to change the operating mode of the processor, change the mode of the secondary processor first. Then change the mode of the primary processor.

Always change the mode of the secondary system first; if both processors are in RUN mode, and if the primary processor is switched to PROGRAM mode first, the primary processor transfers control of the I/O to the secondary system.

Remote Test-Mode

To initiate remote test-mode on a processor in backup configuration (using a 1785-BCM series B module), perform the following steps.

1. Take the secondary processor off-line by removing power or placing the secondary processor in program mode.
2. Initiate the remote-test mode command to the primary processor.

When the primary processor is in remote-test mode, the outputs are disabled.

Editing or Programming On-line

To avoid a control switch from the primary to the secondary processor when you attempt to edit the ladder program or data table of the primary PLC-5 processor using a programming device:

1. **Do not** switch the primary PLC-5 processor to REMOTE PROGRAM mode. Switch the primary PLC-5 processor to REMOTE RUN mode.

Important: If you switch the primary processor to REMOTE PROGRAM mode, the processor transfers control to the secondary processor. In most cases, the new primary then switches to Remote Program mode, shutting the system down.

2. Make edits in the secondary processor first. However, make sure that all necessary changes are made in both processors.

Important: Using the on-line editing/programming function can cause the primary and secondary systems to diverge if the system should switch before you complete the edits in both processors.

What to Do Next

This chapter described the basic operation of the 1785-BCM modules and the PLC-5 backup system, and gave you procedures for operating your module. Read the next chapter to learn how the backup system operates at switchover, and how you need to account for this when programming your system.

Switchover Considerations

Chapter Objectives

When planning programs for the PLC-5 backup system, you must first consider that the program scans of the two processors are not synchronized; that is, the program in the primary processor is not executing the exact same instruction at the same time as the program in the secondary processor. In addition, you must consider:

- timing
- divergence
- I/O forces
- Data Highway Plus switching
- remote I/O switching
- special sections of the data table
- data integrity

This chapter describes these switchover considerations. This chapter also describes switchover diagnostic. It describes how to detect a possible fault in the secondary module and how to consequently avoid switchover problems in the backup system.

Timing Requirements

Although switchover from one processor to the other is fast — less than 50 ms, it does not happen instantly. Make note also that the total switchover time is a factor of the 1785-BCM module delay, plus, at worst case, one program scan of the secondary processor. The time of one program scan is added because the secondary processor technically has not assumed control until one scan of its program and remote I/O after the switchover.

When a failure occurs in the primary system, the remote outputs remain in the state set by the primary processor prior to switchover, as well as while the secondary processor assumes control of the process. Keeping this in mind, you must program the backup system to account for the following time requirements:

- input signal update time
- time-out on remote I/O link
- data table transfer time over the HSSL

Input Signal Update Time

Immediately after the switchover, it is possible that the secondary processor will be reading different input conditions. To avoid a sudden change in the outputs during switchover, all of the input signals must be present for at least a time equal to the sum of:

- program scan
- I/O scan
- input module delay
- 1785-BCM switchover time

If these conditions are not met, outputs may be assigned different states in the two processors. This can cause a sudden change of operation when switchover occurs.

Time-out on Remote I/O Link

The remote I/O chassis are updated one at a time. The total remote I/O update is 10 ms per chassis (typical).

To keep the I/O chassis from faulting and losing control of the I/O, the switchover in the remote I/O link (the time from when the remote I/O relays in the primary 1785-BCM module open to when the remote I/O relays in the secondary 1785-BCM module close) will be accomplished in less than 50 ms. (The 1785-BCM module will do this automatically.)

This switchover time is less than the 100 ms for remote I/O adapter watchdog timeout; therefore it allows continuous control of the I/O from the backup system processors.

Data Table Transfer Time

This time refers to the time it takes to transfer critical data from the primary system to the secondary system. Data table transfer time is dependent on the amount of data to be sent between the two systems, the number of remote I/O chassis, and the number of remote I/O block transfers that are being executed.

Using the 1785-BCM module, the primary system can transfer data to the secondary system at a maximum throughput of 4K words in less than 1 second. This time takes into account:

- program scan
- programming method used to transfer data to secondary processor
- PLC-5 block-transfer queuing
- number of remote I/O chassis
- number of remote I/O block transfers

For actual data table transfer times when transferring different block lengths of data, refer to Appendix A “Sample Programs.”

Divergence

The program scans are not synchronized; therefore, it is possible that the processors read the same inputs and control outputs accordingly, but at slightly different times. Sometimes, the processors will read different input values and make different decisions. This means that the internal states of the two systems may diverge.

If the two systems diverge, the secondary system generates a bump when it takes control of the process. Like data table transfer time, the duration of this bump is a function of how fast the inputs of the machine or process are changing, as well as the amount of data to be sent between the two systems.

To limit divergence, we recommend that the primary and secondary processors execute the same programs.

Important: When you use outputs (from 0 file) to seal-in a rung with non-retentive output instructions, the seal-in will be lost if the processors switch primary and secondary twice, consecutively. This occurs because a PLC-5 processor, when powering-up, going from PROGRAM to RUN mode, or clearing a fault, resets outputs and performs a prescan to force all rungs false before going into RUN mode. This turns off all output bits controlled by non-retentive output instructions. This will cause divergence between the primary and secondary processors.

Forcing I/O

Backup communication functions provided by the PLC-5 backup system **do not** transfer the force tables from the primary to the secondary processors. Thus, if the PLC-5 backup system has forces set in the primary processor, the forces do not transfer to the secondary processor. For this situation, if a switchover occurs, the secondary processor becomes active, but the forces set in the original primary processor are not carried over.



ATTENTION: Set the forces in the secondary processor first and then in the primary processor. Likewise, when removing forces, remove forces in the secondary processor before removing the forces in the primary processor.

If a switchover occurs and forces were not set in the secondary processor first, the secondary processor would not recognize the forced-on input or output.

Data Highway Plus Switching

In the Data Highway Plus link, one station on the link has control of the link at a time. The station with this control is referred to as the station that has the “token.” In the PLC-5 backup system, only the primary processor is connected to the link. But, the secondary processor communicates with the secondary 1785-BCM module, making this processor think that it is on the Data Highway Plus network.

The secondary processor can be programmed through an access-point address which corresponds to the processor node address plus one ($n+1$). The secondary processor becomes part of the link only after a switchover.

It is possible that the primary processor could have possession of the token during a switchover from the primary to the secondary processor. If this is the case, the token could be lost even though passage of the token from one station to the next is done as quickly as possible.

If the token is lost, all the stations on the link have an internal watchdog timeout (250 ms), and the nodes assume the token is lost.

The other stations on the link initiate a token recovery procedure which includes:

- recreating the active node table
- rebuilding the link, including the new primary processor
- ensuring that one node gains control of the link

During this time, while the stations reconstruct the link, communication is interrupted. The length of this time depends on the number of stations involved in the link, and the number of messages received and/or transmitted. (This time is typically less than 50 ms per station).

However, while the link is rebuilding, messages can collide, increasing the amount of time needed to reconstruct the link. As a result, on a typical Data Highway Plus link with 6 – 10 stations, the impact on the link due to switchover could be the loss of communication for as much as 1 – 3 seconds.

Data Highway Plus switching occurs whenever there is a transfer of control from the primary to the secondary processor. The switchover could result from a power failure or because of other system failures. Table 6.A shows what can happen to the link if the token is lost.

Important: Note that when a transfer of control from the primary to the secondary processor occurs, the processor that is now primary has the node address of **n** on the DH+ link. The processor that is now secondary has the node address of **n + 1**.

Table 6.A
DH+ Switchover Scenarios

If the new primary is:	the following could occur	causing this result
Polling the link	Message packet from another station disrupted	The source station turns on error bit in its MSG instruction (You provide programming at the source station to regain synchronization with the receiving station. You can do this by monitoring the message instruction error bit as a condition for re-transmitting the message.)
	Reply packet disrupted	Same as above
	Token pass packet disrupted	The DH+ link times out and must rebuild. (250 ms watchdog timeout) + (50 ms x number of stations on the link).
Listening to the link	New primary processor takes the token	The new primary processor has nothing in its active node table. The DH+ link times out and must rebuild. (250 ms watchdog timeout) + (50 ms x number of stations on the link).
	New primary processor receives a message from another station	The link continues working normally

Important: In the recommended configuration, set both PLC-5 processors to the same station address. The backup modules permit only one of the two processors to be connected to the Data Highway Plus at a time. In this configuration, remote PLC processors and operator stations communicate to the processor that currently has primary status. Note that the secondary processor can also be accessed through the primary PLC-5 processor node address plus one (**n+1**).

Programming

Important: If you are communicating with the primary processor via a programming terminal, do not place it in Remote Program mode. If you do, a switchover will occur and the new primary can go into Remote Program mode, shutting the system down.

Remote I/O Switching

The communications protocol for the remote I/O link is a master-slave half-duplex type. This means that the master station (processor) sends a command message addressed to a slave (remote I/O adapter), and the slave responds with a reply message addressed to the master. This is also called two-way alternating communication.

When the backup system is operating properly, the relays of the primary 1785-BCM are closed and the relays of the secondary 1785-BCM are open. Should a failure occur in the primary system, the relays of the primary 1785-BCM module open and the relays in the secondary 1785-BCM module close.

The secondary processor (remote I/O scanner or adapter) is not part of the remote I/O link, but is communicating with the secondary 1785-BCM's smart switch interface. When the secondary processor is configured for scanner mode, this interface responds to a poll from the secondary processor's scanner with actual data it receives from the primary processor over the HSSL. The scanner "thinks" that it is communicating with the real remote I/O adapters. The function of the interface is to respond to the secondary processor with current data from the primary processor, enabling the input image table of the secondary processor to be a copy of that of the primary processor.

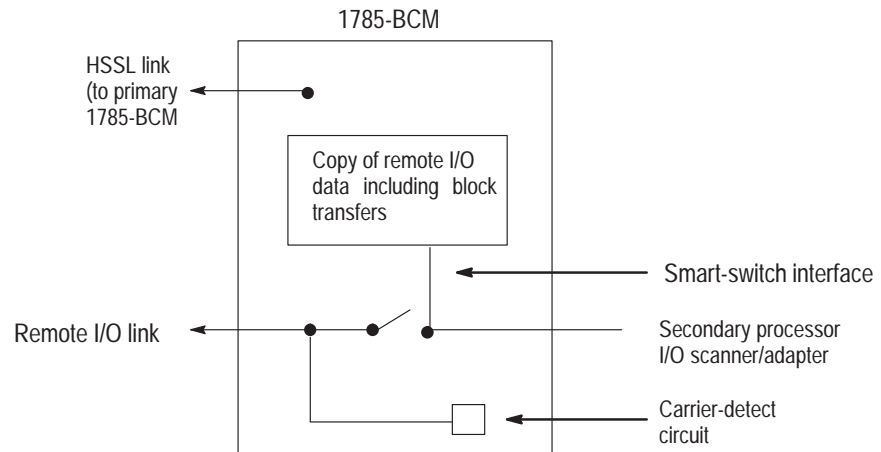
Similarly, when the secondary processor is configured for adapter mode, the 1785-BCM module polls the secondary processor's adapter, updating the input image table of the secondary processor to be a copy of that of the primary processor. Also, a BTR can be performed in the secondary processor to receive data from the supervisory processor.

Important: The smart-switch interface communicates with the secondary processor only when the 1785-BCM module belongs to the secondary system. When the module is primary, the smart switch only monitors the remote I/O link to obtain input/output data.

The smart switch interface also includes a carrier-detect circuit to monitor the activity of the remote I/O link. The purpose of this circuit is to detect an idle remote I/O link before the secondary relays are closed. This guarantees that the former primary system was really disconnected from the link and the remote adapters have completed their response to the last poll from the primary scanner.

In addition, in the event of an HSSL break, the carrier-detect circuit prevents the secondary system from taking control of the link along with the primary system. Figure 6.1 shows the block diagram of the remote I/O switch.

Figure 6.1
Block Diagram of Remote I/O Switch



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To determine the maximum time it takes for the secondary module to close its relays after it detects a switchover, consider the following:

- the primary scanner has just requested a 64-word BTR from the remote module at 57.6 kbaud
- the remote adapter starts to respond
- switchover is triggered

You can calculate the maximum time for the I/O link switchover as follows:

1. remote I/O communication rate = 57.6 kbits/s = 1 byte/.14 ms
2. transfer time = 64 x 2 x .14 = 18 ms
3. HSSL protocol overhead/BCM delay = 12 ms
4. 1785-BCM module remote I/O watchdog timeout = 20 ms

Maximum time = 18 + 12 + 20 = 50 ms

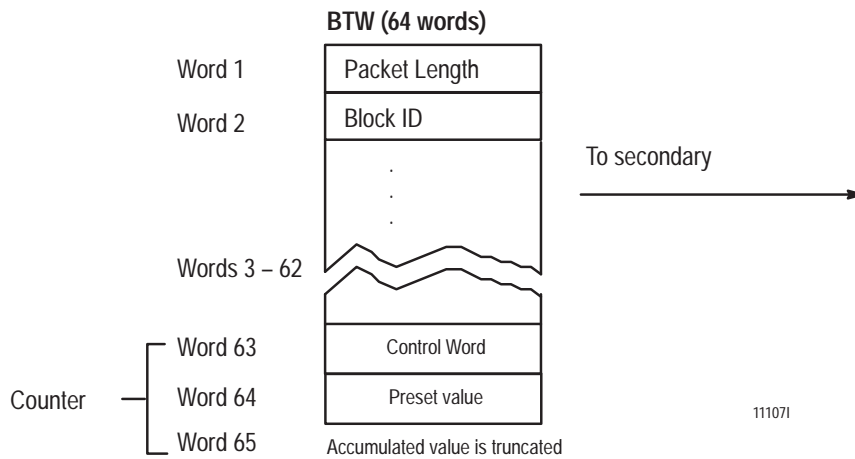
Note that this time is less than the 100 ms remote I/O adapter watchdog timeout, and therefore allows for continuous control of the I/O from the backup system processors.

Data Table Considerations

Several of the data table sections in the PLC-5 processor are not structured with single 16-bit words. You need to consider this when applying the 1785-BCM module.

For example, the BTW of the primary processor transfers 62 words of data to the secondary processor (plus the packet length and block ID word). Some structures such as timers, counters, and floating point control files have three words. If all related words don't fit in a block, some words may be truncated, creating a partial structure in the secondary processor (Figure 6.2).

Figure 6.2
Partial Structure in BTW



Problem structures include:

- timer values
- counter values
- floating point elements
- control registers

Because the secondary processor's program scan and block transfer execution are totally asynchronous, it is possible for the secondary processor to operate on partial data structures. If the secondary processor is executing instructions that operate on any of the multi-word structures that are listed above, the following sequence of events may occur:

1. The 1785-BCM transfers the first word of a multi-word structure to the secondary processor. A partial data structure temporarily exists in the secondary processor.
2. The secondary processor operates on this partial structure and derives invalid results.
3. The partial data structure and the invalid result of the operation exist in the secondary processor until the remaining portion of the structure is transferred. The secondary processor re-executes the operation on the next program scan and overwrites the invalid result with the correct result.
4. If the primary processor were to go de-active before the invalid result of the processor operation was corrected, then the invalid results would persist in the secondary processor for an indeterminate period of time.

Important: To prevent partial structures from occurring in the secondary processor, you must group related data words or multi-word elements (i.e. floating point) so that they fit in one block.

Data Integrity

Some of the PLC-5 processor instructions operate on data structures with less than 16-bit words. These other data structures are:

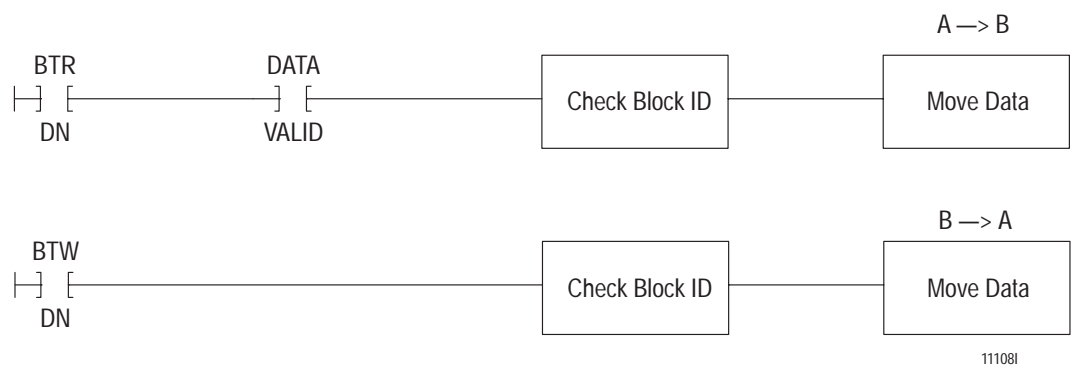
- bits
- bytes
- bit fields

Instructions such as bit-shift and bit-distributor instructions use these other data structures. When using these instructions, you must be aware that the data table will contain invalid data until the processor executes a series of instructions. For example, if you are shifting four bits of BCD data through several words bit by bit, the data table will contain invalid data until each shift is complete.

Should the 1785-BCM module transfer one or more of these values to the secondary system and the primary system fails, the data table of the secondary system will contain intermediate values for an indeterminate amount of time, thus creating illegal BCD values.

Important: Because block transfer instructions operate asynchronously to the execution of the program scan, we suggest using the condition of the done bit (DN) of the BTR or BTW instruction as part of the logic used to initiate the transfer when using block transfer instructions to move data from the primary to the secondary 1785-BCM module. Figure 6.3 shows typical rungs that use the condition of the done bit to initiate a transfer. Refer to appendix A, “Sample Programs” to see these types of rungs used in a program.

Figure 6.3
Typical Data Move Rungs



Switchover Diagnostics

The 1785-BCM backup module continuously executes an internal hardware diagnostics routine to ensure that it is operating correctly. In the case that a primary module detects a major fault like bad RAM memory or bad CPU, its relays will immediately open and a switchover will automatically occur.

Check if the 1785-BCM module is operating correctly and avoid problems in case of an eventual switchover in the backup system by executing a manual switchover when it is possible. If a minor fault is detected during this manual switchover, the module will switch. In addition, it will also turn on the switchover diagnostic bit (bit 16) of the extended status word, indicating that the module should be replaced as soon as possible. Refer to the section in Chapter 8, Diagnosing Faults with Bits of the Auxiliary Diagnostics/Status Words, for further information.

Chapter 6

Switchover Considerations

What to Do Next

In this chapter, you read about switchover considerations for the PLC-5 backup system. By accounting for these considerations in your program, you can execute a smoother and faster switchover should the primary processor fault. Read the next chapter to learn about two different programming techniques you can use when you program your PLC-5 backup system. Read also to learn about program instructions that can cause problems during switchover.

Programming Techniques

Chapter Objectives

Read this chapter to familiarize yourself with techniques used to program your PLC-5 backup system.

In this chapter we describe:

- how to get started with a program to transfer data table values
- two methods you can use to program the PLC-5 backup system to transfer data table values
- the behavior of specific instructions when used in your application program, and give you suggestions for dealing with these instructions.

Getting Started

The 1785-BCM modules control switchover and transfer remote I/O data without additional programming. However, if you want to transfer data table values from the primary to the secondary processor, you must provide a ladder program. Figure 7.1 shows the minimum ladder programming you must provide to transfer 62 words of the data table between the two 1785-BCM modules, and to provide 1785-BCM module status. You need to put this program in both processors.

Figure 7.1
Minimum Program to Transfer Data Table Values
(put this program in both processors)

```

1771-BCM GETTING STARTED PROGRAM                               1 April 1995   Page 1 Program
Listing Report                                           PLC-5/25
Addr 1                                           Rung 2:0

Rung 2:0
|
|                                     NUMBER OF
|                                     SEGMENTS
|                                     STORE WORD
|
|                                     +-----+
|                                     +MOV-----+
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                                     |Source      1|
|                                     |Dest      N10:1|
|                                     |              1|
|                                     +-----+
|                                     BID
|                                     WORD
|                                     +MOV-----+
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                                     |Source      1|
|                                     |Dest      N10:2|
|                                     |              1|
|                                     +-----+

Rung 2:1
| N7:0 N7:5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 15 15                                     +BTR-----+
|                                     |BLOCK TRNSFR READ +- (EN)-+
|                                     |Rack      0|
|                                     |Group    0+- (DN)|
|                                     |Module   0|
|                                     |Control Block N7:0+- (ER)|
|                                     |Data file N10:101|
|                                     |Length   0|
|                                     |Continuous N|
|                                     +-----+

Rung 2:2
| N7:0 N7:5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 15 15                                     +BTW-----+
|                                     |BLOCK TRNSFR WRITE+- (EN)-+
|                                     |Rack      0|
|                                     |Group    0+- (DN)|
|                                     |Module   0|
|                                     |Control Block N7:5+- (ER)|
|                                     |Data file N10:1|
|                                     |Length   0|
|                                     |Continuous N|
|                                     +-----+

Rung 2:3
|
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                                     [END OF FILE]
|-----+-----+-----+-----+-----+-----+-----+-----+-----+

```

Programming Methods to Transfer Data Table Values

This manual provides two solutions to programming your PLC-5 backup system to transfer data table values. These methods are:

- transferring data one block at a time
- transferring data multiple blocks at a time

We describe the operation of these programming methods on the following pages. To view sample programs that use these methods, refer to appendix A, “Sample Programs.”

Method 1 — Transferring Data One Block at a Time

In the first programming method, **transferring data one block at a time**, both the primary and the secondary processors execute and scan identical programs. This method requires that you execute BTR and BTW instructions on alternate program scans. You are able to do this because the primary 1785-BCM module has the ability to identify and increment the block ID by one. (For more information about the block ID, refer to Chapter 5, “Operating Your PLC-5 Backup System.”)

Using this method, your application program can use the block ID returned in the block transfer read (BTR) instruction to control the data file of the block transfer write (BTW) instruction control file.

This method of programming results in a slower overall throughput of data transfer, but gives tighter control of the transfer, allowing automatic re-transmission of a block if an error in the transfer should occur.

A program that uses this method contains:

- A BTW and BTR instruction in each PLC-5 processor. These instructions should be of a free-running nature and be the same in both the primary and secondary processors.
- A chained series of File Copies (COP).

Program operation varies depending on if the system is primary or secondary. The primary 1785-BCM module executes a 64 word BTW instruction and a 2 word BTR instruction; the secondary 1785-BCM module executes a 2 word BTW instruction and a 64 word BTR instruction.

Program Operation in the Primary System

In the primary system's program, COP instructions move data with a block ID of 1 to the BTW data file of the primary processor, where it remains until a block ID of 2 (1+1) is requested through a BTR of the primary 1785-BCM module. When this happens, another COP instruction is enabled. This COP moves data with a block ID of 2 to the BTW data file, where it remains until a block ID of 3 (2+1) is requested by the 1785-BCM module. This sequence continues until the last block of the segment (block ID = segment length) is transferred.

After the primary processor sends the last block of data to the primary 1785-BCM module and then executes a BTR to get the module's status, the module returns a block ID of 1. This tells the primary processor to send a new segment of data. In addition, the primary 1785-BCM module notifies the secondary 1785-BCM module that it has a complete segment in its (the primary 1785-BCM module's) buffer.

If an error occurs during the transmission of a block from the primary processor to its 1785-BCM module, the module requests a re-transmission of that block, and the block ID is not incremented. (The rungs that contain the COP instructions are responsible for triggering the re-transmission.) Blocks that are transferred from the primary processor to the primary 1785-BCM module are in turn sent to the secondary 1785-BCM module. The secondary 1785-BCM module stores all of the data blocks received and sends these blocks to the secondary processor, one at a time, by means of a BTR instruction.

Program Operation in the Secondary System

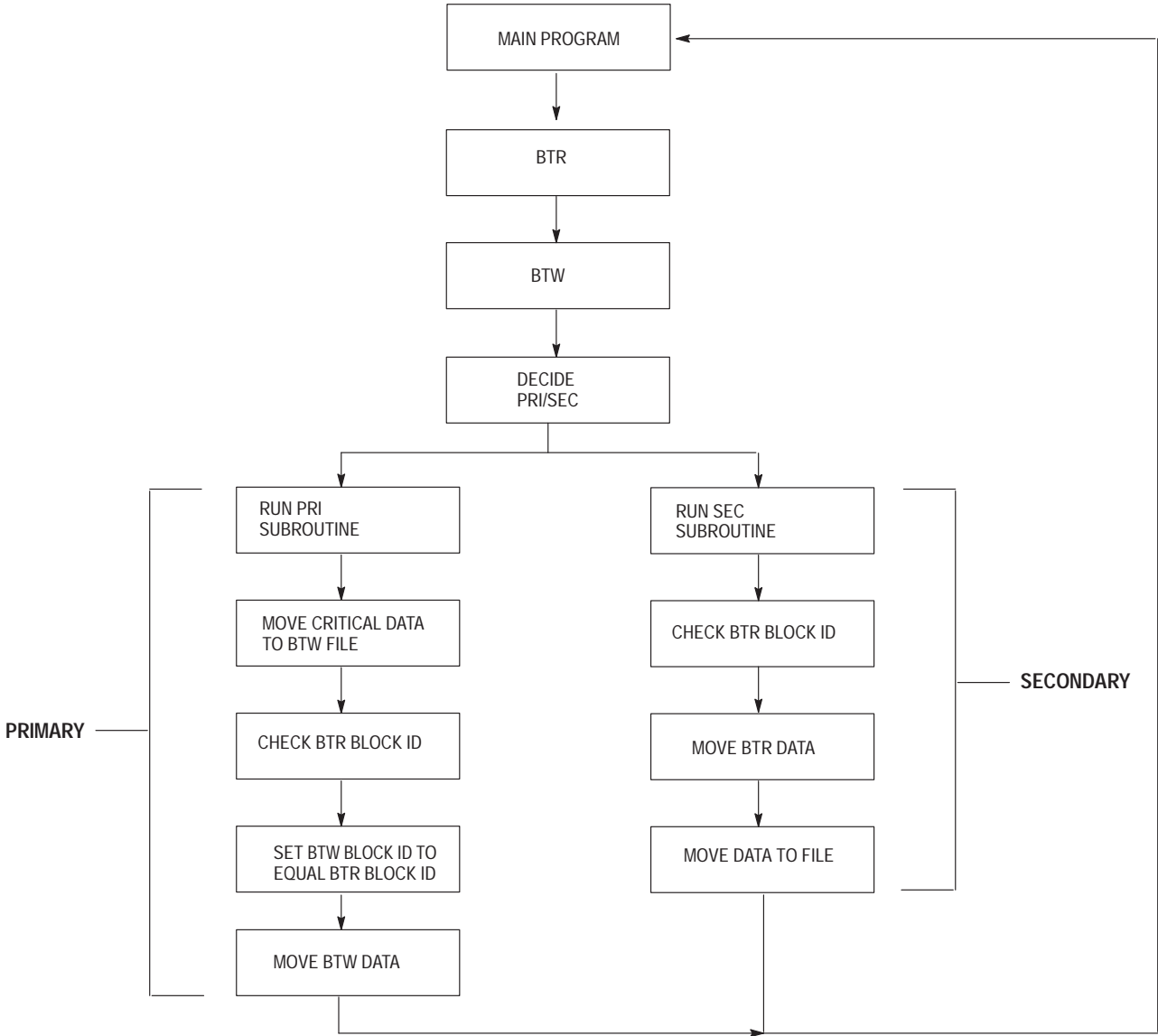
Using the one-block-at-a-time method, the secondary processor executes the same program as the primary, except that its linked COP structure checks the block ID of the BTR instruction and moves the data from the BTR into memory at the proper starting address.

The secondary 1785-BCM module sequences through the blocks sent from the primary module. Successive BTR commands return successive blocks from the module to the local processor. The secondary module does not alter the block ID received from the primary module when sending the block to the secondary processor, but rather shows the block ID of the current transfer.

In addition, the secondary 1785-BCM module compares the segment length specified in the secondary program's BTW instruction with the segment length sent by the primary 1785-BCM module. If the segment lengths are different, the secondary 1785-BCM module turns on the programming error bit (bit 3 is local, bit 11 is remote).

Figure 7.2 shows how a program that uses the one-block-at-a-time method works.

Figure 7.2
Program Flow for Transferring Data One Block at a Time



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Method 2 — Transferring Data Multiple Blocks at a Time

In the second method, **transferring data multiple blocks at a time**, the application program takes advantage of the PLC-5 block transfer queue. Because the PLC-5 processor assigns the task of block transfer to one microprocessor and program scan to another, block transfers are executed asynchronously and simultaneously in relation to the scanning of the program, permitting multiple block transfers per scan.

Using the multiple-blocks-at-a-time method, the primary system transfers various blocks in the same scan. The secondary system checks the transfer after the primary system sends the entire segment. Using this method, the application program of the primary PLC-5/15 or PLC-5/25 processor can contain up to 16 BTW instructions and 1 BTR instruction. The application program of the secondary PLC-5/15 or PLC-5/25 processor can contain up to 16 BTR instructions and 1 BTW instruction.

Note that this method of transfer is suitable in cases where you want to transfer no more than 992 words of data. This number refers to the number of block-transfer requests in the same chassis (16) times the number of words transferred in each data block (62).

If you use a PLC-5/20, -5/30, -5/40, -5/60, or -5/80 processor, the application program of the primary processor can contain up to 64 BTW instructions and 1 BTR instruction. The application program of the secondary processor can contain up to 64 BTR instructions and 1 BTW instruction.

In this case, you can start the transfer of up to 3968 words of data in one single scan. This number refers to the number of block transfer requests in the same chassis (64) time the number of words transferred in each data block (62).

In the following paragraphs, we explain how this method works for a program where:

- the primary processor has 3 BTW instructions and 1 BTR instruction enabled
- the secondary processor has 3 BTR instruction and 1 BTW instruction enabled

Program operation varies depending on if the system is primary or secondary.

Program Operation in the Primary System

The primary processor's program executes the 3 BTW instructions to the primary 1785-BCM module. After the 3 blocks have been transferred, the BTR shows that the next block to be sent is 1. In this way, once the 1785-BCM module confirms that the number of the last block sent (3) equals the size of the segment, the module requests a transfer of new data.

If an error occurs in the transmission of a block from the primary controller to its 1785-BCM module, the module sets the backplane error bit (bit 1 is local, bit 9 is remote) and continues to receive all of the remaining blocks.

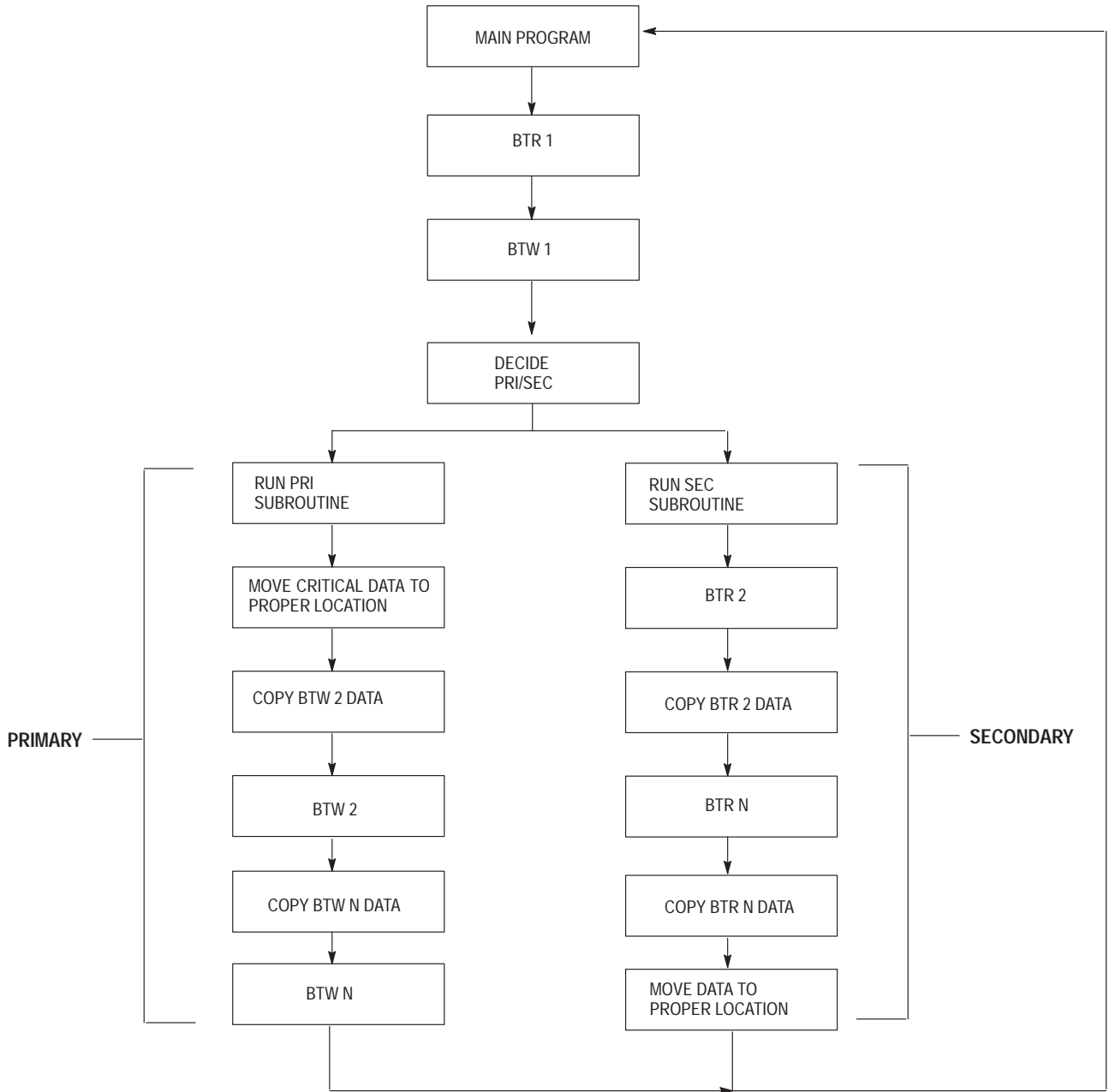
Program Operation in the Secondary System

The secondary processor's application program enables 3 free-running BTR instructions. The program then uses the block IDs of each instruction and COPs (file copy) to move the data to its memory at the proper starting address.

In addition, the secondary 1785-BCM module compares the segment length specified in write block to the segment length sent by the primary 1785-BCM module. If these segment lengths are different, the secondary 1785-BCM module turns on the programming error bit (bit 3 – local, bit 11 – remote). If a block transfer error occurs between the secondary processor and its 1785-BCM module, the module turns on the backplane error bit (bit 1 – local, bit 9 – remote) and continues sending all valid data blocks.

Figure 7.3 shows how a program that uses the multiple-blocks-at-a-time method works.

Figure 7.3
Program Flow for Transferring Data Multiple Blocks at a Time



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Accounting for Instructions That Could Cause Problems During Switchover

Some instructions, when used with a PLC-5 backup system, may operate unpredictably when a switchover occurs if you fail to observe certain programming considerations. For example, you must consider transferring the control element and data elements for instructions that are also being executed in the secondary processor. You also must consider transferring data files which contain more than one word.

Instructions we discuss in this section include:

- timer
- counter
- logical, arithmetic, compare and move
- diagnostic, sequencing, file arithmetic and logic, file search and compare, file copy and fill
- FIFO and bit displacement
- block transfer
- message

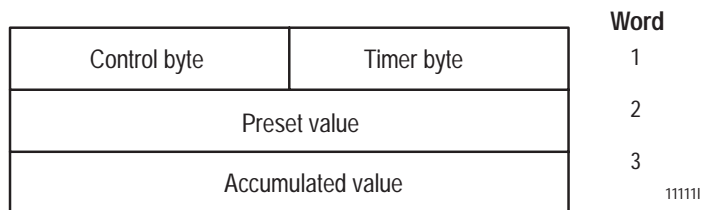
In the remainder of this chapter, we describe the behavior of these instructions in the PLC-5 backup system.

Important: You must be aware when programming your backup system that the primary and secondary system’s program scans are not synchronized; that is, the systems do not necessarily execute the same instructions at the same time. You must also consider that the PLC-5 processor executes block transfers asynchronously to the program scan, and therefore, interrupts this scan asynchronously to access block transfer write (BTW) and block transfer read (BTR) files.

Timer Instructions

The PLC-5 family processors maintain timers by keeping a copy of a hardware timer in a portion of the three word structure (timer byte) used by each timer (Figure 7.4).

Figure 7.4
Timer Structure



The hardware timer of the primary processor is completely asynchronous to the hardware timer of the secondary processor. If the whole three word timer structure, including this timer byte is transferred from the primary to the secondary processor during a switchover, then the timer could encounter a large positive increment in the timer accumulated value. The worst-case increment may be up to 2.55 seconds, which may cause a large bump.

To help prevent this from occurring:

- do not send the first word of the timer control structure
- transfer only the accumulated value, and possibly the preset value (if you have the need to change it)

Even though both processors are executing the same programs, your program should transfer the timer accumulated value from the primary processor to the secondary processor at least once after you:

- start up the backup system
- switch the secondary PLC-5 from PROGRAM to RUN mode
- restart a repaired system

This allows the accumulated value in the secondary processor to track the accumulated value in the primary processor.

Counter Instructions

Counter instructions are similar in structure to timer instructions; however, there is only one problem that could exist with these instructions when used in a PLC-5 backup system. At the point of switchover, a counter that occurs once in a program could increment or decrement twice in one program scan. This problem arises when the following sequence of events occur:

1. The primary system executes a counter up/down instruction conditioned by a rung transition of not-true to true. This increments/decrements the counter accumulated value.
2. The 1785-BCM modules transfer this data into the counter file of the backup processor before the secondary's input image table is updated with the input transition information.
3. The backup processor updates its input image table.
4. The processor in the secondary system (which was at a different point in its program scan) executes the counter instruction again, thus incrementing/decrementing the counter again.

As with the timer instruction, your program should transfer the counter accumulated value from the primary to the secondary processor at least once after you:

- start up the backup system
- switch the secondary PLC-5 from PROGRAM to RUN mode
- restart a repaired system

This allows the accumulated value in the secondary processor to track the accumulated value in the primary processor.

Diagnostic, Sequencing, File Arithmetic and Logic, File Search and Compare, File Copy and Fill Instructions

The behavior of these file instructions, which include the File Arithmetic and Logic instructions (FAL), File Search and Compare (FSC), File Copy (COP), File Fill (FLL), and Diagnostic (FBC and DDT), depends mainly on the type of data you are transferring and how you transfer the data to the secondary processor.

You should place the instruction's control element and the data file it contains all within the same 62 words of data. If you don't, the 1785-BCM module could transfer the control values responsible for control of file at a different point than when it transfers the file. This results in a time lag in the secondary processor between when the file is updated and when the associated control element is updated. Thus, during switchover, it is possible that a file operation that was running may be off by one word, a word could be operated on by the file twice, or perhaps not even be operated at all.

FIFO and Bit Displacement Instructions

Again, the behavior of these instructions depends on the type of data you are transferring and how you transfer the instructions to the secondary processor.

If you are transferring only selected areas of the data files which do not include data for FIFO and bit instructions, the instructions will be executed normally.

However, if you are transferring all of the data table files over the HSSL, you may encounter problems. For example, if you are shifting four bits of BCD data through several words bit by bit, the data table will contain invalid data until **each** shift is complete. Should the 1785-BCM module transfer one or more of these values to the backup system and the primary system fails, the data table of the backup system will contain intermediate values for an indefinite amount of time, thus creating illegal BCD values.

Block Transfer Instructions

It is impossible to guarantee that both processors are executing a given BTW or BTR at the same time, since the remote I/O scans are not synchronized, and since the block transfer data is not transferred instantaneously by both PLC-5 processors. The BTR files in the secondary processor always reflect information contained in the primary processor, except with a time delay. (Refer to appendix B, “Reference Information” for more information about block transfer instruction time delay.)

To avoid the possibility of block transfer data changing during the scan of the program, you can buffer data at the beginning of the ladder program to ensure continuity.

Another potential problem with block transfer instructions is that during switchover, the secondary scanner may skip one or more remote adapters. This may happen because the “new” primary scanner (previously the secondary) was in a different place in its remote I/O chassis scan.

Message Instructions

In your backup system, the secondary processor is disconnected from the Data Highway Plus link. Therefore, it cannot execute message instructions. When programming, you must ensure that when a switchover occurs, that any messages which were running in the primary processor are subsequently enabled in the secondary processor. You can do this by conditioning message instruction rungs in both the primary and secondary processors using the primary/secondary bit of the 1785-BCM status word (Figure 7.5). If necessary, you can pass the results of a message addressed to the primary processor over the HSSL to the secondary processor.

Figure 7.5
Message Instruction Rung



PID Control Files

When using PID instructions, you can have a 23-word integer (N) control file or an 81 word PID (PD) control file. (PID control files are not available on the PLC-5/15 or the PLC-5/25 processor.) You can send all or part of these control files, based on how you back up your PID instructions and the total amount of data to be sent by the BCM modules. Keep in mind that the control files contain such things as your setpoint, gains, and words that are used by the PID instruction for internal storage and should not be manipulated unnecessarily.

Summary of Programming Considerations

When developing a program for the PLC-5 backup system, you must always consider the following:

- non-synchronous I/O scans
- execution times of block transfer instructions
- time for transfer of data from the primary to the secondary processor
- the need to reduce the quantity of data to be transferred, and gathering all related data into a single block
- synchronization of discrete I/O data with regard to program scans even though remote I/O scans are performed asynchronously
- possibility of block transfer data changing during the scan of the program
- automatic transfer of the remote inputs, such as single-transfer and remote block-transfer data from the primary 1785-BCM module to the secondary 1785-BCM module.
- the need to disable message instructions in the secondary processor using the primary/secondary bit (local is bit 6, remote is bit 14)

Diagnosing Faults

Chapter Objectives

This chapter describes how to diagnose faults with your PLC-5 backup system using:

- status indicators on the front of the module
- bits in the system status word (word 1 of the BTR instruction)

Diagnosing Faults with the Status Indicators

The status indicators on the front panel of your 1785-BCM module (Figure 8.1) show both the normal and error conditions of your PLC-5 backup system. Table 8.A lists the indicators and what they indicate.

Figure 8.1
1785-BCM Module Status Indicators

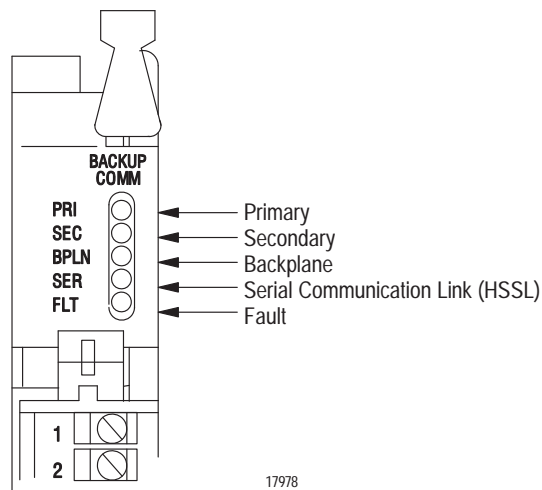


Table 8.A
Status Indicators

Indicator	Color of LED	This LED indicates:
PRI	green	when on — the 1785-BCM module belongs to the primary system
SEC	green	when on — the 1785-BCM module belongs to the secondary system
BPLN	green	when blinking — the 1785-BCM module is executing a block transfer instruction or communicating properly with the I/O chassis backplane when off — there is no communication between the 1785-BCM module and the processor
SER	green	when blinking — proper HSSL communication when off — failure in the HSSL
FLT	red	when on — hardware failure

Primary (PRI) and Secondary (SEC) LED Indicators

Table 8.B lists the possible states of the PRI and SEC LEDs and provides the recommended actions to take in case of a fault.

Table 8.B
PRI and SEC LED Indicators

If this LED	is:	Description	Recommended Action
PRI SEC	● ○	the 1785-BCM module is in primary mode (normal operation)	no action required
PRI SEC	○ ●	the 1785-BCM module is in secondary mode (normal operation)	no action required
PRI SEC	○ ○	the module is without power (refer to other LEDs on the module) hardware failure (see FLT LEDs)	If all LEDs are off, the module is not receiving any power. Remove the module and reinstall it into the I/O chassis. Turn on the power. If the FLT LED is lit, the module has internal hardware failure. Cycle power to the I/O chassis; if the failure condition persists, replace the 1785-BCM module.
PRI SEC	● ●	power turn on hardware failure (refer to other LEDs)	At power turn on, all the LEDs light until, one-by-one they assume their normal state. If the LEDs light during operation, a hardware failure exists. Cycle power to the I/O chassis; if the failure condition persists, replace the 1785-BCM module.

LEGEND: ● = on ○ = off





















Backplane (BPLN), Serial (SER), and Fault (FLT) LED Indicators

Table 8.C lists the possible states of the BPLN, SER, and FLT LEDs, and provides the recommended actions to take in case of a fault.



ATTENTION: When all secondary 1785-BCM module status indicators are blinking, except the FLT indicator, there is a switch-setting error. Check that switch assemblies SW1 and SW2 switches are set in the same positions on both the primary and secondary modules.

Table 8.C
BPLN, SER, and FLT LED Indicators

If this LED	is:	Description	Recommended Action
BPLN SER FLT	  	normal operation	no action required
BPLN SER FLT	  	PLC-5 processor is in PROGRAM mode (normal operation) block-transfer instruction fault; no block-transfer has been requested communication fault between the 1785-BCM module and the I/O chassis such as: short in the I/O chassis connector	Check that the PLC-5 is in RUN mode. Check the program. Also check to see that the module is properly inserted in the I/O chassis. Check the backplane error bit (1 is local, 9 is remote) of the system status word. If the fault persists, replace the 1785-BCM module and check the backplane error bit (1 is local, 9 is remote). If, again the fault persists, a problem may exist with the I/O chassis backplane. If this is the case, contact your local Allen-Bradley sales representative.
BPLN SER FLT	  	High Speed Serial Link (HSSL) fault	Check the HSSL connectors on the 1785-BCM module's wiring arm; check the 1770-CD cable making the HSSL connection also. Check the serial communication error bit (0 is local, 8 is remote). If the error persists, replace the 1785-BCM module.
BPLN SER FLT	 or   or  	internal module hardware failure such as: watchdog fault, checksum error, closing of a relay contact, etc.	Cycle power to the I/O chassis; if the failure condition persists, replace the 1785-BCM module.
BPLN SER FLT	  	1785-BCM module is not receiving power	Turn off the power. Remove and reinstall the module in the I/O chassis. Restore power.
LEGEND:  = on  = off  = blinking			

Diagnosing Faults with Bits of the System Status Word

In the 1785-BCM module, two bits of the status word serve to inform the PLC-5 processor of the state of the local and remote system. (The local system refers to that system whose 1785-BCM module is in the same chassis as the PLC-5 processor that is being monitored.) Figure 8.2 shows both local and remote bits and describes what is occurring in the system when the bits turn off or on. For more information about the system status word, refer to Chapter 5, “Operating Your PLC-5 Backup System.”

Important: The status word bits in Figure 8.2 are included in BTR instructions and are in an integer representation (bits numbered 0–15).

Figure 8.2
System Status Word Error Indications

Remote BCM module bits	Local BCM module bits	Error	If bit condition is: ¹		then the error description is:
			Remote BCM bit	Local BCM bit	
8	0	HSSL	0	0	Normal operation
			0	1	Communication fault with local BCM module
			1	0	Communication fault with remote BCM module
			1	1	Communication fault between local and remote modules
9	1	I/O chassis backplane	0	0	Normal operation.
			0	1	Communication fault between local processor and BCM
			1	0	Communication fault between remote processor and BCM
10	2	Buffer full	1	1	Communication fault in both systems.
			0	0	Normal operation
			0	1	For local, see Note 2
11	3	Program- ming Error	1	0	For remote, see Note 3
			1	1	Both Notes 2 and 3 apply
			0	0	Normal operation
12	4	Remote I/O Communi- cation	0	1	Programming error in local processor
			0	0	Programming error in remote processor
			1	0	Programming error in both PLC-5 processors
			1	1	Programming error in both PLC-5 processors
13	5	Processor Fault	0	0	Normal operation
			0	1	Remote I/O communication failure between local processor and BCM
			1	0	Remote I/O communication failure between remote processor and BCM
			1	1	Remote I/O communication failure between both processors and BCMs
14	6	Primary/ Secondary System	0	0	Normal operation
			0	1	Invalid condition
			1	0	Remote processor failure or is in PROGRAM mode
			1	1	Invalid condition
15	7	Data Valid	0	0	Invalid during operation; valid for power-up and switchover only
			0	1	Local processor is in primary mode; PRI LED on local BCM is lit
			1	0	Remote processor is in primary mode; PRI LED on remote BCM is lit
			1	1	Invalid condition
			0	0	Secondary BCM is not ready to send blocks of data to processor (no complete segments available in buffer) ⁴
			0	1 ⁵	Local BCM is in secondary mode and has a block or complete segment available to send processor ⁴
			1 ⁵	0	Remote BCM is in secondary mode and has a block or complete segment available to send processor ⁴
			1	1	Invalid condition

¹ Bit conditions: 1 = ON, 0 = OFF

² Local BCM, if primary, is receiving 2nd segment after storing 1st, but did not send first segment to secondary BCM; if secondary, received 2nd segment without processing 1st.

³ Remote BCM, if primary, is receiving 2nd segment after storing 1st, but did not send first segment to secondary BCM; if secondary, received 2nd segment without processing 1st.

⁴ This is dependent on the Fast Data Transfer mode either being enabled or not enabled.

⁵ This is an invalid condition for the primary 1785-BCM module.

Diagnosing Faults with Bits of the Auxiliary Diagnostic/Status Words

Bits of the two Auxiliary Diagnostics/Status Words provide further information about the 1785-BCM backup module and 1785-BEM backup expansion module (if any).

Important: The auxiliary diagnostic/status word bits in Figure 8.3 and Figure 8.4 are in an octal representation (bits numbered 0–7 and 10–17).

In the first word W1, the least significant byte (bits 0–7) is reserved for internal usage of the 1785-BCM module. The most significant byte (bits 10–17) provides extended status about the module. Refer to Figure 8.3.

Figure 8.3
Extended Module Status W1 (Auxiliary Diagnostic/Status Word)

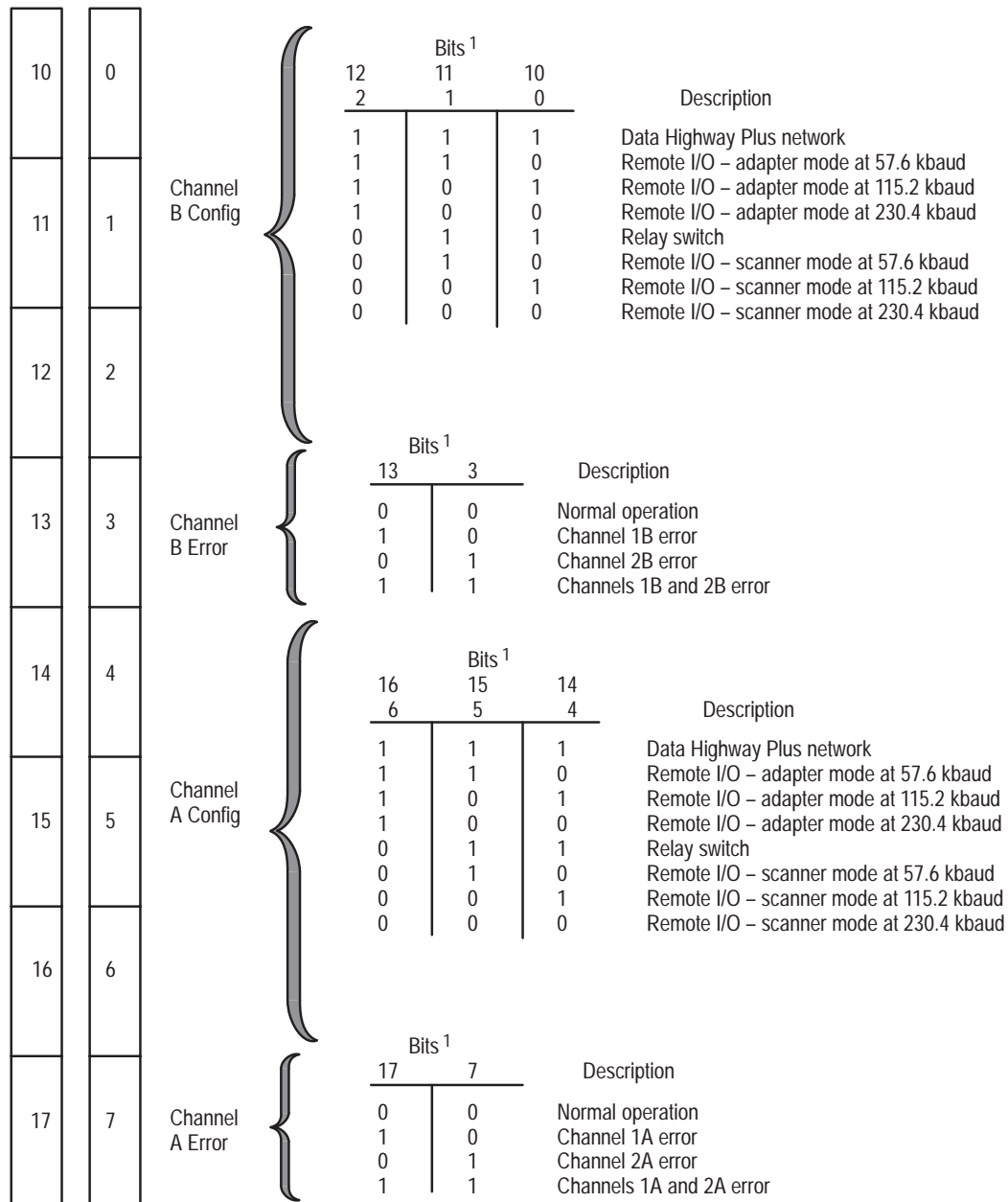
BCM Module Extended Status Bits ¹	Status	If bit condition is: ²	then the description is:
10	1785-BCM series A	{ 0 1	The other 1785-BCM module is a series B. The other 1785-BCM module is a series A.
11	Fast Data-Transfer Mode	{ 0 1	Fast data-transfer mode is disabled. Fast data-transfer mode is enabled.
12	Reserved		
13	Reserved		
14	Reserved		
15	Reserved		
16	Switchover Diagnostic	{ 0 1	Normal operation. Module failure occurred during switchover. Replace the module.
17	1785-BEM Module	{ 0 1	1785-BEM module is not part of the backup system. 1785-BEM module is part of the backup system.

¹ Note that the first byte (bits 0–7) of W1 is reserved for internal usage of the 1785-BCM module.

² **Bit conditions:** 1 = ON, 0 = OFF

Bits of the second Auxiliary Diagnostics/Status Word W2 provide the configuration of the 1785-BCM module and 1785-BEM module (if any) channels, as well as indicate an error condition in any of these channels. Refer to Figure 8.4.

Figure 8.4
BCM and BEM Modules Configuration Status Word W2
(Auxiliary Diagnostic/Status Word)



¹ Bit conditions: 1 = ON, 0 = OFF

Specifications

Specifications

The following specifications are for a 1785-BCM series B module and a 1785-BEM series A module.

Compatible Processors	PLC-5/15 series B, -5/20, -5/25, -5/30, -5/40, and -5/60 processors
Module Location	1771 I/O Chassis (local)
Backplane Current	
BCM	1.0A @ 5V dc
BEM	0.6A @ 5V dc
Keying Locations	between 8 and 10 between 34 and 36
Wiring Arm	1771-WG
Customer Relay	.25A @ 24V dc (resistive)
HSSL	communicates with 1.2 Megabaud
Environmental Conditions	
Operational Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	-40° to 85°C (-40° to 185°F)
Relative Humidity	5 to 95% (without condensation)
Certification	UL – Industrial Control Equipment, E65584 CSA – Class 1, Division 2, LR69960C



ATTENTION: Explosion hazard. Do not disconnect while circuit is live unless area is known to be non-hazardous.

The product(s) described herein, and having the appropriate CSA markings, is certified for use in other equipment where the suitability of combination is determined by CSA or local inspection housing jurisdiction.

Sample Programs

Appendix Objectives

This appendix provides two sample programs to help you understand the following programming methods described in Chapter 7:

- method 1 – Transferring Data One Block at a Time
- method 2 – Transferring Data Multiple Blocks at a Time

You can use either of the sample programs described in this chapter (with slight modification to account for your application) to program your backup system.

For information on programming your PLC-5 processor, refer to the PLC-5 Programming Software: Programming User's Manual (publication 6200-6.4.7)

Method 1 Sample – Transferring Data One Block at a Time

The method 1 program uses one BTR instruction and one BTW instruction to transfer data one block at a time. The BTR instruction obtains status information from the 1785-BCM module and, when part of the secondary system, obtains data from the 1785-BCM module. The BTW instruction sends the segment length, the block ID and, when the BTW belongs to the primary system, sends data to the primary 1785-BCM module.

Data File Organization

We use data files N30 – N34 and several miscellaneous timers and counters for moving and storing data in the sample program for method 1. When you develop your own program, use whatever files you want. Table A.A lists the files and the type of information in each.

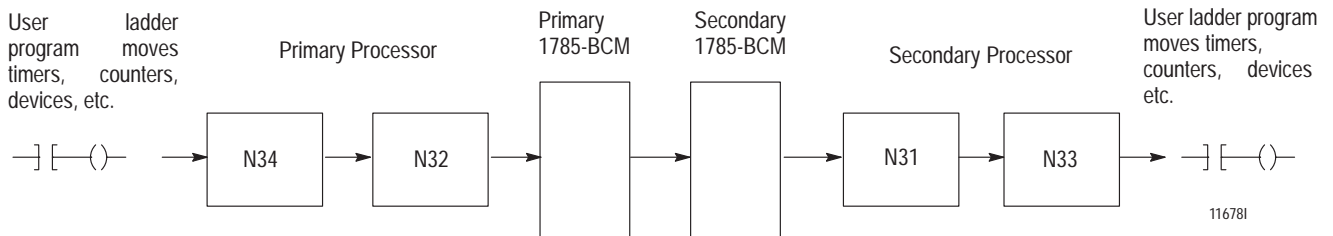
Table A.A
Data Files

This information:	Is in file:
BTR and BTW control files and storage words	N30
BTR data files (this is where the 1785-BCM module sends BTR data)	N31
BTW data files (this is where the 1785-BCM module obtains BTW data)	N32
Buffered data from the primary processor that you want to timers, counters, devices, etc.	N33 (secondary program only)
Data you want to send to the secondary processor, e.g., timers, counters, devices	N34 (primary program only)

Important: Data in file N33 in the secondary processor is identical to data in file N34 in the primary processor.

Figure A.1 shows how these files relate to the transfer of data from the primary to the secondary systems.

Figure A.1
File Relationship to Transfer of Data



Program File Organization

In the sample program method 1, we use 4 program files. Program file 2 contains the main program. This program:

- determines if the processor is primary or secondary
- executes BTR and BTW instructions

Program file 9 contains the secondary subroutine. This file:

- checks the block ID of the BTR
- moves the BTR data to the proper address in file N33

Program file 10 contains the primary subroutine: This file:

- stores the block ID of the BTR
- sets the BTW block ID equal to the BTR block ID
- moves the data from N34 to the BTW file

Program file 11 provides diagnostic rungs that count errors in the program. These rungs are especially helpful when starting up and debugging a backup system for the first time.

The sample program for method 1 is on the following pages. Refer to rung comments for more information about the function of specific rungs. Table A.B, following the sample program, lists the data table transfer time using this method of programming for transferring 1, 3, 7, 10, and 16 blocks of data.

Appendix A Sample Programs

SAMPLE 1771-BCM 1ATATIME PROGRAM
Program Listing Report

PLC-5/25

File 1ATATIME

28 August 1991 Page 1

Rung 2:0

Rung 2:0

THIS RUNG WILL OBTAIN STATUS INFORMATION FROM THE BCM AND WHEN THE PROCESSOR IS SECONDARY IT WILL ALSO OBTAIN DATA FROM THE BCM.

BTR 1	BTW 1				
EN	EN			BTR 1	
N30:0	N30:5			+BTR-----+	
15	15			+BLOCK TRNSFR READ	+- (EN) +-
				Rack	0
				Group	0+- (DN)
				Module	0
				Control Block	N30:0+- (ER)
				Data file	N31:1
				Length	0
				Continuous	N

Rung 2:1

THIS RUNG DETERMINES PRI/SEC FUNCTIONALITY AND EXECUTES THE CORRESPONDING SUBROUTINE.

BTR 1	PROG TO	LOCAL PRI/	REMOTE PRI/		
DN BIT	RUN DELAY	SEC BIT	/SEC BIT	1=LOCAL IS	
N30:0	T29:0	1=LOCAL IS	1=REMOTE	PRIMARY	
13	DN	PRIMARY	IS PRIMARY	STORE BIT	
		N31:1	N31:1	N31:0	
		6	14	0	
				1=REMOTE	
				IS PRIMARY	
				STORE BIT	
				N31:0	
				+--- (U) ---+	
				8	
		LOCAL PRI/	REMOTE PRI/		
		SEC BIT	/SEC BIT	1=REMOTE	
		1=LOCAL IS	1=REMOTE	IS PRIMARY	
		PRIMARY	IS PRIMARY	STORE BIT	
		N31:1	N31:1	N31:0	
		6	14	8	
				1=LOCAL IS	
				PRIMARY	
				STORE BIT	
				N31:0	
				+--- (U) ---+	
				0	
		LOCAL PRI/	REMOTE PRI/		
		SEC BIT	/SEC BIT	1=LOCAL IS	
		1=LOCAL IS	1=REMOTE	PRIMARY	
		PRIMARY	IS PRIMARY	STORE BIT	
		N31:1	N31:1	N31:0	
		6	14	0	
				1=REMOTE	
				IS PRIMARY	
				STORE BIT	
				N31:0	
				+--- (U) ---+	
				8	

Appendix A Sample Programs

```

Rung 2:2
|          |1=LOCAL IS
| PROG TO  |PRIMARY
| RUN DELAY|STORE BIT
|   T29:0  |  N31:0
+-----+-----+-----+
|          |          |          |
|          |          |          |
+-----+-----+-----+
|          |          |          |
|          |          |          |
+-----+-----+-----+

Rung 2:3
|          |1=REMOTE
| PROG TO  |IS PRIMARY
| RUN DELAY|STORE BIT
|   T29:0  |  N31:0
+-----+-----+-----+
|          |          |          |
|          |          |          |
+-----+-----+-----+

```

Rung 2:4
THE BTW WILL SEND THE PACKET LENGTH, BLOCK ID AND, WHEN PRIMARY, IT WILL ALSO SEND DATA. WORD N30:182 IS A USER ADJUSTABLE VALUE THAT DETERMINES THE NUMBER OF BLOCKS SENT. THIS VALUE SHOULD BE CHANGED AND THE DATA FILES N33 AND N34 ADJUSTED TO MATCH THE PACKET SIZE.

```

|          |          |          |
| BTR 1    |BTW 1    |          |
| EN       |EN       |          |
|   N30:0  |  N30:5  |          |
+-----+-----+-----+
|          |          |          |
|          |          |          |
+-----+-----+-----+
|          |          |          |
|          |          |          |
+-----+-----+-----+
|          |          |          |
|          |          |          |
+-----+-----+-----+

+BTW-----+
++BLOCK TRNSFR WRITE +- (EN) +
| Rack      |      0  |
| Group     |      0  |+- (DN)
| Module    |      0  |
| Control Block | N30:5 +- (ER)
| Data file  |   N32:1 |
| Length    |      0  |
| Continuous|      N  |
+-----+

|          |          |          |
| Source    |   N30:182 |
|           |           |
| Dest      |   N32:1   |
|           |           |
+-----+

```

Number of blocks
to transfer

Appendix A Sample Programs

```

Rung 2:5
THIS SUBROUTINE MONITORS THE BLOCK TRANSFER WRITES, READS, READ STATUS DATA AND
INCREMENTS COUNTERS ON ERRORS. PARTS OF THIS SUBROUTINE MAY BE DELETED BASED ON
USER PREFERENCE OR THE ENTIRE SUBROUTINE MAY BE DELETED IF MEMORY IS CRITICAL.
|
|                                     +JSR-----+ |
+-----+JUMP TO SUBROUTINE      +-+ |
|                                     |Prog file number  11| |
|                                     |Input par         | |
|                                     |Return par        | |
|                                     +-----+ |
Rung 2:6
THIS TIMER WILL CAUSE A DELAY OF DATA TRANSFER ON POWER UP AND CHANGES FROM
PROGRAM TO RUN. IT DOES NOT AFFECT SWITCHOVERS.
|
|                                     PROG TO
|                                     RUN DELAY
|                                     +TON-----+ |
+-----+TIMER ON DELAY      +- (EN) -+ |
|                                     |Timer          T29:0 | |
|                                     |Time base      0.01+- (DN) | |
|                                     |Preset          50 | |
|                                     |Accum           50 | |
|                                     +-----+ |
Rung 2:7
|
+-----[END OF FILE]-----+
|

```

Appendix A Sample Programs

Rung 9:0

THIS IS THE SECONDARY SUBROUTINE. THIS RUNG EXAMINES THE DATA FROM THE BCM, CHECKS THE BID, AND MOVES IT TO THE PROPER DESTINATION IN FILE N33. THE DATA IN N33 CAME FROM THE PRIMARY PROCESSOR FILE N34.

	BTR 1	LOCAL BCM		BID	
	BTR 1	DATA VALID		SCRATCH	
	DN BIT	BIT		PAD1	
	N30:0	N31:1			
				+SUB-----+	
				SUBTRACT	++
				Source A N31:2	
				0	
				Source B	1
				Dest N30:180	
				6	
				+-----+	
				BID	
				SCRATCH	
				PAD2	
				+MUL-----+	
				MULTIPLY	++
				Source A N30:180	
				6	
				Source B	62
				Dest N30:181	
				372	
				+-----+	
				BID	
				SCRATCH	
				PAD2	
				BTR DATA	
				IN N33:XX	
				+GEQ-----+	
				+GRTR THAN OR EQUAL+	++
				Source A N30:181	Source #N31:3
				372	Dest #N33 [N30:181]
				Source B	0
					Length 62
					+-----+
				+-----+	

Rung 9:1

THE USER WILL ADD MANY SIMILIAR RUNGS THAT MOVE THE DATA IN N33 TO THE PROPER ADDRESS IN MEMORY. THE DATA IN N33:25 CAME FROM THE PRIMARY PROCESSOR WORD N34:25. IN THE PRIMARY PROCESSOR'S PRIMARY SUBROUTINE THERE IS A SIMILAR RUNG THAT MOVES C5:0.ACC TO N34:25. RUNGS LIKE THESE SHOULD BE ADDED FOR ALL DATA TABLE VALUES THAT NEED TO BE SENT.

	BTR 1				
	DN BIT				
	N30:0				
				+MOV-----+	
				MOVE	++
				Source N33:25	
				5	
				Dest C5:0.ACC	
				5	
				+-----+	

Rung 9:2

----- [END OF FILE] -----

Appendix A Sample Programs

Rung 10:0

OPTIONAL RUNG THAT CAN BE USED TO JUDGE DATA TRANSFER TIME BY COMPARING N34:10 IN THE PRIMARY TO N33:10 IN THE SECONDARY.

T4:0	+TON-----+	
+--]/ [-----+ +TIMER ON DELAY +- (EN) +-+	Timer T4:0	
DN	Time base 0.01+- (DN)	
	Preset 32767	
	Accum 0	
	+-----+	
	+MOV-----+	
	+-----+MOVE++	
	Source T4:0.ACC	
	0	
	Dest N34:10	
	5601	
	+-----+	

Rung 10:1

THE USER WILL ADD MANY SIMILAR RUNGS THAT MOVE DATA TABLE VALUES TO N34. THE COUNTER ACCUMULATED DATA IS PLACED IN N34:25 IN THE PRIMARY PROCESSOR. THE SECONDARY PROCESSOR WILL RECEIVE THE SAME DATA IN N33:25. IN THE SECONDARY PROCESSOR'S SECONDARY SUBROUTINE THERE IS A SIMILAR RUNG THAT MOVES N33:25 TO C5:0.ACC. RUNGS LIKE THESE SHOULD BE ADDED FOR ALL DATA TABLE VALUES THAT NEED TO BE SENT.

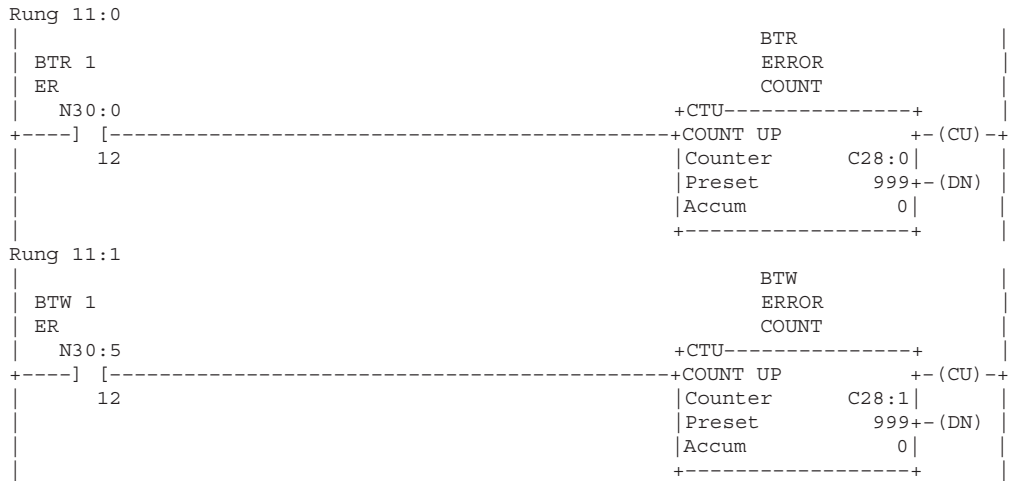
BTW 1		
DN BIT		
N30:5	+MOV-----+	
+----] [-----+ +MOVE++	Source C5:0.ACC	
13	5	
	Dest N34:25	
	5	
	+-----+	

Rung 10:2

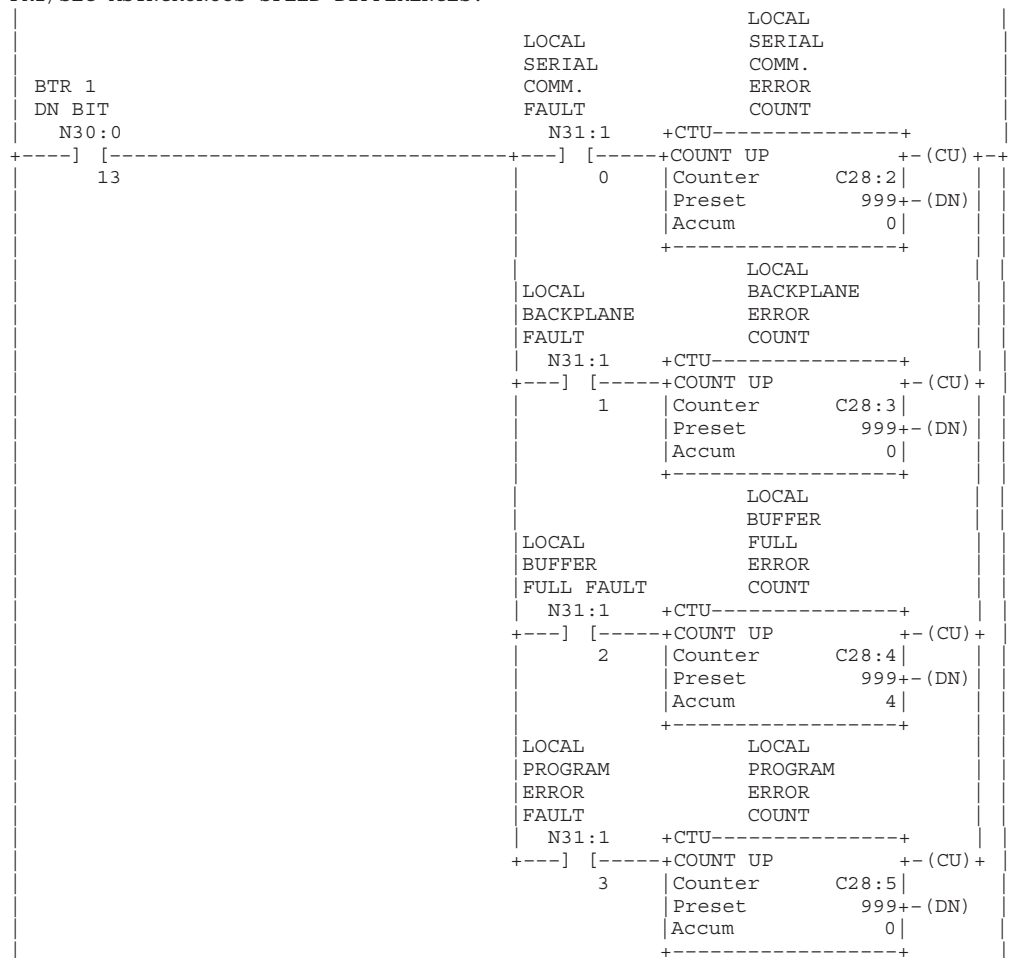
THE CURRENT BID IS MOVED TO N32:0 AND N30:183 IS CALCULATED TO BE USED LATER TO DETERMINE THE INDIRECT ADDRESS SOURCE FOR THE BTW INSTRUCTION.

BTR 1	PROG TO	BID	
DN BIT	RUN DELAY	SCRATCH	
N30:0	T29:0	PAD3	
		+SUB-----+	
+----] [-----] [-----+ +SUBTRACT++		Source A N31:2	
13	DN	0	
		Source B 1	
		Dest N30:183	
		0	
		+-----+	
		BTR	
		CURRENT	
		BID STORE	
		BUFFER	
		+MOV-----+	
		+--MOVE++	
		Source N31:2	
		0	
		Dest N32:0	
		1	
		+-----+	

Appendix A Sample Programs



Rung 11:2
DIAGNOSTIC ERROR RUNG. ALL VALUES EXCEPT THE BUFFER FULL COUNT SHOULD REMAIN AT ZERO. THE BUFFER FULL COUNT MAY INCREMENT AND IS PROBABLY AN INDICATION OF PRI/SEC ASYNCHRONOUS SPEED DIFFERENCES.



Appendix A Sample Programs

Rung 11:3

N31:0/4 IS A USER DIAGNOSTIC FLAG INDICATING A LOCAL ERROR. THE BUFFER FULL BIT MAY NEED TO BE DELETED.

	LOCAL		LOCAL
	SERIAL		ERROR
BTR 1	COMM.		FAULT
DN BIT	FAULT		STORE
N30:0	N31:1		N31:0
			()
13	0		4
	LOCAL		
	BACKPLANE		
	FAULT		
	N31:1		
	1		
	LOCAL		
	BUFFER		
	FULL FAULT		
	N31:1		
	2		
	LOCAL		
	PROGRAM		
	ERROR		
	FAULT		
	N31:1		
	3		

Rung 11:4

N31:0/12 IS A USER DIAGNOSTIC FLAG INDICATING A REMOTE ERROR. THE BUFFER FULL BIT MAY NEED TO BE DELETED.

	REMOTE		REMOTE
	SERIAL		ERROR
BTR 1	COMM.		FAULT
DN BIT	FAULT		STORE
N30:0	N31:1		N31:0
			()
13	8		12
	REMOTE		
	BACKPLANE		
	FAULT		
	N31:1		
	9		
	REMOTE		
	BUFFER		
	FULL FAULT		
	N31:1		
	10		
	REMOTE		
	PROGRAM		
	ERROR		
	FAULT		
	N31:1		
	11		

Table A.B
Data Table Typical Transfer Time Using Method 1 Program
with Minimal Program Scan (3–8 ms)

Number of Blocks Being Transferred	Number of Words Being Transferred	Transfer Time (in ms) for Series A BCM (see notes 1 & 2)	Transfer Time (in ms) for Series B BCM Fast Transfer Mode Enabled (see notes 1, 3, & 4)
1	62	230	40–110
3	186	330–820	50–120
7	434	440–1500	50–160
10	620	1100–1700	60–210
16	992	1900–3300	140–280

¹ These times can significantly change based on program scan. But an increase in the number of blocks does not significantly affect program scan.

² Times were taken using a PLC-5/25 processor.

³ Series B BCM module with fast mode disabled is roughly double the times shown.

⁴ Times were taken using a PLC-5/40 processor with one channel configured for DH+ and three channels configured for remote I/O scanner at 230 kbaud.

Method 2 Sample – Transferring Data Multiple Blocks at a Time

The method 2 differs from method 1 in that the primary system transfers more than one block in the same program scan. These blocks make up a segment that can be from 1 to 16 blocks (PLC-5/15 or PLC-5/25 processor) or from 1 to 64 block (PLC-5/20, -5/30, -5/40, -5/60, or -5/80 processor). You determine the number of blocks needed to transfer information for your application.

Data File Organization

Data file organization for the program sample for method 2 is the same as described for method 1. Again, when you develop your program, use whatever files you want.

Program File Organization

As in our program sample for method 1, file 2 contains the main program. This program contains rungs that determine if the processor is primary or secondary and the first BTR and BTW instructions.

Program file 9 contains the secondary subroutine. This file:

- checks the block ID of the BTR and copies the BTR data with a series of rung pairs, for example, rungs 9:1 and 9:2. (Because we want to transfer 3 blocks at a time in this sample, the program contains 3 of these rung pairs. You can modify your program to transfer from 1 to 16 blocks per segment by adding or deleting rung pairs to this file.)
- moves the BTR data to the proper address in file N33

Program file 10 contains the primary subroutine: This file:

- moves data to the BTW file from file N34
- copies the BTW file and performs the BTW with a series of rungs, for example, rung 10:2. (Because we want to transfer 3 blocks at a time in this sample, the program has 3 rungs. You can modify your program to transfer from 1 to 16 blocks (PLC-5/15 or PLC-5/25 processor) or from 1 to 64 blocks (PLC-5/20, -5/30, -5/40, -5/60, or -5/80 processor) by adding or deleting rungs like 10:2 from file 10.)

Program file 11 contains diagnostic rungs that count errors in your program. These rungs are especially helpful when starting up and debugging a backup system for the first time.

The sample program for method 2 is on the following pages. Refer to rung comments for more information about the function of specific rungs. Table A.C, following the sample program, lists the data table transfer time using this method of programming for transferring 1, 3, 7, 10, and 16 blocks of data.

```

SAMPLE 1771-BCM MULTIPLE BLOCK PROGRAM                21 November 1994  Page 1
Program Listing Report               PLC-5/25   File MULTBLKS             Rung 2:0

Rung 2:0
THIS RUNG WILL OBTAIN STATUS INFORMATION FROM THE BCM AND WHEN THE PROCESSOR IS
SECONDARY IT WILL ALSO OBTAIN DATA FROM THE BCM.
| BTR 1      |BTW 1
| EN         |EN
| N30:0      N30:5
+----] / [----] / [-----] +BTR-----+
|      15      15               +BLOCK TRNSFR READ   +- (EN) +-
|                                     |Rack              00 |
|                                     |Group              0+-(DN) |
|                                     |Module             0 |
|                                     |Control Block     N30:0+- (ER)
|                                     |Data file         N31:1 |
|                                     |Length           0 |
|                                     |Continuous       N |
|                                     +-----+

```

Appendix A Sample Programs

Rung 2:1

THIS RUNG DETERMINES PRI/SEC FUNCTIONALITY AND EXECUTES THE CORRESPONDING SUBROUTINE.

BTR 1 DN BIT N30:0	PROG TO RUN DELAY T29:0	1=LOCAL IS PRIMARY N31:1	REMOTE PRI/ /SEC BIT 1=REMOTE IS PRIMARY N31:1	1=LOCAL IS PRIMARY STORE BIT N31:0
+---]	[-----]	[-----]	[-----]	[-----]
13	DN	6	14	(L) 0
				+--- (U) ---+
				8
		LOCAL PRI/ SEC BIT 1=LOCAL IS PRIMARY N31:1	REMOTE PRI/ /SEC BIT 1=REMOTE IS PRIMARY N31:1	1=REMOTE IS PRIMARY STORE BIT N31:0
		+---]	[-----]	[-----]
		6	14	(L) 8
				+--- (U) ---+
				0
		LOCAL PRI/ SEC BIT 1=LOCAL IS PRIMARY N31:1	REMOTE PRI/ /SEC BIT 1=REMOTE IS PRIMARY N31:1	1=LOCAL IS PRIMARY STORE BIT N31:0
		+---]	[-----]	[-----]
		6	14	(U) 0
				+--- (U) ---+
				8

Rung 2:2

THIS RUNG EXECUTES THE PRIMARY SUBROUTINE.

PROG TO RUN DELAY T29:0	1=LOCAL IS PRIMARY STORE BIT N31:0	1=LOCAL IS PRIMARY N31:1	1=REMOTE IS PRIMARY STORE BIT N31:0
+---]	[-----]	[-----]	[-----]
DN	0	+JSR-----+	
		+JUMP TO SUBROUTINE	
		Prog file number 10	
		Input par	
		Return par	
		+-----+	

Rung 2:3

THIS RUNG EXECUTES THE SECONDARY SUBROUTINE.

PROG TO RUN DELAY T29:0	1=REMOTE IS PRIMARY STORE BIT N31:0	1=REMOTE IS PRIMARY STORE BIT N31:0	1=LOCAL IS PRIMARY STORE BIT N31:0
+---]	[-----]	[-----]	[-----]
DN	8	+JSR-----+	
		+JUMP TO SUBROUTINE	
		Prog file number 9	
		Input par	
		Return par	
		+-----+	

Appendix A Sample Programs

Rung 2:4

THE BTW WILL SEND THE PACKET LENGTH, BLOCK ID AND, WHEN PRIMARY, IT WILL ALSO SEND DATA. WORD N30:182 IS A USER ADJUSTABLE VALUE THAT DETERMINES THE NUMBER OF BLOCKS SENT. THIS VALUE SHOULD BE CHANGED AND THE DATA FILES N33 AND N34 ADJUSTED TO MATCH THE PACKET SIZE.

BTR 1	BTW 1	PACKET	
EN	EN	LENGTH	
N30:0	N30:5	STORED IN	
		N30:182	
		+MOV-----+	
-----] / [-----] / [-----]		+MOVE	++
15	15	Source N30:182	
		3	←
		Dest N32:1	
		3	
		+-----+	
		BTW 1	
		BID=1	
		+MOV-----+	
		+MOVE	++
		Source 1	
		Dest N32:2	
		1	
		+-----+	
		BTW 1	
		DATA	
		+COP-----+	
		+COPY FILE	++
		Source #N34:0	
		Dest #N32:3	
		Length 62	
		+-----+	
		BTW 1	
		+BTW-----+	
		++BLOCK TRNSFR WRITE	+-- (EN) +
		Rack 00	
		Group 0	+-- (DN)
		Module 0	
		Control Block N30:5	+-- (ER)
		Data file N32:1	
		Length 0	
		Continuous N	
		+-----+	

Number of blocks that make up total segment.

Rung 2:5

THIS SUBROUTINE MONITORS THE BLOCK TRANSFER WRITES, READS AND READ STATUS DATA AND INCREMENTS COUNTERS ON ERRORS. PARTS OF THIS SUBROUTINE MAY BE DELETED BASED ON PACKET LENGTH OR THE ENTIRE SUBROUTINE MAY BE DELETED IF THE MEMORY IS CRITICAL.

```

|
|                                     JUMP TO
|                                     WATCHDOG/
|                                     ERROR
|                                     SUB
|
|-----+-----+-----+-----+
|                                     +JSR-----+
|-----+-----+-----+-----+
|                                     +JUMP TO SUBROUTINE  +-+
|                                     |Prog file number   11|
|                                     |Input par          |
|                                     |Return par         |
|-----+-----+-----+-----+

```

Rung 2:6

THIS TIMER WILL CAUSE A DELAY OF DATA TRANSFER ON POWER UP AND CHANGES FROM PROGRAM TO RUN. IT DOES NOT AFFECT SWITCHOVERS.

```

|
|                                     PROG TO
|                                     RUN DELAY
|
|-----+-----+-----+-----+
|                                     +TON-----+
|-----+-----+-----+-----+
|                                     +TIMER ON DELAY  +- (EN) +-+
|                                     |Timer          T29:0|
|                                     |Time base      0.01+- (DN)|
|                                     |Preset         50|
|                                     |Accum          50|
|-----+-----+-----+-----+

```

Rung 2:7

```

|-----+-----+-----+-----+
|                                     [END OF FILE]
|-----+-----+-----+-----+

```


Rung 9:2
THIS RUNG IS A PAIR WITH RUNG 9:1.

BTR 2 LOCAL BCM BTR 2 DATA VALID DN BIT N30:10 N31:65	BID SCRATCH PAD1 +SUB-----+
+----] [-----] [-----+	SUBTRACT Source A N31:66 2 Source B 1 Dest N30:180 0 +-----+
13 7	BID SCRATCH PAD2 +MUL-----+
+-----+	MULTIPLY Source A N30:180 0 Source B 62 Dest N30:181 0 +-----+
BID SCRATCH PAD2	BTR DATA IN N33:XX
+GEQ-----+	+COP-----+
++GRTR THAN OR EQUAL++	++COPY FILE++
Source A N30:181	Source #N31:67
0	Dest #N33[N30:181]
Source B 0	Length 62
+-----+	+-----+

Rung 9:3
THIS RUNG IS A PAIR WITH RUNG 9:4.

BTR 3 EN N30:20	BTR 3 +BTR-----+
+---]/[-----+	BLOCK TRNSFR READ +- (EN)+
15	Rack 00
+-----+	Group 0+- (DN)
+-----+	Module 0
+-----+	Control Block N30:20+- (ER)
+-----+	Data file N31:129
+-----+	Length 0
+-----+	Continuous N
+-----+	+-----+

Appendix A Sample Programs

Rung 9:4
THIS RUNG IS A PAIR WITH RUNG 9:3

BTR 3	BTR 3	LOCAL BCM	BID
DN	DN	DATA VALID	SCRATCH
N30:20	N31:129	BIT	PAD1
			+SUB-----+
			SUBTRACT
13	7		Source A N31:130
			3
			Source B 1
			Dest N30:180
			0
			+-----+
			BID
			SCRATCH
			PAD2
			+MUL-----+
			MULTIPLY
			Source A N30:180
			0
			Source B 62
			Dest N30:181
			0
			+-----+
			BID
			SCRATCH
			PAD2
			BTR DATA
			IN N33:XX
			+GEQ-----+
			+GRTR THAN OR EQUAL+
			Source A N30:181
			0
			Source B 0
			Dest #N33 [N30:181]
			Length 62
			+-----+

Place additional rungs here to transfer more blocks at a time. You can have up to 16 rungs total when using a PLC-5/15 or PLC-5/25 processor. You can have up to 64 rungs total when using a PLC-5/20, -5/30, -5/40, -5/60, or -5/80 processor. The number of rungs you have here must equal the number of rung pairs you have in file 10.

Rung 9:5
THE USER WILL ADD MANY SIMILIAR RUNGS THAT MOVE DATA IN N33 TO THE PROPER ADDRESS IN MEMORY.THE DATA IN N33:25 CAME FROM THE PRIMARY PROCESSOR WORD N34:25. IN THE PRIMARY PROCESSOR'S PRIMARY SUBROUTINE THERE IS A SIMILIAR RUNG THAT MOVES C5:0.ACC TO N34:25. RUNGS LIKE THESE SHOULD BE ADDED FOR ALL DATA TABLE VALUES THAT NEED TO BE SENT.

BTR 1		
DN BIT		
N30:0		
		+MOV-----+
		MOVE
13		Source N33:25
		8
		Dest C5:0.ACC
		8
		+-----+

Rung 9:6
-----[END OF FILE]-----

Appendix A Sample Programs

Rung 10:0

THIS IS THE START OF A SUBROUTINE PROGRAM FILE THAT WILL BE EXECUTED
IN THE PRIMARY PROCESSOR TO MOVE AND BTW DATA TO THE SECONDARY PROCESSOR.

THIS OPTIONAL RUNG CAN BE USED TO JUDGE DATA TRANSFER TIME BY COMPARING N34:10
IN THE PRIMARY TO N33:10 IN THE SECONDARY.

```

| T4:0
+---] / [-----+ +TON-----+ |
| DN | |TIMER ON DELAY +- (EN) +-+ | |
| | | Timer T4:0 | |
| | | Time base 0.01+- (DN) | |
| | | Preset 32000 | |
| | | Accum 1370 | |
| | |-----+ |
| | | +MOV-----+ |
| | | +-----+MOVE +-+ |
| | | Source T4:0.ACC |
| | | 0 |
| | | Dest N34:10 |
| | | 1370 |
| | |-----+ |

```

Rung 10:1

THE USER WILL ADD MANY SIMILIAR RUNGS THAT MOVE DATA TABLE VALUES TO N34. THE
COUNTER ACCUMULATED DATA IS PLACED IN N34:25 IN THE PRIMARY PROCESSOR. THE
SECONDARY PROCESSOR WILL RECEIVE THE SAME DATA IN N33:25. IN THE SECONDARY
PROCESSOR'S SECONDARY SUBROUTINE THERE IS A SIMILIAR RUNG THAT MOVES N33:25 TO
C5:0.ACC. RUNGS LIKE THESE SHOULD BE ADDED FOR ALL DATA TABLE VALUES THAT NEED
TO BE SENT.

```

| BTW 1
| DN
| N30:5
+---] [-----+ +MOV-----+ |
| 13 | | +-----+MOVE +-+ |
| | | Source C5:0.ACC |
| | | 8 |
| | | Dest N34:25 |
| | | 8 |
| | |-----+ |

```

Appendix A Sample Programs

Rung 10:2

THERE IS A RUNG FOR EACH BLOCK WRITE (1-16) THAT PREFORMS THE BTW AND MOVES THE DATA FROM N34 TO THE PROPER BTW DATA FILE. TO ADJUST THIS PROGRAM DELETE EACH UNUSED BLOCK ID RUNG AND ADJUST WORD N30:182 TO THE DESIRED PACKET LENGTH.

BTW 2	PACKET
EN	LENGTH
N30:15	STORED IN
	N30:182
	+MOV-----+
-----] / [-----	+MOVE
15	Source N30:182
	3
	Dest N32:65
	3
	+-----+
	BTW 2
	BID=2
	+MOV-----+
	+MOVE
	Source 2
	Dest N32:66
	2
	+-----+
	BTW 2
	DATA
	+COP-----+
	+COPY FILE
	Source #N34:62
	Dest #N32:67
	Length 62
	+-----+
	BTW 2
	+BTW-----+
	+BLOCK TRNSFR WRITE +- (EN) +
	Rack 00
	Group 0+- (DN)
	Module 0
	Control Block N30:15+- (ER)
	Data file N32:65
	Length 0
	Continuous N
	+-----+

```

Rung 10:3
THIS RUNG IS SIMILAR TO RUNG 10:2.

BTW 3
EN
  N30:25
] / [
  15
          PACKET
          LENGTH
          STORED IN
          N30:182
          +MOV-----+
          |-----+
          | | MOVE | | | |
          | | Source  N30:182 | |
          | | | | 3 | |
          | | | Dest   N32:129 | |
          | | | | 3 | |
          |-----+
          |
          |   BTW 3
          |   BID=3
          |
          | +MOV-----+
          | |-----+
          | | | MOVE | | | | |
          | | | Source    3 | |
          | | | | Dest   N32:130 | |
          | | | | | | 3 | |
          | | | |-----+
          | | |
          | | |   BTW 3
          | | |   DATA
          | | |
          | | | +COP-----+
          | | | |-----+
          | | | | COPY FILE | |
          | | | | Source   #N34:124 | |
          | | | | Dest    #N32:131 | |
          | | | | Length   62 | |
          | | | |-----+
          | | |
          | | |   BTW 3
          | | |
          | | | +BTW-----+
          | | | ++BLOCK TRANSFR WRITE +- (EN) +
          | | | | Rack           00 |
          | | | | Group         0+- (DN)
          | | | | Module        0 |
          | | | | Control Block  N30:25+- (ER)
          | | | | Data file     N32:129
          | | | | Length       0 |
          | | | | Continuous   N |
          | | | |-----+
          |
          Rung 10:4
          |-----[END OF FILE]-----+
  
```

Place additional rungs here to transfer more blocks at a time. You can have up to 16 rungs total when using a PLC-5/15 or PLC-5/25 processor. You can have up to 64 rungs total when using a PLC-5/20, -5/30, -5/40, -5/60 or -5/80 processor. The number of rungs you have here must equal the number of rung pairs you have in file 9.

Appendix A Sample Programs

```

Rung 11:0
THIS IS THE START OF AN OPTIONAL SUBROUTINE PROGRAM FILE THAT IS USED FOR
DIAGNOSTICS AND ERROR REPORTING. THIS RUNG MONITORS AND COUNTS BTR 1 ERRORS.
      BTR 1
      ERROR
      COUNT
      N30:0
+----] [-----+CTU-----+
|          |COUNT UP      +- (CU) +
|          |Counter      C28:0 |
|          |Preset      999+- (DN)
|          |Accum      0 |
+-----+-----+

```

```

Rung 11:1
THIS RUNG MONITORS AND COUNTS BTW 1 ERRORS.
      BTW 1
      ERROR
      COUNT
      N30:5
+----] [-----+CTU-----+
|          |COUNT UP      +- (CU) +
|          |Counter      C28:1 |
|          |Preset      999+- (DN)
|          |Accum      0 |
+-----+-----+

```

```

Rung 11:2
DIAGNOSTIC ERROR RUNG. ALL VALUES EXCEPT THE BUFFER FULL COUNT SHOULD REMAIN AT
ZERO. THE BUFFER FULL COUNT MAY INCREMENT AND IS PROBABLY AN INDICATION OF
PRI/SEC ASYNCHRONOUS SPEED DIFFERENCES.

```

```

      LOCAL SERIAL COMM.
      LOCAL BACKPLANE ERROR COUNT
      LOCAL BUFFER FULL ERROR COUNT
      LOCAL PROGRAM ERROR COUNT
      BTR 1
      DN BIT
      N30:0
+----] [-----+CTU-----+
|          |COUNT UP      +- (CU) +
|          |Counter      C28:2 |
|          |Preset      999+- (DN)
|          |Accum      0 |
+-----+-----+
      LOCAL BACKPLANE ERROR COUNT
      LOCAL BUFFER FULL ERROR COUNT
      LOCAL PROGRAM ERROR COUNT
      N31:1
+----] [-----+CTU-----+
|          |COUNT UP      +- (CU) +
|          |Counter      C28:3 |
|          |Preset      999+- (DN)
|          |Accum      0 |
+-----+-----+
      LOCAL BUFFER FULL ERROR COUNT
      LOCAL PROGRAM ERROR COUNT
      N31:1
+----] [-----+CTU-----+
|          |COUNT UP      +- (CU) +
|          |Counter      C28:4 |
|          |Preset      999+- (DN)
|          |Accum      0 |
+-----+-----+
      LOCAL PROGRAM ERROR COUNT
      N31:1
+----] [-----+CTU-----+
|          |COUNT UP      +- (CU) +
|          |Counter      C28:5 |
|          |Preset      999+- (DN)
|          |Accum      0 |
+-----+-----+

```

Appendix A Sample Programs

Rung 11:3

N31:0/4 IS A USER DIAGNOSTIC FLAG INDICATING A LOCAL ERROR. THE BUFFER FULL BIT MAY NEED TO BE DELETED.

	LOCAL		LOCAL
	SERIAL		ERROR
BTR 1	COMM.		FAULT
DN BIT	FAULT		STORE
N30:0	N31:1		N31:0
			()
13	0		4
	LOCAL		
	BACKPLANE		
	FAULT		
	N31:1		
	1		
	LOCAL		
	BUFFER		
	FULL FAULT		
	N31:1		
	2		
	LOCAL		
	PROGRAM		
	ERROR		
	FAULT		
	N31:1		
	3		

Rung 11:4

N31:0/12 IS A USER DIAGNOSTIC FLAG INDICATING A REMOTE ERROR. THE BUFFER FULL BIT MAY NEED TO BE DELETED.

	REMOTE		REMOTE
	SERIAL		ERROR
BTR 1	COMM.		FAULT
DN BIT	FAULT		STORE
N30:0	N31:1		N31:0
			()
13	8		12
	REMOTE		
	BACKPLANE		
	FAULT		
	N31:1		
	9		
	REMOTE		
	BUFFER		
	FULL FAULT		
	N31:1		
	10		
	REMOTE		
	PROGRAM		
	ERROR		
	FAULT		
	N31:1		
	11		

Appendix A
Sample Programs

Rung 11:5
THIS RUNG IS USED TO RESET THE ERROR COUNTERS.

USER		BTR 1
DEFINED		ERROR
ERROR		COUNT
RESET BIT		C28:0
I:010		
		+(RES)---
00		
		BTR 2
		ERROR
		COUNT
		C28:6
		+(RES)---
		BTR 3
		ERROR
		COUNT
		C28:7
		+(RES)---
		LOCAL
		SERIAL
		COMM.
		ERROR
		COUNT
		C28:2
		+(RES)---
		LOCAL
		BACKPLANE
		ERROR
		COUNT
		C28:3
		+(RES)---
		LOCAL
		BUFFER
		FULL
		ERROR
		COUNT
		C28:4
		+(RES)---
		LOCAL
		PROGRAM
		ERROR
		COUNT
		C28:5
		+(RES)---

Appendix A Sample Programs

Rung 11:6

THIS RUNG IS USED TO RESET THE ERROR COUNTERS.

USER DEFINED ERROR RESET BIT I:010 00	BTW 1 ERROR COUNT C28:1 (RES)
00	BTW 2 ERROR COUNT C28:21 (RES)
00	BTW 3 ERROR COUNT C28:22 (RES)

You can add error count reset rungs here as required.

Rung 11:7

THIS RUNG MONITORS AND COUNTS THE BTR 2 ERRORS.

BTR 2 ER N30:10 12 LOCAL SERIAL COMM. BTR 2 DN N30:10 N31:65 13 LOCAL BACKPLANE FAULT N31:65 1 LOCAL PROGRAM ERROR FAULT N31:65 3	BTR 2 ERROR COUNT +CTU-----+ COUNT UP +- (CU) + Counter C28:6 Preset 999+- (DN) Accum 0 -----+
---	---

Rung 11:8

THIS RUNG MONITORS AND COUNTS THE BTW 2 ERRORS.

BTW 2 ER N30:15 12	BTW 2 ERROR COUNT +CTU-----+ COUNT UP +- (CU) + Counter C28:21 Preset 999+- (DN) Accum 0 -----+
-----------------------------	--

Appendix A Sample Programs

```

Rung 11:9
THIS RUNG MONITORS AND COUNTS THE BTR 3 ERRORS.

|      BTR 3      |      BTR 3      | | | |
|      ER        |      ERROR      |
|      N30:20    |      COUNT      |
|      ] [-----] |      +CTU-----] |
|      12        |      +COUNT UP |      +- (CU) +- |
|      |         |      |Counter    |      C28:7 |
|      | LOCAL   |      |Preset     |      999+- (DN) |
|      | SERIAL  |      |Accum      |      0 |
|      | COMM.   |      +-----+ |
|      | DN      |      |           |
|      | N30:20  |      | N31:129  |
|      +----] [-----] [-----] |
|      13        |      0          | | |
|      |         |      | LOCAL    |
|      | BACKPLANE |      | BACKPLANE |
|      | FAULT     |      | FAULT     |
|      | N31:129  |      | N31:129  |
|      +----] [-----] |
|      |         |      | 1        |
|      | LOCAL    |      | LOCAL    |
|      | PROGRAM  |      | PROGRAM  |
|      | ERROR    |      | ERROR    |
|      | FAULT    |      | FAULT    |
|      | N31:129  |      | N31:129  |
|      +----] [-----] |
|      3          |

```

```

Rung 11:10
THIS RUNG MONITORS AND COUNTS THE BTW 3 ERRORS.

|      BTW 3      |      BTW 3      | | | |
|      ER        |      ERROR      |
|      N30:25    |      COUNT      |
|      ] [-----] |      +CTU-----] |
|      12        |      +COUNT UP |      +- (CU) +- |
|      |         |      |Counter    |      C28:22 |
|      |         |      |Preset     |      999+- (DN) |
|      |         |      |Accum      |      0 |
|      +-----+ |

```

You can add more rungs here as required to monitor and count the BTR and BTW instructions in your program .

```

Rung 11:11
|-----[END OF FILE]-----|

```

Table A.C
Data Table Typical Transfer Time Using Method 2 Program
with Minimal Program Scan (4–9 ms)

Number of Blocks Being Transferred	Number of Words Being Transferred	Transfer Time (in ms) for Series A BCM (see notes 1 & 2)	Transfer Time (in ms) for Series B BCM Fast Transfer Mode Enabled (see notes 1, 3, & 4)
1	62	170–250	60–80
3	186	200–300	90–120
7	434	350–500	130–180
10	620	350–600	170–230
16	992	400–1000	180–260 ⁵
32	1984	–	320–720 ⁶
64	3968	–	700–1400 ⁷

¹ These times do not significantly change with program scan, but as the number of blocks increase so does program scan.

² Times were taken using a PLC-5/25 processor.

³ Series B BCM module with fast mode disabled is approximately 50% slower than the times shown.

⁴ Times were taken using a PLC-5/40 processor with one channel configured for DH+ and three channels configured for remote I/O scanner at 230 kbaud.

⁵ Program scan 12–16 ms.

⁶ Program scan 20–25 ms.

⁷ Program scan 30–35 ms.

Reference Information

Appendix Objectives

This appendix provides the following reference information:

- answers to PLC-5 backup configuration questions
- formulas for determining delay and transfer times between the primary and secondary processors

Answers to PLC-5 Backup Configuration Questions

The following questions may arise when you are configuring a PLC-5 backup system. We've provided answers to these questions and also provided references to pages in this manual and to other publications to help you find more information if needed.

Q. What size I/O chassis should I use for installing the PLC-5 processors in the backup system?

- A. You can use any size chassis for the PLC-5 processors. However, keep in mind that only the PLC-5 processor, power supply, the 1785-BCM module, and the 1785-BEM module (if any) will reside in the chassis; therefore, we recommend a 4-slot chassis (cat. no. 1771-A1B).

Q. Can I install I/O modules in the local I/O chassis?

- A. The PLC-5 backup system **does not** back up local I/O. Since the objective of having a backup system is to guard against interruptions due to shutdown of your operation, we recommend that you do not install modules for controlling your process in the local chassis. (Refer to page 3-1 for more information.)

Q. In which slot of the local I/O chassis do I install the 1785-BCM module?

- A. You can install the 1785-BCM module in any slot of the I/O chassis. We, however, recommend that you install the module in the left-most slot of the first I/O module group in the I/O chassis for ease in making connections and programming. (Refer to Chapter 3 for more information.)

Q. In which slot of the local I/O chassis do I install the 1785-BEM module?

A. We recommend that you install the 1785-BEM module in the right-most slot of the first I/O module group in the I/O chassis for ease in making connections and programming. Note that the 1785-BEM module must be in the same I/O group as the 1785-BCM module. (Refer to Chapter 3 and Chapter 4 for more information.)

Q. Does the 1785-BEM module have to go next to the 1785-BCM module?

A. Yes. They should be placed in the same I/O module group.

Q. How do I set the local I/O chassis backplane switches for a PLC-5 backup system?

A. Set the switches as shown in the following table. (Refer to Chapter 3 for more information.)

Set switch(es)	To this position:
1	OFF – to turn off outputs in the chassis when a fault is detected.
2 and 3	both OFF – these switches are not used
4 and 5 ¹	4 – ON configure for 1/2-slot addressing* 5 – OFF configure for 1/2-slot addressing*
6 and 7	as required for your application
8	as required for your application

* The 1785-BCM module appears to the PLC-5 processor as a 32-point input module. You must configure switches 4 and 5 for 1/2-slot addressing or 1-slot addressing. If not configured as 1/2- or 1-slot addressing, a PLC-5 processor fault will occur. If you are installing a 1785-BEM module, you must select 1/2-slot addressing.

Q. How do I set the remote I/O chassis backplane switches for a PLC-5 backup system?

A. The operation of the PLC-5 backup system is independent of the operation of the remote I/O chassis; therefore, you can set these switches as required for your application. For more information about setting the I/O chassis switches, refer to the PLC-5 Enhanced and Ethernet Programmable Controllers User Manual (publication 1785-6.5.12).

- Q. How do I configure the remote I/O chassis in the PLC-5 backup system?**
- A. Any valid remote I/O chassis configuration is acceptable. For more information configuring remote I/O chassis, refer to the PLC-5 Enhanced and Ethernet Programmable Controllers User Manual (publication 1785-6.5.12). PLC-5 Family Programmable Controllers Installation Manual (publication 1785-6.6.1).
- Q. What power supply should I use to supply power to the PLC-5 backup system?**
- A. In this manual, we use the 1771-P4S slot power supply as an example. You, however, can use any of the power supplies listed in Chapter 3 to supply power to your PLC-5 backup system.
- Q. Should I use a separate power supply for each PLC-5 processor in the backup system?**
- A. Yes, you should use a separate power supply for each processor to avoid the loss of an entire system due to power failure. In addition, you should connect the power supplies to different power sources to take precautions against interruptions and incoming power failures.
- Q. How do I terminate my Data Highway Plus and remote I/O links in the PLC-5 backup system?**
- A. You should set each PLC-5 processor in the backup system as if the other PLC-5 processor did not exist and no 1785-BCM modules are present. For more information about terminating the Data Highway Plus and remote I/O links, refer to the PLC-5 Enhanced and Ethernet Programmable Controllers User Manual (publication 1785-6.5.12). PLC-5 Family Programmable Controllers Installation Manual (publication 1785-6.6.1).
- Q. Should my PLC-5 processors have the same Data Highway Plus station address?**
- A. Both PLC-5 processors must have the same Data Highway Plus station address. To provide transparency to other stations on the DH+ link, you set both stations to the same address. The 1785-BCM modules permit only one of the two modules to be connected to the Data Highway Plus at a time. In this configuration, remote PLC processors and operator stations communicate to the processor that currently has primary status.

- Q. Can I use a 1785-BCM Series B module with a 1785-BCM Series A module?**
- A. Yes, when you properly set switch 1 of the switch assembly SW1 and switches of switch assembly SW2 of the 1785-BCM Series B module. (Refer to Chapter 3 for more information.)
- Q. Can the 1785-BEM backup expansion module work with the 1785-BCM Series A module?**
- A. No. The 1785-BEM module can only work with the 1785-BCM Series B module.
- Q. Is it necessary to use the 1785-BEM backup expansion module with the PLC-5/40 or PLC-5/60 processor?**
- A. It depends on your specific application. If you want to back up all four channels of the processor, you must use the 1785-BCM Series B module and the 1785-BEM module.
- Q. Is it necessary to connect the programming device directly to the processor port in order to program the secondary PLC-5 processor?**
- A. No. You must assign both the primary and secondary processor the same node address in the Data Highway Plus link. When you set both processors node address to **n**, the 1785-BCM module reserves the following node address **n+1** as an access point address to the secondary processor, that is, this address is accessed by a programming device in order to program the secondary processor.
- Q. Is there any memory limit to the number of I/O points or to block transfer instruction in the remote I/O link?**
- A. You can store up to 92 BTR instructions per remote I/O channel. There is no limit for I/O or BTW instructions.

Determining Data Table Transfer Time

Use Table B.A and Table B.B to estimate your data table transfer times. These tables provide tested values that are derived from method 1 and method 2 sample applications programs provided in Appendix A.

Table B.A
Data Table Typical Transfer Time Using Method 1 Program with Minimal Program Scan (3–8 ms)

Number of Blocks Being Transferred	Number of Words Being Transferred	Transfer Time (in ms) for Series A BCM (see notes 1 & 2)	Transfer Time (in ms) for Series B BCM Fast Transfer Mode Enabled (see notes 1, 3, & 4)
1	62	230	40–110
3	186	330–820	50–120
7	434	440–1500	50–160
10	620	1100–1700	60–210
16	992	1900–3300	140–280

¹ These times can significantly change based on program scan. But an increase in the number of blocks does not significantly affect program scan.

² Times were taken using a PLC-5/25 processor.

³ Series B BCM module with fast mode disabled is roughly double the times shown.

⁴ Times were taken using a PLC-5/40 processor with one channel configured for DH+ and three channels configured for remote I/O scanner at 230 kbaud.

Table B.B
Data Table Typical Transfer Time Using Method 2 Program
with Minimal Program Scan (4–9 ms)

Number of Blocks Being Transferred	Number of Words Being Transferred	Transfer Time (in ms) for Series A BCM (see notes 1 & 2)	Transfer Time (in ms) for Series B BCM Fast Transfer Mode Enabled (see notes 1, 3, & 4)
1	62	170–250	60–80
3	186	200–300	90–120
7	434	350–500	130–180
10	620	350–600	170–230
16	992	400–1000	180–260 ⁵
32	1984	–	320–720 ⁶
64	3968	–	700–1400 ⁷

¹ These times do not significantly change with program scan, but as the number of blocks increase so does program scan.

² Times were taken using a PLC-5/25 processor.

³ Series B BCM module with fast mode disabled is approximately 50% slower than the times shown.

⁴ Times were taken using a PLC-5/40 processor with one channel configured for DH+ and three channels configured for remote I/O scanner at 230 kbaud.

⁵ Program scan 12–16 ms.

⁶ Program scan 20–25 ms.

⁷ Program scan 30–35 ms.

General Considerations

Data table transfer time increases with the number of blocks in a data segment. This is because the secondary 1785-BCM module must wait for the last block to be transferred from the primary system before it can release its first block for BTR by the secondary processor (normal transfer).

In time-critical applications, you may use Fast Data Transfer mode (switch 2 of switch assembly SW1). In this case, the secondary processor does not need to wait for the complete data segment in order to release its first block for BTR by the secondary processor.

Using a Series A 1785-BCM Module

Appendix Objectives

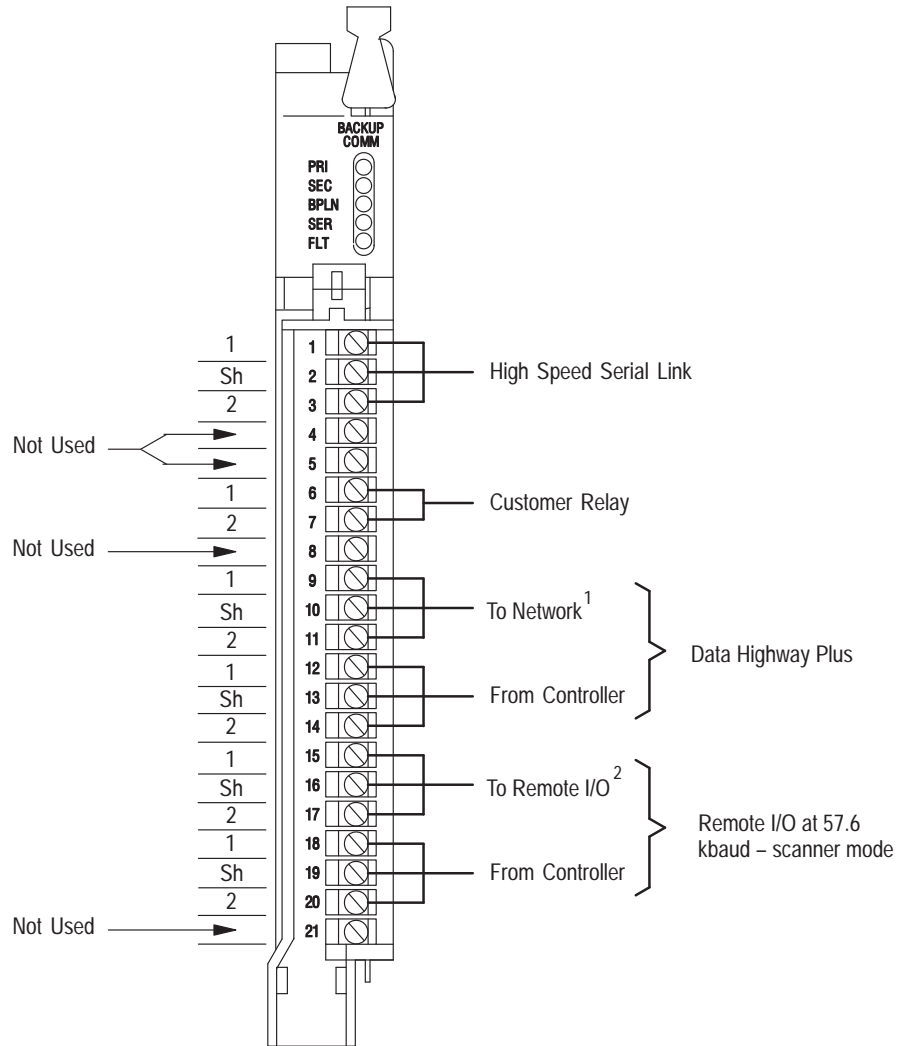
This appendix briefly describes the differences between a 1785-BCM series A backup module and a 1785-BCM Series B backup module.

1785-BCM Series A Backup Module Characteristics

The series A version of the 1785-BCM module has the following differences from the series B version of the 1785-BCM module.

- It communicates only with the PLC-5/15 and PLC-5/25 processor. Series A modules **cannot** communicate with PLC-5/20, -5/30, -5/40, -5/60, or -5/80 processors.
- The module is not compatible with the 1785-BEM backup expansion module.
- The module has a maximum data segment length of 16 blocks.
- The module has **no** remote programming capability for secondary processor.
- The module has **no** user-configurable communication channels. The 1785-BCM series A module has two fixed communication links: one for connection with Remote I/O and one for Data Highway Plus. Refer to Figure C.1 on page C-2.
- The module operates only with the fast mode disabled.
- The module has no switches to set.
- The series A module High-Speed Serial Link operates at 115 kbaud; the series B module operates at 1.2 Megabits.

Figure C.1
1785-BCM Series A Module Communication Links



17979

¹ Terminals 9, 10, and 11 are connected between the 1785-BCM modules in the backup system; in addition terminals 9, 10, and 11 of one of the 1785-BCM modules are connected to the DH+ network.

² Terminals 15, 16, and 17 are connected between the 1785-BCM modules in the backup system; in addition, terminals 15, 16 and 17 of one of the 1785-BCM modules are connected to a Remote I/O adapter module.

Numbers

1785-BCM module
 communication links, 2-2
 compatibility, 1-7
 customer relay, 2-5
 features and capabilities, 1-6
 hardware, 2-1
 installation procedures, 3-5
 relays, 2-4
 series A module differences, C-1
 smart switch interface, 6-7
 status indicators, 2-1
 switch assemblies, 2-6
 system status word, 5-6
 wiring arm, 2-2

1785-BEM module, 4-1
 backup expansion, 1-7
 communication links, 4-3
 communication ports, 4-4
 connecting channels, 4-12
 customer relay, 4-5
 I/O backplane interface, 4-6
 installation procedures, 4-7
 setting the switch assembly, 4-10
 status indicators, 4-1
 switch assembly, 4-6
 wiring arm, 4-2

A

answers to PLC-5 backup system questions, B-1
 audience, i
 auxiliary diagnostics/status word, 5-9
 channel configurations word two, 5-11
 module extended status word one, 5-10

B

backup expansion module, 1-7, 4-1
 backup system concepts, 1-1
 bit displacement instructions, 7-11
 block id word
 in BTR instruction, 5-7
 in BTW instruction, 5-9
 block transfer instructions
 description of, 5-5
 programming considerations, 7-12
 block transfer read instruction, 5-5
 block transfer write instruction, 5-8

C

common questions for a PLC-5 backup system, B-1
 communication links
 configurable ports, 2-2
 description of, 2-4
 figure of, 2-3, C-2
 configurable channels, 2-2
 connecting, 1785-BCM modules, 3-10
 counter instructions, 7-10
 customer relay, 2-5, 4-5

D

Data Highway Plus
 connections, 3-16
 switching
 description of, 6-4
 scenarios, 6-6
 data integrity, 6-10
 switchover diagnostics, 6-11
 data table
 BTR instruction, 5-5
 BTW instruction, 5-8
 considerations, 6-9
 transfer time, 6-2

- data table data transfer
 - method of, 5-3
 - sequence of, 5-3
 - data transfer
 - data in the data table, 5-2
 - overview, 1-5
 - remote input data, 5-1
 - default communication mode, 2-4
 - diagnosing faults
 - with bits of auxiliary diagnostic/status word, 8-6
 - with bits of the system status word, 8-4
 - with status indicators, 8-1
 - diagnostic instructions, 7-11
 - disconnecting failed PLC-5 backup system, 5-18
 - discrete I/O delay, B-1
 - divergence, 6-3
- E**
- editing on-line, 5-20
 - electrostatic discharge information, 3-5, 4-9
- F**
- fast data transfer mode
 - disabled, 5-15
 - enabled, 5-15
 - FIFO instructions, 7-11
 - file copy and fill instructions, 7-11
 - forcing I/O, 6-4
 - formula, for determining discrete I/O delay, B-1
- H**
- hardware
 - 1785-BCM module, 2-1
 - PLC-Backup System, 1-2
 - high speed serial link, description of, 2-4
- I**
- I/O backplane interface, 2-7
 - I/O chassis switches, 3-4, 4-7
 - I/O rack timing, 6-2
 - input signal speed, 6-1
 - Input signal update time, 6-2
 - inserting the 1785-BCM module into the chassis, 3-9
 - inserting the 1785-BEM module into the chassis, 4-11
- K**
- keying the I/O chassis
 - 1785-BCM module, 3-6
 - 1785-BEM module, 4-9
- M**
- message instructions, 7-12
 - minimum program to transfer data table data, 7-1
- O**
- operation of PLC-5 backup system, 5-13
- P**
- packet length word, 5-9
 - PID control files, 7-12
 - PLC-5 backup system
 - configuration, 3-2
 - disconnecting failed system, 5-18
 - how the system works, 1-5
 - operation of, 5-13
 - powering-up the system, 5-18
 - restarting a repaired system, 5-19
 - starting up the system, 5-17
 - power supply requirements
 - with 1785-BCM modules, 3-3
 - with 1785-BEM modules, 4-6
 - powering up the PLC-5 backup system, 5-18
 - primary program, 5-14

- problem instructions
 - block transfer, 7-12
 - counter, 7-10
 - diagnostic, 7-11
 - FIFO, 7-11
 - file arithmetic and logic, 7-11
 - message, 7-12
 - relay logic, 7-9
 - sequencing, 7-11
 - timer, 7-9
 - procedures
 - 1785-BEM module installation, 4-7
 - connecting 1785-BEM channels, 4-12
 - connecting the 1785-BCM modules, 3-10
 - determining power supply requirements using 1785-BCM module, 3-3
 - determining power supply requirements using 1785-BEM module, 4-6
 - disconnecting/repairing a faulted system, 5-18
 - editing or programming online, 5-20
 - inserting the 1785-BCM into the chassis, 3-9
 - inserting the 1785-BEM into the chassis, 4-11
 - keying your I/O chassis, 3-6
 - making Data Highway Plus connections, 3-16
 - powering up the backup system, 5-18
 - restarting a repaired system, 5-19
 - setting 1785-BCM module switch assemblies, 3-6
 - setting 1785-BEM module switch assembly, 4-10
 - setting the I/O chassis switches, 3-4
 - starting up the backup system, 5-17
 - switching the processor's mode, 5-19
 - terminating the DH+ and RIO links, 3-4
 - program flow
 - sample programs, A-1
 - transferring data multiple blocks at a time method (2), 7-8
 - transferring data one block at a time method (1), 7-5
 - programming
 - on-line, 5-20
 - secondary processor remote programming, 5-12
 - programming considerations, summary, 7-13
 - programming techniques
 - transferring data multiple blocks at a time method (2), 7-6
 - transferring data one block at a time method (1), 7-3
- R**
- receiver program, 5-15
 - Related Publications, iii
 - relays
 - 1785-BCM module, 2-4
 - 1785-BEM module, 4-4
 - remote I/O
 - block diagram of switch, 6-8
 - switching, 6-6
 - remote programming capability for secondary processor, 5-12
 - remote test-mode, 5-19
 - restarting a repaired PLC-5 backup system, 5-19

S

sample programs
 transferring data multiple blocks at a time, A-13
 transferring data one block at a time, A-1

secondary processor remote programming, 5-12

secondary program, 5-15

sequencing instructions, 7-11

Series A 1785-BCM compatibility, C-1

setting 1785-BCM module switch assemblies, 3-6

smart switch interface, 6-7

specifications, 9-1

starting up the PLC-5 backup system, 5-17

status indicators
 BPLN, SER, FLT, 8-2
 description of, 2-1, 8-1
 diagnosing faults, 8-1
 diagnosing faults with, 8-2
 PRI and SEC, 8-2

switch assemblies
 definition for 1785-BCM module, 2-6
 definition for 1785-BEM module, 4-6
 settings for 1785-BCM module, 3-6
 settings for 1785-BEM module, 4-10

switching the processor's operating mode, 5-19

switchover
 description of, 6-1
 overview, 1-6

switchover considerations
 data integrity, 6-10
 data table considerations, 6-9
 DH+ switching, 6-4

divergence, 6-3
 forcing I/O, 6-4
 remote I/O switching, 6-6
 timing requirements, 6-1

switchover diagnostics, 6-11

system status word, 5-6
 diagnosing faults with bits of, 8-4

T

terminating the DH+ and RIO links, 3-4

terms and conventions, ii

timer instructions, 7-9

timing requirements
 data table transfer time, 6-2
 input signal speed, 6-1
 input signal update time, 6-2
 time-out on remote I/O link, 6-2

transferring data multiple blocks at a time
 description of, 7-6
 program flow, 7-8
 sample program, A-13

transferring data one block at a time
 data table transfer times, A-13, B-5
 description of, 7-3
 program flow, 7-5
 sample program, A-1

transferring data table values
 getting started program, 7-1
 multiple blocks at a time, 7-6
 one block at a time, 7-3

transmitter program, 5-14

W

wiring arm
 1785-BCM module, 2-2
 1785-BEM module, 4-2

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