



***Allen-Bradley***

***PLC-5 VME  
VMEbus  
Programmable  
Controllers***

***(1785-V30B, -V40B,  
-V40L, and -V80B)***

# **User Manual**

## Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to ensure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based on the examples shown in this publication.

Allen-Bradley publication SGI-1.1, Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations:



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

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Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

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

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## Summary of Changes

This release of the PLC-5/VME VMEbus Programmable Controllers User Manual contains new and updated information on PLC-5/VME™ systems.

For information about:	See chapter/appendix:
CE compliance	2
making VME self-references in POST tests	2
improved .WRDY and .LOCK bit description	3
changes to the status file	4
setting the NOCV bit to 0	7
revised specifications	C
additional troubleshooting tips	D

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

In addition to the new and updated information discussed above, we have altered the way we reference software documentation in this manual. Rather than show specific screens and key sequences which may vary according to the software package you are using, we refer you instead to the programming software documentation that accompanies your particular software package. Of course, we still provide the basic background information you need to accomplish your programming tasks, but if you have specific questions, you should refer to your programming software documentation set.



## Using this Manual

### Manual Objectives

The purpose of this manual is to familiarize you with the installation and use of the PLC-5/VME programmable controllers. This manual focuses on the specific VMEbus aspects of this processor. Typically, you use this processor in a VMEbus system with one or more host CPU modules that control(s) and communicate(s) with the processor. You need to develop software driver programs to execute on the host CPU module(s) to accomplish this. You must also write ladder programs for your processor to monitor and control the I/O of your control system. This manual helps you write the VMEbus-specific aspects of these programs.

### What this Manual Contains

Chapter/ Appendix	Title	Contents
1	Overview	Overview of the PLC-5/VME processors
2	Installation	Configuration and installation procedures
3	VMEbus Interface	Configuration registers and commands
4	Ladder-Program Interfaces	How to interact with your VMEbus environment from your ladder program
5	Commands	Commands used to interface to the processor
6	PLC-5/VME Processor Communications Commands	The function of the extended PCCCs in the PLC-5/VME processor
7	Performance and Operation	Overview of the performance and operation of the PLC-5/VME processor
A	Sample Applications	How to write applications to interact with your PLC-5/VME processor
B	Sample API Modules	How to write API modules to interact with your PLC-5/VME processor
C	Specifications	PLC-5/VME processor specifications
D	Troubleshooting	Troubleshooting and error-code information
E	Cable Connections	Communication boards and cable connections for PLC-5 <sup>®</sup> family processors

### Audience

This manual assumes that you have background in:

- VMEbus concepts and basics
- PLC-5 ladder logic
- PLC-5/VME operation
- C-language programming

## Terms and Conventions

We refer to the:	As the:
Data Highway	DH link
Data Highway Plus™	DH+™ link
Programmable Logic Controller	processor
PLC-5® Processor	PLC-5/VME processor. Unless noted otherwise, we use PLC-5/VME processor to denote all processors.
Programmable Controller Communications Commands	PCCC
Release on request	ROR
Release when done	RWD

Term	Definition
Extended-local I/O	I/O connected to a processor across a parallel link, thus limiting its distance from the processor
Extended-local I/O link	a parallel link for carrying I/O data between a PLC-5/V40L processor and extended-local I/O adapters
Remote I/O link	a serial communication link between a PLC-5 processor port in scanner mode and an adapter as well as I/O modules that are located remotely from the PLC-5 processor
Remote I/O chassis	the hardware enclosure that contains an adapter and I/O modules that are located remotely on a serial communication link to a PLC-5 processor in scanner mode
Discrete-transfer data	data (words) transferred to/from a discrete I/O module
Block-transfer data	data transferred, in blocks of data up to 64 words, to/from a block-transfer I/O module (for example, an analog module)

In addition, you may encounter words in different typefaces. We use these conventions to help differentiate descriptive information from information that you enter while programming your processor.

- The Enter key looks like this (boldface and in brackets):

**[Enter]**

- Words or commands that you enter appear in boldface. For example:

**CTV #            SVI**

- Variables that you enter appear in italics. For example:

*vmeaddr width*

- “Type” means type in the information.
- “Enter” means type in the information and then press the **[Enter]** key.

## Related Publications

The 1785 PLC-5 programmable controller documentation is organized into manuals according to the tasks that you perform. This organization lets you find the information that you want without reading through information that is not related to your current task.



For more information on 1785 PLC-5 programmable controllers or the above publications, contact your local Allen-Bradley sales office, distributor, or system integrator.

We also suggest that you acquire the following publications for reference:

- *Data Highway / Data Highway Plus DH-485 Communication Protocol and Command Set Reference*, Allen-Bradley, publication 1770-6.5.16
- *The VMEbus Specification—Rev: C.1*, Motorola, HB212
- *VMEbus User's Handbook*, Steve Heath, CRC Press, ISBN 0-8493-7130-9

## Overview

### Chapter Objectives

Read this chapter to understand the overall operation of the PLC-5/VME processor, how you can use it in VME systems, and how its features and functions relate to those of other Allen-Bradley processors.

### Features

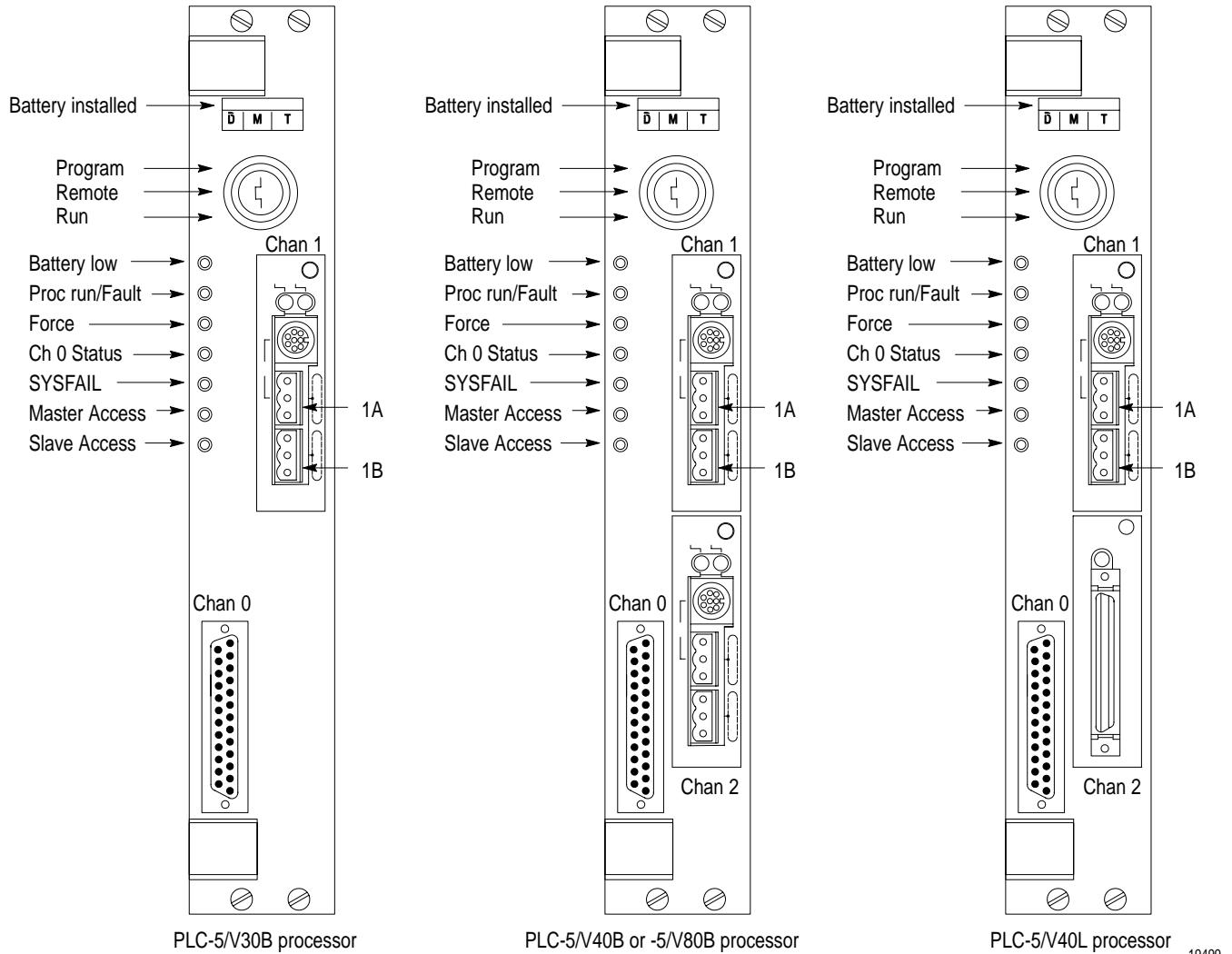
PLC-5/VME processors are programmable controllers that bring the technology of the 1785 PLC-5 processor to the VMEbus environment.

The PLC-5/VME processor is equivalent (in terms of I/O, ladder programming, and instruction timing) to the standard PLC-5 processor, except that the PLC-5/VME processor:

- plugs into a VMEbus system
- has a VMEbus communication interface designed for use with other VMEbus CPU modules
- can access VMEbus I/O modules
- has no EEPROM memory module

Figure 1.1 shows examples of the PLC-5/VME processors.

**Figure 1.1**  
**Examples of PLC-5/VME Processors**



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All PLC-5/VME processors have at least one configurable I/O channel and one serial port (channel 0).

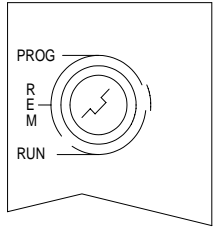
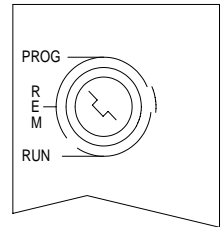
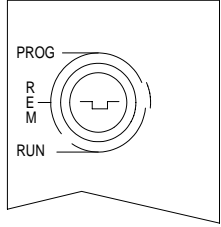
Channel:	Is configured for:
0	supporting RS-232C  The PLC-5/VME processor channel 0 protocol defaults to the system mode of operation (DF1 point-to-point), which allows programming from a PC terminal. The default communication rate is 2400.
1A	DH+ mode (by default)
1B	scanner mode (by default)
2 (if applicable)	DH+ and remote I/O (RIO) communication or extended-local I/O

In the PLC-5/V40B, both channels (1 and 2) are identical although they are independently configurable. In the PLC-5/V40L, channel 2 is a local I/O (LIO) interface.

The PLC-5/VME processor has the same instruction set as the standard PLC-5 processor. It supports:

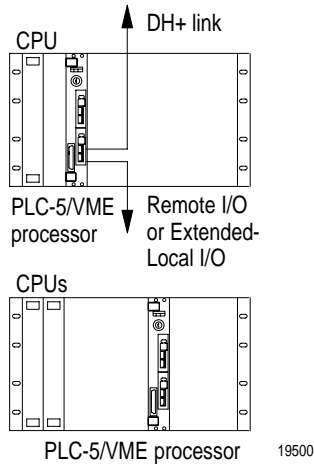
- complex expressions in compare and compute instructions
- statistical instructions
- floating-point calculations in PID instructions
- ASCII string-handling instructions
- main control programs (MCPs)

Use the keyswitch to change the mode in which a processor is operating.

If you want to:	Turn the keyswitch to:
<ul style="list-style-type: none"> <li>Run your program, force I/O, and save your programs to a disk drive. Outputs are enabled. (Equipment being controlled by the I/O addressed in the ladder program begins operation.)</li> <li>Enable outputs.</li> </ul> <p><b>Note:</b> You cannot create or delete a program file, create or delete data files, or change the modes of operation through the programming software while in run mode.</p>	<p><b>RUN</b></p> 
<ul style="list-style-type: none"> <li>Disable outputs</li> <li>Create, modify, and delete ladder files or data files; download to an EEPROM module; and save/restore programs.</li> </ul> <p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>The processor does not scan the program.</li> <li>You cannot change the mode of operation through the programming software while in program mode.</li> </ul>	<p><b>PROG (program)</b></p> 
<p>Change between remote program, remote test, and remote run modes through the programming software.</p> <p><b>Remote run</b></p> <ul style="list-style-type: none"> <li>Enable outputs.</li> <li>You can save/restore files and edit online.</li> </ul> <p><b>Remote program</b></p> <p>See the program-mode description above.</p> <p><b>Remote test</b></p> <ul style="list-style-type: none"> <li>Execute ladder programs with outputs disabled.</li> <li>You cannot create or delete ladder programs or data files.</li> </ul>	<p><b>REM (remote)</b></p> 

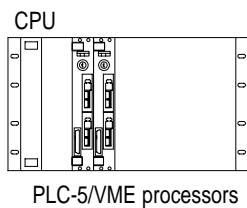
## System Description

Use the PLC-5/VME processor in a 6U (full-height) VMEbus chassis. You can use the PLC-5/VME processor by itself (i.e., with no other VME modules), but typically the PLC-5/VME processor is used in conjunction with other VMEbus computers (CPUs) and I/O modules. The examples below illustrate possible configurations.

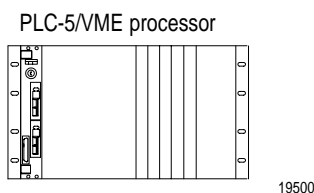


The PLC-5/VME processor is used in conjunction with a VMEbus CPU module. The processor serves as a real-time I/O processor under the direction of the CPU. The processor is a slave of the CPU, where, in addition to its normal ladder logic and I/O processing in each scan loop, the processor responds to directions from the CPU and passes data back to the CPU.

There is no fixed relationship between processor and CPU, so multiple CPUs can communicate with one processor. Multiple CPUs run multiple tasks, all sending and receiving data from the processor at the same time.

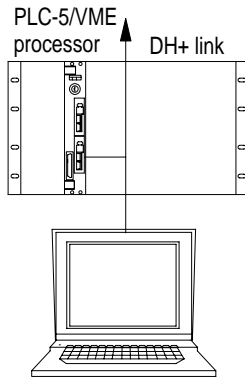


One CPU can control multiple PLC-5/VME processors. Each processor maps into the VMEbus address space; so you map each processor to a different address space.

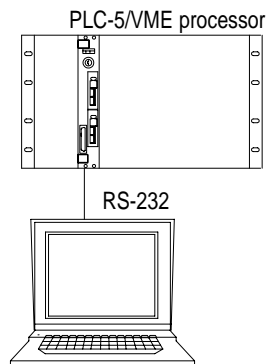


No CPU interacts with the processor. The processor interacts with I/O modules in one or more remote I/O racks and has the capability, from its ladder program, of generating VMEbus accesses. This means that the processor can access VMEbus I/O modules as well.

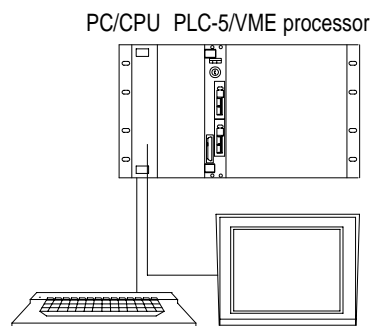
The following diagrams show three basic configurations for programming and debugging your ladder-logic programs.



Connect a computer via the DH+ link, typically using a 1784-KT communication device in your IBM AT<sup>®</sup> computer and a 1784-CP6 cable.



Connect a computer using the RS-232C on-board serial port of the PLC-5/VME processor. In this configuration, the RS-232C cable connects one of the computer's COM ports to the channel 0 (serial) port of the processor.



You can program as well as download files directly over the VMEbus backplane to your PLC-5/VME processor if you:

- run 6200 Series PLC-5 Programming Software release 4.4 or later
- use an 8086-based CPU from RadiSys—i.e., a EPC-1, EPC-4, or EPC-5 VME PC-compatible computer.

**Important:** In order to use the **save** feature of the 6200 Series PLC-5 Programming Software when you communicate with the processor in this way, you must run release 4.5 or later.

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## VMEbus Interface

The PLC-5/VME is fully compliant with the C.1 VMEbus specification. The PLC-5/VME processor occupies two 6U VMEbus slots. It can reside in any adjacent pair of slots, including slot 1, the system-controller slot. The PLC-5/VME processor has a single VMEbus P1 connector, allowing it to be used in VMEbus systems that have either the full J1 and J2 backplanes or only the J1 backplane.

The PLC-5/VME processor occupies 64 bytes in the VME A16 (or “short”) address space, and you can configure an additional 64 Kbytes of the A24 (or “standard”) address space.

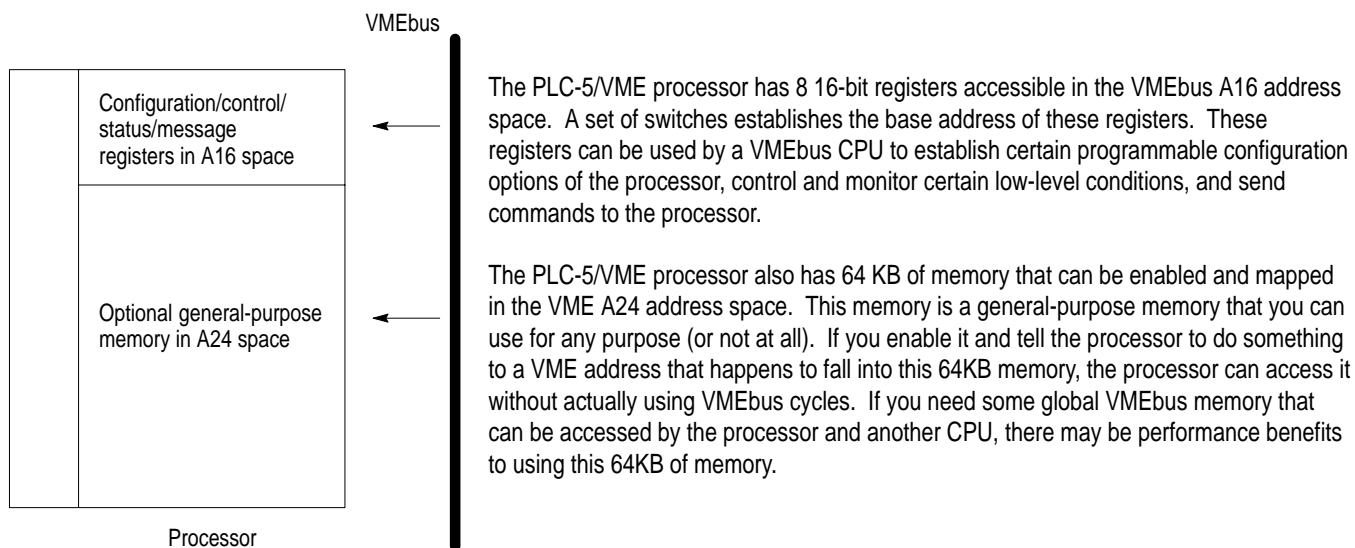
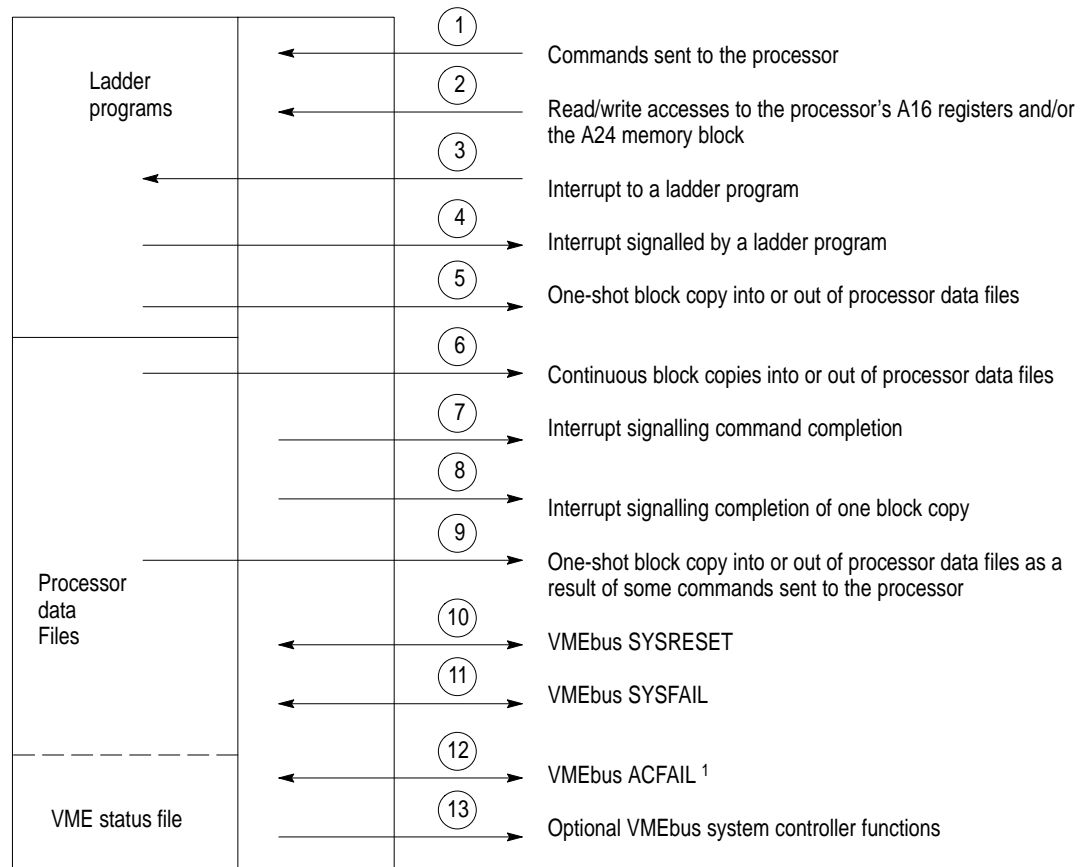


Figure 1.2 illustrates the basic forms of communications. Table 1.A summarizes these communication forms.

**Figure 1.2**  
**Basic Forms of Communications**



<sup>1</sup> Required by the PLC-5/VME processor. Asserted by VME power supply.

**Table 1.A**  
**Summary of Figure 1.2**

In Figure 1.2, when you see :	It means that:
1	Commands are high-level directives sent to the processor from another VMEbus master, typically a controlling CPU. Commands specific to the VME processor can establish a continuous block copy to/from the processor and tell the processor to which VMEbus interrupts it should respond. You can also send any PCCC via this mechanism. PCCCs are commands supported in all 1785 PLC-5 processors. You can use them to change and modify processor state, for example, or to upload and download memory files.
2	The PLC-5/VME processor responds as a VMEbus slave to certain A16 accesses (to its configuration registers) and to certain A24 accesses (to its general-purpose memory, if enabled).
3	You can configure the PLC-5/VME processor to respond as an interrupt handler to specified VMEbus interrupt lines. When one of these interrupts occurs, the processor performs an 8-bit interrupt acknowledge cycle on the VMEbus to read an 8-bit status/ID from the interrupter. The interrupt and the status/ID value are then posted for accessibility by the ladder program.
4	The PLC-5/VME processor can perform as a VMEbus interrupter (sender of interrupts) in three different ways: <ul style="list-style-type: none"> <li>• from a ladder program; the ladder MSG instruction has been extended in the PLC-5/VME processor to allow a ladder program to generate a VMEbus interrupt.</li> <li>• signalling completion of a command (see 7).</li> <li>• signalling a completion of each block copy operation for the continuous copy operations (see 8).</li> </ul>
5	Another function available via the MSG instruction is VMEbus reads and writes. Rather than just individual 8- or 16-bit accesses, the function allows a block read or write to be done (i.e., of an arbitrary number of bytes). This is done between a data file in the processor and an arbitrary address range on the VMEbus. The ladder program can specify the VMEbus address space and data widths to be used.
6	One of the main interfaces of the 6008-LTV processor, and one preserved in the PLC-5/VME processor, is the ability to predefine two block-copy operations, one into the processor data files and one out of the processor data files, to be executed automatically every scan loop. These operations are predefined to the processor via initialization commands from the CPU or from your programming software.
7	The processor can be a VMEbus interrupter signalling completion of a command. This is an option on all commands and can serve as a way to synchronize the CPU and the processor.
8	The processor can be a VMEbus interrupter signalling completion of each block copy operation for the continuous copy operations. This is another option that allows the CPU to synchronize with the scan loop of the processor.
9	Certain standard PCCC commands cause data to be moved into and out of the processor; thus these commands represent another type of VMEbus interface between the processor and a controlling CPU.
10	The PLC-5/VME processor can be reset with the VME SYSRESET <sup>1</sup> signal. The PLC-5/VME processor also asserts SYSRESET <sup>1</sup> during power-up initialization until its VMEbus interface hardware is capable of responding to VMEbus accesses.
11	The PLC-5/VME processor asserts the VME SYSFAIL <sup>1</sup> signal after a reset until the firmware's self-test completes successfully. The PLC-5/VME processor makes the state of the VME SYSFAIL <sup>1</sup> signal available to the ladder program.
12	Assertion of VME ACFAIL <sup>1</sup> causes the processor to halt, with integrity of the ladder program and data files maintained in the battery-backed memory such that the processor can be restarted upon power up. Your power supply must assert ACFAIL <sup>1</sup> at least 9ms in advance of the +5VDC supply dropping beneath 4.75V.
13	The PLC-5/VME processor can serve as a VMEbus slot-1 system controller. This enables the PLC-5/VME processor as a single-level arbiter, a bus timeout timer, and the driver of the VMEbus 16 MHz SYSCLK signal.

<sup>1</sup> indicates a low true signal.

## **Compatibility with the Standard PLC-5 Processor**

Ladder programs from a standard PLC-5 processor run in the PLC-5/VME processor. The PLC-5/VME processor has the same program scan time as the PLC-5 processor. The PLC-5/VME processor has the same extended instruction set as the PLC-5 processor.

Features of the PLC-5 processor not present in the PLC-5/VME processor are:

- PIIs
- EEPROM memory module
- logical rack 0 (128 less I/O points)

Features of the PLC-5/VME processor not present in the PLC-5 processor are:

- The PLC-5/VME processor defines a special data file called the “VME status file.” This file gives ladder programs the ability to control and monitor certain VMEbus state information.
- The ladder MSG instruction is extended to allow ladder programs to perform VMEbus data transfers and generate VMEbus interrupts.

Finally, features present in both but implemented or represented differently are:

- The serial port (channel 0) on the PLC-5/VME processor is RS-232C only (not configurable for RS-422 and RS-423).
- Different batteries are used (cat. no. 1770-XYV).
- The PLC-5/VME processor has a memory-protect switch. In the PLC-5 processor, the equivalent switch is on the 1771 I/O rack.

## **Compatibility with the 6008-LTV Processor**

The PLC-5/VME processor retains a significant amount of compatibility with the 6008-LTV processor. This eases the task of converting 6008-LTV ladder programs and CPU driver programs to use with the PLC-5/VME processor.

6008-LTV ladder programs may need editing because the VME status file in the PLC-5/VME processor is different in several ways from 6008-LTV status file. The 6008-LTV ladder programs that access the VME status file will need to be changed.

**Table 1.B**  
**Comparison of 6008-LTV and PLC-5/VME Processor Attributes**

Attributes	6008-LTV	PLC-5/VME	Comments
VME slots	3	2	
Bus arbitration	No	Yes or No (user configurable)	Single level arbiter
VME master	Yes	Yes	
VME Slave	Yes	Yes	
Global memory (bytes) <sup>1</sup>	1K short, 4K short or standard	64K standard	Global memory is selectable
Programming and downloading over backplane	No	Yes	With 6200 series software release 4.4 and later
Saving over backplane	No	Yes	With 6200 series software release 4.5 and later
PLC <sup>®</sup> data table to global memory transfer method	Continuous-copy command	Continuous-copy and/or ladder MSG commands	
Asserts VME SYSFAIL	Yes	Yes	
PLC resets upon VME SYSRESET	Yes	Yes	
Bus request line	0, 1, 2, 3	1, 3	
Bus release	ROR, RWD, ROC	ROR, RWD, ROC	
Continuous-copy command file size	500 words	1000 words	
Ladder MSG file size	N/A	1000 words	
RS-232 port	No	Yes	
Remote I/O baud rate	57.6k baud fixed	57.6k, 115.2k, 230.4k baud configurable	
Remote I/O fractional rack addressing	No	Yes	

<sup>1</sup> All of the 6008-LTV's global memory could be configured to be totally within short memory. Because the PLC-5/VME processor's global memory would totally fill all of VME short memory, it can only be selected with a standard memory address. This may be a consideration when replacing a 6008-LTV with a PLC-5/VME processor.

There are some areas of potential incompatibility to consider:

- The configuration/control/status/message registers are slightly different, requiring changes to the host driver program.
- The LTV VME global memory can be selected to be in short or standard memory space. The PLC-5/VME processor's global memory can only be selected to be in standard memory. Because of this, the 6008-LTV will accept address modifiers 2D, 3D 29 and 39. The PLC-5/VME processor will only respond to address modifiers 3D.
- The 6008-LTV supports logical rack address 0; the PLC-5/VME processor does not.
- The 6008-LTV has a status/configuration bit to enable or ignore ROC (release on clear). The PLC-5/VME processor will always respond to ROC.

- The PLV-5/VME processor status files in the processor status area are different in several ways.
- When floating point values are converted to integer, they are rounded differently. 6008-LTV rounds 0.5 to the next highest integer, the PLC-5/VME processor rounds to the nearest even integer.

CPU driver programs are affected in these ways:

- The low-level protocol for how commands are given to the processor and how command-sending errors are reported is significantly different. However, the higher-level interfaces (e.g., the commands themselves) are compatible.
- The manner in which the VME setup interface parameters are configured is significantly different:

In the:	The information is in the:
PLC-5/VME processor	configuration registers in the A16 space.
6008-LTV processor	"Slave 0" global memory in the A16 space.

See chapter 3 for more information.

## Installation

### Chapter Objectives

Read this chapter to learn how to set the switches in your PLC-5/VME processor and install it into a VMEbus chassis.

See the Classic 1785 PLC-5 Programmable Controller Hardware Installation Manual, publication 1785-6.6.1 for more information about installing PLC-5 family processors.

### Compliance to European Union Directives

If this product has the CE mark it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

#### EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This product is intended for use in an industrial environment.

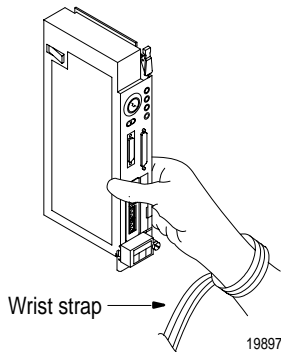
#### Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131-2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information required by EN 61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- Industrial Automation Wiring and Grounding Guidelines For Noise Immunity, publication 1770-4.1
- Enhanced and Ethernet PLC-5 Programmable Controller User Manual, publication 1785-6.5.12
- Guidelines for Handling Lithium Batteries, publication AG-5.4
- Automation Systems Catalog, publication B111

## Handling the Processor



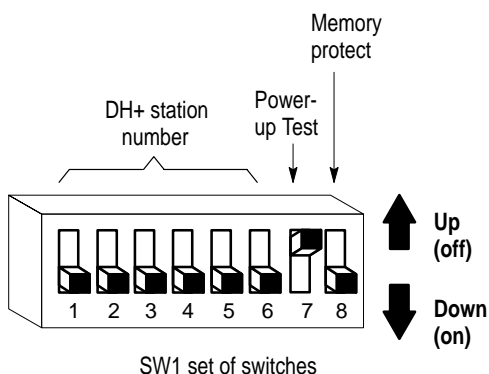
The processor is shipped in a static-shielded container to guard against electrostatic damage. Electrostatic discharge can damage integrated circuits or semiconductors in the processor module if you touch backplane connector pins. It can also damage the module when you set configuration plugs or switches inside the module. Avoid electrostatic damage by observing the following precautions.

- Remain in contact with an approved ground point while handling the module (by wearing a properly grounded wrist strap).
- Do not touch the backplane connector or connector pins.
- When not in use, keep the module in its static-shielded container.

## Setting the Switches

Before installing the PLC-5/VME processor, you need to make some decisions about its configuration and operation and set the switches on the circuit board accordingly. You need to know:

- DH+ station (node) number
- Memory protection—whether you want the processor's program RAM protected
- Location of configuration registers in VMEbus A16 address space
- System controller—whether you want the processor to serve as the VMEbus slot-1 system controller
- VMEbus request level—whether you want the processor to request access to the VMEbus at level 3 or level 1



**Figure 2.1**  
**Switch Location**

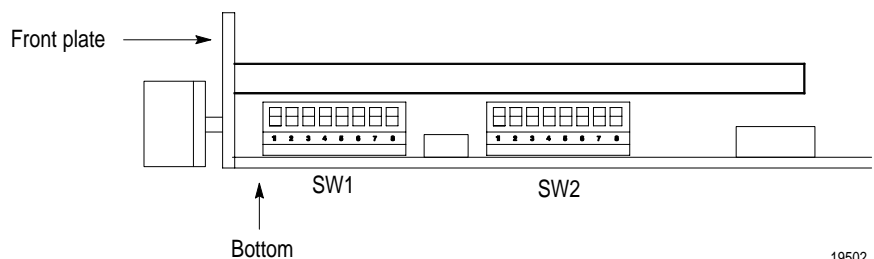


Table 2.A and Table 2.B describe the switch settings for SW1.



**Table 2.A**  
**SW1 Set of Switches**

Switches 1-6	Switch 7	Switch 8
DH+ station number for channels 1A and 0 (see Table 2.B)	Unused (off)	Memory protect. If on, RAM memory protect is enabled.

**Table 2.B**  
**Station Numbers SW1 (Switches 1-6)**

Station Number (Octal)	LSD			MSD		
	1	2	3	4	5	6
0	on	on	on	on	on	on
1	off	on	on	on	on	on
2	on	off	on	on	on	on
3	off	off	on	on	on	on
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
77	off	off	off	off	off	off

Table 2.C and Table 2.D describe the switch settings for SW2.

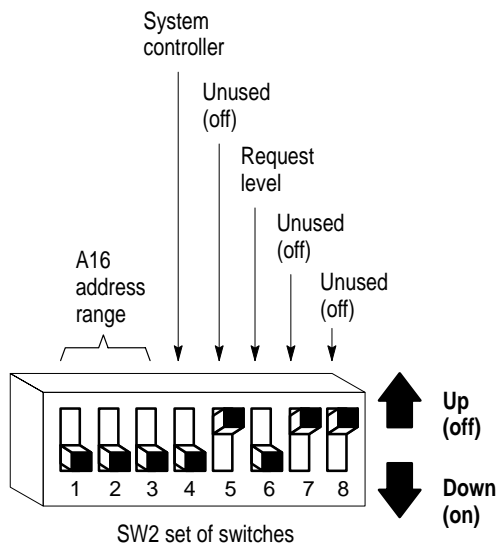
**Table 2.C**  
**SW2 Set of Switches**

Switches 1-3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8
A16 address range of the configuration registers. See Table 2.D.	If on, the processor functions as the VMEbus system controller, and no other VME cards should attempt to be the system controller.  <b>Important:</b> The PLC-5/VME processor must be in the left-most slot of the VME chassis. See page 3-1 for a description of the system controller.	Unused (off)	VMEbus request level. If switch 4 is OFF, switch 6 on defines the bus request level as 3. If switch 6 is OFF, the bus request level is 1.  If switch 4 is ON, the bus request level is 3 independent of the setting of switch 6.	Unused (off) <sup>1</sup>	Unused (off)

**Important:** Switch 6 is meaningful only if switch 4 is off.

<sup>1</sup> SW2, position 7, now controls whether the PLC-5 processor makes a VME self-reference in its POST test. If you set SW2, position 7 to OFF (up position), then the VME will make self-references as it did before series C, revision K. If you set SW2, position 7 to ON (down position), then the POST test will skip all VME self-references, causing the following effects:

- The PLC-5 processor cannot test its bus-master hardware.
- The PLC-5 processor cannot determine its own unique logical address and assumes its ULA is F0H regardless of how you set SW2, positions 1–3.
- The VME status file ULA field (word 1, bits 3-15) will always contain 000, regardless of how you set SW2, positions 1–3.

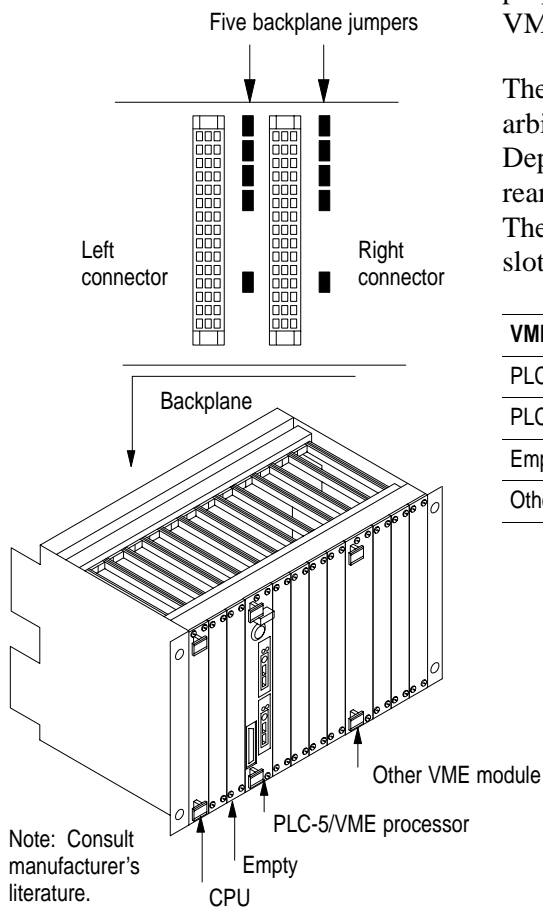


**Table 2.D**  
**Address Range SW2 (Switches 1-3)**

ULA <sup>1</sup>	1	2	3	A16 Address Range
0	on	on	on	FC00-FC3F (hex)
1	off	on	on	FC40-FC7F
2	on	off	on	FC80-FCBF
3	off	off	on	FCC0-FCFF
4	on	on	off	FD00-FD3F
5	off	on	off	FD40-FD7F
6	on	off	off	FD80-FDBF
7	off	off	off	FDC0-FDFF

<sup>1</sup> Unique Logical Address is used by the 6200 series programming software to determine the A16 base address of the PLC-5/VME processor's registers..

## Configuring the VME Backplane Jumpers



The VMEbus contains several daisy-chained control signals. Almost all VMEbus backplanes contain jumpers for these control signals to allow systems to operate with empty slots. Failing to install these jumpers properly is a common source of problems in configuring a new VMEbus system.

There are five jumpers per VME slot, one for each of the four bus-grant arbitration levels and one for the interrupt-acknowledge daisy chain. Depending on the backplane manufacturer, the jumpers can be on the rear pins of the J1 connector or alongside it on the front of the backplane. The PLC-5/VME processor uses two slots. Based on what is in the VME slot, install or remove the backplane jumpers as follows:

VME Slot Content	Five Backplane Jumpers
PLC-5/VME processor's left slot	Remove
PLC-5/VME processor's right slot	Install
Empty slot	Install
Other VME module	Consult manufacturer's literature

## Inserting the Processor into a Chassis

You insert the PLC-5/VME processor in two adjacent slots in a 6U (full-height) VMEbus chassis.

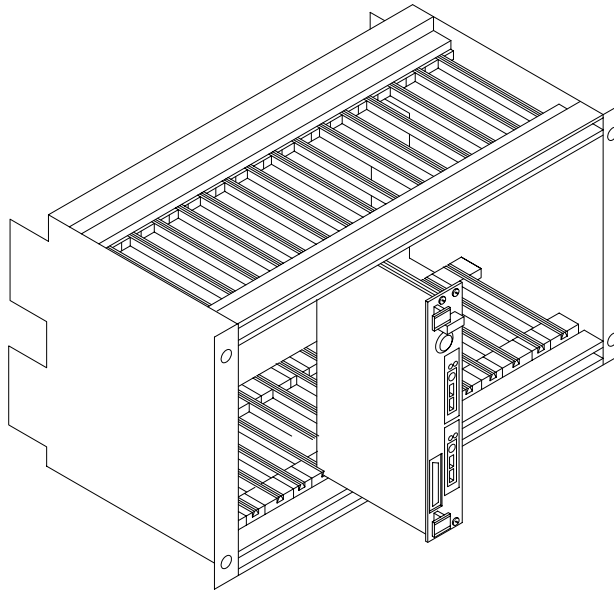


**ATTENTION:** Make sure that your VME system is powered off. The PLC-5/VME processor is not designed to be inserted or removed from a live system.



**ATTENTION:** Avoid touching the circuit board and connectors.

After sliding the processor into the VME chassis using its cardguides, use firm pressure on the top and bottom handles of the processor to make its P1 connector fit firmly into the connector on the backplane. Tighten the screws in the top and bottom of the front panel to prevent your PLC-5/VME processor from loosening.



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## Grounding

Allen-Bradley makes specific recommendations for properly grounding its racks so that their operation is as safe and error-free as possible. VME systems, on the other hand, may have no formal specifications for grounding the VME chassis frame. Allen-Bradley recommends that you ground the VME chassis frame and that you connect the logic ground (common) of the VME power supply to the chassis frame's earth ground.

The specific procedure for grounding a VME chassis varies depending on the style of the chassis. Read the instructions found in the Classic PLC-5 Family Programmable Controllers Installation Manual, publication 1785-6.6.1 for information on how Allen-Bradley racks are grounded, and try to ground your VME chassis frame in a similar way.



**ATTENTION:** If you are using a PLC-5/V40L processor, your VME power supply should not float with respect to earth ground. Connect the power supply's logic ground (common) for the 5V supply before connecting the PLC-5/40L processor to a 1771-ALX adapter. Also, use a single point of ground between the VME chassis and the extended-local I/O system to ensure proper performance.

## Determining Power-Supply Requirements

The PLC-5/VME processor draws 4 A (maximum)—3.2 A (typical)—from the VME power supply. The processor also monitors the ACFAIL signal on the backplane to determine when the +5 VDC supply is within tolerances. The VME power supply must assert ACFAIL at least 9 ms in advance of the +5 VDC supply dropping beneath 4.75V or memory corruption and processor fault occurs. Therefore, make sure that your power supply has ACFAIL capability.

You must use a Safety Extra Low Voltage (SELV)- or Protected Extra Low Voltage (PELV)-certified power supply with the VME processor to comply with Low Voltage directive requirements.

## Connecting to Remote I/O

Use Belden 9463 twin-axial cable (cat. no.1770-CD) to connect devices to a remote I/O link. To connect a remote I/O link, do the following:

To connect a remote I/O link, you must:	See page:
Make sure the cables are the correct length	2-6
Prepare the cable	2-7
Make the remote I/O connections	2-7
Terminate the link	2-8

### Make Sure that You Have Correct Cable Lengths

Verify that your system's design plans specify remote I/O cable lengths within allowable measurements.

A remote I/O link using this communication rate:	Cannot exceed this cable length:
57.6 kbps	3,048 m (10,000 ft)
115.2 kbps	1,524 m (5,000 ft)
230.4 kbps	762 m (2,500 ft)

### **Prepare the Cable**

Cut the cable according to the lengths you need. Route the cable to the devices.

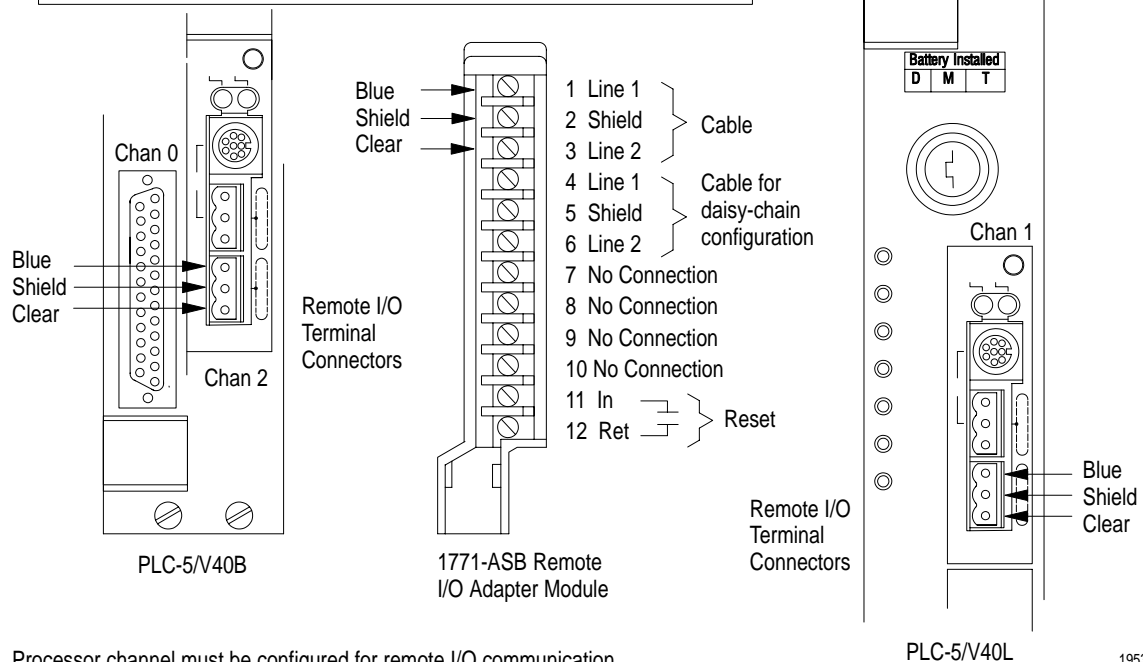
### **Make Remote I/O Connections**

Use Figure 2.2 when connecting the remote I/O cable to PLC-5 processors and remote I/O adapter modules.

**Figure 2.2**  
**Remote I/O Terminal Connectors**

To connect remote I/O cable, do the following:

1. Run the cable (1770-CD) from the processor to each remote I/O adapter module or processor in the remote I/O system.
2. Connect the signal conductor with blue insulation to the 3-pin connector terminal labeled 1 on the processor and to each remote I/O adapter module (or PLC-5 adapter) in the remote I/O system.
3. Connect the signal conductor with clear insulation to the 3-pin connector terminal labeled 2.
4. Connect the shield drain wire to the 3-pin terminal labeled SH.
5. Tie wrap the remote I/O network cable to the chassis to relieve strain on the cable.



Processor channel must be configured for remote I/O communication.

## Terminate the Link

For proper operation, terminate **both** ends of a remote I/O link by using the external resistors shipped with the programmable controller. Use either a 150Ω or 82Ω terminator.

If your remote I/O link:	Use this resistor rating:	The maximum number of <i>physical</i> devices you can connect on the link	The maximum number of racks you can scan on the link
operates at 230.4 kbps	82Ω	32	16
operates at 57.6 kbps or 115.2 kbps <b>and</b> no devices listed in Table 2.A are on the link			

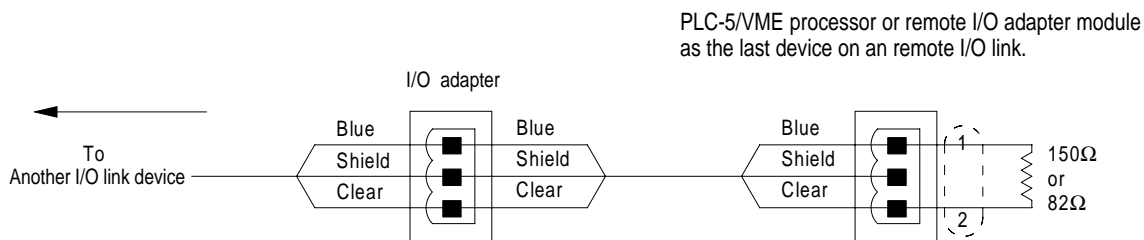
If your remote I/O link:	Use this resistor rating:	The maximum number of <i>physical</i> devices you can connect on the link	The maximum number of racks you can scan on the link
contains any device listed in Table 2.A	150Ω	16	16
operates at 57.6 kbps or 115.2 kbps, and you do not require the link to support more than 16 physical devices.			

As shown in the table above, the terminators you use determine how many devices you can connect on a single remote I/O link.

**Table 2.A**  
**I/O Link Devices that Require 150-Ω Termination Resistors**

Device Type	Catalog Number	Series
Scanners	1771-SN	All
	1772-SD, -SD2	
	1775-SR	
	1775-S4A, -S4B	
	6008-SQH1, -SQH2	
Adapters	1771-AS	A
	1771-ASB	
Miscellaneous	1771-AF	All
	1771-DCM	

**Figure 2.3**  
**Terminating a Remote I/O Link Using a Resistor**



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## Connecting an Extended-Local I/O Link

Use the extended-local I/O cables. These cables have a single-end connector on one end and a dual-end connector on the other. The maximum cable length for an extended-local I/O system is 30.5 cable-m (100 cable-ft). Connect extended-local I/O adapters by using any of these cables (Table 2.B):

**Table 2.B**  
**Standard Extended-Local I/O Cables**

Cable Length:	Catalog Number:
1 m (3.3 ft)	1771-CX1
2 m (6.6 ft)	1771-CX2
5 m (16.5 ft)	1771-CX5

**Important:** You cannot connect or splice extended-local I/O cables to form a custom cable length. For example, if you have a distance of four meters between two extended-local I/O adapters or between a processor and an extended-local I/O adapter, you cannot connect two 2-m cables together. You would have to use the 5-m cable and have the extra meter as slack.

You must set switches on the extended-local I/O adapter module. For information, see its installation data, publication 1771-2.200.



To make extended-local I/O connections, do the following:



**ATTENTION:** Turn off power to the extended-local I/O adapter module before connecting or disconnecting extended-local I/O cables.

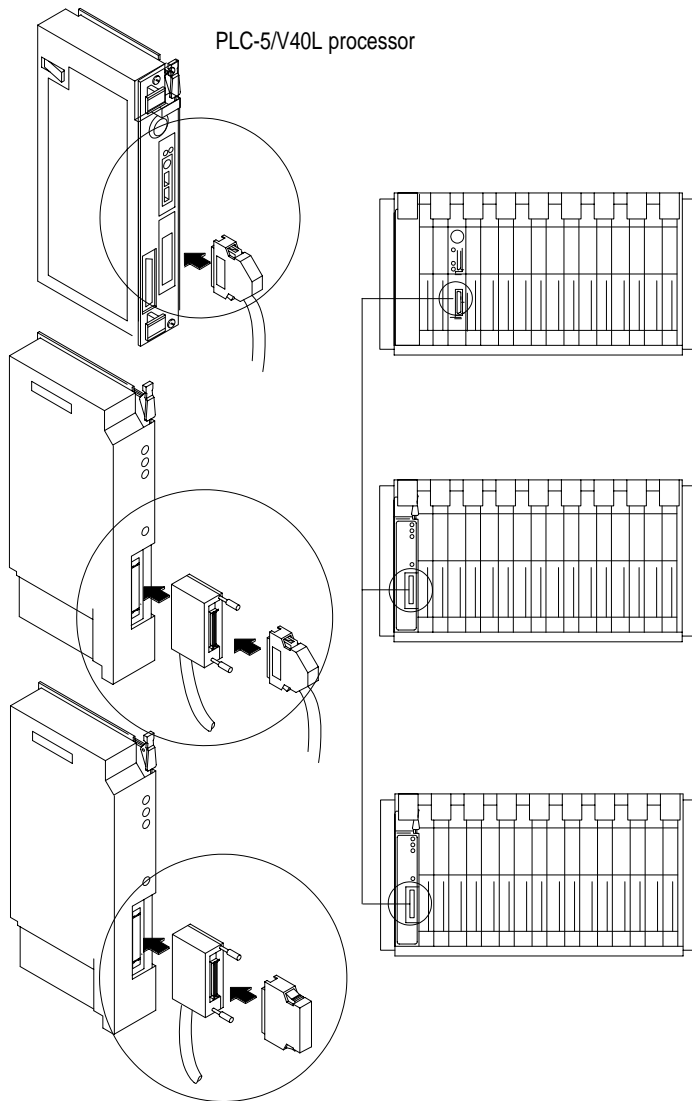
Do not apply power to an I/O rack containing an extended-local I/O adapter module until all extended-local I/O cables are installed and connected.

1. Connect the single-end connector to channel 2 of the processor.

2. Route the cable to the first extended-local I/O adapter.

3. Connect the dual-end connector to the extended-local I/O adapter module. Be sure to screw in the retaining screws tightly.

4. If the adapter:	Then:
is not the last one on the link	<p>1. Connect the single-end of a local I/O network cable to the exposed end connector on the adapter module. Press and hold the clips and snap to the mating connector.</p> <p>2. Route the cable to the next adapter and connect the dual-end connector to it.</p>
is the last one on the link	<p>Terminate the link by installing the local I/O terminator (1771-CXT) to the exposed end of the dual-end connector on the last adapter module. The system will not run without it. The terminator is included with the processor.</p>

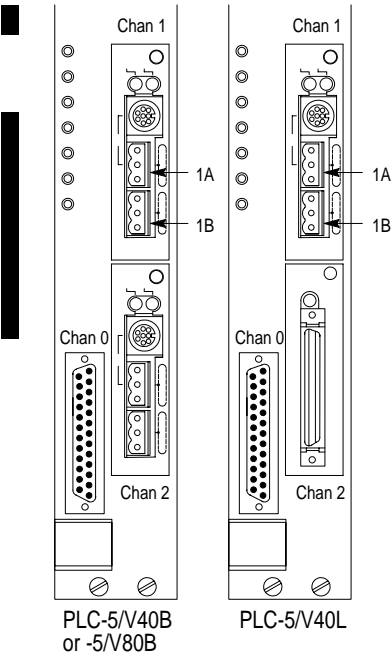


**ATTENTION:** If you are not using any extended-local I/O adapter modules, connect the extended-local I/O terminator, 1771-CXT, to channel 2 of the PLC-5/V40L processor to ensure proper performance of the processor. This terminator is included with your processor.

# Connecting a DH+ Link

Once you connect the programming device through a local DH+ link to one processor, the device can communicate with any PLC-5/VME processor on the link. You can also communicate with PLC-2, PLC-3, and PLC-5/250 processors connected to the link provided you have the appropriate programming software installed.

The processor has electrically parallel DH+ connectors.



This processor:	Has these electrically parallel DH+ connectors:
PLC-5/V40B PLC-5/V80B	<ul style="list-style-type: none"><li>• 8-pin connector for each of channel 1A and 2A</li><li>• 3-pin connector on each of channel 1A and 2A</li></ul> <p>Channels 1A and 2A must be configured to support DH+ communication to use the connectors described above. Note that Channel 1A's default configuration is DH+ communication.</p> <p>Channels 1B and 2B can also support DH+ communication if properly configured, but they do not have parallel connectors.</p>
PLC-5/V40L	<ul style="list-style-type: none"><li>• 8-pin connector for channel 1A</li><li>• 3-pin connector for channel 1A</li></ul> <p>Channel 1A must be configured to support DH+ communication to use the connectors described above. Note that Channel 1A's default configuration is DH+ communication.</p> <p>Channel 1B can also support DH+ communication if properly configured, but it does not have parallel connectors.</p>

Use the Belden 9463 twinaxial cable (1770-CD) to connect the processor to the DH+ link.

Follow these guidelines while installing DH+ communication links:

- do not exceed these cable lengths:
  - trunkline-cable length—3,048 m (10,000 cable-ft)
  - drop-cable length—30.4 m (100 cable-ft)
- do not connect more than 64 stations on a single DH+ link

Use the 3-pin connector on the processor to connect a DH+ link. The connector's port must be configured to support a DH+ communication link.

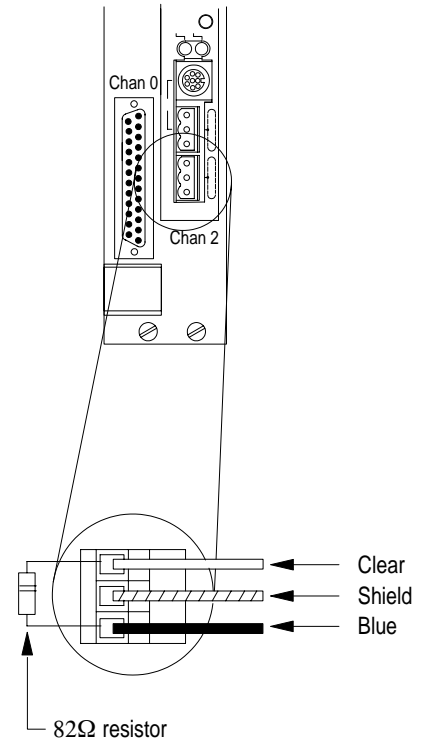
You can connect a DH+ link two ways:

- trunkline/dropline—from the dropline to the connector screw terminals on the DH+ connectors of the processor
- daisychain—to the connector screw terminals on the DH+ connectors of the processor

To make connections:

1. Connect the signal conductor with **CLEAR** insulation to the 3-pin connector terminal 1 at each end of each cable segment.
2. Connect the **SHIELD** drain wire to the 3-pin connector SH terminal at both ends of each cable segment.
3. Connect the signal conductor with **BLUE** insulation to the 3-pin connector terminal 2 at each end of each cable segment.

For more information, see the Data Highway/Data Highway Plus/Data Highway II/Data Highway 485 Cable Installation Manual, publication 1770-6.2.2.



To connect a programming terminal via the 8-pin connector on a PLC-5/VME processor on a DH+ link, use the following:

#### Communication card to access a DH+ link

1784-PCMK

1784-KTX

#### Cable

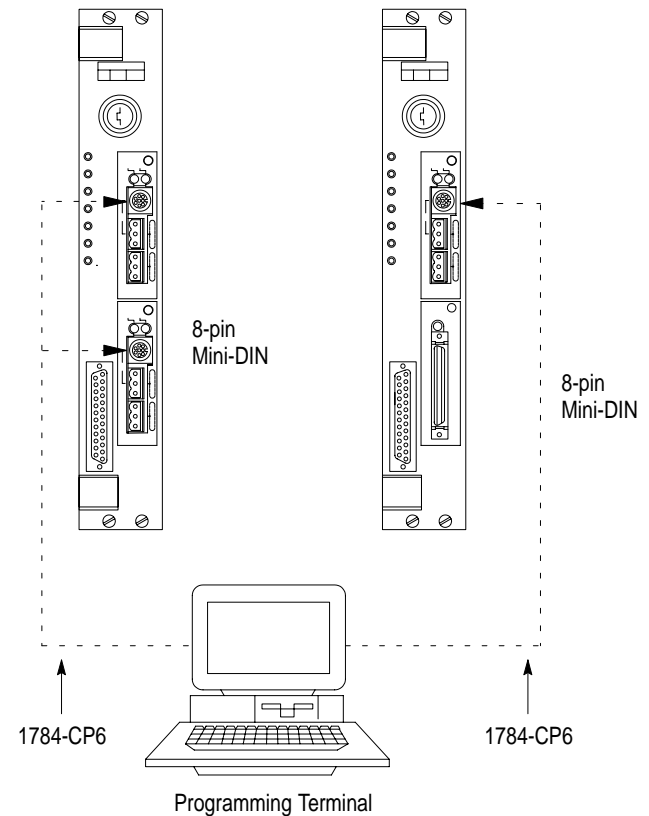
1784-PCM5 with a 1784-CP7 adapter

1784-CP12 with a 1784-CP7 adapter  
OR

1784-CP13 direct connect to the front of the PLC-5/VME processor

PLC-5/V40B or -5/V80B

PLC-5/V40L



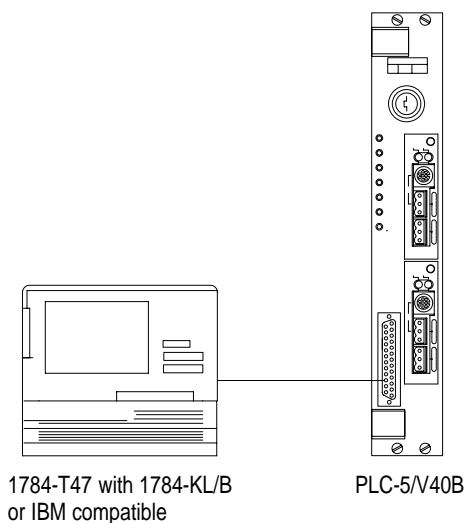
## Connecting a Programming Terminal to Channel 0

You can connect COM1 or COM2 from the programming terminal directly to channel 0 on the PLC-5/VME processor. This serial port supports RS-232C only.

You can configure channel 0 to either:

- user mode—Configure channel 0 to user mode when you are connecting it to RS-232 devices such as bar code readers, weigh scales, and message displays. You can then communicate and manipulate instructions through the ladder-logic ASCII read and write.
- system mode—This is the default. Use this configuration when connecting to programming operators interfaces (such as 6200 series software and ControlView) using a built-in point-to-point protocol. Although the communication is much like DH+ link, there is no access to DH+ through Channel 0; therefore, the channel does not require a DH+ station address. The default baud rate is 2400.

**Figure 2.4**  
Programming Terminal to Channel 0 of a PLC-5/VME Processor



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You can use the following cables to connect to channel 0:

**Table 2.C**  
Programming Terminal to Channel 0 Interconnect Cables

If you want to connect:	Use:
1784-T53 or IBM AT to channel 0	1784-CP10 or Cable #1
1784-T53 or IBM AT to channel 0 through a modem	Cable #6
1784-T47 or IBM XT to channel 0	1784-CP11 or Cable #2
1784-T47 or IBM AT to channel 0 through a modem	Cable #6

See Appendix E for more information on cable connections.

## Installing, Removing, and Disposing of the Battery

If the processor is not powered, the processor battery retains processor memory. The appropriate battery for your processor is shipped with the processor and requires special handling. See Allen-Bradley Guidelines for Lithium Battery Handling and Disposal, publication AG-5.4.



**ATTENTION:** Installing the battery requires handling the processor, which can cause electrostatic discharge. See Chapter 1 for details.

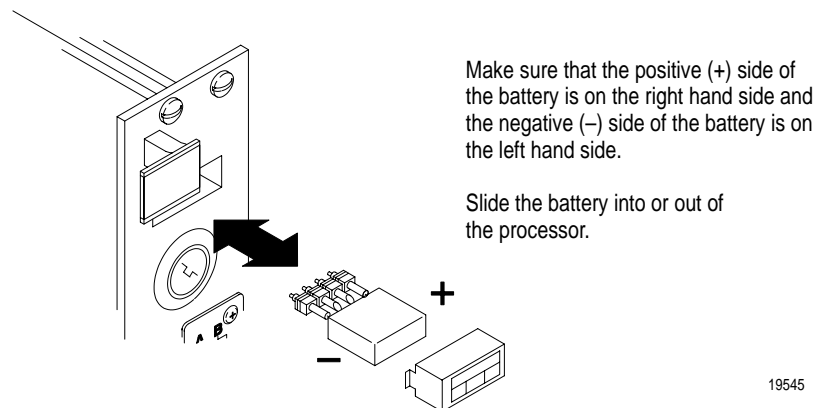
The battery indicator (BATT) warns you when the battery is low. The indicator first lights when the processor has 10 days of battery back-up power remaining. The LED will only light when the processor is powered.

### Installing or Removing the Processor Battery

To install or remove the battery (cat. no. 1770-XYV), follow these steps:

1. Remove the processor's battery cover.
2. Locate the battery.
3. Install or remove the battery according to Figure 2.5.

**Figure 2.5**  
Installing a Processor Battery (cat. no. 1770-XYV)



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4. Replace and secure the battery cover.
5. Write the date that you installed the battery on the battery cover.

**Important:** You can insert or remove the battery without powering down the processor. If you do not want to lose your program, make sure that the processor is powered when replacing the battery.

## Disposing of the Battery

Refer to the Allen-Bradley Guidelines for Lithium Battery Handling and Disposal, publication AG-5.4.

Do not dispose of lithium batteries in a general trash collection when their combined weight is greater than or equal to 1/2 gram. A single 1770-XYV battery contains .65 grams of lithium. Check your state and local regulations that deal with the disposal of lithium batteries.



**ATTENTION:** Follow these precautions:

- Do not incinerate or expose the battery to high temperatures.
  - Do not solder the battery or leads; the battery could explode.
  - Do not open, puncture, or crush the battery. The battery could explode; and toxic, corrosive, and flammable chemicals could be exposed.
  - Do not charge the battery. An explosion may result, or the cell may overheat and cause burns.
  - Do not short positive and negative terminals together. The battery will heat up.
-

## VMEbus Interface

### Chapter Objectives

Read this chapter to understand the basic low-level interface to the PLC-5/VME processor. The orientation of this chapter is based on a driver program running on a separate CPU module communicating with the processor.

Unless otherwise noted, all multiple-byte numerical fields are represented in big-endian (Motorola) format, meaning that the most-significant data byte appears in the lowest-addressed byte.

### System Controller

You can configure the PLC-5/VME processor as a VMEbus system controller by installing it in the left-most slot in the VME chassis. Its system controller functions are limited, so this mode of operation is intended for configurations where there is no more-capable CPU in the system.

As a system controller, a PLC-5/VME processor is a single-level (SGL) arbiter—it recognizes requests on level 3 only. In this mode, it also generates the 16 MHz SYSCLK, begins the IACK daisy chain, and has a bus timer. The bus timer timeouts any VMEbus transaction that asserts a data strobe (DS0 or DS1) for longer than 93.75-125 microseconds. The PLC-5/VME processor never asserts BCLR.

When it is not the system controller, you can configure the PLC-5/VME processor to request the VMEbus on levels 3 or 1.

You select the system controller mode and bus request level by using a switch (see page 2-3).

## Bus-Release Modes

Two software-selectable bus-release modes are provided:

When set to:	The PLC-5/VME processor:
ROR	releases control of the VMEbus immediately after the current data-transfer operation if it sees one of the bus-request lines asserted; otherwise it remains "parked" on the bus.
RWD	once granted the bus, keeps ownership of the bus for the duration of a series of contiguous data transfers (e.g., a copy operation), after which it relinquishes control of the bus (i.e., does not stay parked on the bus).

There is one exception—when set to RWD, the PLC-5/VME processor always relinquishes the bus after the current data-transfer operation if BCLR is asserted. Thus, when used with a priority arbiter, the PLC-5/VME processor honors higher-priority requests even when in the midst of a contiguous copy in RWD mode. To configure your system for this latter case, the PLC-5/VME processor must be using bus-request level 1 and the separate system controller must be set to priority arbitration.

## VME LEDs

Three of the front-panel LEDs show VMEbus state information:

When this LED is lit:	It means that:
SYSFAIL	the PLC-5/VME processor is driving the VMEbus SYSFAIL signal.
master-access	the PLC-5/VME processor is performing a VMEbus cycle.
slave-access	a VMEbus master is performing an A24 slave access to the PLC-5/VME processor.

**Important:** The PLC-5/VME processor does not respond to the VMEbus SYSRESET signal if it is in a faulted state. In a faulted state, only a power-on reset resets the processor.



## VME Signal Usage

Table 3.A shows the usage of the VMEbus signals on the P1 connector.

**Table 3.A**  
**VMEbus Signals on the P1 Connector**

Pin	Row A		Row B		Row C	
	Name	Use <sup>②</sup>	Name	Use <sup>②</sup>	Name	Use <sup>②</sup>
1	D00	IO	BBSY <sup>①</sup>	IO	D08	IO
2	D01	IO	BCLR <sup>①</sup>	I	D09	IO
3	D02	IO	ACFAIL <sup>①</sup>	I	D10	IO
4	D03	IO	BG0IN <sup>①</sup>	I	D11	IO
5	D04	IO	BG0OUT <sup>①</sup>	O <sup>③</sup>	D12	IO
6	D05	IO	BG1IN <sup>①</sup>	I	D13	IO
7	D06	IO	BG1OUT <sup>①</sup>	O	D14	IO
8	D07	IO	BG2IN <sup>①</sup>	I	D15	IO
9	GND	G	BG2OUT <sup>①</sup>	O <sup>③</sup>	GND	G
10	SYSCLK	O <sup>③</sup>	BG3IN <sup>①</sup>	I	SYSFAIL <sup>①</sup>	IO
11	GND	G	BG3OUT <sup>①</sup>	O	BERR <sup>①</sup>	IO
12	DS1 <sup>①</sup>	IO	BR0 <sup>①</sup>		SYSRESET <sup>①</sup>	IO
13	DS0 <sup>①</sup>	IO	BR1 <sup>①</sup>	O	LWORD <sup>①</sup>	IO
14	WRITE <sup>①</sup>	IO	BR2 <sup>①</sup>		AM5	IO
15	GND	G	BR3 <sup>①</sup>	IO	A23	IO
16	DTACK <sup>①</sup>	IO	AM0	IO	A22	IO
17	GND	G	AM1	IO	A21	IO
18	AS <sup>①</sup>	IO	AM2	IO	A20	IO
19	GND	G	AM3	IO	A19	IO
20	IACK <sup>①</sup>	IO	GND	G	A18	IO
21	IACKIN <sup>①</sup>	I	SERCLK		A17	IO
22	IACKOUT <sup>①</sup>	O	SERDAT <sup>①</sup>		A16	IO
23	AM4	IO	GND	G	A15	IO
24	A07	IO	IRQ7 <sup>①</sup>	IO	A14	IO
25	A06	IO	IRQ6 <sup>①</sup>	IO	A13	IO
26	A05	IO	IRQ5 <sup>①</sup>	IO	A12	IO
27	A04	IO	IRQ4 <sup>①</sup>	IO	A11	IO
28	A03	IO	IRQ3 <sup>①</sup>	IO	A10	IO
29	A02	IO	IRQ2 <sup>①</sup>	IO	A09	IO
30	A01	IO	IRQ1 <sup>①</sup>	IO	A08	IO
31	-12V	P	+5VSTDBY		+12V	P
32	+5V	P	+5V	P	+5V	P

① indicates a low true signal.

② How the signal is used: I = input; O = output; IO = input/output; P = power; G = ground; blank = unused and unconnected

③ Only if the PLC-5/VME processor is configured as the slot-1 system controller. Otherwise logically unconnected.

④ BG0OUT and BG2OUT are driven directly by the corresponding BGxIN's. This is done so that you need not worry about the VMEbus backplane jumpers for the leftmost slot occupied by the PLC-5/VME processor. You should not install the five bus-grant and IACK daisy-chain jumpers in the leftmost slot.

## Configuration Registers

The configuration registers are a standard way of identifying, configuring, controlling, and monitoring the PLC-5/VME processor as a VMEbus device. They are mapped into the VMEbus A16 address space at a location defined by switches 1-3 of SW2. For example, if these three switches are set to ON, the first register (the ID register) is at address FC00 (hex).

The registers are shown in Figure 3.1 and described individually thereafter.

**Figure 3.1**  
**The Eight Configuration Registers**

offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	offset
ID Register																	
	C				F				E				C				
00	1	1	0	0	1	1	1	1	1	1	1	0	1	1	0	0	01
Device-Type Register																	
	7				F				E				8				
02	0	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	03
Status/Control Register																	
04	GRE	1	1	SYSF	1	NOCV	1	1	SRIE	RELM	MYAS	1	RDY	PASS	NOSF	RSTP	05
Offset Register																	
06	SLAVE BASE								1	1	1	1	1	1	1	1	07
Command Control Register																	
08	WRDY	LOCK	ERR	1	COPY-TO-STATE		COPY-FR-STATE		ERROR CODE								09
Command Control and Lock Register																	
0A	WRDY	LOCK	ERR	1	COPY-TO-STATE		COPY-FR-STATE		ERROR CODE								0B
Command High Register																	
0C																	0D
Command Low Register																	
0E																	0F

**Important:** The system repeats these registers eight times; you can use only the first eight registers as the configuration register.

These registers are described in detail below. Where a bit position has been described as a 0 or 1, the bit is a read-only bit and writing to it has no effect.

Unless otherwise noted, register bits:

- are initialized to 0 at reset.
- directly control the associated hardware function, so that changing a register bit has an instantaneous effect on the function it controls.

The ID register, whose value is CFEC (hex), and the next (device-type) register, 7FE8(hex), uniquely identify the PLC-5/VME processor.

The status/control register contains status and control bits, primarily for use by a separate VME CPU (see Table 3.A).

**Table 3.A**  
**Status/Control Register**

Bit	Register	Function	Definition
15	GRE	Global RAM enable	If set by an application program (1), the PLC-5/VME processor is enabled as an VMEbus A24 slave. This bit is not altered by the PLC-5/VME firmware. The 64K of global RAM is enabled by this bit.
12	SYSF	SYSFAIL	The PLC-5/VME processor drives the VME SYSFAIL line and the SYSFAIL LED on the front panel while this bit is 0. This bit is set (to 1) by the PLC-5/VME processor firmware at initialization and not altered thereafter by the PLC-5/VME processor unless a hardware failure occurs. One purpose of this bit is to allow a separate VMEbus CPU to determine which VME module is asserting SYSFAIL.
10	NOCV	No check VME status file	The VME status file, a file in the PLC-5/VME processor memory holds certain state information for compatibility with the 6008-LTV processor. As in the 6008-LTV processor, ladder programs can modify certain parts of the VME status file. If NOCV is 0, the PLC-5/VME processor checks its VME status file every scan loop to see if any parameters have changed. This will increase your processor scan and communication time. You should initialize this bit to 0 if you are changing the status file from a ladder program or if you are using 6200 software from an external device. See Chapter 7 for more information.
7	SRIE	SYSRESET input enable	If 1, VME SYSRESET causes a full hardware reset of the PLC-5/VME processor. If reset, VME SYSRESET is ignored by the processor, except for resetting its VMEbus interface and terminating any current VMEbus operations. This bit is reset by a hardware reset and set by PLC-5/VME processor firmware early in its initialization process.
6	RELM	Bus release mode	If 1, the bus release mode is ROR, otherwise it is RWD. This bit is not altered by the PLC-5/VME processor. Bus release mode only applies to PLC-5/VME processor that behaves as a VMEbus master.
5	MYAS	My address strobe	When 0, the PLC-5/VME processor is in the midst of VMEbus master transfer. This state bit is not intended for use by other masters; it has meaning to only the PLC-5/VME processor's firmware.
3	RDY	Ready	If 1, the PLC-5/VME processor is ready to accept commands. RDY and PASS are alerted at the same point by the PLC-5/VME processor.
2	PASS	Self-test passed	This bit is set by the PLC-5/VME processor after initialization if its self-test completes successfully. The bit is not altered thereafter by the PLC-5/VME processor. If RDY=1 and PASS=0, the PLC-5/VME processor has failed its self-test.
1	NOSF	SYSFAIL inhibit	If 1, the PLC-5/VME processor cannot assert SYSFAIL. This bit is not altered by the PLC-5/VME processor
0	RSTP	Reset	<p>If 1, the PLC-5/VME processor is in the reset state. During the reset state, the PLC-5/VME processor is inactive and pending interrupts and bus requests are cleared. This register set is active and can be accessed by other VMEbus devices. This bit is not altered by the PLC-5/VME firmware.</p> <p>Changing it from 1 to 0 releases the PLC from its reset state and it follows its normal power sequence (if the PLC-5/VME processor is not in a faulted state).</p> <p><b>Attention:</b> This bit causes the processor to reset and the I/O to stop communicating. Unpredictable operation may occur with possible damage to equipment and/or injury to personnel.</p>

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	offset
Offset Register																
SLAVE BASE								1	1	1	1	1	1	1	1	07

The SLAVE-BASE field in the offset register defines the A24 mapping of the PLC-5/VME processor; register bits 15-8 are the values of the VME address bits A23-A16. This field is not altered by the PLC-5/VME processor.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	offset
Command Control Register																
WRDY	LOCK	ERR	1	COPY-TO-STATE	COPY-FR-STATE	ERROR CODE										09

Command Control and Lock Register																
WRDY	LOCK	ERR	1	COPY-TO-STATE	COPY-FR-STATE	ERROR CODE										0B

The command-control register and command-control-and-lock register contain state bits (Table 3.B) associated with the command register. They are identical except how they read the command-control-and-lock register and affect the state of the LOCK bit. The command-control-and-lock register and the LOCK bit are provided to support multiple independent senders of commands to the PLC-5/VME processor; you can ignore both the register and the bit if you do not need this facility.

**Table 3.B**  
**Registers Containing State Bits**

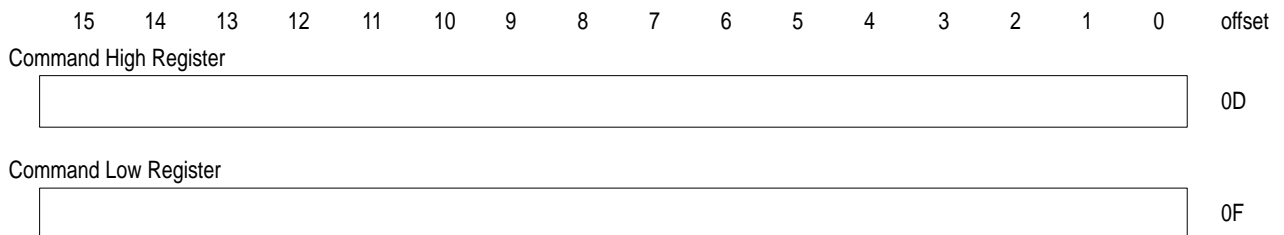
Bit	Register	Function	Definition
15	WRDY	Write ready	If 1, the command register is armed for an incoming command. A write to the command-low register clears this bit.
14	LOCK	Command register lock	If 1, the command register has been locked. If clear, the command register can be locked for the sending of a command.
13	ERR	Protocol error	If 1, a protocol error occurred associated with the last command received.
11-10	COPY-TO-STATE	The current state of the continuous-copy-to-VME operation	00 None is enabled 01 Currently enabled and no errors encountered 10 Currently enabled but a noncatastrophic error has occurred 11 Shutdown because a catastrophic error has occurred
9-8	COPY-FROM-STATE	The current state of the continuous-copy-from-VME operation	Same encoding as above.
7-0	ERROR CODE	Error code	If ERR=1, this field is a code describing the error. See specific requesting command types or Appendix D for a list of error codes.

WRDY is used by another VMEbus master to determine whether or not the PLC-5/VME processor is ready to receive a command. The VME master processor should check that WRDY is set before it writes a command value to the Command High/Command Low registers. This prevents the VME master processor from accidentally overwriting a previously written command.

The Command High/Command Low registers are a 1-deep FIFO. A WRDY bit of 1 indicates that the command register FIFO is empty and that the VME master processor may write a command value into the command registers. Before the write cycle is completed, the processor hardware clears the WRDY bit to indicate that the command register FIFO is full and so that no other commands are sent. When the processor reads the FIFO to process the command, the FIFO is emptied and the WRDY bit is automatically set so that the processor can send a new command.

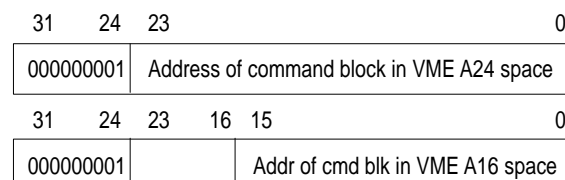
When a single PLC-5/VME processor is controlled by two or more master processors, the LOCK bit acts as a semaphore to prevent the processor from accidentally overwriting another processor's commands.

A master processor attempts to get the LOCK bit by reading the Command/Control/Lock register. If the LOCK bit is 0, that processor has exclusive control. This is the only processor that sees a LOCK bit value of 0; all other processors reading the Command/Control/Lock register see a value of 1. The master processor executes its command and then clears the LOCK bit in the Command/Control/Lock register so that another processor can execute its command.



## Commands

Commands are the primary form of communication from a separate VMEbus CPU to the PLC-5/VME processor. A command is sent by placing one of the following 32-bit values in the command registers.



If you designate:	The PLC-5/VME processor accesses the command block as an:
A24	A24 access with the 3D (standard supervisory data access) address modifier.
A16	A16 access with the 2D (short supervisory access) address modifier.

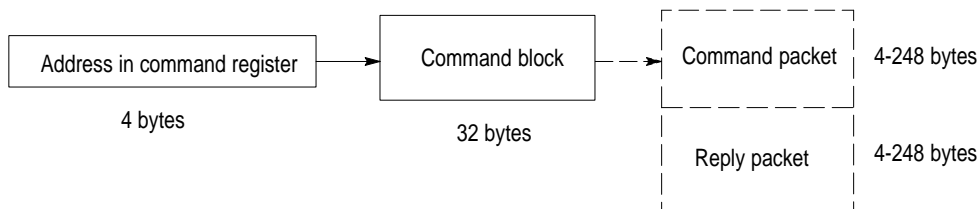
One exception in the situation where A24 is designated:

When you enable the PLC-5/VME processor's slave memory and the A24 address resides within the slave memory, the PLC-5/VME processor accesses the memory locally. Every time the PLC-5/VME processor is given an A24 address (e.g., of a command, within a command), it determines whether or not the address falls within its enabled slave memory. It does not take the implicit or explicit length of the data item or structure into account.

**Important:** Data structures must be wholly within or without the slave memory; data structures cannot be "half in and half out" of the slave memory.

Also, the PLC-5/VME processor assumes it can do all master accesses to commands as D16 and D08(E0). For data transfers, D16 versus D08(E0) is programmable (to allow access to 8-bit I/O devices).

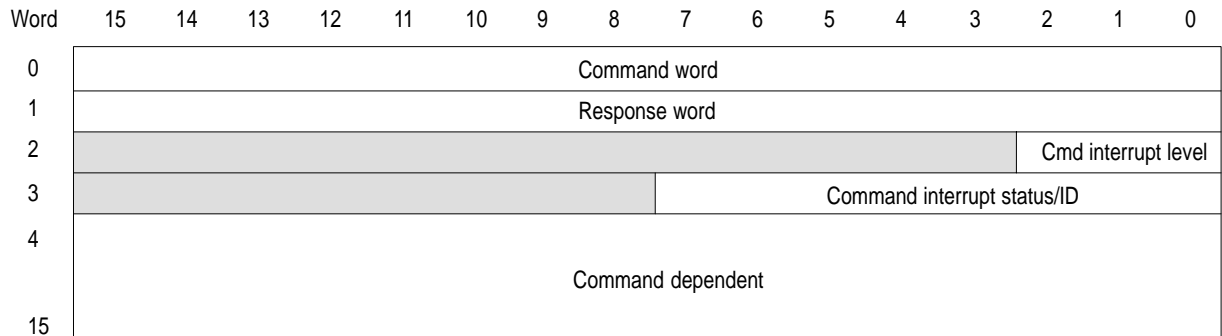
The diagram below shows the remainder of the command structure. The message points to a command block, which identifies the type of command. Some commands are wholly contained within the command block. Others, specifically the PCCC commands, are contained in a separate command packet. Such commands typically have data returned as a reply; space for the reply packet is assumed to be allocated by the sending VME CPU at the end of the command packet.



The command-processing state of the PLC-5/VME processor can be observed in several ways. After a command has been sent, readiness of the command register indicates that processing of the previous command has started.

Two ways are provided to detect completion of command processing. The command block contains a response field into which a success or error code is placed upon completion of the command. Optionally, the PLC-5/VME processor can signal an interrupt at the end of command processing.

The structure of the command block is shown below:



Word	Command	Description
0	Command word	Specifies the type of command and implicitly specifies whether there is an associated command packet.
1	Response word	The sender should set this to 0. PLC-5/VME processor stores a nonzero value in this word when completion of command processing occurs. The value 00FF de-notes successful completion. Other values are used for errors.
2	Command interrupt level	<p>If nonzero, specifies that PLC-5/VME processor should generate a VMEbus interrupt immediately after storing into the response word after command completion.</p> <p>000 specifies no interrupt,  001 specifies interrupt level 1,  010 specifies level 2,  ...,  111 specifies level 7.</p>
3	Command interrupt status/ID	The status/ID value returned during an interrupt-acknowledge cycle for the above interrupt.

## Ladder-Program Interfaces

### Chapter Objectives

Read this chapter to help you understand how to interact with the VMEbus environment from your ladder program.

The PLC-5/VME processor allows ladder programs to perform direct VMEbus read and write operations as well as to generate VMEbus interrupts through the MSG instruction. This is the same data instruction that is used for Data Highway, and it is programmed the same way. Four messages are available:

- Copy to VME
- Copy from VME
- Send VME interrupt
- Check VME status file

### Ladder Messages

To enter a VME message instruction, use your programming software to edit the MSG control block. You will need to do the following:

- specify a control block address for the MSG instruction
- select ASCII as the message type

**Important:** You cannot use indirect addresses for the control-block address in an MSG instruction.

- enter channel 3A as the channel/port number
- enter the appropriate VME command and accept the parameters you've entered in the software

An internal processor interprets the ASCII string entered to determine the VME operation to complete. The syntax for the ASCII strings is as follows:



**Table 4.A**  
**Four Ladder Messages**

Message	ASCII Syntax	Page
Copy to VME	<b>CTV</b> # <i>Xf</i> : <i>e vmeaddr width numelts</i>	4-3
Copy from VME	<b>CFV</b> <i>vmeaddr width</i> # <i>Xf</i> : <i>e numelts</i>	4-4
Send VME interrupt	<b>SVI</b> <i>vmeint statid</i>	4-5
Check VME status file	<b>CSF</b>	4-5

where:

*x* is the file type.

File Type	Words per Element
counter C	3
floating point F	2
input I	1
integer N	1
output O	1
control R	3
status S	1
timer T	3
ASCII A	1
BCD D	1

*f* is the file number—0 is the output image; 1 is the input image; 2 is the status file; and 3-999 are any type except input, output, and status files.

If the *x* file type is I, O, or S, the *f* parameter is optional.

*e* is the element number—0-192 octal for I/O files, 0-127 decimal for the status file, 0-999 decimal for all other files.

*vmeaddr* is the A16 or A24 VME address. A 6-character hexadecimal number denotes an A24 address, which generates a 3D address modifier. A 4-character hexadecimal number denotes an A16 address, which generates a 2D address modifier on the VMEbus.

*width* is the width of VME transfers.

Width	Denotes
D16	16-bit transfers
D08	8-bit transfers (even/odd)
D08O	8-bit transfers (odd only)
D08B	8-bit transfers (even or odd depending on the starting VME address)

*numelts* is the number of elements to be transferred (1-1000 decimal).

*vmeint* is the VMEbus interrupt number (1-7).

*statid* is the interrupt status/ID, a two-character hexadecimal number given to the interrupt handler during the interrupt acknowledge cycle.

You can use indirect addressing for the *f* and *e* parameters. Indirect address format is:

*X f : e*

where:

*X*, *f*, and *e* are as specified above, except that *f* and *e* cannot specify indirect addresses.

## Copy to VME

This message tells the processor to read the specified amount of data from the specified file and write it using one or more VMEbus write operations. As with the continuous-copy operations, if the address falls within the enabled VMEbus slave memory of the PLC-5/VME processor, the data is written into this dual-port memory directly without doing actual VMEbus operations.

Example 1: **CTV #N8:10 A00000 D16 2**

Example 1 reads elements 10 and 11 from file N8 and writes them in two D16 writes to addresses A00000 and A00002 in the VME A24 address space.

Example 2: **CTV #N7:0 FF01 D08O 5**

Example 2 reads the lower byte of elements 0 through 4 of file 7 and writes them to addresses FF01 through FF09 (odd bytes only).

Data in PLC Processor		Result of Transfer to VMEbus		
Address	Data (hex)	Address	Data	Address
N7:0	0044	FF00	00 44	FF01
N7:1	0055	FF02	00 55	FF03
N7:2	0066	FF04	00 66	FF05
N7:3	2077	FF06	00 77	FF07
N7:4	3088	FF08	00 88	FF09

### Copy from VME

This message tells the PLC-5/VME processor to read the specified amount of data from VMEbus memory using VMEbus read operations and write it into the specified file. As with the continuous-copy operations, if the address falls within the enabled VMEbus slave memory of the PLC-5/VME processor, the data is read from this dual-port memory directly without doing actual VMEbus operations.

Example 1: **CFV D004 D08 #N8:0 4**

The example above performs eight D08 read operations beginning at VME address D004 and then writes the data as four elements (0-3) in file N8.

Example 2: **CFV FF01 D08B #N7:0 3**

Example 2 reads three consecutive bytes starting at FF01 in the VME A16 address space and writes the data into three elements in file N7:0.

Data on VMEbus		Result of Transfer to PLC Processor		
Address	Data (hex)	Address	Data	Address
N7:0	0022	FF00	11 22	FF01
N7:1	0033	FF02	33 44	FF03
N7:2	0044	FF04	55 66	FF05

**Tip**

Your ladder program must clear the **Received** field for a certain interrupt level, located in word 24 of the VME status file, so that the ladder program can recognize another interrupt at that level. The update field in the VME status file must also be set to one to reflect the fact that the VME status file has changed and is ready to receive new interrupt information.

## Send VME Interrupt

This message tells the PLC-5/VME processor to assert a VMEbus interrupt. When the interrupt handler replies with an interrupt-acknowledge cycle, the status/ID byte is returned to the interrupt handler.

For example:

**SVI 2 F0**

The example above asserts IRQ2 and gives status/ID value F0H to the interrupt handler.

## Check VME Status File

This message tells the PLC-5/VME processor to check the VME status file for changes or to update the file with new VMEbus information. Before executing this command, set bit 8 in element 28 of the VME status file if you made changes to the file associated with the continuous-copy configuration and you want the changes to take effect.

This command is needed when the NOCV bit of the status control register is set.

For example:

**CSF**

If the NOCV flag in the VME status/control register is:	This message:
0	serves no useful purpose because the PLC-5/VME processor firmware periodically checks the VME status file for changes (so that the PLC-5/VME processor knows to update its internal state to reflect the changes to the VME status file).
1	allows the ladder program to communicate changes to the PLC-5/VME processor. An example of such a change would be the ladder program's modification of the interrupt mask in the VME status file.

## Message Completion and Status Bits

The PLC-5/VME processor manipulates only two of the status bits in the control word of the internal message control block:

- DN (done)
- ER (error)

For the copy operations, DN is not set until and unless the data are successfully transferred. If an error occurs, ER is set and an error code is placed in the message control block.

For the SVI operation, DN is set if and when the interrupt-acknowledge cycle is successfully performed by the interrupt handler. If the message syntax is incorrect (interrupt is not 1-7 or status/ID is not two hexadecimal digits), ER is set along with an error code. For the CSF operation, DN is set immediately.

For unrecognizable messages, ER is set along with an error code. The error codes are:

Code	Explanation
0000H	Success
0001H	Invalid ASCII message format
0002H	Invalid file type
0003H	invalid file number
0004H	Invalid file element
0005H	Invalid VME address
0006H	Invalid VME transfer width
0007H	Invalid number of elements requested for transfer
0008H	Invalid VME interrupt level
0009H	Invalid VME interrupt status-id value
000AH	VMEbus transfer error (bus error)
000BH	Unable to assert requested interrupt (already pending)
000CH	Raw data transfer setup error
000DH	Raw data transfer crash (PLC switched out of run mode)
000EH	Unknown message type (message type not ASCII)

If the PLC-5/VME processor receives the same message control block with the same msg\_address field from the processor core with the .TO (timeout) bit set, the current operation is terminated.

## VME Status File

The VME status file is a data file in the processor's memory. It is used to store VME setup and status information. It contains the setup information for the continuous copy to/from VME. The VME status file number is placed in word 15 of the PLC-5/VME status file. This file should be an unused integer file. The PLC-5/VME processor accesses word 15 only at initialization; thus any change of word 15 after initialization will have an unpredictable effect.

Your programming software package should provide you with the following types of capabilities:

- monitor processor status
- clear minor and major faults
- monitor VME status

See your programming software documentation for specific information about how to get to and use the software screens.

The following is the physical structure of the VME status file:

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0															VSYSF	PSYSF
1	ULA				SC											
2	RELM															
3	Reserved															
4								SLE	SLADDRESS (HI BYTE)							
5	SLADDRESS															
6	FEN				FAM				FDS	FERROR						
7	Reserved															
8									FADDRESS (HI BYTE)							
9	FADDRESS															
10	FLENGTH															
11	FFILE															
12	FELEMENT															
13															FINT	
14									FSTATUSID							
15	TEN				TAM				TDS	TERROR						
16	Reserved															
17									TADDRESS (HI BYTE)							
18	TADDRESS															
19	TLENGTH															
20	TFILE															
21	TELEMENT															
22															TINT	
23									TSTATUSID							
24	IRQ7E	IRQ6E	IRQ5E	IRQ4E	IRQ3E	IRQ2E	IRQ1E		IRQ7R	IRQ6R	IRQ5R	IRQ4R	IRQ3R	IRQ2R	IRQ1R	
25	IRQ2SID								IRQ1SID							
26	IRQ4SID								IRQ3SID							
27	IRQ6SID								IRQ5SID							
28	UPDATED								IRQ7SID							
29	Reserved															
31																

The fields are explained in Table 4.B. The fields marked in white are read-only; they are for monitoring only and should not be overwritten.

**Table 4.B**  
**Fields for the Physical Structure of the VME Status File**

Word	Code	Function	Explanation
0 <sup>1</sup>	VSYSF	Describes the state of the VME SYSFAIL signal. Read only.	If 0, SYSFAIL is being asserted (including by the PLC-5/VME processor); if 1, SYSFAIL is not being asserted.
0 <sup>1</sup>	PSYSF	Read only	Describes the state of the VME SYSFAIL signal as being driven by the PLC-5/VME processor. If 0, the PLC-5/VME processor is asserting SYSFAIL; if 1, it is not.
1 <sup>1</sup>	ULA	Unique logical address. Read only.	The three-switch setting that determines the A16 base address of the PLC-5/VME processor's registers.  000 corresponds to FC00, 001 corresponds to FC40, ..., 111 corresponds to FFD0.
1 <sup>1</sup>	SC	System controller. Read only.	If 1, the PLC-5/VME processor has been configured as the VMEbus slot-1 system controller.
2 <sup>1</sup>	RELM	VMEbus release mode. Read only.	If 0, the PLC-5/VME processor has been configured as RWD (release when done); if 1, the PLC-5/VME processor has been configured as ROR (release on request).
4 <sup>1</sup>	SLE	Slave enable. Read only.	If 1, the PLC-5/VME processor's slave memory in the VMEbus A24 address space has been enabled.
4 <sup>1</sup>	SLADDRESS (HI BYTE)	Read only	Address bits 23-16 of the base address of the PLC-5/VME processor's slave memory in the VMEbus A24 address space.
5 <sup>1</sup>	SLADDRESS	Read only	Address bits 15-0 of the base address of the PLC-5/VME processor's slave memory in the VMEbus A24 address space.

<sup>1</sup> PLC ladder logic cannot write to status file fields that reflect A16 configuration register settings; these fields are read-only to ladder logic.



## Continuous Copy to/from VME

The PLC-5/VME can automatically read and write every ladder scan to the the VMEbus without ladder-logic programming. You can configure this function using your programming software or the ladder program itself. See your programming software documentation for specific information about where and how to configure this function in the software.

**Important:** If you use ladder logic to make changes to your VME status file, you must set word 28, bit 8 to 1 to apply the changes to your VME processor.

You can only enable these operations when the PLC-5/VME processor is in Run mode. You can specify up to 1000 words as the transfer length. These words must be contiguous elements in files, but the transfer can span files (see Figure 5.1).

The PLC-5/VME processor does not have the same programmable synchronization control as the 6008-LTV processor.

The 6008-LTV processor allows:

- copy transfer before or after the I/O update during housekeeping
- transfer to be asynchronous or synchronous with the ladder scan

In other words, the ladder scan would keep going (regardless of whether the VME transfer finished or not) rather than holding the ladder scan until the transfer is complete.

The PLC-5/VME processor allows copying of data between the VMEbus and the PLC-5/VME's data table:

- during the housekeeping of the ladder processor
- concurrently with the I/O update.

The data coming from the VMEbus is buffered and comes from the previous ladder scan. If the new data is not ready from the VMEbus, then housekeeping is held up until the new data is available. The data going from the PLC-5/VME to the VMEbus is transferred into VME during the next ladder scan, just after housekeeping. There is a separate on-board coprocessor that handles all VME transfers; and it is this processor that is sending data to the VMEbus during the ladder scan.

You can read the processor's input table. Because the transfer occurs asynchronously with the I/O scan, however, values obtained from the input table would likely be a mix of most recent values and values from the previous scan cycle.

See Appendix A for examples of the commands and Chapter 7 for details about performance and operation.

## Error Codes

These are errors reported during the repeated continuous-copy operations initiated by the continuous-copy-to-VME and continuous-copy-from-VME commands. The existence of the error can be determined by examining the copy-to-state and copy-from-state fields in the command control register. The error code itself can be found in the VME status file.

Code	Explanation
01H	VMEbus transfer error (VME bus error)
07H	Bad data address
FDH	Length specified as 0 or too large
FEH	Last end-of-copy interrupt not acknowledged

## VMEbus Interrupts

As well as being able to generate VMEbus interrupts, the PLC-5/VME processor can receive interrupts generated by itself and other cards in the system. You can enable or disable the function of receiving any or all of the seven VME interrupt levels using your programming software.

See your programming software documentation set for information about how and where to enable or disable this function.

Your ladder program must clear the `Received` field for a certain interrupt level, located in word 24 of the VME status file, so that the ladder program can recognize another interrupt at that level. The `update` field in the VME status file must also be set to one to reflect the fact that the VME status file has changed and is ready to receive new interrupt information.

The following is the physical structure of the VME operation configuration file:

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0															VSYSF	PSYSF
1	ULA				SC											
2	RELM															
3	Reserved															
4								SLE	SLADDRESS (HI BYTE)							
5	SLADDRESS															
6	FEN			FAM				FDS	FERROR							
7	Reserved															
8								FADDRESS (HI BYTE)								
9	FADDRESS															
10	FLENGTH															
11	FFILE															
12	FELEMENT															
13															FINT	
14									FSTATUSID							
15	TEN			TAM				TDS	TERROR							
16	Reserved															
17									TADDRESS (HI BYTE)							
18	TADDRESS															
19	TLENGTH															
20	TFILE															
21	TELEMENT															
22															TINT	
23									TSTATUSID							
24	IRQ7E	IRQ6E	IRQ5E	IRQ4E	IRQ3E	IRQ2E	IRQ1E		IRQ7R	IRQ6R	IRQ5R	IRQ4R	IRQ3R	IRQ2R	IRQ1R	
25	IRQ2SID								IRQ1SID							
26	IRQ4SID								IRQ3SID							
27	IRQ6SID								IRQ5SID							
28	UPDATED								IRQ7SID							
29	Reserved															
31																

The fields are explained in Table 4.C. Fields marked read-only are for monitoring only and should not be overwritten.

**Table 4.C**  
**Fields for the Physical Structure of the VME Status File**

Word	Code	Function	Explanation
6 <sup>2</sup>	FEN	From-VME enabled	If 1, the continuous-copy-from-VME operation is enabled (active when in run mode).
6 <sup>2</sup>	FAM	From-VME address modifier	If 0, the continuous-copy-from-VME operation uses the 2D VMEbus address modifier (A16); if 1, it uses 3D (A24).
6 <sup>2</sup>	FDS	From-VME data size	If 0, the continuous-copy-from-VME operation does D16 VMEbus transfers; if 1, it does D08(E0) transfers.
6 <sup>2</sup>	FERROR	From-VME error code	If nonzero, refer to page 11 for the most-recent error.
8 <sup>2</sup>	FADDRESS (HI BYTE)	Meaningful only if TAM=1	Address bits 23-16 of the address of the first byte of the VMEbus source.
9 <sup>2</sup>	FADDRESS	VMEbus source	Address bits 15-0 of the address of the first byte of the VMEbus source.
10 <sup>2</sup>	FLENGTH	From-VME copy length	The number of 16-bit words to be transferred by the continuous-copy-from-VME operation.
11 <sup>2</sup>	FFILE	From-VME file number	The number of the processor destination file of the continuous-copy-from-VME operation.
12 <sup>2</sup>	FELEMENT	From-VME element number	The number of the first element to be transferred in the destination file of the continuous-copy-from-VME operation.
13 <sup>2</sup>	FINT	From-VME interrupt	If nonzero, the VMEbus interrupt level of the interrupt to be generated after completion of each continuous-copy-from-VME operation. 000 specifies no interrupt, 001 specifies interrupt level 1, 010 specifies level 2, ..., 111 specifies level 7.
14 <sup>2</sup>	FSTATUSID	From-VME status/ID	The VMEbus status/ID value transmitted during interrupt-acknowledge cycles of the above interrupt.
15 <sup>2</sup>	TEN	To-VME enabled	If 1, the continuous-copy-to-VME operation is enabled (active when in run mode).
15 <sup>2</sup>	TAM	To-VME address modifier	If 0, the continuous-copy-to-VME operation uses the 2D VMEbus address modifier (A16); if 1, it uses 3D (A24).

<sup>2</sup> Both PLC ladder logic and the VME host computer can write to the status file fields that control the continuous-copy-from function. When both the ladder program and the host computer try to update the status file simultaneously, the ladder program overwrites the changes made by the host.

Word	Code	Function	Explanation
15 <sup>3</sup>	TDS	To-VME data size	If 0, the continuous-copy-to-VME operation does D16 VMEbus transfers; if 1, it does D08(E0) transfers.
15 <sup>3</sup>	TERROR	To-VME error code	If nonzero, refer to NO TAG for the most-recent error.
17 <sup>3</sup>	TADDRESS (HI BYTE)	Meaningful only if TAM=1	Address bits 23-16 of the address of the first byte of the VMEbus destination .
18 <sup>3</sup>	TADDRESS	VMEbus destination	Address bits 15-0 of the address of the first byte of the VMEbus destination.
19 <sup>3</sup>	TLENGTH	To-VME copy length	The number of 16-bit words to be transferred by the continuous-copy-to-VME operation.
20 <sup>3</sup>	TFILE	To-VME file number	The number of the processor source file of the continuous-copy-to-VME operation.
21 <sup>3</sup>	TELEMENT	To-VME element number	The number of the first element to be transferred in the source file of the continuous-copy-to-VME operation.
22 <sup>3</sup>	TINT	To-VME interrupt	If nonzero, the VMEbus interrupt level of the interrupt to be generated after completion of each continuous copy to VME operation.  000 specifies no interrupt, 001 specifies interrupt level 1, 010 specifies level 2, ..., 111 specifies level 7.
23 <sup>3</sup>	TSTATUSID	To-VME status/ID	The VMEbus status/ID value transmitted during interrupt acknowledge cycles of the above interrupt.
<sup>3</sup> Both IPLC ladder logic and the VME host computer can write to the status file fields that control the continuous-copy-to function. When both the ladder program and the host computer try to update the status file simultaneously, the ladder program overwrites the changes made by the host.			
24 <sup>4</sup>	IRQxE	Interrupt x enabled	If bit x is 1, the PLC-5/VME processor is an interrupt handler for interrupt IRQx. If IRQx is asserted, the PLC-5/VME processor will perform a VMEbus interrupt acknowledge cycle, store the interrupt status/ID received in IRQxSID, and set bit IRQxR.
24 <sup>4</sup>	IRQxR	Interrupt x received	If bit x is 1, the PLC-5/VME processor has accepted a VMEbus interrupt for IRQx since bit IRQxR was last 0.
<sup>4</sup> For bits 8 through 15, Both PLC ladder logic and the VME host computer can write to the VME IRQ status file field. When both the ladder program and the host computer try to update the status file simultaneously, the ladder program overwrites the changes made by the host. If a given IRQxE flag is set to 0, then the corresponding IRQxR and IRQxSID flags are also cleared to 0. If a given IRQxE flag is set and a VME interrupt is received on the corresponding level, then the corresponding IRQxR flag is set and the corresponding IRQxSID field is loaded with 8-bit status ID that the interruptor returns. To clear the IRQxR and IRQxSID fields, write a non-zero value into the VSF Updated field with your ladder program. This clears all IRQxR bits and IRQxSID fields. If more than one interrupt arrives on a given level before the ladder program clears the IRQxR/IRQxSID fields, the corresponding IRQxR bit remains set and the IRQxSID field contains the SID from the last interrupt received. If any interrupts are pending when the VME status file update byte is set, the IRQxR/IRQxSID fields are cleared and the interrupts discarded. Subsequent interrupts are handled as described above.  Status file contents are preserved across a power cycle or SYSRESET except in the following conditions: -If a change is made to A16 configuration registers or board jumpers (i.e. system controller, bus grant level, ULA, etc.), the changes are reflected in words 0-5 of the status file. -The IRQxR and IRQxSID fields are initially set to 0. When you cycle or reset power to the hardware, any interrupts that were pending become meaningless.  When you set the NOCV bit in the status and control register, continuous updating of the status file is disabled. Therefore, the coprocessor continues to execute continuous copies and handle VME interrupts according to the last status file settings you made – the last time you set the NOCV bit or sent a CSF ladder message. Any changes that the ladder program makes to the status file are not forwarded to the coprocessor until you send a CSF message or clear the NOCV bit. Similarly, VME interrupts are not flagged in the status file until you clear the NOCV bit or send a CSF message.			
25-27	IRQxSID	Interrupt x status/ID	If IRQxR is 1, this field is the VMEbus status/ID received from the interrupt acknowledge cycle. Read only.
28	UPDATED	Accept status file changes	Unless bit NOCV is 1 in the VMEbus status/control register, the PLC-5/VME processor reads this field every scan cycle as an indication of whether anything in the VME status file has changed. A nonzero value denotes a change, in which case the PLC-5/VME processor determines the whole status file for changes, records them as internal state, and stores zero in the UPDATED field. If a ladder program or an external programming terminal changes the status file, it should put a nonzero value in this field after making all the other needed changes to the status file.

## Commands

### Chapter Objectives

Read this chapter to understand the command interface to the PLC-5/VME processor. The orientation of this chapter is based on a driver program running on a separate CPU module communicating with the processor.

Unless otherwise noted, all multiple-byte numerical fields are represented in big-endian (Motorola) format, meaning that the most-significant data byte appears in the lowest-addressed byte.

### Command Types

There are four types of commands:

Command	Command Word	Definition
Continuous Copy to VME	0001H	Instructs the PLC-5/VME processor to copy processor file memory to VMEbus memory once per scan cycle of the processor.  It is similar in definition to the corresponding command in the 6008-LTV processor.
Continuous Copy from VME	0002H	Instructs the PLC-5/VME processor to copy VMEbus memory to the processor file memory once per scan cycle.
Handle Interrupts	0003H	Defines which VMEbus interrupts the PLC-5/VME processor behaves as an interrupt handler.
Send PCCC	FFFFH	Sends a command packet containing a standard PCCC. These were referred to as "selective" commands in the 6008-LTV processor.

## Continuous-Copy Commands

The command:	Has the value of:	Configures the PLC-5/VME processor to copy a block of data:
Continuous copy to VME	0001	<b>from</b> its data table during each ladder scan.
Continuous copy from VME	0002	<b>into</b> its data table during each ladder scan.

See Appendix A for a sample implementation of this command.

You can only enable these operations when the PLC-5/VME processor is in Run mode. You can specify up to 1000 words as the transfer length. These words must be contiguous elements in files, but the transfer can span files (Figure 5.1).

**Figure 5.1**  
**Continuous-Copy Command Structure**

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Command word															
1	Response word															
2	Reserved													Cmd interrupt level		
3	Reserved								Command interrupt status/ID							
4	Reserved															
5	Reserved															
6	Reserved															
7	Enable							Width		Address modifier						
8	Data address (high)															
9	Data address (low)															
10	Data size															
11	Data table file number															
12	Element number															
13	Reserved													Op interrupt level		
14	Reserved								Op status/ID							
15	Reserved															

Word	Command	Description
0	Command word	Has value 0001H (to VME) or 0002H (from VME).
1	Response word	As defined previously for all commands in common. See page 3-9.
2	Command interrupt level	As defined previously for all commands in common. See page 3-9.
3	Command interrupt status/ID	As defined previously for all commands in common. See page 3-9.
7	Enable	If 0, none of the subsequent fields are interpreted and the currently defined copy-to-VME (or from-VME) operation is disabled. If 1, this command establishes a new copy-to-VME or copy-from-VME operation.
7	Width	This defines the data width used to perform reads and writes to VME for the copy operations. 0 denotes D16 and 1 denotes D08(E0).
7	Address modifier	This defines the address space in which the VME data are accessed. Only two values are valid: 2D (A16) and 3D (A24 or data falls in PLC-5/VME processor's slave memory).
8-9	Data address	This specifies the VME address at which data transfer is to begin. Bits 23-16 of the A24 VME address are in bits 7-0 of word 8, and bits 15-0 of the VME address are in word 9. If A16 is specified, word 8 is unused and word 7 contains the A16 address.  If the PLC-5/VME processor's slave memory is enabled, if A24 is specified, and if this address falls into where the slave memory is mapped, the data is transferred into the slave memory without performing any VMEbus accesses. Otherwise, the PLC-5/VME processor does the transfer as a VMEbus master.
10	Data size	This specifies the number of 16-bit words to be transferred.
11	Data table file number	This specifies the file number of the PLC-5/VME processor's data table file to or from which data is to be transferred.
12	Element number	This specifies the element number in the data table file at which the transfer is to begin.
13	Op interrupt level	If nonzero, specifies the VMEbus interrupt to be generated upon completion of each copy operation.  000 specifies no interrupt, 001 specifies interrupt level 1, 010 specifies level 2, ..., 111 specifies level 7.
14	Op status/ID	If an end-of-each-copy interrupt is specified in the previous field, this field is the status/ID value returned by the PLC-5/VME processor as a result of the corresponding interrupt-acknowledge cycle.

## Notes on Copy Operations

For convenience of checking by the driver program, the on-going state of continuous copy is described in the command control register (see Chapter 3, page 3-6). If this indicates that an error has occurred, the driver reads the VME status file (via a PCCC command) to obtain the specific error code.

To change the copy parameters—i.e., to establish a different continuous copy—in the PLC-5/VME processor, the driver must issue another command to set bit 8 of element 28 in the VME status file using a PCCC write operation.



## Copy Synchronization

The PLC-5/VME processor does not have the same programmable synchronization control as does the 6008-LTV processor.

The 6008-LTV processor allows the copy transfer to:

- happen before or after the I/O update during housekeeping
- be asynchronous or synchronous with the ladder scan

In other words, the ladder scan would keep going (regardless of whether the VME transfer finished or not) rather than holding until the transfer is complete.

The PLC-5/VME processor allows the copying of data between the VMEbus and the PLC-5/VME's data table:

- during the housekeeping of the ladder processor
- concurrently with the I/O update

The data coming from the VMEbus is buffered and was collected during the previous ladder scan. If the new data is not ready from the VMEbus, the housekeeping is held up until the new data is available. The data going from the PLC-5/VME to the VMEbus is transferred into VME during the next ladder scan, just after housekeeping. There is a separate on-board coprocessor that handles all VME transfers; and it is this processor that is sending data to the VMEbus during the ladder scan.

You can read the processor's input table. Because the transfer occurs asynchronously with the I/O scan, however, values obtained from the input table would likely be a mix of most recent values and values from the previous scan cycle.

See Appendix A for examples of the commands and Chapter 7 for details about performance and operation.

## Error Codes

These are errors reported during the repeated continuous-copy operations initiated by the continuous-copy-to-VME and continuous-copy-from-VME commands. The existence of the error can be determined by examining the copy-to-state and copy-from-state fields in the command control register. The error code itself can be found in the VME status file.

**Table 5.A**  
**Error Codes**

Code	Explanation
01H	VMEbus transfer error (VMEbus bus error)
07H	Bad data address
09H	Past end of data file
FDH	Length specified as 0 or too large
FEH	Last end-of-copy interrupt not acknowledged

# Handle-Interrupts Command

This command, whose command word has the value 0003, defines the VME interrupts to be handled by the PLC-5/VME processor (Figure 5.2).

**Figure 5.2**  
**Handle-Interrupts Command Structure**

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Command word															
1	Response word															
2	Reserved													Cmd interrupt level		
3	Reserved								Command interrupt status/ID							
4	Reserved															
5	Reserved															
6	Reserved															
7	Enable	Reserved														
8	Reserved															
12	Reserved															
13	Reserved													Op interrupt level		
14	Reserved															
15	Reserved															

See Appendix A for a sample implementation of this command.

Word	Command	Description
0	Command word	Has value 0003H
1	Response word	As defined previously for all commands in common, see page 3-9.
2	Command interrupt level	As defined previously for all commands in common, see page 3-9.
3	Command interrupt status/ID	As defined previously for all commands in common, see page 3-9.
7	Enable	If 0, handling of the specified interrupt (op interrupt level) is disabled. If 1, handling of the specified interrupt is enabled.
13	Op interrupt level	Specifies the VMEbus interrupt whose handling is to be enabled or disabled.  000 specifies no interrupt, 001 specifies interrupt level 1, 010 specifies level 2, ..., 111 specifies level 7.

When you enable an interrupt, the PLC-5/VME processor detects this interrupt on the VMEbus, performs an 8-bit interrupt-acknowledge cycle, and reads an 8-bit status/ID from the interrupter. The interrupt and status/ID is then posted in the VME status file for accessibility to the ladder program.

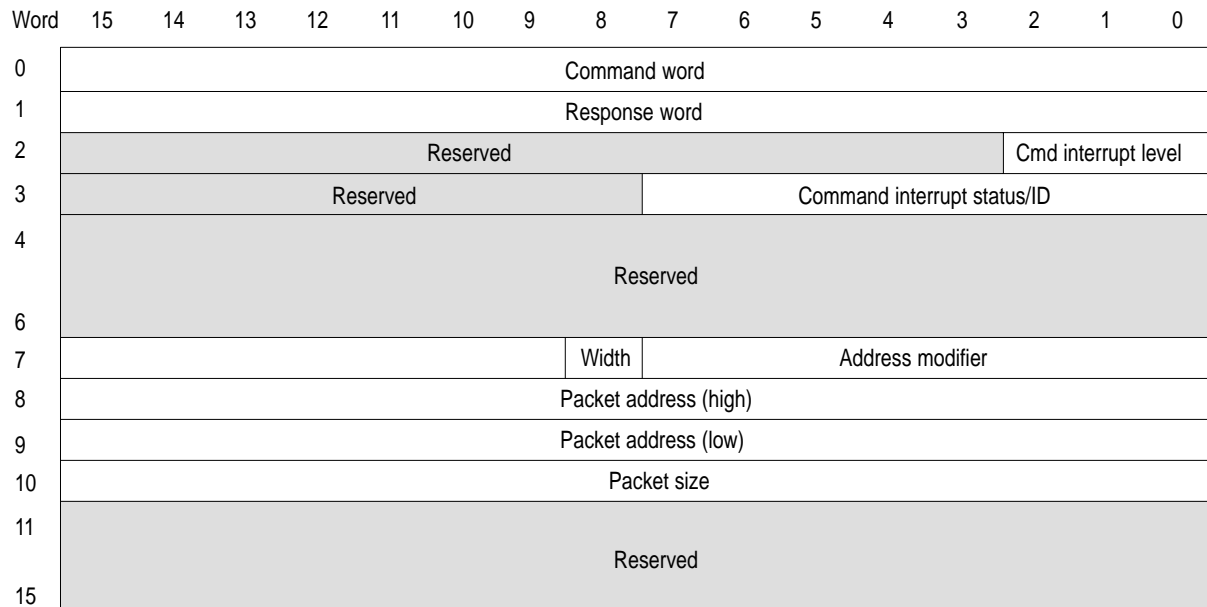
This mechanism allows VME interrupts to make a mark in the VME status file in the processor. The ladder program can test this element in the status file to determine whether or not the interrupt has occurred. This essentially converts interrupts to polled events from the point of view of the ladder program and thus introduces some small fixed overhead to the scan time; but it gives the ladder program considerable flexibility in determining the interrupt latency. For example, the ladder program can test for the interrupt each scan, multiple times each scan (for smaller latency), or every N scans.

## Send-PCCC Command

This command, whose command word has the value FFFF, sends an Allen-Bradley Programmable Controller Communications Command. In the 6008-LTV processor, this was known as the “selective command.”

See Appendix A for a sample implementation of this command.

**Figure 5.3**  
**Send-PCCC Command Structure**



Word	Command	Description
0	Command word	Has value FFFFH
1	Response word	As defined previously for all commands in common. Note that command completion is defined as the point where the PLC-5/VME processor has processed the PCCC command and formed the reply packet.
2	Command interrupt level	
3	Command interrupt status/ID	
7	Width	This defines the data width used to perform VME accesses to the packet. 0 denotes D16 and 1 denotes D08(E0).
7	Address modifier	This defines the address space in which the packet is accessed. Only two values are valid: 2D (A16) and 3D (A24 or data falls in PLC-5/VME processor's slave memory)
8 - 9	Packet address	<p>This specifies the VME address at which the PCCC command packet begins. Bits 23-16 of the A24 VME address are in bits 7-0 of word 8, and bits 15-0 of the VME address are in word 9.</p> <p>If the PLC-5/VME processor's slave memory is enabled and if this address falls into where the slave memory is mapped, the data is transferred into the slave memory without performing any VMEbus accesses. Otherwise, the PLC-5/VME processor does the transfer as a VMEbus master.</p>
10	Packet size	The size of the PCCC command packet in bytes.

## **Command-Protocol Error Codes**

These are the command-protocol codes placed in the error-code field of the command-control register when the ERR bit is 1.

<b>Code</b>	<b>Explanation</b>
00H	No error
01H	Invalid value in command register
02H	Cannot access first word of command block (usually a VMEbus bus error)
03H	Cannot access other than first word of command block
04H	Cannot write response word in command block

## **Response-Word Error Codes**

These are errors reported in the response word of the command block when the command cannot be carried out successfully. The even byte of the response word describes the type of error and the odd byte describes the time or situation of occurrence.

<b>Code</b>	<b>Explanation</b>
00FFH	Command successfully completed
0200H	Bad address modifier in command block
0300H	Bad VME address in command block
0400H	Bad command word (word 0)
0500H	Bad data/packet size (word 10)
0600H	Local PCCC queue overflow; PCCC not processed
8000H	VMEbus error

## PLC-5/VME Processor Communications Commands

### Chapter Objectives

Read this chapter to understand the function of the extended PCCCs in the PLC-5/VME processor.

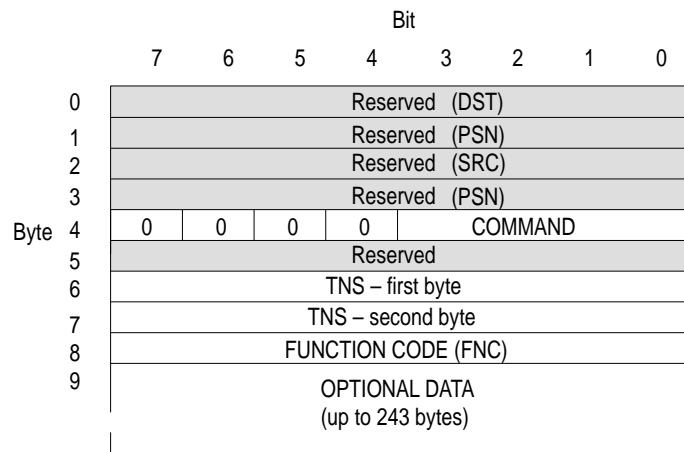
**Important:** Numerical data in the extended PCCCs is defined in little-endian (Intel) format.

See the Data Highway / Data Highway Plus / DH-485 Communication Protocol and Command Set reference manual, publication number 1770-6.5.16, for more information on PCCC commands.

### PCCC Structure

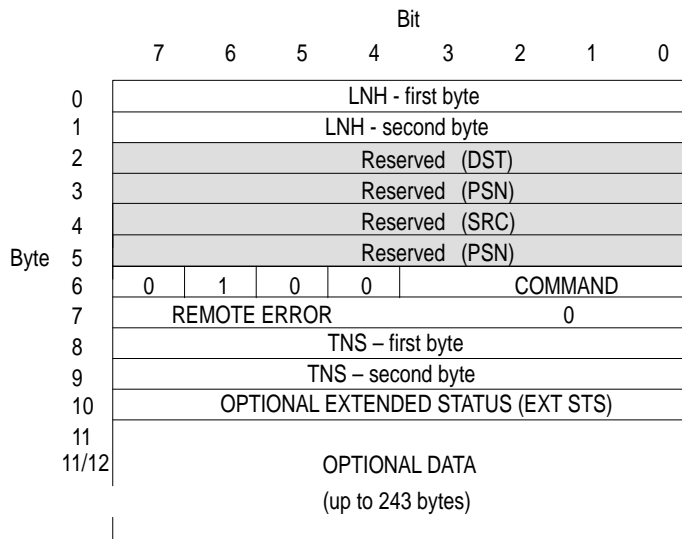
PCCCs are transferred in a command packet attached to a send-PCCC command. When the PLC-5/VME processor has finished processing the PCCC, a reply is returned by appending a reply packet to the PCCC command packet.

A PCCC command packet has the following format:



Command	Description
First four words	Currently unused and unexamined. To assure compatibility with any future use of these bytes, they should be initialized to 0. DST, PSN and SRC are included for reference only.
COMMAND	Specifies the PCCC command type.
TNS	Transaction or sequence word. A value that is copied into the reply packet to associate commands with replies. There cannot be more than one PCCC active in the PLC-5/VME processor with the same TNS from any source.
FUNCTION CODE	This is an extension of the COMMAND field.
OPTIONAL DATA	The value(s) and size of this field are specific to the type of command.

A PCCC reply packet has the following format:



Command	Description
LNH	Length of the optional portion of the reply packet in bytes. The first byte of LNH is the high-order byte (actual length = LNH - 4). <sup>1</sup>
COMMAND	Copied from the associated command packet.
REMOTE ERROR	If nonzero, the PLC-5/VME processor has encountered a problem attempting to process the command. 0001-1110 represent error codes listed separately. 1111 indicates that the EXT STS field contains an error code.
TNS	Copied from the associated command packet.
OPTIONAL EXTENDED STATUS	This field contains an error code when the REMOTE-ERROR field has the value 1111.
OPTIONAL DATA	This contains data returned as part of the reply. The value(s) and size of this field are specific to the type of command. Whether this field starts at offset 10 or offset 11 depends on whether the specified command is defined to return the extended status byte.

<sup>1</sup> As we stated early in this chapter, all numerical data in the extended PCCCs is defined in Intel format, however, this is the exception. This is in the Motorola format.

The host CPU driver program is responsible for leaving sufficient space for the reply packet immediately after the command packet in memory. The actual size of the reply packet depends on the specific type of PCCC command.

## Supported PCCCs

All PCCCs supported by the PLC-5 processor are supported by the PLC-5/VME processor. Since only a subset are useful to driver programs, only the useful subset and the PCCCs compatible with the “selective commands” of the 6008-LTV processor are described here.

PCCC Name	6008-LTV Processor (Equivalent Name)	Command	FNC	Page	Sample
Echo	Echo	06H	00H	6-5	B-59
Identify host and status	Identify PLC-5/VME processor, report status	06	03	6-6	B-67
Read-modify-write	Write bit	0F	26	6-8	B-76
Typed read	Read block	0F	68	6-10	
Typed write	Write block	0F	67	6-18	
Set CPU mode	Set processor mode	0F	3A	6-20	B-84
Upload all requests	Set upload privilege	0F	53	6-21	B-87
Download all requests	Set download privilege	0F	50	6-23	B-53
Upload complete	Restart after upload	0F	55	6-24	B-50
Download complete	Restart after download	0F	52	6-25	B-56
Read bytes physical	Physical read	0F	17	6-26	B-70
Write bytes physical	Physical write	0F	18	6-27	B-44
Get edit resource		0F	11	6-29	B-62
Return edit resource		0F	12	6-30	B-73
Apply port configuration		0F	8F	6-31	B-47
Restore port configuration		0F	90	6-32	B-81

Status codes returned in the reply packet are not defined for each PCCC, but they are listed together in a subsequent section.

Some PCCCs require the specification of a system address as part of the data. PCCCs support different formats of system addresses, but the only form described in this manual is a binary memory address of something in the file storage of the processor. The form recommended is compatible with the form used in the 6008-LTV processor. Thus, the term “system address” in the context of the following command descriptions is the following seven-byte value.

06	FF	file number	FF	element number
----	----	-------------	----	----------------

For instance, the 7-byte system address 06 FF 01 00 FF 02 01 specifies element 258 (0102h) in file 1 (0001h).



## Header Bit/Byte Descriptions

Table 6.A describes the bytes that compose the headers of command and reply packets. We do not repeat their descriptions in the description of each command that follows.

**Important:** All numbers are decimal except where noted by an “H” for Hexadecimal.

**Table 6.A**  
**Command and Reply Packets**

Header Bytes	Function	Description
CMD	Command	CMD and FNC bytes together define the command to be executed. Command codes are included in command descriptions later in this chapter.
STS	Status	<p>If the PLC-5/VME processor detects an error, it reports error codes in the reply packet. Zero means no error. Error codes are described for each command, below.</p> <p>Set to zero in the command packet.</p> <p>STS and EXT STS (extended status) are returned in the reply packet in response to some commands. STS bits 07-00 contain the value F0H when reporting extended status. Status and extended status codes that could be returned in the reply packet are described for each command, below.</p>
TNS	Transaction code (two bytes)	<p>The host CPU's driver program should generate a unique 16-bit number for each transaction so that it can match replies to corresponding commands. There should not be more than one active packet with the same transaction number from any source.</p> <p>Whenever the PLC-5/VME processor receives a command, it copies the TNS value of the command packet into the same field of the corresponding reply packet without changing the TNS value.</p>
FNC	Function code	For a command packet, it combines with the CMD byte to define the command. See CMD, above.
EXT STS	Extended status code	If the PLC-5/VME processor detects an error, it reports extended status codes in the reply packets of some commands. See STS, above.

The reply packet also contains the CMD byte. The PLC-5/VME processor copies the CMD value from the command packet into the corresponding reply packet.

Bit	Description
07	Always zero
06	Designates command or response. The host CPU resets this bit when sending a command. The PLC-5/VME processor sets this bit to 1 when sending a reply. (0 = command, 1 = reply)
05, 04	Not used (set to zero)
03-00	<p>Command codes (in Hex)</p> <p>Use command codes with function codes FNC to specify the type of command.</p>

## Echo

Use this command to debug or test PCCC transmission capability. The command packet can contain up to 243 bytes of data. The processor simply returns (“echos”) the same data in the reply packet.

### Message Format

#### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	DATA
00	00	00	00	06	00		00	up to 243 bytes

#### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	SAME DATA
Hi	Lo	00	00	00	00	46H			up to 243 bytes

### Error Codes

Extended status codes are reported in the response packet. The STS byte contains 00H if no error, F0H when the PLC-5/VME processor detects an error. If an error, the error code is indicated in the EXT STS byte as follows:

STS	EXT STS	Description
00H	–	No error
F0H	10H	Illegal command or format
	20H	Host has a problem and will not communicate
	30H	Remote station host is missing, disconnected, or shut down
	40H	Host could not complete function due to hardware fault
	50H	Addressing problem or memory protect rungs
	60H	Function disallowed due to command protection selection
	80H	Compatibility mode file missing or communication zone problem
	90H	Remote station cannot buffer command
	B0H	Remote station problem due to download

Refer to page D-3 for additional information on PCCC status codes.

### Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VECHO.H	B-58	P40VECHO.C	B-59

## Identify Host and Status

Use this command to:

- diagnostic command when debugging your host CPU's driver program
- confirm communication with the specified PLC-5/VME processor
- identify its operating mode
- report other useful information before initiating an upload or download

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC
00	00	00	00	06	00		03

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	STATUS (36 bytes)
Hi	Lo	00	00	00	00	46H			/ /

See the “Header Bit/Byte Descriptions” section on page 6-4 for descriptions of all bytes except the table on the next page.

The STATUS field returned in the reply packet indicates the following:

Byte	Description		
1	Operating status of the PLC-5/VME processor		
	Bits 2-0	000 = program load 100 = remote program load 110 = remote run	010 = run mode 101 = remote test 001, 011, 111 = not used
	Bit 3	0 = no fault	1 = major fault
	Bit 4	0 = not downloading	1 = download mode
	Bit 5	0 = not uploading	1 = upload mode
	Bit 6	0 = not testing edits	1 = testing edits
	Bit 7	0 = no edits in PLC-5/VME processor	1 = edits in processor
2	EBH	PLC-5/VME processor	
3	38H	Processor expansion type	
4-7	Processor Memory Size (96K bytes) (low word, low byte first)		
8	Series and revision of PLC-5/VME processor		
	Bits 4-0	00000 = Revision A	00001 = Revision B, etc.
	Bits 7-5	000 = Series A	001 = Series B, etc.
9	Processor station number		
	Bits 5-0	Station number 0-63	
10	FDH	Future development	
11	00H	Future development	

Byte	Description
12,13	Number of data files used (highest assigned file number + 1) (low byte first)
14, 15	Number of program files used (highest assigned file number + 1) (low byte first)
16	Forcing status
	Bit 0                      0 = no forces active                      1 = forces active
	Bit 4                      0 = no forces present                      1 = forces present
	All other bits = 0
17	Memory protect
	Bits 7-0                      0 = memory not protected                      any bit set = memory is protected
18	RAM invalid
	Bits 7-0                      0 = RAM valid                      any bit set = invalid RAM
19	Debug mode (non zero means Debug mode is on)
20, 21	Hold point file (low byte first) if Debug mode is on
22, 23	Hold point element (low byte first) if Debug mode is on
24, 25	Edit time stamp seconds (low byte first)
26, 27	Edit time stamp minute (low byte first)
28, 29	Edit time stamp hour (low byte first)
30, 31	Edit time stamp day (low byte first)
32, 33	Edit time stamp month (low byte first)
34, 35	Edit time stamp year (low byte first)
36	Port number this command received on (10H = port 1A, 11H = port 1B, 20H = port 2A, 21H = port 2B, 30H = port 3A, )

## Error Codes

Extended status codes are reported in the response packet. The STS byte contains 00H if no error, F0H when the PLC-5/VME processor detects an error. If an error, the error code is indicated in the EXT STS byte as follows:

STS	EXT STS	Description
00H	–	No error
F0H	10H	Illegal command or format
	20H	Host has a problem and will not communicate
	30H	Remote station host is missing, disconnected, or shut down
	40H	Host could not complete function due to hardware fault
	50H	Addressing problem or memory protect rungs
	60H	Function disallowed due to command protection selection
	80H	Compatibility mode file missing or communication zone problem
	90H	Remote station cannot buffer command
	B0H	Remote station problem due to download

Refer to page D-3 for additional information on PCCC status codes.

### Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VIHAS.H	B-64	P40VIHAS.C	B-67

## Read-Modify-Write

Use this command to set or reset specified bits in specified words of data table memory. The command tells the PLC-5/VME processor to apply a read-modify-write cycle to:

- read out the data
- apply an AND mask
- apply an OR mask
- return the results to the specified address

The address/mask field (up to 242 bytes) in the command packet contains multiple blocks, each of which contains an PLC-5/VME processor file address, a 2-byte AND mask, and a 2-byte OR mask.

Read-Modify-Write changes bits in one or more elements in the processor's memory. The data field in the command contains up to 242 bytes of address/OR/AND mask field. For each element specified, the processor reads a 16-bit word, ANDs it with the AND mask, ORs it with the OR mask, and writes the result back into the location in the processor memory.

An address/OR/AND mask field is an 11-byte value defined as:

System address	OR mask	AND mask
7	2	2

As an example, 06 FF 02 00 FF 03 00 00 00 00 00 clears (zeroes) the word at element 3 in file 2.

**Important:** The controller may change the states of the original bits in memory before this command can write the word back to memory. Therefore, some data bits may unintentionally be overwritten. To help prevent this, we suggest that you use this command to write into the storage area of a programmable controller's data table, and have the controller read the word only, not control it.

See the “Header Bit/Byte Descriptions” section on page 6-4 for descriptions of all bytes except the following:

Use the:	To specify:
PLC-5/VME processor ADDR field	the address of the element(s) to be modified. You can use the 242-byte address/mask field to modify selected words in and between data files.
AND mask (2-bytes field)	which bits are reset to 0 in the addressed word. A 0 in the AND mask resets the corresponding bit in the addressed word to 0. A 1 in the AND mask leaves the corresponds bit unchanged. Low byte comes first in the AND mask.
OR mask (2-byte field)	which bits to set to 1 in the addressed word. A 1 in the OR mask sets to 1 the corresponding bit the addressed word. A 0 in the OR mask leaves the corresponding bit unchanged. Low byte comes first in the OR mask.

## Message Format

### Command Packet

DST 00	PSN 00	SRC 00	PSN 00	CMD 0F	STS 00	TNS	FNC 26H	PLC-V5 ADDRESS	AND Lo Hi	OR Lo Hi
PLC-V5 ADDR								repeats, up to 242 bytes		
06		FF		FILE # Lo Hi		FF		ELEM # Lo Hi		

### Reply Packet

LNH Hi	LNH Lo	DST 00	PSN 00	SRC 00	PSN 00	CMD 4FH	STS	TNS	EXT STS
-----------	-----------	-----------	-----------	-----------	-----------	------------	-----	-----	------------

## Error Codes

Extended status codes are reported in the response packet. The STS byte contains 00H if no error, F0H when the PLC-5/VME processor detects an error. If an error, the error code is indicated in the EXT STS byte as follows:

STS	EXT STS	Description
00H	—	No error
F0H	01H	Illegal address—address field has an illegal value
	02H	Illegal address—not enough fields specified
	03H	Illegal address—specified too many address levels
	06H	Illegal address—file does not exist
	07H	Beyond end of file
	0BH	Access denied—privilege violation

Refer to page D-3 for additional information on PCCC status codes.

## Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VRMW.H	B-75	P40VRMW.C	B-76

## Typed Read

This command lets the host CPU read file data from the PLC-5/VME processor one packet at a time, starting at a specified address plus offset. Your driver program must:

- re-issue the command for each packet the number of times required to complete the total transaction.
- manipulate the offset field to get the data for each packet.

The PLC-5/VME processor:

- automatically checks that the size and total transaction values do not exceed the number of words in the data file.
- returns the specified data type as an array.

This read-block command contains a data-type ID. The host CPU places the data-type code in the write-block command packet. The PLC-5/VME processor places the data-type code in the reply packet of a read-block command. The type of data received in a read-block command must match the file type receiving the data. The driver program of the host CPU must convert data types when necessary.

See the “Header Bit/Byte Descriptions” section on page 6-4 for descriptions of all bytes except the following:

Use the:	To:
PLC-5/VME processor ADDR field	specify the first element of file data to be read. If the total transaction requires more than one packet, keep this address constant and manipulate the OFFSET value.
OFFSET field (2 byte, low byte first)	point to the starting element of each packet when the total transaction requires more than one packet. The offset specifies the number of elements above the base address (PLC-5/VME processor ADDR). Set the offset to zero for the first packet and manipulate its value for each successive packet. The PLC-5/VME processor does not check overlaps or spaces between packets.
TOTAL TRANSACTION field (2 bytes, low byte first)	specify the number of data elements (excluding ID bytes) of the total transaction. By specifying the total transaction in the first of multiple packets, the PLC-5/VME processor can generate an error code if the total transaction value will exceed the end boundary of the specified file.
SIZE field (2 bytes, low byte first)	specify the number of DATA elements the PLC-5/VME processor must return in each reply packet. The PLC-5/VME processor automatically returns an array of data in response to a read-block command.

**Important:** The PLC-5/VME processor ADDR, OFFSET, and TOTAL TRANS fields work together when the total number of words to be read requires multiple packets.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	OFFSET	TOTAL	PLC-V5	SIZE
00	00	00	00	0F	00		68H	Lo Hi	TRANS	ADDR	Lo Hi

PLC-V5 ADDR

06	FF	FILE #	FF	ELEM #
		Lo Hi		Lo Hi

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	a	b
Hi	Lo	00	00	00	00	4FH				DATA at address + offset

|———— up to 244 bytes ———|

a — data-type ID code byte(s). If there is an error, this field indicates EXT STS extended status and no data is returned in field b.

b — DATA is returned starting at the PLC-5/VME ADDR plus OFFSET, low byte then high byte for each word. The PLC-5/VME processor returns an array of the specified data type containing the number of elements specified by the SIZE byte field. See section on Data Types.

## Error Codes

Extended status codes are reported in the reply packet. The STS byte contains 00H if no error, F0H when the PLC-5/VME processor detects an error. If an error, the error code is indicated in the EXT STS byte as follows:

STS	EXT STS	Description
00H	—	No error
F0H	03H	Illegal address—specified too many address levels
	06H	Illegal address—file does not exist
	07H	Illegal address—beyond the end of the file
	0BH	Access denied—privilege violation

Refer to page D-3 for additional information on PCCC status codes.



## Data Types

Data types are those resident in the PLC-5/VME processor. In the typed-write and typed-read commands described in this chapter, each data type has a code representing its ID. The data-type code is stored in byte field “a” of the command or reply. Some data types have a corresponding size. The data-type size is the number of bytes required to store one element of the data type.

The field that stores the data-type ID and size codes has a default length of one byte for ID and size codes 3-7. When the code exceeds 7, additional bytes are appended to the default byte to specify ID and size. We describe this in Table 6.B and Table 6.C.

**Table 6.B**  
**Data-Type Field Specified in Default Byte**

ID Code	Data Type		Description
	Abbr.	Size	
3	A	1	ASCII
4	N, S, I, O	2	Integer (signed, two's complement) includes status and I/O data
5	T	10	A-B timer
6	C	6	A-B counter
7	R	6	A-B control

**Table 6.C**  
**Data-Type Field Specified in Appended Bytes**

ID Code	Data Type		Description
	Abbr.	Size	
8	F	4	Floating point (IEEE single precision)
9	—	—	Array (specifies data type and size)
10-15	—	—	Reserved
16	D	2	BCD

**Important:** If you want to write one element of a data type per packet, select any of the standard data-type codes such as for integer, timer, counter, control, or floating point. If you want to write multiple elements of the same data type per packet, select the data-type code for the array. You specify the data-type and size codes of any standard data type in the array.

## Data-Type Field

The data-type field specifies the ID (type of data) and size (number of bytes per element) of the data type used in these typed-write and typed-read commands. The default data-type field (1 byte) contains an ID format bit and value field for defining ID and size.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ID Format Bit	ID Code			Size Format Bit	Size Code		

The data-type field can vary in length if more descriptor bytes are required. Either of two format bits (bit 7 and/or 3) distinguish between a 1-byte or multi-byte field.

If the format bit is:	Then the adjacent 3-bit field:
Zero	contains a binary code (0-7) that specifies the data type ID or size.
One	defines the number of descriptor bytes appended to the default byte.

The appended descriptor bytes specify the ID or size. The order of descriptor bytes is least to most significant. The most significant (MS) bytes of zero value are permitted but overlooked.

When both the ID and size codes are appended, the ID bytes precede the size bytes.

For example, the following data-type descriptor fields have identical value. They describe an ID code of 4 (integer) and a size code of 2 (bytes per element).

Bit 76543210	Bit 76543210	Bit 76543210
01000010	01001001	01001010
	00000010	00000010
		00000000

## Example Data Types

We now present examples of several data-type IDs and corresponding data field (fields a and b in the command or reply packets).

**Important:** The packet for a typed-write command is limited to one element of a specified data type except for the array and character string.

### Integer Example

The first byte is the data-type field (field a), the 2-byte element contains the data (field b).

Bit 76543210		
a	01001010	ID = 4 for integer Size = 2 bytes per element
b	00000010	LS
	00000000	MS
value = 254		

### Floating-Point Example

The first two bytes are the data-type field (field a), the 4-byte element contains the data (field b) which is single precision IEEE.

Bit 76543210		
a	10010100	ID in next one byte Size = 4 bytes per element
	00001000	ID = 8 for floating point
b	11111110	LS
	11111110	
	11111110	
	11111110	MS
value not computed		

### Control Structure Example

The first byte is the data-type field (field a), the 6-byte element contains the data (field b).

Bit 76543210		
a	01110110	ID = 7 for control, Size = 6 bytes
b	00000000	word 0 (LS)
	00000000	(MS)
	00000000	word 1 (LS)
	00000000	(MS)
	00000000	word 2 (LS)
	00000000	(MS)
value = 0		

### Counter Example

The first byte is the data-type field (field a), the 6-byte element contains the data (field b). Bits in the control word are:

Bit 76543210				
a	01100110	ID = 6 for control, Size = 6 bytes	<b>If you see:</b>	<b>It means:</b>
	00000000	Control byte (LS)	15	up counter enabled
	10000000	Control byte (MS)	14	down counter enabled
	00000000	Preset (LS)	13	counter done
	00000001	(MS)	12	overflow
	00000111	Accumulated (LS)	11	underflow
	00000000	(MS)		
value: up counter enabled, not done, no overflow/underflow, preset = 256, accumulated = 7				

### Timer Example

The first two bytes are the data-type field (field a), the 10-byte element contains the data (field b). Bits in the control word are:

Bit 76543210				
a	01011001	ID = 5 for timer, Size in next one byte	<b>If you see:</b>	<b>It means:</b>
	00001010	Size = 10 bytes per element	15	timer enabled
b	00000000	Control byte (LS)	14	timer timing
	11000010	Control byte (MS)	13	timer done
	00001010	Preset (LS)	9 & 8	time base (10 for 1 second)
	00000000	Preset (MS)		
	00000000	Reserved		
	00000000	Reserved		
	00001001	Accumulated (LS)		
	00000000	Accumulated (MS)		
	00000000	Reserved		
	00000000	Reserved		
value: Timer enabled, timing, not done, preset = 10 sec, accumulated = 9 sec.				

### Array Example

The array includes two ID descriptors, the first specifies the structure as an array and its total length, the second specifies the type of data in the array and the number of bytes per element. You must count the second descriptor as part of the data field.

**Important:** Select the array structure when transferring multiple elements of the same data type.

In this example, the first byte is the data-type field and specifies size (total number of data bytes including second descriptor), the second byte is the ID descriptor for the array (both bytes in field a), the third byte is the ID descriptor for the data type followed by data bytes (field b).

		Bit 76543210	
a		10010111	ID in next one byte Size = 7 bytes including second descriptor
		00001001	ID = 9 for array
b a		01000010	ID = integer, size = 2 bytes per element
	b	00000000	Integer 0 (LS)
		00000000	(MS)
		11111110	Integer 1 (LS)
		11111111	(MS)
		11111111	Integer 2 (LS)
		00000000	(MS)
		value: 0, -2, 255	

This array could include enough bytes to fill a packet.

**Example of Character String**

The first byte(s) are the descriptor (field a), followed by the character string (field b). The string is not NULL determined.

Bit 76543210			Bit 76543210		
a	00110011	ID = 3 Size = 3	a	00111001	ID = 3 for CS Size in next byte
b	01000011	ASCII C		00010111	Size = 23 bytes
	01100001	ASCII a	b	01010100	ASCII T
	01110100	ASCII t		01101000	ASCII h
value = Cat				01101001	ASCII i
				01110011	ASCII s
			// //		
				01101100	ASCII l
				01100101	ASCII e
				00101110	ASCII .
			value = this is a fine example.		

## Typed Write

This command lets the host CPU write file data to the PLC-5/VME processor one packet at a time starting at a specified address plus packet offset. Your driver program must:

- re-issue the command for each packet the number of times required to complete the total transaction.
- manipulate the offset field to place data of each packet in the correct destination location.

The PLC-5/VME processor:

- automatically checks that the total transaction value does not extend beyond the end of the data file.
- does not check for overlap or spaces between packets.

Typed-write commands contain a data-type ID. The host CPU places the data-type code in the typed-write command packet. The PLC-5/VME processor places the data-type code in the reply packet of a typed-read command. The type of data sent with this typed-write command must match the file type written to. The driver program of the host CPU must convert data types when necessary.

**Important:** You may write multiple elements of the same data type in a packet by selecting the data-type ID for the array. You may write one element of a data type in each packet by selecting any of the standard data-type codes such as for integer, timer, counter, control, or floating point.

See the “Header Bit/Byte Descriptions” section on page 6-4 for descriptions of all bytes except the following:

Use the:	To:
PLC-5/VME processor ADDR field	specify the destination file number and first element number. If the total transaction requires more than one packet, keep this address constant and manipulate the OFFSET value.
OFFSET field (2 byte, low byte first)	point to the starting element of each packet when the total transaction requires more than one packet. The offset specifies the number of elements above the base address (PLC-5/VME processor ADDR). Set the offset to zero for the first packet and manipulate its value for each successive packet. The PLC-5/VME processor does not check overlaps or spaces between packets.
TOTAL TRANS field (2 bytes, low byte first)	specify the number of data elements (excluding ID bytes) of the total transaction. By specifying the total transaction in the first of multiple packets, the PLC-5/VME processor can generate an error code if the total transaction value will exceed the end boundary of the destination file.

**Important:** The PLC-5/VME processor ADDR, OFFSET, and TOTAL TRANS fields work together when the total number of words to be written requires multiple packets.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	OFFSET		TOTAL TRANS	PLC-V5 ADDR	a	b
00	00	00	00	0F	00		67H	Lo	Hi				

PLC-V5 ADDR

06	FF	FILE #	FF	ELEM #
		Lo Hi		Lo Hi

| — up to 244 bytes — |

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH			STS

a — data type ID code byte(s).  
 b — DATA byte field.

See Data Typed section

## Error Codes

Extended status codes are reported in the reply packet. The STS byte contains 00H if no error, F0H when the PLC-5/VME processor detects an error. If an error, the error code is indicated in the EXT STS byte as follows:

STS	EXT STS	Description
00H	—	No error
F0H	02H	Illegal address—not enough fields specified
	03H	Illegal address—specified too many address levels
	06H	Illegal address—file does not exist
	07H	Illegal address—beyond the end of the file
	0BH	Access denied—privilege violation
	11H	Mismatched data type

Refer to page D-3 for additional information on PCCC status codes.



## Set CPU Mode

Use this command to set PLC-5/VME processor's operating mode.

A no-privilege error is returned if the requester does not have the privilege of placing the host in a download mode. This error occurs when:

- the processor is not in Remote mode (must be in Remote Program mode, Remote Run mode, or Remote Test mode)
- the processor is being edited
- some other node is already downloading to the processing

Bits 0 and 1 of the flag byte determine the operating mode of the PLC-5/VME processor. To select the operating mode, set bits 1 and 0 in flag byte "a."

Mode	Bit 01	Bit 00
Program Load (program scan idle, I/O scan disabled)	0	0
Remote Test (program scan enabled, I/O scan disabled)	0	1
Remote Run (program scan enabled, I/O scan enabled)	1	0
No change to Operating Mode (only remote bit affected)	1	1

Bit 02 Remote Lock. If set, this will attempt to lock out all other remote devices from changing the CPU mode.

Bits 03-07 are not used (set to zero).

See the "Header Bit/Byte Descriptions" section on page 6-4 for all byte descriptions.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	Flag Byte	7	3	2	1	0
00	00	00	00	0F	00		3A		Unused	Lock Bit	Mode Select		

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH			STS

## Error Codes

The STS byte contains 00H if no error. When detected, the PLC-5/VME processor reports errors in its reply packet as follows:

STS	EXT STS	Description
00H	–	No error
F0H	0CH	Resource not available—someone else already holds the edit resource or has set the remote lockout bit

Refer to page D-3 for additional information on PCCC status codes.

## Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VSCM.H	B-83	P40VSCM.C	B-84

## Upload All Request

Use this command to place the PLC-5/VME processor in an upload mode before uploading PLC-5/VME processor memory.

During upload, the PLC-5/VME processor is in upload/program, upload/run, or upload/remote run mode. The host CPU can verify only static memory segments if the PLC-5/VME processor is in upload/run or upload/remote run mode, or if PLC-5/VME processor memory is altered by message commands from a DH+ station during upload. Do this using compare segments of memory segment pointers.

A no-privilege error is returned if the requester does not have the privilege of placing the host in a download mode. This error occurs when:

- the processor is being edited
- some other node is already downloading to the processing

**Important:** This command returns information needed by the host CPU to upload the PLC-5/VME's processor memory. It returns pointers to segments of memory that are used to process it sequentially. The result is a physical image of the processor's memory that can only be downloaded to the same processor model, series, and revision. After the upload is completed, this image must not be modified.

See the "Header Bit/Byte Descriptions" section on page 6-4 for descriptions of remaining bytes.

For a complete description of the upload algorithm, see page 6-34.

## Message Format

### Command Packet

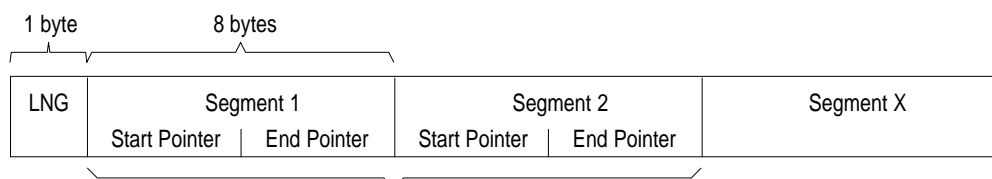
DST	PSN	SRC	PSN	CMD	STS	TNS	FNC
00	00	00	00	0F	00		53H

### Reply Packet

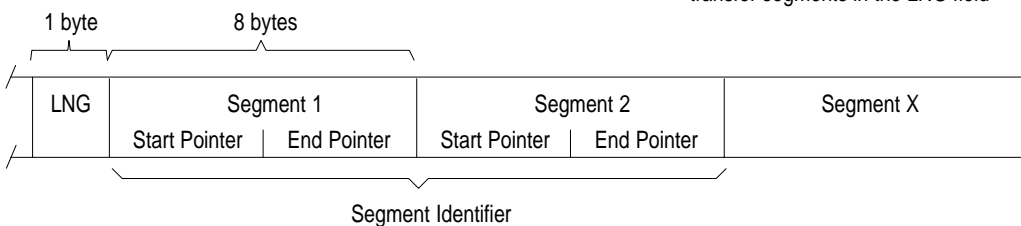
LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT	Memory Segment Pointers
Hi	Lo	00	00	00	00	4FH			STS	// //

## Memory Segment Pointers

### Upload/download Segments



### Compare Segments



LNG — the number of transfer or compare segments that follow this single byte quantity.  
Segment X — repeats for the number of transfer segments in the LNG field.

## Error Codes

The STS byte contains 00H if no error. When detected, the PLC-5/VME processor reports errors in its reply packet as follows:

STS	EXT STS	Description
00H	—	No error
F0H	0BH	Access denied—PLC-5/VME processor in upload or download mode

Refer to page D-3 for additional information on PCCC status codes.

## Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VULA.H	B-86	P40VULA.C	B-87

## Download All Request

Use this command to place the PLC-5/VME processor in download mode before downloading memory. This command clears PLC-5/VME processor memory and loads default program files 0 and 1 (ladder), and data files 0, 1, and 2 (I/O and status).

See the “Header Bit/Byte Descriptions” section on page 6-4 for a description of each byte.

For a complete description of the download algorithm, see page 6-34.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC
00	00	00	00	0F	00		50H

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH			STS

## Error Codes

The PLC-5/VME processor reports errors, if detected, in its reply packet as follows:

STS	EXT STS	Description
00H	–	No error
F0H	0BH	Access denied—PLC-5/VME processor is in run mode, memory protected, or being programmed from a programming terminal
	0DH	PLC-5/VME processor already available

Refer to page D-3 for additional information on PCCC status codes.

## Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VDLA.H	B-52	P40VDLA.C	B-53

## Upload Complete

Use this command at the completion of an upload to return the PLC-5/VME processor to its pre-upload operating mode. If the upload was initiated with the PLC-5/VME processor in program mode, now your driver program can change the operating mode to run or Run/Program to resume processor operation.

See the “Header Bit/Byte Descriptions” section on page 6-4 for a description of each byte.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC
00	00	00	00	0F	00		55H

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH			STS

## Error Codes

The STS byte contains 00H if no error. When detected, the PLC-5/VME processor reports errors in its reply packet as follows:

STS	EXT STS	Description
00H	–	No error
F0H	0BH	Access denied
	0DH	PLC-5/VME processor already available

Refer to page D-3 for additional information on PCCC status codes.

## Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VULC.H	B-49	P40VULC.C	B-50

## Download Complete

Use this command to return the PLC-5/VME processor from download/program to Program mode after downloading memory. Now, your driver program can change the PLC-5/VME processor's operating mode to run or Run/Program to resume processor operation.

See the "Header Bit/Byte Descriptions" section on page 6-4 for a description of each byte.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC
00	00	00	00	0F	00		52H

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH			STS

## Error Codes

The PLC-5/VME processor reports errors, if detected, in its reply packet as follows:

STS	EXT STS	Description
00H	—	No error
F0H	0BH	Access denied
	0DH	PLC-5/VME processor already available

Refer to page D-3 for additional information on PCCC status codes.

## Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VDLC.H	B-55	P40VDLC.C	B-56

## Read Bytes Physical

Use this command to upload segments of PLC-5/VME processor memory after a successful upload-all-requests command. You can upload up to 244 bytes (122 words) per packet. Words are loaded low byte first. The first byte and the number of bytes read must be an even number.

Your upload PLC-5/VME processor memory uses successive read bytes physical commands for each of three memory segments. The memory segments are defined by start and end pointers returned by the upload all requests command. The first command starts at the physical address defined by a memory segment pointer. You must increment the physical address in successive commands. You increment the current physical address over the previous physical address by the same number of bytes (equal to the SIZE value) for each command until the segment is complete. The packet size of the last command may be less.

See the “Header Bit/Byte Descriptions” section on page 6-4 for a description of all bytes except the following:

**SIZE**—this is a 2-byte field (low byte first) that contains the number of bytes to read (up to 244, even number only) with each read bytes physical command.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	a	SIZE
00	00	00	00	0F	00		17H		

a – The physical address is a four-byte field (order of bytes is lowest to highest) where the current packet starts to read (for example, 00 0A 00 00 for physical address A00).

### Reply Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	a	DATA (up to 244 bytes)
00	00	00	00	4FH	00			

a – This byte will be the EXT STS extended status byte if there is an error. Otherwise, the PLC-5/VME processor omits this byte.

## Error Codes

The STS byte contains 00H if no error. When detected, the PLC-5/VME processor reports errors in its reply packet as follows:

STS	EXT STS	Description
00H	–	No error
10H	–	Incorrect command format
40H	–	Internal error such as a parity error
F0H	03H	Incorrect address
	07H	Segment exceeds the end of user memory
	0AH	Transaction size too large for a packet
	0BH	Access denied
	12H	Invalid packet format

Refer to page D-3 for additional information on PCCC status codes.

## Sample API Module

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VRBP.H	B-69	P40VRBP.C	B-70

## Write Bytes Physical

Use this command to download PLC-5/VME processor memory after a successful download-all-requests command. You can download up to 119 words (238 bytes) per packet. Words are loaded low byte first. The first byte and the number of bytes written must be an even number.

You download PLC-5/VME processor memory using successive write bytes physical commands for each of three memory segments. The memory segments are defined by start and end pointers returned by the upload all requests command. The first command starts at the physical address defined by a memory segment pointer. You must increment the physical address of successive commands. You increment the current physical address over the previous physical address by the same number of bytes (equal to the SIZE value) each command until the segment is complete. The packet size of the last command may be less.

See the “Header Bit/Byte Descriptions” section on page 6-4 for a description of each byte.



## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	a	b
00	00	00	00	0F	00		18H		

a – The physical address is a four-byte field (order of bytes is lowest to highest) where the current packet starts to write. For example, 00 0A 00 00.

b – You can write up to 119 data words (two bytes per word) per command packet (enter low byte first).

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH	00		STS

## Error Codes

The STS byte contains 00H if no error. When detected, the PLC-5/VME processor reports errors in its reply packet as follows:

STS	EXT STS	Description
00H	–	No error
10H	–	Incorrect command format
40H	–	Internal error such as a parity error
60H	–	Write operation disallowed
F0H	03H	Incorrect address
	07H	Segment exceeds the end of user memory
	12H	Invalid packet format
	0BH	Access denied

Refer to page D-3 for additional information on PCCC status codes.

## Sample API

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VWBP.H	B-43	P40VWBP.C	B-44

## Get Edit Resource

Use this command to secure the edit resource for the programming device. Once you have obtained the edit resource, no one else can write to or modify the device.

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC
00	00	00	00	0F	00		11H

### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH			STS

## Error Codes

The PLC-5/VME processor reports errors, if detected, in its reply packet as follows:

STS	EXT STS	Description
00H	–	No error
F0H	0BH	Access denied
	0CH	Another module already has edit resource
	0DH	Module already has edit resource

Refer to page D-3 for additional information on PCCC status codes.

## Sample API

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VGER.H	B-61	P40VGER.C	B-62

## Return Edit Resource

Use this command to return the edit resource when editing is completed. When you return the edit resource, the programming device can be written to or modified.

### Message Format

#### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC
00	00	00	00	0F	00		12H

#### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH			STS

### Error Codes

The PLC-5/VME processor reports errors, if detected, in its reply packet as follows:

STS	EXT STS	Description
00H	—	No error
F0H	0CH	Another module has edit resource

Refer to page D-3 for additional information on PCCC status codes.

### Sample API

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VRER.H	B-72	P40VRER.C	B-73

## Apply Port Configuration

Use this command to change the configuration of some or all ports. No parameters means to change all ports. This command reconfigures the ports based on information in the processor's physical memory. It is normally used as part of a physical download operation where the processor memory and configuration are to be fully restored.

You must have the edit resource to use this command.

### Command Parameters

1. Number of ports to change—zero means all ports
2. Port-number list

### Message Format

#### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	a	b
00	00	00	00	0F	00		8FH		

- a – The number of ports to change is a one-byte field—00 means “all ports.”  
b – Port numbers in this list are two bytes each, low byte first.

#### Reply Packet

LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT	DATA
Hi	Lo	00	00	00	00	4FH	00		STS	

This data is returned only if there is an EXT STS error 12H. It contains the file and element that relate to the error.

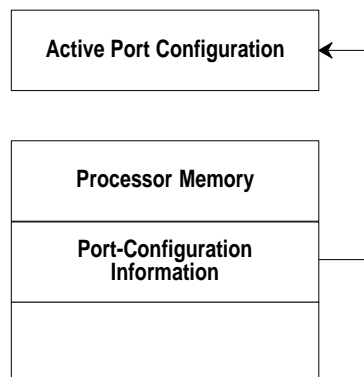
### Error Codes

The PLC-5/VME processor reports errors, if detected, in its reply packet as follows:

STS	EXT STS	Description
00H	–	No error
F0H	12H	Error in configuration

Refer to page D-3 for additional information on PCCC status codes.

## Operation



This command applies the port-configuration information that exists in physical memory to the chips that control the I/O ports. This makes it possible to restore the I/O ports to the state that they were in during full physical memory restore operations (i.e., download all request).

## Sample API

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VAPC.H	B-46	P40VAPC.C	B-47

## Restore Port Configuration

Use this command to replace the working configuration with the permanent configuration. This command saves the current active I/O port-configuration information into the processor's physical memory. It is normally used as part of a physical upload operation where the processor memory and configuration are to be fully saved.

The edit resource is required for this operation.

## Command Parameters

1. Number of ports to change—zero means all ports
2. Port-number list

## Message Format

### Command Packet

DST	PSN	SRC	PSN	CMD	STS	TNS	FNC	a	b
00	00	00	00	0F	00		90H		

a – The number of ports to change is a one-byte field—00 means “all ports.”

b – Port numbers in this list are two bytes each, low byte first.

### Reply Packet

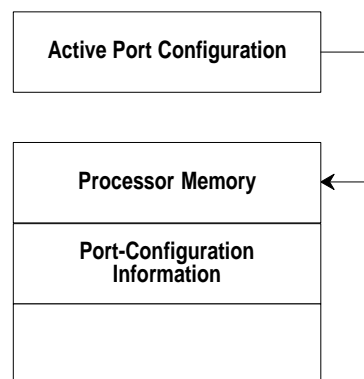
LNH	LNH	DST	PSN	SRC	PSN	CMD	STS	TNS	EXT
Hi	Lo	00	00	00	00	4FH	00		STS

## Error Codes

STS	EXT STS	Description
00H	–	No error

Refer to page D-3 for additional information on PCCC status codes.

## Operation



This command saves the port-configuration information in the chips that control the I/O ports into the physical image. This makes it possible to save it during full physical memory save operations (i.e., upload all request).

## Sample API

For a sample interface header file:	Refer to page:	For a sample implementation source file:	Refer to page:
P40VRPC.H	B-80	P40VRPC.C	B-81

## Upload and Download Procedure

The upload-and-download procedure is a PLC-5/VME processor physical save-and-restore procedure that uploads and downloads a binary image from a PLC-5 processor out of and into VME memory.

### Upload Procedure

An example of this procedure is included in Appendix A.

1. Identify the PLC-5/VME processor.
2. Set the processor's operating mode to Program or Remote Program. You can do this by using the PCCC command Set CPU Mode described on page 6-20.
3. Clear all faults in the processor. Determine whether or not a processor has faults by using the PCCC command Identify Host and Status described on page 6-6.
4. Get the edit resource from the processor. This prohibits anyone else from modifying or writing to the processor while upload is in progress. You can do this by using the PCCC command Get Edit Resource described on page 6-29.
5. Ensure that the current port configurations will be saved into the physical image. You can do this by using the PCCC command Restore Port Configuration described on page 6-32.
6. Inform the processor that you are going to upload all of its physical memory. You can do this by using the PCCC command Upload All Request described on page 6-21.
7. Extract the number of segments from the LNG field in the response packet.
8. For each segment in the response packet, do the following:
  - a. Extract the startPointer for the segment by accessing the first four bytes following the LNG field in the response packet.
  - b. Extract the endPointer for the segment by accessing the first four bytes following the startPointer in the response packet.
  - c. Determine the segment size:
$$segmentSize = endPointer - startPointer + 1$$

- d. Calculate the number of full physical reads that will be done from the processor during the upload operation.

The maximum number of bytes is 244 for a physical read. We will use 238 bytes in this example because that is the maximum for physical write operations—this makes it easier to download the processor's memory in the future. This is an integer division calculation:

$$\text{fullReadCount} = \text{segmentSize} / 238$$

- e. Calculate the number of bytes in the final physical read that may have to be done from the processor. This could be zero if the segmentSize is an even multiple of 238 bytes. This is a modulus integer calculation:

$$\text{fullReadSize} = \text{segmentSize} \% 238$$

- f. Do fullReadCount PCCC Read Bytes Physical (see page 6-26) operations on the processor. For each packet read from the processor, write the following into a binary file:

Address Read From PLC	(4 bytes)
Physical Read Size	(1 byte)
Processor Memory	(up to 238 bytes)

Verify the upload by reading the packet just written to the file against the version in memory.

Be sure that you update the next address to read by the Physical Read Size in your reading loop.

9. Verify the upload by repeating the process described in step 8 with this change: instead of writing the data to a file, compare it to the data that you previously stored in the file.
10. Terminate the processor upload operation. You can do this by using the PCCC command Upload Complete described on page 6-24.
11. Return the edit resource so that others can write to the processor. You can do this by using the PCCC command Return Edit Resource described on page 6-30.



## Download Procedure

An example of this procedure is included in Appendix A.

1. Identify the PLC-5/VME processor.
2. Set the processor's operating mode to Program or Remote Program. You can do this by using the PCCC command Set CPU Mode described on page 6-20.
3. Clear all faults in the processor. You can determine whether or not a processor has faults by using the PCCC command Identify Host and Status described on page 6-6.
4. Inform the processor that you are going to download to its memory. You can do this by using the PCCC command Download All Request described on page 6-23.
5. For each file packet that you wrote to a binary file on doing a processor upload, do the following:
  - a. Read a file packet from the binary file.
  - b. Do a PCCC command Write Bytes Physical (see page 6-27) using the processor address, number of bytes, and data in the file packet.
  - c. Verify the download by using the PCCC command Read Bytes Physical (see page 6-26) to read the data that was just written to the processor. Compare the data just read from the processor to the original in memory.
6. After all the file packets have been restored to the processor, issue the PCCC command Download Complete (see page 6-25) to terminate the download to the processor.
7. Get the edit resource from the processor. This prohibits anyone else from modifying or writing to the processor while upload is in progress.
8. Restore the saved port configurations by using the PCCC command Apply Port Configuration described on page 6-31.
9. Return the edit resource so that others can write to the processor. You can do this by using the PCCC command Return Edit Resource described on page 6-30.

## Performance and Operation

### Chapter Objectives

Read this chapter to learn about the performance and theory of operations of the PLC-5/VME processor.

### VME Throughput Time

The PLC-5/VME is a standard PLC-5 processor with an embedded VME coprocessor that uses standard port 3A for coprocessor communication. The embedded VME coprocessor:

- handles any VME ladder-logic message instructions
- serves the continuous-to/from-copy function in the PLC processor
- maintains the VME status file in the PLC processor
- handles all host VME processor requests for communication to the PLC processor

All message instructions from the PLC processor going to the VMEbus are processed like other message instructions in the PLC processor. The control bits act exactly the same way. Once the VME coprocessor gets the command, it processes it according to the function.

For a VME write instruction (CTV), the coprocessor makes another request back to the PLC processor to get the data being sent to the VMEbus. It arbitrates for the bus if necessary and then transfers the data. After the last DTACK from the VMEbus, it sends a command back to the PLC processor to let it know the command completed; and then the done bit is set for the message instruction.

For a VME read instruction (CFV), the coprocessor arbitrates for the VMEbus and fetches the data. It sends the data to the PLC processor and then tells the PLC processor that it is completed.

For the send VME interrupt, the coprocessor gets the command along with the interrupt level and status ID code. It generates the VMEbus interrupt and waits for the interrupt-acknowledge signal on the VME backplane. When it sees this signal, it puts the status ID on the backplane along with DTACK for the interrupt handler. It then sends a command back to the PLC processor to let it know of completion so that it can set the done bit to the message instruction.

For the check-VME-status-file command,

If you want the VME:	Set the NOCV bit to:
to check the VME status file for changes during every program scan	zero. <b>Important:</b> This causes the performance of message instruction transfers to degrade by a factor of 2 or greater.
not to check the VME status file	one. You can still check the VME status file by issuing the "check VME status file" command using the message instruction "CSF."

See Chapter 4 for information on the check-VME-status-file command.

Because the PLC processor uses the message instruction for VME transfers, it competes with other message-instruction activity going to the communication processor that handles this traffic in the PLC processor. For example, having a programming terminal attached to the PLC processor can have a large impact on VME transfers using the message instruction. If the PLC processor is attached to a large DH+ network, with many transfers going to the PLC-5/VME processor, then this will impact it as well.

## Communication Methods

The PLC processor initiates the communication with the VME host CPU in two ways:

- configuring an end-of-scan transfer
- through ladder logic and the message instruction

Both methods use the dual-port memory as an intermediate buffer between the PLC processor and VME coprocessor.

It is important to note that the two methods exchange data with the dual port in different ways. The transfer can be either during the housekeeping section of the PLC scan or the ladder logic section of the scan. The effect on total PLC scan is the same but it is important to make the distinction between them.

### End-of-Scan Transfer

This method uses the copy-to-VME and copy-from-VME end-of-scan transfer commands. You can execute one or both commands in a single ladder scan and transfer up to 1000 words each.

When using this method, the housekeeping time is impacted. This is because the transfer delays the ladder processor until the transfer with the dual-port is complete; therefore, it is synchronous with and occurs only once per scan.

The PLC scan-time impact for either a read or write transfer with the dual-port memory can be calculated as:

$$\text{Transfer time} = 22.41\mu s + (2.332\mu s)N + 0.83\mu s(N-1)$$

Where:	Is the:
$22.41\mu s$	dual port set-up time
$(2.332\mu s)N$	dual port access per word
$0.83\mu s(N-1)$	VME coprocessor loop time
$N$	number of words to transfer
Note: a transfer of 100 words = 337.78 $\mu s$	

### Ladder-Logic Method

The ladder-logic method uses four VME commands:

- Copy to VME
- Copy from VME
- Send VME interrupt
- Check VME status file

When scanned by the ladder-logic processor, the message instruction sets a flag for the VME coprocessor. Once the coprocessor sees the flag, it examines the command to determine the requested function and the address of the data; it then executes the transfers.

There are some additional considerations when using this method:

- It adds additional throughput time to the completion of the message instruction because the coprocessor has to examine the requested command
- Because it is a standard message, the VME messages have to compete with the other message-instruction activity in the PLC processor, so timing is subject to many variables. For example, having a programming terminal attached to the PLC processor increases the transfer time.

Once the data is exchanged with the dual port, the ladder-logic processor starts or is allowed to continue scanning the program and the VME coprocessor asynchronously passes the data between the dual-port and VME memory.

When using the message instruction, the ladder scan is impacted. The message instruction transfer is totally asynchronous with the ladder scan and may start and complete anywhere within the scan. It possibly could take more than one scan to complete in a very fast program or could happen more than once per scan with a continuous message in a very long program.

## Benchmark Tests

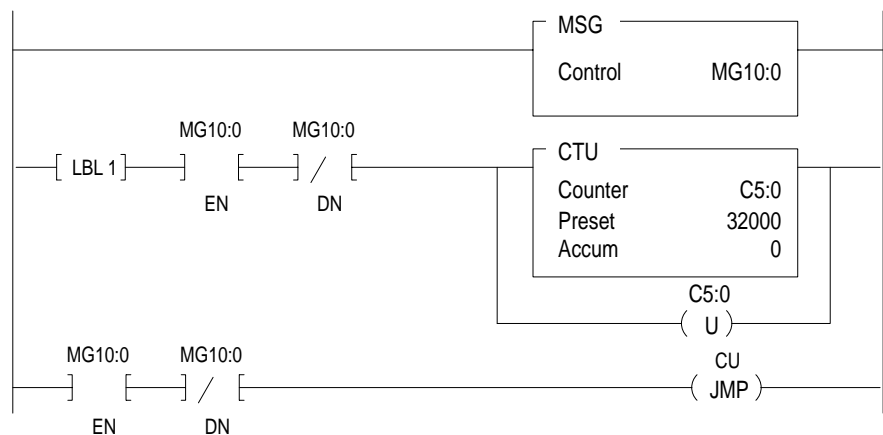
The benchmark tests that we ran show approximately how long it takes to perform a ladder-logic message instruction. This means the total elapsed time from when the enable bit of the instruction went true until the done bit went true. But the time it takes the data to get to the VMEbus in a write instruction may actually be a little less than the elapsed time between the enable and done bits. The reason is that the data actually makes it to the VMEbus some time before the PLC processor can set the done bit. This is difficult to measure, but a good estimate would be about 1 msec.

We used the following setup to run the benchmark tests:

- The matrix of tests was done in a Motorola development system that used a MVME 050 system controller card.
- One other master board was in the system, but it was not running any tasks and it was not arbitrating for the VMEbus.
- The PLC-5/V40 processor was a series C, revision G processor.
- The channels were configured as follows:

Channel:	Was configured to:
0 (serial port)	system point-to-point (unused)
1A	DH+ link
1B	a scanner with no racks attached
2A	nothing (unused)
2B	nothing (unused)

We used the ladder-logic technique to measure the time it takes to perform a VME transfer. Ladder logic enables a message instruction to do the VME transfer. Then the ladder logic goes into an endless loop incrementing a counter every time it goes through the loop. It stays in the loop until the done bit is set. By knowing the exact time it takes to scan the logic in the loop, the elapsed time until the done bit is set is calculated by multiplying the accumulated value of the counter by the time it takes to scan the loop once. The time it took to scan the following logic in the loop was 16.1 msec.



Due to the different loading that can be placed on the communication processor in the PLC/5 processor, transfer times are not consistent every time. For each test, 20 readings were taken to calculate the numbers. We present the minimum, maximum, and average values.

### Setup #1

- NOCV = 1 (VME coprocessor does not constantly read PLC processor)
- Copy to global VME RAM on-board the PLC processor at 0xA00000
- Programming terminal not attached to PLC processor

Command	Minimum msec.	Maximum msec.	Average msec.
CTV #N7:0 A0000 D16 1	4.0	8.0	5.0
CTV #N7:0 A0000 D16 500	8.0	9.0	8.0
CTV #N7:0 A0000 D16 1000	12.0	13.0	12.0
CFV A0000 D16 #N7:0 1	4.0	7.0	5.0
CFV A0000 D16 #N7:0 500	8.0	9.0	8.0
CFV A0000 D16 #N7:0 1000	12.0	13.0	12.0
SVE 1 55	3.0	8.0	3.0
CSF	4.0	5.0	4.0

### Setup #2

- NOCV = 1 (VME coprocessor does not constantly read PLC processor)
- Copy to global VME RAM on-board the PLC processor at 0xA00000
- Programming terminal attached to PLC processor monitoring ladder file

Command	Minimum msec.	Maximum msec.	Average msec.
CTV #N7:0 A0000 D16 1	4.0	16.0	6.0
CTV #N7:0 A0000 D16 500	8.0	17.0	11.0
CTV #N7:0 A0000 D16 1000	12.0	22.0	14.0
CFV A0000 D16 #N7:0 1	5.0	15.0	7.0
CFV A0000 D16 #N7:0 500	8.0	18.0	12.0
CFV A0000 D16 #N7:0 1000	12.0	17.0	13.0
SVE 1 55	3.0	14.0	5.0

### Setup #3

- NOCV = 1 (VME coprocessor does not constantly read PLC processor)
- Copy to global VME RAM off-board the PLC processor at 0x70000
- Programming terminal attached to PLC processor monitoring ladder file

Command	Minimum msec.	Maximum msec.	Average msec.
CTV #N7:0 70000 D16 1	4.0	16.0	6.0
CTV #N7:0 70000 D16 500	7.0	18.0	10.0
CTV #N7:0 70000 D16 1000	11.0	21.0	13.0
CFV 70000 D16 #N7:0 1	5.0	15.0	7.0
CFV 70000 D16 #N7:0 500	8.0	19.0	11.0
CFV 70000 D16 #N7:0 1000	11.0	23.0	13.0
SVE 1 55	3.0	14.0	5.0

### Setup #4

- NOCV = 0 (VME coprocessor constantly read PLC processor)
- Copy to global VME RAM on-board the PLC processor at 0xA00000
- Programming terminal not attached to PLC processor

Command	Minimum msec.	Maximum msec.	Average msec.
CTV #N7:0 A0000 D16 1	6.0	11.0	7.0
CTV #N7:0 A0000 D16 500	10.0	14.0	12.0
CTV #N7:0 A0000 D16 1000	14.0	18.0	16.0
CFV A0000 D16 #N7:0 1	6.0	10.0	7.0
CFV A0000 D16 #N7:0 500	10.0	14.0	13.0
CFV A0000 D16 #N7:0 1000	14.0	19.0	18.0
SVE 1 55	4.0	8.0	6.0

### Setup #5

- NOCV = 0 (VME coprocessor constantly read PLC processor)
- Copy to global VME RAM on-board the PLC processor at 0xA00000
- Programming terminal attached to PLC processor monitoring ladder file

Command	Minimum msec.	Maximum msec.	Average msec.
CTV #N7:0 A0000 D16 1	6.0	20.0	10.0
CTV #N7:0 A0000 D16 500	10.0	27.0	16.0
CTV #N7:0 A0000 D16 1000	114.0	25.0	18.0
CFV A0000 D16 #N7:0 1	6.0	20.0	10.0
CFV A0000 D16 #N7:0 500	10.0	22.0	15.0
CFV A0000 D16 #N7:0 1000	16.0	26.0	21.0
SVE 1 55	5.0	14.0	8.0

### Setup #6

- NOCV = 0 (VME coprocessor constantly read PLC processor)
- Copy to global VME RAM off-board the PLC processor at 0x70000
- Programming terminal attached to PLC processor monitoring ladder file

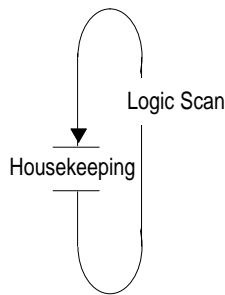
Command	Minimum msec.	Maximum msec.	Average msec.
CTV #N7:0 A0000 D16 1	6.0	21.0	10
CTV #N7:0 A0000 D16 500	9.0	28.0	13.0
CTV #N7:0 A0000 D16 1000	12.0	27.0	18.0
CFV A0000 D16 #N7:0 1	6.0	20.0	10.0
CFV A0000 D16 #N7:0 500	11.0	26.0	16.0
CFV A0000 D16 #N7:0 1000	13.0	32.0	21.0
SVE 1 55	5.0	14.0	8.0

## Introduction to PLC-5/VME Processor Scanning

The basic function of a programmable controller system is to read the status of various input devices (such as pushbuttons and limit switches), make decisions based on the status of those devices, and set the status of output devices (such as lights, motors, and heating coils). To accomplish this, the PLC-5/VME processor performs two primary operations:

- program scanning—where logic is executed and housekeeping is performed.
- I/O scanning—where input data is read and output levels are set.





## Program Scanning

The program scan cycle is the time it takes the processor to execute the logic scan once, perform housekeeping tasks, and then start executing logic again.

The processor continually performs logic scanning and housekeeping. In a PLC-5/V40, for example, basic housekeeping takes 3.2 ms. If it takes the processor 21.8 ms to execute a logic scan, the overall program scan cycle is 25 ms. You can monitor the program scan time using the processor status screen.

Housekeeping activities for PLC-5/VME processors include:

- processor internal checks
- updating the input image table with remote I/O input status as contained in the remote I/O buffer
- updating the remote I/O buffer with output data from the output image table

Housekeeping activities for other standard PLC-5 processors also include:

- updating the input image table with processor-resident I/O input status
- updating processor-resident local I/O output modules with data from the output image table

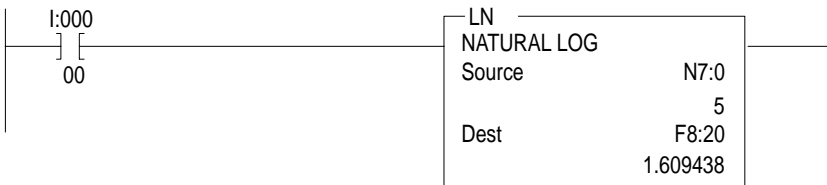
**Important:** PLC-5/V40L processors also scan extended-local I/O chassis (on channel 2) during housekeeping.

If no change in input status occurs and the processor continues to execute the same logic instructions, the program scan cycle remains consistent (in our example, at 25 ms). In real systems, however, the program scan cycle fluctuates due to the following factors:

- false logic executes faster than true logic
- different instructions execute at different rates
- different input states cause different sections of logic to be executed
- interrupt programs affect program scan times

**Effects of False versus True Logic on Scan Time**

The rung below—which changes states from one program scan to the next—will change your scan time by about 400  $\mu$ s.



If I:000/00 is:	Then the rung is:
On	true and the processor calculates the natural log. A natural-log instruction takes 409 $\mu$ s to execute
Off	false and the processor scans the rung but does not execute it. It takes only 1.4 $\mu$ s just to scan the rung.

Other instructions may have a greater or lesser effect.

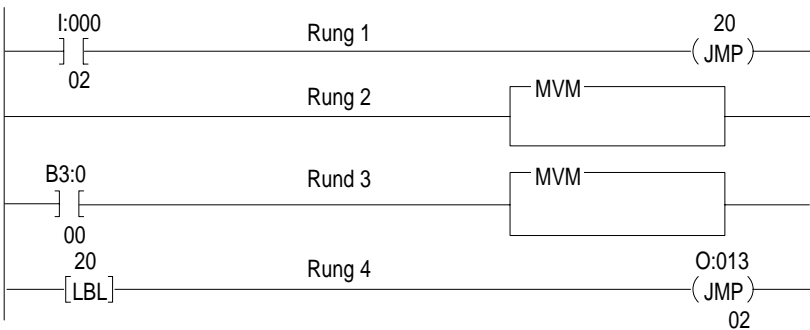
**Effects of Different Instructions on Logic Scan Time**

Some instructions have a much greater effect on logic scan time than others based on the time it takes to execute each instruction.

Program scan time is also affected by the basic construction of your ladder rungs. The sizes of rungs and the number of branches in each can cause the scan time to fluctuate greatly.

**Effects of Different Input States on Logic Scan Time**

You can write your logic so that it executes different rungs at different times, based on input conditions. The different amounts of logic executed in the logic scans causes differences in program scan times. For example, the simple differences in rung execution in the following example cause the logic scan times to vary.



If I:000/02 is:	Rungs 2 and 3 are:
On	Skipped
Off	Executed

If you use subroutines, program scan times can vary by the scan time of entire logic files.

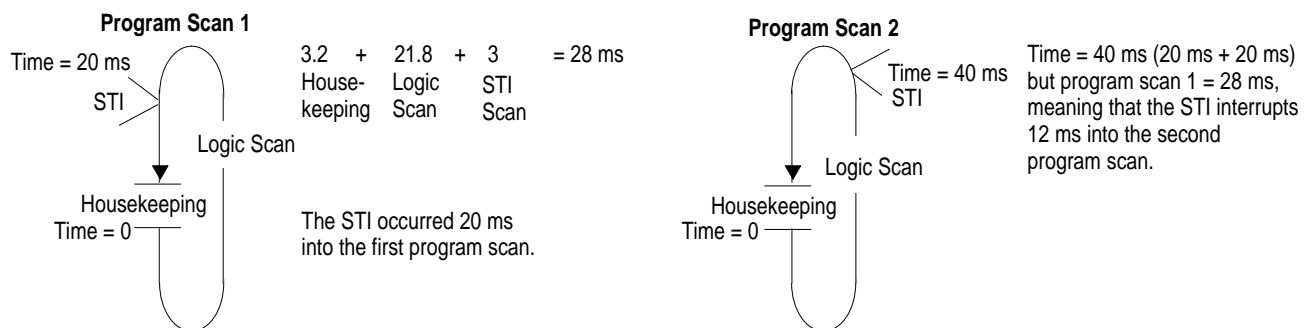
### Effects of Using Interrupts on Program Scan Time

Program scan time is also affected by interrupt programs. An interrupt is a special situation that causes a separate program to run independent of the normal logic scan. You define the special event and the type of interrupt that is to occur.

For example, a selectable timed interrupt (STI) is a program file that you define to execute once every time period. If :

- you configure an STI to execute every 20 ms
- the STI program takes 3 ms to execute
- the logic scan is 21.8 ms
- housekeeping takes 3.2 ms

the first program scan in this example lasts a total of 28 ms.



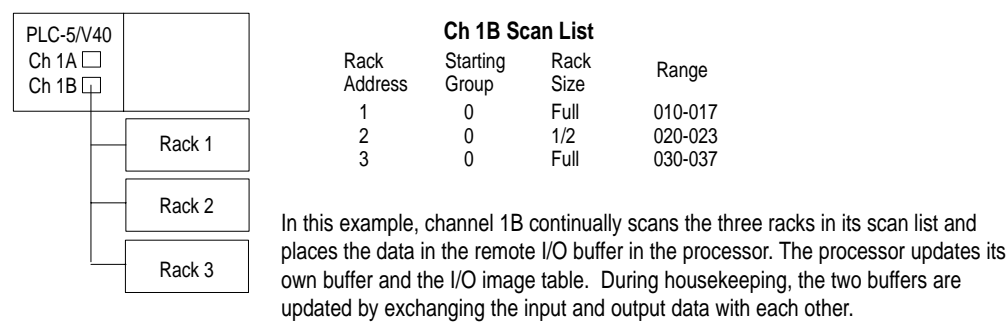
Since the first program scan takes 28 ms, the STI actually occurs 12 ms into the second program scan ( $28 + 12 = 40$ , which is the time for the second STI to occur). This example points out that when the STI time period is different than the program scan time, the STI occurs in different places in the program scan. Also note that, due to fluctuations in program-scan times, multiple STIs may be executed during one scan and no STIs during other scans.

When you enable VME interrupts on the PLC-5 processor, you must disable the corresponding levels of the VME host's interrupt-handling hardware. If you do not do this, and both the VME host and the PLC-5 processor try to handle the same interrupt level, a hardware race condition ensues and indeterminate interrupt processing may occur.

### I/O Scanning

The remote I/O scan cycle is the time that it takes for the processor (configured as a scanner) to communicate with all of the entries in its rack scan-list once. The remote I/O scan is independent of and asynchronous to the program scan.

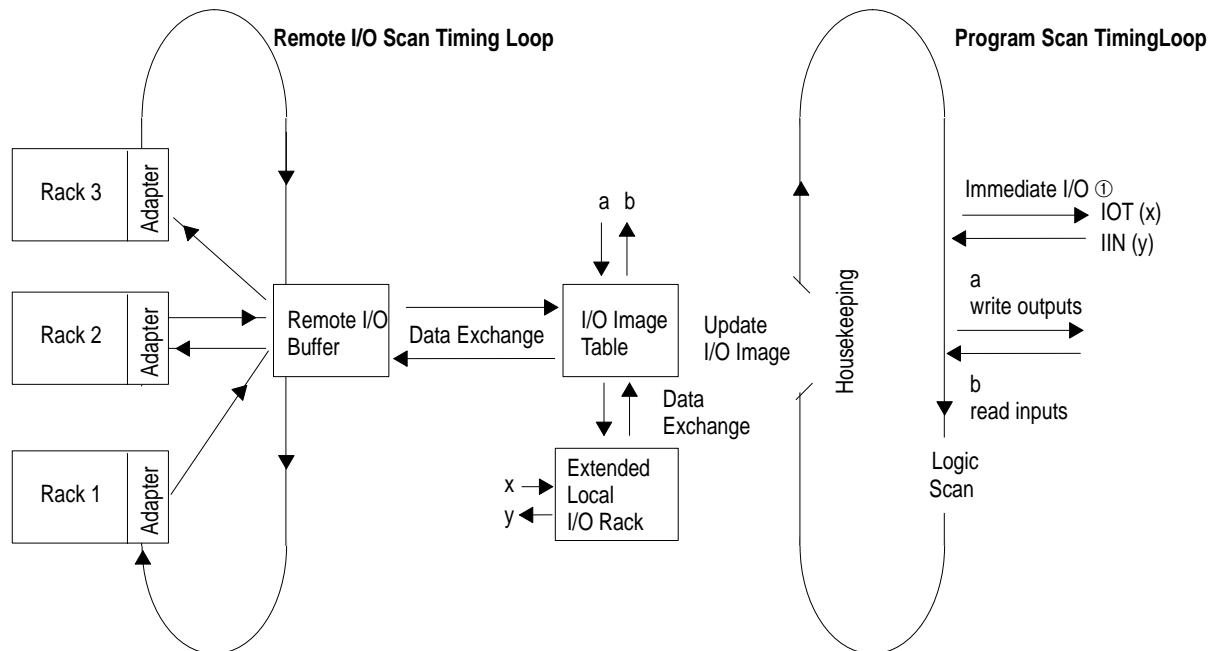
The scanner processor keeps a list of all of the devices connected to each remote I/O link. An example system would look like this:



**Important:** The remote I/O scan for each channel configured for scanner mode is independent and asynchronous to the remote I/O scan for any other channel.

Figure 7.1 shows timing loops for discrete data transfer in a PLC-5/VME processor.

### Figure 7.1 Remote I/O Scan and Program Scan Timing Loops



① The processor responds to immediate input (IIN) and immediate output (IOT) requests during the logic scan. The logic scan is suspended at the request for immediate input/output data. The logic scan resumes after obtaining the data and fulfilling the request.

IIN and IOT data transfer directly to and from I/O modules in extended-local I/O chassis.

With remote I/O, only the remote I/O buffer is updated.

For more information, see the instruction quick reference in chapter 22.

During the housekeeping portion of the program scan, the remote I/O buffer is updated. Remember that the I/O scanner is constantly updating the remote I/O buffer asynchronously to the program scan.

## Discrete and Block Transfer I/O Scanning

PLC-5/VME processors can transfer discrete data and block data to/from processor-resident local I/O, extended-local I/O chassis, and/or remote I/O chassis.

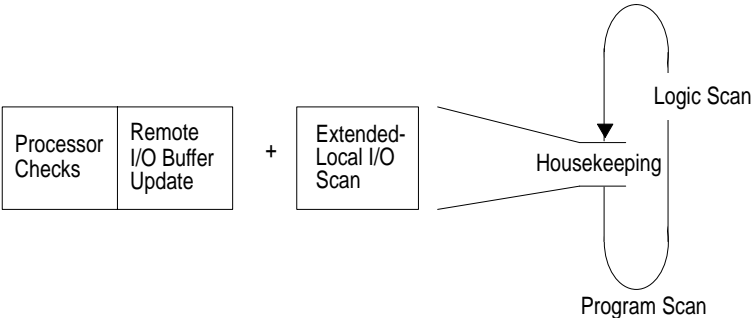
## Transferring Discrete Data

The remote I/O system is scanned in a separate and asynchronous scan to the program scan. The remote I/O scan takes output data from the remote I/O buffer to output modules and puts input data into the remote I/O buffer from input modules. The remote I/O scan time can take 3, 6, or 10 ms per one rack in a chassis on the remote I/O link, depending on baud rate. The PLC-5/VME processor then exchanges the input and output image table data with the remote I/O buffer during the I/O-update portion of housekeeping.

**Extended-Local I/O**

Processors that have extended-local I/O capability scan the extended-local I/O chassis (on channel 2) during the housekeeping portion of the program scan. Extended-local I/O discrete data is exchanged between the processor data-table image and the I/O in the extended-local I/O chassis. The time that it takes to scan extended-local I/O chassis is added to the housekeeping time. See Figure 7.2.

**Figure 7.2**  
**Extended-Local I/O Scan Time**



The time in ms that it takes to scan extended-local I/O chassis depends on the number of 1771-ALX adapter modules and the number of extended-local I/O logical racks. The formula used to calculate the total time to scan extended-local I/O chassis is:

$$\text{extended-local I/O scan time} = (0.32 \text{ ms} \times A) + (0.13 \text{ ms} \times L)$$

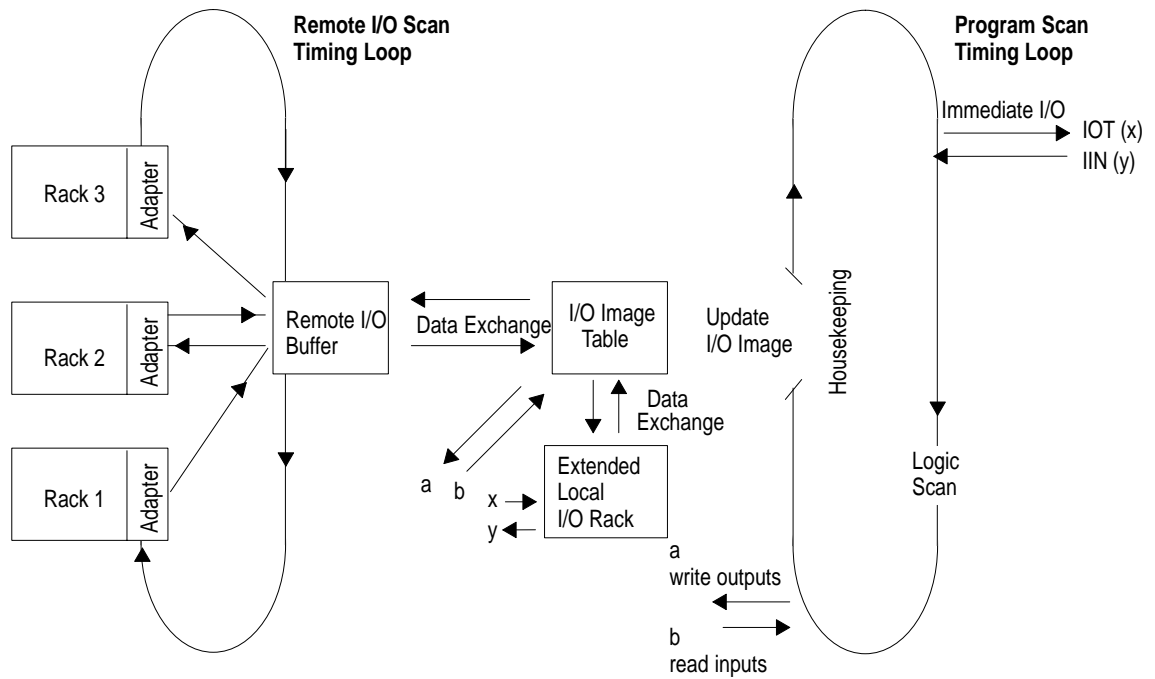
Where:	Is the:
<i>A</i>	number of 1771-ALX modules
<i>L</i>	number of logical racks in the extended-local I/O system

If you have three 1771-ALX modules in three chassis and a total of 4 logical racks, for example, the total time is calculated as follows:

$$\begin{aligned} \text{extended-local I/O scan time} &= (0.32 \text{ ms} \times 3) + (0.13 \text{ ms} \times 4) \\ \text{or} \\ \text{extended-local I/O scan time} &= 1.48 \text{ ms} \end{aligned}$$

$$\begin{aligned} \text{housekeeping time} &= 1.48 \text{ ms (extended-local I/O)} + 4.50 \text{ ms} \\ &\text{(other housekeeping) or} \\ \text{housekeeping time} &= 5.98 \text{ ms} \end{aligned}$$

**Figure 7.3**  
**PLC-5/V40L Timing Loops for Discrete Data Transfer**



### Immediate I/O

The processor responds to immediate input (IIN) and immediate output (IOT) requests during the logic scan. The logic scan is suspended at the request for immediate input/output data. The logic scan resumes after obtaining the data and fulfilling the request.

IIN and IOT data transfers directly to and from I/O modules in extended-local I/O chassis. With remote I/O, only the remote I/O buffer is updated.

### Transferring Block Data

The exchange of block-transfer data and the logic scan run independently and concurrently. The following sections explain block-transfer for extended-local I/O and then for remote I/O.

#### Extended-Local I/O

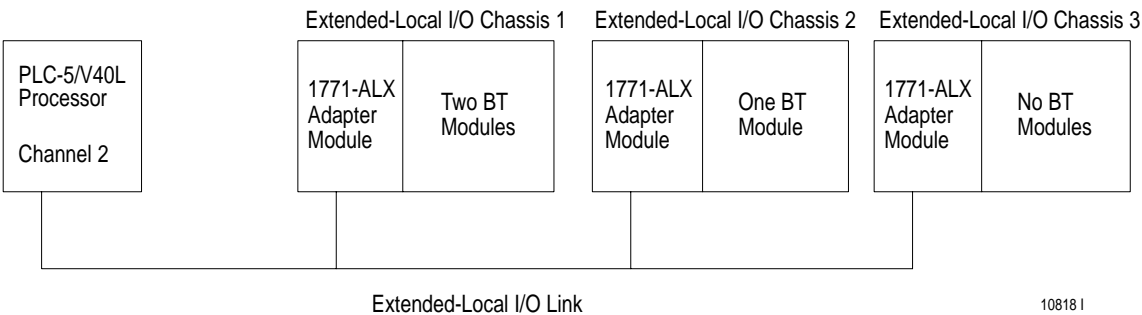
Requests for block-transfer data occur during the logic scan. Concurrent with the execution of the logic, block-transfer requests are forwarded to the appropriate 1771-ALX adapter module(s) and data is transferred. A 1771-ALX adapter module may start block-transfer operations to multiple slots and have block-transfer data transactions on-going in parallel within the 1771 chassis.

Block-transfer duration is the time interval between the enabling of the block-transfer instruction and the receipt of the done bit. The following example and formulas make two assumptions:

- block-transfer instructions are consecutively placed in the logic program
- block-transfer modules in the I/O chassis are ready to perform when operations are requested

The following example sets up a system and provides two formulas for calculating block-transfer timing. The first formula is a worst-case calculation for the completion of all block-transfers in the system. The second formula enables you to calculate the time to perform a block-transfer for any one block-transfer module in the system.

For example, a PLC-5/V40L may have three extended-local I/O chassis connected to channel 2. The first chassis contains two block-transfer modules; the second chassis contains one block-transfer module; and the third chassis does not contain block-transfer modules. It takes the logic scan 15 ms to complete; it takes housekeeping approximately 6 ms to complete (as calculated in the formula on page 7-13). The longest block-transfer request is 20 words.



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**Formula 1**—Worst-case time to complete all block-transfers in extended-local I/O system where block-transfer duration (in ms) =  $D \times R$

$$D = 2E \times L + (0.1W)$$

Where:	Is the:
E	number of extended-local chassis with block-transfer modules
L	largest number of block-transfer modules in any extended-local I/O chassis
W	number of words in the longest block-transfer request

$$D \text{ (ms)} = (2 \times 2) \times (2) + (0.1 \times 20) \text{ or } D = 10 \text{ ms}$$

$$R = 1 \text{ (when } D < \text{ logic scan time) } \text{ OR}$$

$$R = \frac{\text{Logic Scan} + \text{Housekeeping}}{\text{Logic Scan}}$$

In this example,

$$R = 1 \text{ (because the value of } D \text{ (10 ms)} < 15 \text{ ms logic scan time)}$$

$$\text{block-transfer duration (ms)} = 10 \times 1 \text{ or } 10 \text{ ms}$$

The block-transfer duration shown above does not affect logic scan time. This transfer of data occurs concurrent with execution of program logic.

**Formula 2**—Time for any one block-transfer in extended-local I/O system (calculate for chassis 2 with block-transfer request of 20 words) where block-transfer duration (in ms) =  $D \times R$

$$D \text{ (ms)} = 2C \times M + (0.1W)$$

Where:	Is the:
C	number of extended-local chassis with 1771-ALX adapter modules and block-transfer modules
M	number of block-transfer modules in the chassis of the module being calculated
W	number of words in block-transfer request being calculated

$$D \text{ (ms)} = (2 \times 2) \times (1) + (0.1 \times 20) \text{ or } D = 6 \text{ ms}$$

$$R = 1 \text{ (when } D < \text{ logic scan time) } \text{ OR}$$

$$R = \frac{\text{Logic Scan} + \text{Housekeeping}}{\text{Logic Scan}}$$

In this example,

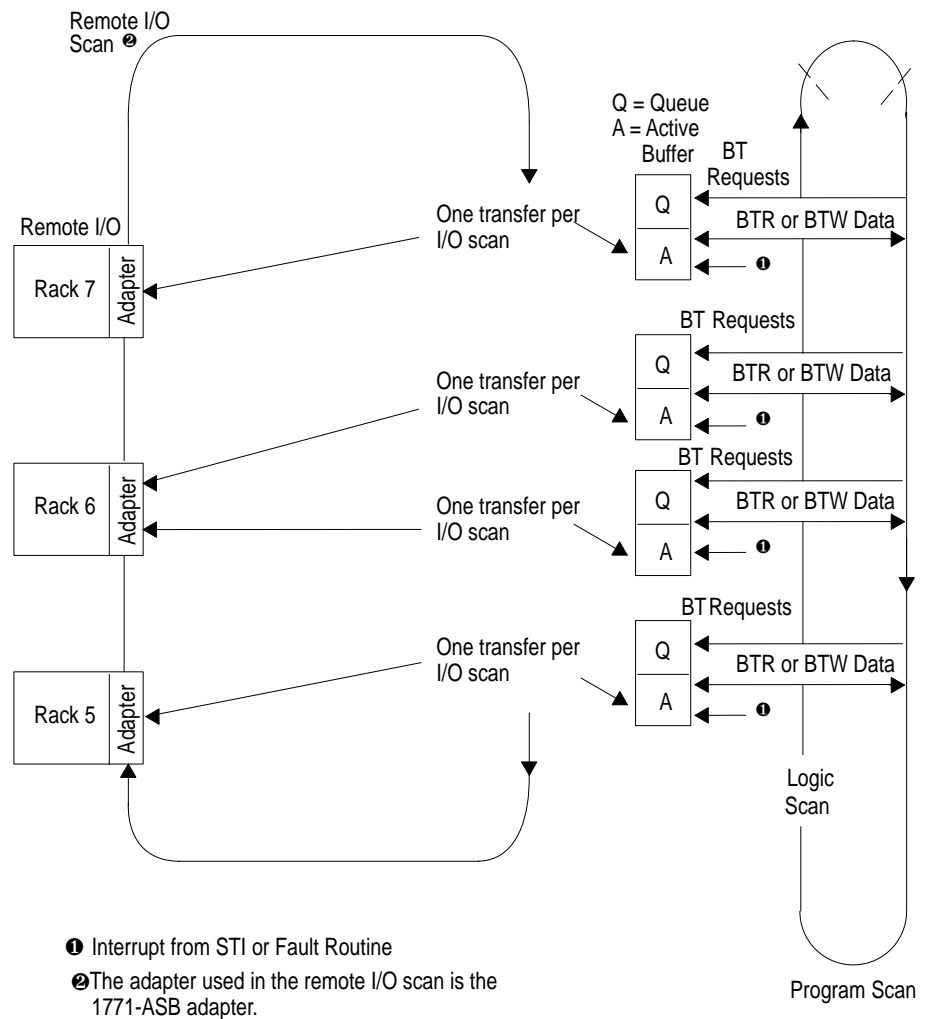
$R = 1$  because the value of  $D$  (6 ms) < 15 ms logic scan time  
block-transfer duration (ms) =  $6 \times 1$  or 6 ms

The block-transfer duration shown above does not affect logic scan time.  
This transfer of data occurs concurrent with execution of program logic.

### Remote I/O

The processor performs block transfers asynchronously to the program scan. The processor also interrupts the program scan asynchronously to momentarily access BTW and BTR data files. The processor performs one remote block transfer per addressed rack and per remote I/O scan. Figure 7.4 shows timing loops for block transfer from a PLC-5/VME processor.

**Figure 7.4**  
Transferring Block Data to Local and Remote I/O



## Sample Applications

### Appendix Objectives

Read this appendix to understand how to write applications in a separate VMEbus CPU to interact with your PLC-5/VME processor.

The following programs are C-language programs that interact with the PLC-5/VME processor from a separate CPU. The details of these programs vary depending on the CPU, operating system, and C-compiler used. These specific programs run on RadiSys Corporation VMEbus EPC (PC compatible) CPUs. The sample programs interact with the RadiSys' EPCConnect software library, which is a set of interfaces to the VMEbus hardware on the EPC CPUs.

For this application:	Refer to page:	For this make file:	Refer to page:
VMEDEMO.CPP	A-2	VMEDEMO.MAK	A-13
UPLOAD.CPP	A-15	UPLOAD.MAK	A-26
DOWNLOAD.CPP	A-27	DOWNLOAD.MAK	A-34



**ATTENTION:** Because of the variety of uses for the functions in these sample applications, the user and those responsible for applying this information must satisfy themselves that all the necessary steps have been taken to ensure that the application of this information meets all performance and safety requirements. In no event shall Allen-Bradley Company, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this information.

These sample applications are intended solely to illustrate the principles of using PCCC commands, Radisys VME Driver, and C programming. Allen-Bradley Company, Inc. cannot assume responsibility or liability (to include intellectual property liability) for actual use based on these samples.

**Note:** These sample applications are available on the Allen-Bradley SuppotPlus Bulletin Board [(216) 646-6728]. Download file VMEAPI.ZIP. This file also contains application programming interface (API) code.

## VMEDEMO.CPP

```

/*****
/***** INCLUDE FILES *****/
/*****
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <string.h>
#include <conio.h>
#include <dos.h>

#include "epc_obm.h"          // Radisys API Definitions
#include "epc_err.h"          // Radisys API Error Definitions
#include "busmgr.h"           // Radisys's VME Driver Definitions
#include "p40vcco.h"          // AB Continuous Copy Command Definitions
#include "p40vihas.h"         // AB PCCC Id Host and Status Definitions
#include "p40vspcc.h"         // AB Send PCCC Command Definitions
#include "common.h"           // Common AB Definitions

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
// A record which contains information concerning what continuous copy
// operation has been enabled. By using this record to store the data
// when the user enters it during the enable continuous copy menu choice,
// we can use this data to halt the continuous copy operation rather than
// asking the user for it...
typedef struct
{
    BOOL isInitialized;
    ULONG vmeCmdBlkAddr;
    UWORD baseAddr;
    UWORD fileNumber;
    UWORD elementNumber;
    UWORD wordCount;
    ULONG vmeDataAddr;
} CC_TYPE;

// A record which contains information concerning which PLC-5/VME has had
// its onboard VME enabled and where that memory has been placed in VME
// A24 address space. We can use this data when we want to disable the
// memory rather than asking the user for it...
typedef struct
{
    BOOL isInitialized;
    ULONG vmeSlaveAddr;
    UWORD baseAddr;
} MEM_TYPE;

/*****
/***** PRIVATE DEFINITIONS *****/
/*****

// Global to this file. It contains the continuous copy to information.
static CC_TYPE cc_to;

// Global to this file. It contains the continous copy from information.
static CC_TYPE cc_from;

// Global to this file. It contains the enabled PLC-5/VME memory info.
static MEM_TYPE mem;
```

```

/*****
/***** PRIVATE FUNCTIONS DEFINITIONS *****/
/*****
void display_status(PLC540V_STATUS_TYPE *status);
void test_init_cc_to_vme(void);
void test_halt_cc_to_vme(void);
void test_init_cc_from_vme(void);
void test_halt_cc_from_vme(void);
void test_disable_slave_memory(void);
void test_enable_slave_memory(void);
void test_epc_to_plc_global_memory(void);
void show_error(char *str);
void test_pccc_id(void);
char *get_key_mode(int keyMode);
void go(void);

/*****
/***** MAINLINE *****/
/*****

/*****
*
* PURPOSE:      This is the main function for the general VME demonstration
*               program.  This program implements a main menu to "test drive"
*               various PLC-5/VME and Radisys functions.
*
* INPUT:        None.
*
* OUTPUT:       None
*
* RETURNS:      This program will return 1 to the DOS shell if there is an
*               error and 0 if the program completed normally.
*
* EXAMPLE:
*               vmedemo <CR>
*
*               where:
*               <CR> is a carriage return
*
* BUILD ENVIRONMENT:
*               Borland C++ 3.0 compiler
*               Use the VMEDEMO.MAK makefile to build the executable.
*
* EDIT HISTORY:
*
*               Copyright Allen-Bradley Company, Inc. 1994
*
*****/
main()
{
    // Let's clear the screen
    clrscr();

    // Verify that the Radisys VME driver is present
    if (EpcCkBm() != EPC_SUCCESS)
    {
        show_error("Fatal Error: Bus manager not installed.");
        exit(1);
    }

    // Let's process menu selections...
    go();

```

```
// Goodbye
clrscr();
gotoxy(0, 0);

return(0);
}

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
/***** GO *****/
/*****

void go(void)
{
    // This function will continuously process the user's menu selections

    // Current menu selection
    int menuChoice = 0;

    // Current status of a PLC-5/VME operation
    PLC540V_STATUS_TYPE status;

    // Main menu title line
    static char *abTitle =
    "***** Allen-Bradley's VME Demo *****";

while(menuChoice != 100)
{
    /* Let's show the centered title on the first line. */
    clrscr();
    highvideo();
    gotoxy(1, 1);
    cprintf(abTitle);
    normvideo();

    /* Present the menu to the user. */
    gotoxy(20, 3); cprintf("1) Initiate continuous copy to VME.");
    gotoxy(20, 4); cprintf("2) Halt continuous copy to VME.");
    gotoxy(20, 5); cprintf("3) Initiate continuous copy from VME.");
    gotoxy(20, 6); cprintf("4) Halt continuous copy from VME.");
    gotoxy(20, 7); cprintf("5) Enable the PLC's slave memory.");
    gotoxy(20, 8); cprintf("6) Disable the PLC's slave memory.");
    gotoxy(20, 9); cprintf("7) Initiate EPC to PLC global memory test.");
    gotoxy(20, 10); cprintf("8) Do the PCCC id host & status test.");
    gotoxy(20, 11); cprintf("100) EXIT");
    highvideo();
    gotoxy(20, 20); cprintf("Enter a menu number:");
    gotoxy(46, 20);
    normvideo();

    // Get the user's selection
    scanf("%d", &menuChoice);
}
```

```
// Process the user's selection
switch(menuChoice)
{
    case 1:
        // Initiate a continuous copy operation from a PLC data file
        // to VME memory.
        test_init_cc_to_vme();
        break;

    case 2:
        // Stop a previously initiated continuous copy operation from
        // a PLC data file to VME memory.
        test_halt_cc_to_vme();
        break;

    case 3:
        // Initiate a continous copy operation from VME to a PLC data
        // file.
        test_init_cc_from_vme();
        break;

    case 4:
        // Stop a previously initiated continuous copy operation from
        // VME to a PLC data file.
        test_halt_cc_from_vme();
        break;

    case 5:
        // Enable the PLC-5/VME's VME memory.
        test_enable_slave_memory();
        break;

    case 6:
        // Disable the PLC-5/VME's VME memory.
        test_disable_slave_memory();
        break;

    case 7:
        // Continuously write values to VME memory and have the
        // PLC read them and write to a SIM card.
        test_epc_to_plc_global_memory();
        break;

    case 8:
        // Get the PLC-5/VME's identity and status info.
        test_pccc_id();
        break;

    case 100:
        // Quit
        break;

    default:
        // OOps... An error!
        show_error("Error: Invalid menu choice");
}
}
```

```

/*****
/***** SHOW_ERROR *****/
/*****
void show_error(char *str)
{
    // This function will inform the user of an error.

    gotoxy(20, 16);
    highvideo();
    cprintf(str);
    gotoxy(20, 17);
    cprintf("Press the backspace key to continue...");
    while(!kbhit());
    gotoxy(20, 16);
    clreol();
    gotoxy(20, 17);
    clreol();
    normvideo();
}

/*****
/***** TEST_EPC_TO_PLC_GLOBAL_MEMORY *****/
/*****
void test_epc_to_plc_global_memory(void)
{
    // This routine will instruct the EPC to write the values from
    // 0 to 255 to VME shared global memory and then the PLC-5/40V
    // will read the value and send it to a SIM module for display.

    ///// WARNING! THIS ROUTINE EXPECTS VME ADDRESS E00000 EXISTS! /////

    // A loop counter
    short i;

    // Tell the user how to exit this demo
    clrscr();
    gotoxy(20, 10);
    cprintf("Press the backspace key when you wish to exit this demo...");

    // While the user doesn't touch the keyboard, show the value and send it
    // to VME using the Radisys driver.
    while (!kbhit())
    {
        if ((i >= 0) && (i <= 255))
        {
            // Write the value to VME memory. */
            gotoxy(20, 12);
            cprintf("Sending this value to global VME memory: ");
            gotoxy(61, 12);
            cprintf("%03d", i);

            EpcToVmeAm(BM_MBO | A24SD, BM_W16, (char far *) &i, 0xE00000, 2);

            // Up our counter...
            i++;
        }
        else
        {
            // Reset the value to zero so it is within the range of
            // numbers that can be displayed on the SIM card.
            i = 0;
        }
    }
}

```



```

/*****
/***** TEST_PCCC_ID *****/
/*****
void test_pccc_id(void)
{
    // This function will test the PCCC Id Host & Status command.

    // Address where to store command block
    ULONG vmeCmdBlkAddr = 0;

    // Address where the PLC-5/VME's registers exists
    UWORD baseAddr = 0;

    // Status information
    PLC540V_STATUS_TYPE status;

    // Id Host & Status reply info
    PLC540V_PCCC_IHAS_RPY_TYPE reply;

    // Clear the screen and get the desired command block and processor info
    clrscr();
    gotoxy(0, 10);
    cprintf(
        "Enter the VME command block address in hex (for the A24 addr space): ";
    scanf("%lx", &vmeCmdBlkAddr);
    gotoxy(0, 11);
    cprintf("Enter the base address for the PLC-5/40V in hex: ");
    scanf("%x", &baseAddr);

    // Ask the PLC for its identity and status info
    plc540v_pccc_id_host_and_status(
        vmeCmdBlkAddr,
        baseAddr,
        kVME_D16_DATA_WIDTH,
        kVME_A24_ADDR_SPACE,
        &reply,
        &status);

    // Show the important data
    gotoxy(20, 13);
    cprintf("Processor Series:      %c", reply.plcStatus.series + 'A');
    gotoxy(20, 14);
    cprintf("Processor Revision:      %c", reply.plcStatus.revision + 'A');
    gotoxy(20, 15);
    cprintf("Station Number:          %05d", reply.plcStatus.stationNumber);
    gotoxy(20, 16);
    cprintf("Key Switch Mode:         %s", get_key_mode(reply.plcStatus.keyswitchMode));
    gotoxy(20, 17);
    cprintf("Major Faults:           %s",
        reply.plcStatus.majorFault == kPLC540V_NO_MAJOR_FAULT ? "False": "True");
    gotoxy(20, 18);
    cprintf("Memory Size (words):     %05ld", reply.plcStatus.memorySize/2);
    gotoxy(20, 19);
    cprintf("Data Table File Count:   %05d", reply.plcStatus.dataTableFileCount);
    gotoxy(20, 20);
    cprintf("Program File Count:      %05d", reply.plcStatus.programFileCount);

    gotoxy(20, 24);
    cprintf("Press the backspace key to continue...");
    while(!kbhit());
    gotoxy(20, 24);
    clreol();
    normvideo();

    display_status(&status);
}

```

```

/*****
/***** GET_KEY_MODE *****/
/*****
char *get_key_mode(int keyMode)
{
    // Return a string which textually described the state of the key
    // switch on the PLC.

    static char mode[80+1];
    switch (keyMode)
    {
        case kPLC540V_PROGRAM_LOAD:
            strcpy(mode, "Program Load");
            break;

        case kPLC540V_RUN:
            strcpy(mode, "Run");
            break;

        case kPLC540V_REMOTE_PROGRAM_LOAD:
            strcpy(mode, "Remote Program Load");
            break;

        case kPLC540V_REMOTE_TEST:
            strcpy(mode, "Remote Test");
            break;

        case kPLC540V_REMOTE_RUN:
            strcpy(mode, "Remote Run");
            break;
    }

    return(mode);
}

/*****
/***** TEST_ENABLE_SLAVE_MEMORY *****/
/*****
void test_enable_slave_memory(void)
{
    // Enable the onboard VME memory on the PLC-5/VME processor.

    // Status information
    PLC540V_STATUS_TYPE status;

    // A list of all the PLC's in this VME chassis. We will use a list of 1.
    LOCATED_PLC540V_ARRAY_TYPE plcList;

    // Prepare the records which will contain info concerning the enabled
    // VME memory for the PLC.
    memset((char *) &plcList, 0x0, sizeof(LOCATED_PLC540V_ARRAY_TYPE));
    memset((char *) &mem, 0x0, sizeof(MEM_TYPE));
    mem.isInitialized = 1;

    // Ask the user for the target PLC's base address and where they want
    // to locate the PLC's memory in VME space.
    clrscr();
    gotoxy(0, 10);
    cprintf(
"Enter the desired VME slave address for the PLC (for the A24 addr space): ";
    scanf("%lx", &mem.vmeSlaveAddr);
    gotoxy(0, 11);
    cprintf("Enter the base address for the PLC-5/40V in hex: ");
    scanf("%x", &mem.baseAddr);

```

```

    plcList[0] = mem.baseAddr;

    // Turn on the memory on the PLC at the requested VME location.
    plc540v_enable_shared_memory(plcList[0], mem.vmeSlaveAddr, &status);

    display_status(&status);
}

/*****
/***** TEST_DISABLE_SLAVE_MEMORY *****/
/*****
void test_disable_slave_memory(void)
{
    // Disable the VME memory on a PLC-5/VME processor.

    // Status info
    PLC540V_STATUS_TYPE status;

    // A list of PLC's in the VME chassis. This is a list of 1.
    LOCATED_PLC540V_ARRAY_TYPE plcList;

    // Verify that they have already enabled the VME memory
    if (mem.isInitialized == 0)
    {
        show_error("You must first enable the PLC slave memory.");
        return;
    }

    memset((char *) &plcList, 0x0, sizeof(LOCATED_PLC540V_ARRAY_TYPE));
    plcList[0] = mem.baseAddr;

    // Turn off the memory.
    plc540v_disable_shared_memory(plcList[0], mem.vmeSlaveAddr, &status);

    display_status(&status);
}

/*****
/***** TEST_INIT_CC_TO_VME *****/
/*****
void test_init_cc_to_vme(void)
{
    // Initiate a continuous copy from a PLC data file to VME memory.

    // Status information
    PLC540V_STATUS_TYPE status;

    memset((char *) &cc_to, 0x0, sizeof(CC_TYPE));
    cc_to.isInitialized = 1;

```

```
// Get the continuous copy information from the user.
clrscr();
gotoxy(0, 10);
cprintf(
    "Enter the VME command block address in hex (for the A24 addr space): ");
scanf("%lx", &cc_to.vmeCmdBlkAddr);
gotoxy(0, 11);
cprintf("Enter the base address for the PLC-5/40V in hex: ");
scanf("%x", &cc_to.baseAddr);
gotoxy(0, 12);
cprintf("Enter the VME data address in hex (for the A24 addr space): ");
scanf("%lx", &cc_to.vmeDataAddr);
gotoxy(0, 13);
cprintf("Enter the file number to be copied from: ");
scanf("%d", &cc_to.fileNumber);
gotoxy(0, 14);
cprintf("Enter the element number to be copied from: ");
scanf("%d", &cc_to.elementNumber);
gotoxy(0, 15);
cprintf("Enter the number of words to be copied: ");
scanf("%d", &cc_to.wordCount);

// Start the continuous copy operation...
plc540v_init_cont_copy_to_VME(
    cc_to.vmeDataAddr,
    cc_to.wordCount,
    cc_to.vmeCmdBlkAddr,
    cc_to.baseAddr,
    kVME_D16_DATA_WIDTH,
    kVME_A24_ADDR_SPACE,
    cc_to.fileNumber,
    cc_to.elementNumber,
    kVME_NO_INT_LEVEL,
    0,
    kVME_NO_INT_LEVEL,
    0,
    &status);

display_status(&status);
}

/*****/
/***** TEST_HALT_CC_TO_VME *****/
/*****/
void test_halt_cc_to_vme(void)
{
    // Disables the previous started continuous copy from a PLC data file to
    // VME memory.

    // Status information
    PLC540V_STATUS_TYPE status;

    // Verify that a continuous copy operation has been initialized.
    if (cc_to.isInitialized == 0)
    {
        show_error("You must first initialize continuous copy to VME.");
        return;
    }
}
```

```
// Stop the continuous copy operation...
plc540v_halt_cont_copy_to_VME(
    cc_to.vmeDataAddr,
    cc_to.wordCount,
    cc_to.vmeCmdBlkAddr,
    cc_to.baseAddr,
    kVME_D16_DATA_WIDTH,
    kVME_A24_ADDR_SPACE,
    cc_to.fileNumber,
    cc_to.elementNumber,
    kVME_NO_INT_LEVEL,
    0,
    kVME_NO_INT_LEVEL,
    0,
    &status);

    display_status(&status);
}

/*****
/***** TEST_INIT_CC_FROM_VME *****/
/*****/
void test_init_cc_from_vme(void)
{
    // Initiate a continuous copy to a PLC data file from VME memory.

    // Status information
    PLC540V_STATUS_TYPE status;

    memset((char *) &cc_from, 0x0, sizeof(CC_TYPE));
    cc_from.isInitialized = 1;

    // Get the continuous copy information
    clrscr();
    gotoxy(0, 10);
    cprintf(
        "Enter the VME command block address in hex (for the A24 addr space): ");
    scanf("%lx", &cc_from.vmeCmdBlkAddr);
    gotoxy(0, 11);
    cprintf("Enter the base address for the PLC-5/40V in hex: ");
    scanf("%x", &cc_from.baseAddr);
    gotoxy(0, 12);
    cprintf("Enter the VME data address in hex (for the A24 addr space): ");
    scanf("%lx", &cc_from.vmeDataAddr);
    gotoxy(0, 13);
    cprintf("Enter the file number to be copied to: ");
    scanf("%d", &cc_from.fileNumber);
    gotoxy(0, 14);
    cprintf("Enter the element number to be copied to: ");
    scanf("%d", &cc_from.elementNumber);
    gotoxy(0, 15);
    cprintf("Enter the number of words to be copied: ");
    scanf("%d", &cc_from.wordCount);
}
```

```
// Initiate the continuous copy from VME to a PLC data file
plc540v_init_cont_copy_from_VME(
    cc_from.vmeDataAddr,
    cc_from.wordCount,
    cc_from.vmeCmdBlkAddr,
    cc_from.baseAddr,
    kVME_D16_DATA_WIDTH,
    kVME_A24_ADDR_SPACE,
    cc_from.fileNumber,
    cc_from.elementNumber,
    kVME_NO_INT_LEVEL,
    0,
    kVME_NO_INT_LEVEL,
    0,
    &status);

    display_status(&status);
}

/*****
/***** TEST_HALT_CC_FROM_VME *****/
/*****/
void test_halt_cc_from_vme(void)
{
    // Disables the previous started continuous copy to a PLC data file from
    // VME memory.

    // Status information
    PLC540V_STATUS_TYPE status;

    // Verify that a continuous copy operation has been initialized.
    if (cc_from.isInitialized == 0)
    {
        show_error("You must first initialize continuous copy from VME.");
        return;
    }

    // Stop the continuous copy operation...
    plc540v_halt_cont_copy_from_VME(
        cc_from.vmeDataAddr,
        cc_from.wordCount,
        cc_from.vmeCmdBlkAddr,
        cc_from.baseAddr,
        kVME_D16_DATA_WIDTH,
        kVME_A24_ADDR_SPACE,
        cc_from.fileNumber,
        cc_from.elementNumber,
        kVME_NO_INT_LEVEL,
        0,
        kVME_NO_INT_LEVEL,
        0,
        &status);

    display_status(&status);
}
```

```

/*****
/***** DISPLAY_STATUS *****/
/*****
void display_status(PLC540V_STATUS_TYPE *status)
{
    // This function determines if the status was an error.  If so, it will
    // display a specific error type to the screen.  Three areas can create
    // errors: The PLC-5/VME Processor, the EPC Driver or PCCC commands.

    char buf[80+1];
    if (status->plc540vStatus != 0)
    {
        cprintf("\7\7\7");
        switch(status->statusCategory)
        {
            case kPLC540V_STATUS:
                sprintf(buf, "%s: 0x%04x", status->plc540vStatus);
                show_error(buf);
                break;

            case kEPC_STATUS:
                sprintf(buf, "%s: %04d", status->epcStatus);
                show_error(buf);
                break;

            case kPCCC_STATUS:
                sprintf(buf, "%s: 0x%04x", status->pcccStatus.value);
                show_error(buf);
                break;

            default:
                show_error("Unknown error!");
        }
    }
}

```

## VMEDMO.MAK

```

.AUTODEPEND

#                *Translator Definitions*
CC = bcc +VMEDMO.CFG
TASM = TASM
TLIB = tlib
TLINK = tlink
LIBPATH = C:\BORLANDC\LIB
INCLUDEPATH = C:\BORLANDC\INCLUDE

#                *Implicit Rules*
.c.obj:
    $(CC) -c {$< }

.cpp.obj:
    $(CC) -c {$< }

#                *List Macros*

```

```
EXE_dependencies = \  
p40vihas.obj \  
common.obj \  
p40vcco.obj \  
p40vspcc.obj \  
vmedemo.obj \  
{$(LIBPATH)}bmclib.lib  
  
#           *Explicit Rules*  
vmedemo.exe: vmedemo.cfg $(EXE_dependencies)  
$(TLINK) /v/x/n/P-/L$(LIBPATH) @&&|  
c0l.obj+  
p40vihas.obj+  
common.obj+  
p40vcco.obj+  
p40vspcc.obj+  
vmedemo.obj  
vmedemo  
# no map file  
bmclib.lib+  
emu.lib+  
mathl.lib+  
cl.lib  
|  
  
#           *Individual File Dependencies*  
p40vihas.obj: vmedemo.cfg p40vihas.c  
  
common.obj: vmedemo.cfg common.c  
  
p40vcco.obj: vmedemo.cfg p40vcco.c  
  
p40vspcc.obj: vmedemo.cfg p40vspcc.c  
  
vmedemo.obj: vmedemo.cfg vmedemo.cpp
```



```
#                *Compiler Configuration File*
vmedemo.cfg: vmedemo.mak
  copy &&|
-mt
-v
-y
-vi
-w-ret
-w-nci
-w-inl
-wpin
-wamb
-wamp
-w-par
-wasm
-wcln
-w-cpt
-wdef
-w-dup
-w-pia
-wsig
-wnod
-w-ill
-w-sus
-wstv
-wucp
-wuse
-w-ext
-w-ias
-w-ibc
-w-pre
-w-nst
-IS$(INCLUDEPATH)
-L$(LIBPATH)
-P
| vmedemo.cfg
```

## UPLOAD.CPP

```
/*
*****
***** INCLUDE FILES *****
*****
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include <string.h>

#include "busmgr.h"          // Radisys's VME driver definitions
#include "pccc.h"            // Generic Allen-Bradley (AB) PCCC definitions
#include "p40vger.h"         // AB PCCC Get Edit Resource
#include "p40vrer.h"         // AB PCCC Return Edit Resource
#include "p40vrpc.h"         // AB PCCC Restore Port Configuration
#include "p40vrpb.h"         // AB PCCC Read Bytes Physical
#include "p40vihas.h"        // AB PCCC Id Host and Status
#include "p40vula.h"         // AB PCCC Upload All
#include "p40vulc.h"         // AB PCCC Upload Complete
#include "p40vscm.h"         // AB PCCC Set CPU Mode

/*
*****
***** PRIVATE DEFINITIONS *****
*****
// PLC-5/40V is using 0x900000 for VME communications.
const unsigned long kvmeSlaveAddress = 0x900000L;
```

```
// PLC-5/40V is using ULA0 which is 0xFC00
const unsigned short kplc540vUla = 0xFC00;

// This is the number of bytes to be read from the PLC-5/40V.
const unsigned short kReadSize = kPLC540V_PCCC_MAX_RBP_DATA;

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
// The "bucket" that we are using to writing the PLC data, address and length
// to the output file.
#pragma pack(1)
typedef struct
{
    // The PLC memory address
    unsigned long plcAddress;

    // The number of bytes of PLC data in this packet.
    unsigned short plcDataLength;

    // The PLC data...
    unsigned char plcData[kReadSize];
}FILE_PACKET_TYPE;
#pragma pack()

/*****
/***** PRIVATE FUNCTIONS DEFINITIONS *****/
/*****
unsigned long extract_start_pointer(char far *data);
unsigned long extract_end_pointer(char far *data);
unsigned long calc_segment_size(unsigned long startPointer, unsigned long endPointer);
unsigned short calc_physical_read_count(unsigned long segmentSize);
unsigned short calc_final_phys_read_size(unsigned long segmentSize);
void show_upload_statistics(PLC540V_PCCC_ULA_RPY_TYPE *replyPacket);
void read_plc_to_file(unsigned long readAddr, FILE *out,
                     unsigned short readSize, unsigned short readCount);
void upload_is_complete(void);
void upload_all(PLC540V_PCCC_ULA_RPY_TYPE *replyPacket);
void get_edit_resource(void);
void return_edit_resource(void);
void restore_port_configuration(void);
void plc_in_remote_program_mode(void);
void check_for_faults(void);
```

```

/*****
/***** MAINLINE *****/
/*****

*
* PURPOSE:   This is the main function for the upload demonstration
*            program. This program implements the algorithm to
*            successfully save the entire processor memory of the
*            PLC-5/40V to a disk file on the Radisys EPC-4. Please
*            note that this implementation will also save the current
*            port configurations so they can be restored as part of
*            the physical restore procedure.
*
* INPUT:     You must supply a filename on the command line. This name
*            will be used for the output file which is created on the
*            Radisys EPC-4. If the file already exists, it will be
*            overwritten without any warning!
*
* OUTPUT:    When this program exits to the shell (under normal and error
*            conditions), it will have created the output file which was
*            specified on the command line.
*
* RETURNS:   This program will return 1 to the DOS shell if there is an
*            error and 0 if the program completed normally.
*
* EXAMPLE:   upload procmem.sav <CR>
*
*            where:
*                procmen.sav is the output file
*                <CR> is a carriage return
*
* BUILD ENVIRONMENT:
*            Borland C++ 3.0 compiler
*            Use the UPLOAD.MAK makefile to build the executable.
*
* EDIT HISTORY:
*
*            Copyright Allen-Bradley Company, Inc. 1994
*
*****/

```

```

main(int argc, char *argv[])
{
    // The segment pointers
    unsigned short physicalReadCount = 0;
    unsigned short finalPhysicalReadSize = 0;
    unsigned long segmentSize = 0L;
    unsigned long readAddr = 0L;
    unsigned long endPointer = 0L;

    // The reply packet from the physical bytes read
    PLC540V_PCCC_ULA_RPY_TYPE replyPacket;

    // Loop counter
    register int i;

    // The output file pointer
    FILE *out;

    // Validate the command line...
    if (argc != 2)
    {
        printf("\nUSAGE: upload save_file_name");
        exit(1);
    }
}

```

```
// Open the output file for saving PLC memory.
if ((out = fopen(argv[1], "w+b")) == NULL)
{
    printf("\n\nFailed to open %s file", argv[1]);
    exit(1);
}

// Make certain the processor is in remote program mode
plc_in_remote_program_mode();

// Make certain there are no faults...
check_for_faults();

// Get the edit resource from the processor.
get_edit_resource();

// Ensure that the current port configuration will be saved in the
// physical image.
restore_port_configuration();

// Issue the upload all request.
upload_all(&replyPacket);

// Show upload stats and dump the reply packet contents
printf("\n\nUpload all request was successful.");
show_upload_statistics(&replyPacket);

// Now let's read the PLC memory and write it to a file.
// Let's get the starting address to read from and other
// statistics. The PLC-5/V40 currently has only one segment
readAddr = extract_start_pointer(replyPacket.data);
endPointer = extract_end_pointer(replyPacket.data);
segmentSize=calc_segment_size(readAddr, endPointer);
physicalReadCount=calc_physical_read_count(segmentSize);
finalPhysicalReadSize=calc_final_phys_read_size(segmentSize);

// Let's upload each kReadSize chunk of memory from the
// PLC and write it to disk. The final read may or may
// not be necessary. It is handled outside of this loop.

// REMEMBER... PHYSICAL READ COUNT IS FOR THE NUMBER OF FULL READS...
// YOU WILL STILL NEED TO DETERMINE IF AN ADDITIONAL ONE IS
// NECESSARY FOR THE FINAL NON-FULL READ. FOR EXAMPLE, IF
// YOU ARE GOING TO UPLOAD 101912 BYTES AND WILL BE READING
// 244 BYTES AT A TIME, YOU WILL PERFORM 417 FULL READS AND
// ONE ADDITIONAL ONE OF 164 BYTES.

for (i=0; i<physicalReadCount; i++)
{
    read_plc_to_file(readAddr, out, kReadSize, i+1);
    readAddr = readAddr + kReadSize;
}

// Determine if there are any left over bytes to read.
// They may exist because the number of bytes wasn't an
// exact multiple of kReadSize.
if (finalPhysicalReadSize != 0)
{
    printf("\n\nFinal Physical Read Required:");
    read_plc_to_file(readAddr, out,
        finalPhysicalReadSize, i+1);
}
```

```

        printf("\n\nFinal Address: 0x%08.8lx",
               readAddr + finalPhysicalReadSize);
    }

    // Close the output file
    fclose(out);

    // Upload Complete command.
    upload_is_complete();

    // Return the edit resource to the processor.
    return_edit_resource();

    printf("\n\nUpload was successfully completed.");

    return 0;
}

/*****
/***** PRIVATE FUNCTIONS *****/
/*****/

/*****/
/*****/ GET_EDIT_RESOURCE *****/
/*****/
void get_edit_resource(void)
{
    // This function will ask the processor for the edit resource.

    PLC540V_PCCC_GER_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

    plc540v_pccc_get_edit_resource(kvmeSlaveAddress,
                                   kplc540vUla,
                                   KVME_D16_DATA_WIDTH,
                                   KVME_A24_ADDR_SPACE,
                                   &replyPacket,
                                   &status);

    if(status.plc540vStatus != 0)
    {
        printf("\nGetting the edit resource failed.");
        exit(1);
    }
}

/*****/
/*****/ RETURN_EDIT_RESOURCE *****/
/*****/
void return_edit_resource(void)
{
    // This function will attempt to return the edit resource to the
    // processor

    PLC540V_PCCC_RER_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

```

```

    plc540v_pccc_return_edit_resource(kvmeSlaveAddress,
                                     kplc540vUla,
                                     kVME_D16_DATA_WIDTH,
                                     kVME_A24_ADDR_SPACE,
                                     &replyPacket,
                                     &status);
    if(status.plc540vStatus != 0)
    {
        printf("\nReturning the edit resource failed.");
        exit(1);
    }
}

/*****
/***** RESTORE_PORT_CONFIGURATION *****/
/*****
void restore_port_configuration(void)
{
    // This function will make certain that the current port configuration
    // information FOR ALL THE CHANNELS is saved when a physical save is
    // performed.

    PLC540V_PCCC_RPC_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

    plc540v_pccc_restore_port_config(kvmeSlaveAddress,
                                     kplc540vUla,
                                     kVME_D16_DATA_WIDTH,
                                     kVME_A24_ADDR_SPACE,
                                     &replyPacket,
                                     &status);
    if(status.plc540vStatus != 0)
    {
        printf("\nRestoring port configurations failed.");
        exit(1);
    }
}

/*****
/***** PLC_IN_REMOTE_PROGRAM_MODE *****/
/*****
void plc_in_remote_program_mode(void)
{
    PLC540V_PCCC_IHAS_RPY_TYPE replyPacket;
    PLC540V_PCCC_SCM_RPY_TYPE scmReplyPacket;
    PLC540V_STATUS_TYPE status;
    PLC540V_PCCC_SCM_CTLMODE_TYPE ctlMode;

    ctlMode.modeSelect=kPLC540V_SCM_PROGRAM_LOAD_MODE;

    plc540v_pccc_id_host_and_status(kvmeSlaveAddress,
                                    kplc540vUla,
                                    kVME_D16_DATA_WIDTH,
                                    kVME_A24_ADDR_SPACE,
                                    &replyPacket,
                                    &status);

    if (status.plc540vStatus != 0)
    {
        printf("\nGetting the PLC's keyswitch mode failed.");
        exit(1);
    }
}

```

```

else
{
    if (replyPacket.plcStatus.keyswitchMode!=kPLC540V_REMOTE_PROGRAM_LOAD)
    {
        printf("\nPLC is not in remote program mode.");
        printf("\n\tAttempting to change its mode to program load...");
        plc540v_pccc_set_cpu_mode(kvmeSlaveAddress,
                                kplc540vUla,
                                kVME_D16_DATA_WIDTH,
                                kVME_A24_ADDR_SPACE,
                                ctlMode,
                                &scmReplyPacket,
                                &status);

        if (status.plc540vStatus != 0)
        {
            printf("   FAILED");
            exit(1);
        }
        else
            printf("   OK...");
    }
}

}

/*****
/***** CHECK_FOR_FAULTS *****/
/*****
void check_for_faults(void)
{
    // This function will check the processor for any faults.

    PLC540V_PCCC_IHAS_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

    plc540v_pccc_id_host_and_status(kvmeSlaveAddress,
                                    kplc540vUla,
                                    kVME_D16_DATA_WIDTH,
                                    kVME_A24_ADDR_SPACE,
                                    &replyPacket,
                                    &status);

    if (status.plc540vStatus != 0)
    {
        printf("\nChecking the PLC for faults failed.");
        exit(1);
    }
    else
    {
        // Check for major faults...
        if (replyPacket.plcStatus.majorFault != 0)
        {
            printf("\nProcessor has major faults so we cannot continue.");
            exit(1);
        }

        // Check for bad RAM...
        if (replyPacket.plcStatus.ramInvalid != 0)
        {
            printf("\nProcessor has bad RAM so we cannot continue.");
            exit(1);
        }
    }
}
}

```

```

/*****
/*****  EXTRACT_START_POINTER  *****/
/*****
unsigned long extract_start_pointer(char far *data)
{
    // This function will extract the starting pointer to the segment.

    unsigned long startPoint = 0L;
    unsigned long far *ptr = NULL;

    // Set a pointer to the first segment address and extract the long.
    (char *) ptr = &data[1];
    startPoint = *ptr;

    return(startPoint);
}

/*****
/*****  EXTRACT_END_POINTER  *****/
/*****
unsigned long extract_end_pointer(char far *data)
{
    // This function will extract the ending segment address.

    unsigned long endPoint = 0L;
    unsigned long far *ptr = NULL;

    // Set a pointer to the second segment address and extract the long.
    (char *) ptr = &data[5];
    endPoint = *ptr;

    return(endPoint);
}

/*****
/*****  CALC_SEGMENT_SIZE  *****/
/*****
unsigned long calc_segment_size(unsigned long startPoint,
                               unsigned long endPoint)
{
    // Calculate the size of the segment.
    return(endPoint - startPoint + 1);
}

/*****
/*****  CALC_PHYSICAL_READ_COUNT  *****/
/*****
unsigned short calc_physical_read_count(unsigned long segmentSize)
{
    // Returns the number of physical reads which will be necessary
    // to read the entire segment. This calculation assumes that
    // we are reading kReadSize bytes at a time.

    // REMEMBER... THIS COUNT IS FOR THE NUMBER OF FULL READS...
    // YOU WILL STILL NEED TO DETERMINE IF AN ADDITIONAL ONE IS
    // NECESSARY FOR THE FINAL NON-FULL READ. FOR EXAMPLE, IF
    // YOU ARE GOING TO UPLOAD 101912 BYTES AND WILL BE READING
    // 244 BYTES AT A TIME, YOU WILL PERFORM 417 FULL READS AND
    // ONE ADDITIONAL ONE OF 164 BYTES.

    return(segmentSize / kReadSize);
}

```



```

/*****
/*****  CALC_FINAL_PHYS_READ_SIZE  *****/
/*****
unsigned short calc_final_phys_read_size(unsigned long segmentSize)
{
    // Returns the number of bytes we will need to read to get the
    // last remaining bytes of memory. In other words, if the amount
    // of memory wasn't an exact multiple of kReadSize.

    return(segmentSize % kReadSize);
}

/*****
/*****  SHOW_UPLOAD_STATISTICS  *****/
/*****
void show_upload_statistics(PLC540V_PCCC_ULA_RPY_TYPE *replyPacket)
{
    // Dump upload statistics to the terminal.

    unsigned long segmentSize = 0L;
    unsigned short physicalReadCount = 0;
    unsigned short finalPhysicalReadSize = 0;
    unsigned long startPoint = 0L;
    unsigned long endPoint = 0L;
    PCCC_RPY_PKT_TYPE *replyPointer;
    char *ptr;

    // Extract and calculate the upload parameters.
    startPoint = extract_start_pointer(replyPacket->data);
    endPoint = extract_end_pointer(replyPacket->data);
    segmentSize=calc_segment_size(startPoint, endPoint);
    physicalReadCount=calc_physical_read_count(segmentSize);
    finalPhysicalReadSize=calc_final_phys_read_size(segmentSize);

    // Display the stats...
    printf("\n\nUpload Statistics:");
    printf("\n\tStart Pointer: 0x%08.8lx", startPoint);
    printf("\n\tEnd Pointer: 0x%08.8lx", endPoint);
    printf("\n\tSegment Size: 0x%08.8lx (%lu)", segmentSize, segmentSize);
    printf("\n\tPhysical Read Count (w/o possible final read): 0x%04x (%u)",
        physicalReadCount, physicalReadCount);
    printf("\n\tFinal Physical Read Size: 0x%04x (%u)",
        finalPhysicalReadSize, finalPhysicalReadSize);

    ptr = (char *) replyPacket;
    replyPointer = (PCCC_RPY_PKT_TYPE *) ptr;

    printf("\n\nReply Packet Contents:");
    printf("\n\tlnh First Byte: %x", replyPointer->lnhFirstByte);
    printf("\n\tlnh Second Byte: %x", replyPointer->lnhSecondByte);
    printf("\n\tdst: %x", replyPointer->dstRpyPkt);
    printf("\n\tpsn: %x", replyPointer->psn1RpyPkt);
    printf("\n\tsrc: %x", replyPointer->srcRpyPkt);
    printf("\n\tpsn: %x", replyPointer->psn2RpyPkt);
    printf("\n\tcommand: %x", replyPointer->command);
    printf("\n\tremote error: %x", replyPointer->remoteError);
    printf("\n\ttns: %x", replyPointer->tns);

    // The PLC-5/40V always responds with a single segment and its
    // compare segment. Let's dump their contents.
    printf("\n\nMemory Segment Information:");
    printf("\n\tSegment 1 lng: %x", replyPointer->optionalData[0]);

```

```

printf("\n\tSegment 1 Start Pointer: %x %x %x %x",
        replyPointer->optionalData[1],
        replyPointer->optionalData[2],
        replyPointer->optionalData[3],
        replyPointer->optionalData[4]);
printf("\n\tSegment 1 End Pointer: %x %x %x %x",
        replyPointer->optionalData[5],
        replyPointer->optionalData[6],
        replyPointer->optionalData[7],
        replyPointer->optionalData[8]);
printf("\n\tCompare 1 lng: %x", replyPointer->optionalData[9]);
printf("\n\tCompare 1 Start Pointer: %x %x %x %x",
        replyPointer->optionalData[10],
        replyPointer->optionalData[11],
        replyPointer->optionalData[12],
        replyPointer->optionalData[13]);
printf("\n\tCompare 1 End Pointer: %x %x %x %x",
        replyPointer->optionalData[14],
        replyPointer->optionalData[15],
        replyPointer->optionalData[16],
        replyPointer->optionalData[17]);
printf("\n\nUploading Log:\n");
}

/*****
/***** READ_PLC_TO_FILE *****/
/*****
void read_plc_to_file(unsigned long readAddr, FILE *out,
        unsigned short readSize, unsigned short readCount)
{
    // Read the specified memory and write it to the output file.

    PLC540V_STATUS_TYPE status;
    PLC540V_PCCC_RBP_RPY_TYPE replyPacket;
    FILE_PACKET_TYPE filePacket;

    // Initialize the file packet
    memset((char *) &filePacket, 0x0, sizeof(FILE_PACKET_TYPE));

    // Display the address we are reading.
    printf("\n\tCnt: %d, Uploading Address: 0x%08.8lx, Size: %d",
            readCount, readAddr, readSize);

    // Send the read command and wait for the reply
    plc540v_pccc_read_bytes_physical(kvmeSlaveAddress,
            kplc540vUla,
            kvme_D16_DATA_WIDTH,
            kvme_A24_ADDR_SPACE,
            readAddr,
            readSize,
            &replyPacket,
            &status);

    if (status.plc540vStatus != 0)
    {
        printf("\n%s %s 0x%08.8lx",
                "Read Bytes Physical reply failed",
                "at address:",
                readAddr);
        exit(1);
    }
    else
    {
        // Write the read packet and address to
        // the output file.

```

```

// Save this read address in the file packet
filePacket.plcAddress = readAddr;

// Save this read length in the file packet
filePacket.plcDataLength = readSize;

// Save the plc data into the file packet
memmove((char *) &filePacket.plcData,
        (char *) &replyPacket.data[0],
        readSize);
fwrite((char *) &filePacket, 1, sizeof(FILE_PACKET_TYPE), out);
}
}

/*****
/***** UPLOAD_IS_COMPLETE *****/
/*****
void upload_is_complete(void)
{
    // Tell the processor that the upload is now completed.

    PLC540V_PCCC_ULC_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

    plc540v_pccc_upload_complete(kvmeSlaveAddress,
                                kplc540vUla,
                                kVME_D16_DATA_WIDTH,
                                kVME_A24_ADDR_SPACE,
                                &replyPacket,
                                &status);

    if(status.plc540vStatus != 0)
    {
        printf("\nUpload Complete command failed.");
        exit(1);
    }
}

/*****
/***** UPLOAD_ALL *****/
/*****
void upload_all(PLC540V_PCCC_ULA_RPY_TYPE *replyPacket)
{
    // Issue the upload all request.

    PLC540V_STATUS_TYPE status;

    plc540v_pccc_upload_all(kvmeSlaveAddress,
                            kplc540vUla,
                            kVME_D16_DATA_WIDTH,
                            kVME_A24_ADDR_SPACE,
                            replyPacket,
                            &status);

    if(status.plc540vStatus != 0)
    {
        printf("\nUpload All command failed.");
        exit(1);
    }
}
}

```

## UPLOAD.MAK

```
.AUTODEPEND

#                      *Translator Definitions*
CC = bcc +UPLOAD.CFG
TASM = TASM
TLIB = tlib
TLINK = tlink
LIBPATH = C:\BORLANDC\LIB
INCLUDEPATH = C:\BORLANDC\INCLUDE

#                      *Implicit Rules*
.c.obj:
    $(CC) -c {$< }

.cpp.obj:
    $(CC) -c {$< }

#                      *List Macros*

EXE_dependencies = \
    p40vula.obj \
    p40vulc.obj \
    p40vrbp.obj \
    p40vihas.obj \
    p40vrpc.obj \
    p40vrer.obj \
    p40vger.obj \
    common.obj \
    p40vspcc.obj \
    p40vscm.obj \
    upload.obj \
    {$(LIBPATH)}bmclib.lib

#                      *Explicit Rules*
upload.exe: upload.cfg $(EXE_dependencies)
    $(TLINK) /v/x/n/P-/L$(LIBPATH) @&&|
c0l.obj+
p40vula.obj+
p40vulc.obj+
p40vrbp.obj+
p40vihas.obj+
p40vrpc.obj+
p40vrer.obj+
p40vger.obj+
common.obj+
p40vspcc.obj+
p40vscm.obj+
upload.obj
upload
    # no map file
bmclib.lib+
emu.lib+
mathl.lib+
cl.lib
|

#                      *Individual File Dependencies*
p40vula.obj: upload.cfg p40vula.c

p40vulc.obj: upload.cfg p40vulc.c

p40vrbp.obj: upload.cfg p40vrbp.c
```

```
p40vihas.obj: upload.cfg p40vihas.c

p40vrpc.obj: upload.cfg p40vrpc.c

p40vrer.obj: upload.cfg p40vrer.c

p40vger.obj: upload.cfg p40vger.c

common.obj: upload.cfg common.c

p40vspcc.obj: upload.cfg p40vspcc.c

p40vscm.obj: upload.cfg p40vscm.c

upload.obj: upload.cfg upload.cpp

#           *Compiler Configuration File*
upload.cfg: upload.mak
    copy &&|
-m1
-v
-y
-vi
-w-ret
-w-nci
-w-inl
-wpin
-wamb
-wamp
-w-par
-wasm
-wcln
-w-cpt
-wdef
-w-dup
-w-pia
-wsig
-wnod
-w-ill
-w-sus
-wstv
-wucp
-wuse
-w-ext
-w-ias
-w-ibc
-w-pre
-w-nst
-I$(INCLUDEPATH)
-L$(LIBPATH)
-P
| upload.cfg
```

## DOWNLOAD.CPP

```

/*****
/***** INCLUDE FILES *****/
/*****
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include <string.h>
```

```
#include "busmgr.h"           // Radisys's VME driver definitions
#include "pccc.h"             // Generic Allen-Bradley (AB) PCCC definitions
#include "p40vger.h"          // AB PCCC Get Edit Resource
#include "p40vrer.h"          // AB PCCC Return Edit Resource
#include "p40vapc.h"          // AB PCCC Apply Port Configuration
#include "p40vwbp.h"          // AB PCCC Write Bytes Physical
#include "p40vihas.h"         // AB PCCC Id Host and Status
#include "p40vdla.h"          // AB PCCC Download All
#include "p40vdlc.h"          // AB PCCC Download Complete
#include "p40vscm.h"          // AB PCCC Set CPU Mode

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
// PLC-5/40V is using 0x900000 for VME communications.
const unsigned long kvmeSlaveAddress = 0x900000L;

// PLC-5/40V is using ULA0 which is 0xFC00
const unsigned short kplc540vUla = 0xFC00;

// This is the number of bytes to be written to the PLC-5/40V.
const unsigned short kWriteSize = kPLC540V_PCCC_MAX_WBP_DATA;

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
// The "bucket" that we are using to writing the PLC data, address and length
// to the output file.
#pragma pack(1)
typedef struct
{
    // The PLC memory address
    unsigned long plcAddress;

    // The number of bytes of PLC data in this packet.
    unsigned short plcDataLength;

    // The PLC data...
    unsigned char plcData[kWriteSize];
}FILE_PACKET_TYPE;
#pragma pack()

/*****
/***** PRIVATE FUNCTIONS DEFINITIONS *****/
/*****
void write_filepacket_to_plc(FILE_PACKET_TYPE *filePacket, UWORD writeCounter);
void download_is_complete(void);
void download_all(void);
void get_edit_resource(void);
void return_edit_resource(void);
void apply_port_configuration(void);
void plc_in_remote_program_mode(void);
void check_for_faults(void);

/*****
/***** MAINLINE *****/
/*****
```

```

/*****
*
* PURPOSE:      This is the main function for the download demonstration
*               program. This program implements the algorithm to
*               successfully restore the entire physical processor memory of
*               the PLC-5/40V from a disk file on the Radisys EPC-4. Please
*               note that this implementation will also restore the saved
*               port configurations.
*
* INPUT:        You must supply a filename on the command line. This name
*               is the image of processor memory which was created using
*               the upload sample application.
*
* OUTPUT:       When this program exits to the shell (under normal and error
*               conditions), it will have restored the processor's memory
*               and port configurations.
*
* RETURNS:      This program will return 1 to the DOS shell if there is an
*               error and 0 if the program completed normally.
*
* EXAMPLE:
*
*               download procmem.sav <CR>
*
*               where:
*                   procmen.sav is the processor image file
*                   <CR> is a carriage return
*
* BUILD ENVIRONMENT:
*               Borland C++ 3.0 compiler
*               Use the DOWNLOAD.MAK makefile to build the executable.
*
* EDIT HISTORY:
*
*               Copyright Allen-Bradley Company, Inc. 1994
*
*****/
main(int argc, char *argv[])
{
    // A "bucket" of information from the physical save image file.
    FILE_PACKET_TYPE filePacket;

    // A counter of the number of writes being done.
    UWORD writeCounter = 1;

    // The output file pointer
    FILE *in;

    // A flag indicating that more filePackets exist to be read from
    // the input file.
    int moreFilePackets = 0;

    // Validate the command line...
    if (argc != 2)
    {
        printf("\nUSAGE: download save_file_name");
        exit(1);
    }

    // Open the input file for restoring PLC memory.
    if ((in = fopen(argv[1], "r+b")) == NULL)
    {
        printf("\n\nFailed to open %s file", argv[1]);
        exit(1);
    }
}

```

```

// Make certain the processor is in remote program mode
plc_in_remote_program_mode();

// Make certain there are no faults...
check_for_faults();

// Issue the download all request.
download_all();

// Let's read the file "bucket"...
memset((char *) &filePacket, 0x0, sizeof(FILE_PACKET_TYPE));

// Now let's attempt to read the first filePacket...
moreFilePackets = fread((char *) &filePacket, 1,
                        sizeof(FILE_PACKET_TYPE), in);

// While there are filePackets to process... Let's do them!
while (moreFilePackets)
{
    // Let's download each kWriteSize chunk of memory from the
    // file to the PLC.
    write_filepacket_to_plc(&filePacket, writeCounter);
    writeCounter++;

    // Let's clear and read the file "bucket"...
    memset((char *) &filePacket, 0x0, sizeof(FILE_PACKET_TYPE));
    moreFilePackets = fread((char *) &filePacket, 1,
                            sizeof(FILE_PACKET_TYPE), in);
}

// Close the input file
fclose(in);

// Download Complete command.
download_is_complete();

// Get the edit resource from the processor.
get_edit_resource();

// Apply the port configuration
apply_port_configuration();

// Return the edit resource to the processor.
return_edit_resource();

printf("\n\nDownload was successfully completed.");

return 0;
}

/*****
/***** PRIVATE FUNCTIONS *****/
/*****/

/*****/
/***** GET_EDIT_RESOURCE *****/
/*****/
void get_edit_resource(void)
{
    // This function will ask the processor for the edit resource.

    PLC540V_PCCC_GER_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

```



```

plc540v_pccc_get_edit_resource(kvmeSlaveAddress,
                               kplc540vUla,
                               kVME_D16_DATA_WIDTH,
                               kVME_A24_ADDR_SPACE,
                               &replyPacket,
                               &status);

if(status.plc540vStatus != 0)
{
    printf("\nGetting the edit resource failed.");
    exit(1);
}
}

/*****/
/*****/ RETURN_EDIT_RESOURCE *****/
/*****/
void return_edit_resource(void)
{
    // This function will attempt to return the edit resource to the
    // processor

    PLC540V_PCCC_RER_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

    plc540v_pccc_return_edit_resource(kvmeSlaveAddress,
                                      kplc540vUla,
                                      kVME_D16_DATA_WIDTH,
                                      kVME_A24_ADDR_SPACE,
                                      &replyPacket,
                                      &status);

    if(status.plc540vStatus != 0)
    {
        printf("\nReturning the edit resource failed.");
        exit(1);
    }
}

/*****/
/*****/ APPLY_PORT_CONFIGURATION *****/
/*****/
void apply_port_configuration(void)
{
    // This function will make certain that the port configuration
    // information FOR ALL THE CHANNELS is restored when a physical restore
    // is performed.

    PLC540V_PCCC_APC_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

    plc540v_pccc_apply_port_config(kvmeSlaveAddress,
                                   kplc540vUla,
                                   kVME_D16_DATA_WIDTH,
                                   kVME_A24_ADDR_SPACE,
                                   &replyPacket,
                                   &status);

    if(status.plc540vStatus != 0)
    {
        printf("\nApplying port configurations failed.");
        exit(1);
    }
}
}

```

```

/*****
/*****  PLC_IN_REMOTE_PROGRAM_MODE *****/
/*****
void plc_in_remote_program_mode(void)
{
    PLC540V_PCCC_IHAS_RPY_TYPE replyPacket;
    PLC540V_PCCC_SCM_RPY_TYPE scmReplyPacket;
    PLC540V_STATUS_TYPE status;
    PLC540V_PCCC_SCM_CTLMODE_TYPE ctlMode;

    ctlMode.modeSelect=kPLC540V_SCM_PROGRAM_LOAD_MODE;

    plc540v_pccc_id_host_and_status(kvmeSlaveAddress,
                                    kplc540vUla,
                                    kVME_D16_DATA_WIDTH,
                                    kVME_A24_ADDR_SPACE,
                                    &replyPacket,
                                    &status);

    if (status.plc540vStatus != 0)
    {
        printf("\nGetting the PLC's keyswitch mode failed.");
        exit(1);
    }
    else
    {
        if (replyPacket.plcStatus.keyswitchMode!=kPLC540V_REMOTE_PROGRAM_LOAD)
        {
            printf("\nPLC is not in remote program mode.");
            printf("\n\tAttempting to change its mode to program load...");
            plc540v_pccc_set_cpu_mode(kvmeSlaveAddress,
                                      kplc540vUla,
                                      kVME_D16_DATA_WIDTH,
                                      kVME_A24_ADDR_SPACE,
                                      ctlMode,
                                      &scmReplyPacket,
                                      &status);

            if (status.plc540vStatus != 0)
            {
                printf("  FAILED");
                exit(1);
            }
            else
                printf("  OK...");
        }
    }
}

/*****
/*****  CHECK_FOR_FAULTS *****/
/*****
void check_for_faults(void)
{
    // This function will check the processor for any faults.

    PLC540V_PCCC_IHAS_RPY_TYPE replyPacket;
    PLC540V_STATUS_TYPE status;

    plc540v_pccc_id_host_and_status(kvmeSlaveAddress,
                                    kplc540vUla,
                                    kVME_D16_DATA_WIDTH,
                                    kVME_A24_ADDR_SPACE,
                                    &replyPacket,
                                    &status);

```

```

if (status.plc540vStatus != 0)
{
    printf("\nChecking the PLC for faults failed.");
    exit(1);
}
else
{
    // Check for major faults...
    if (replyPacket.plcStatus.majorFault != 0)
    {
        printf("\nProcessor has major faults so we cannot continue.");
        exit(1);
    }

    // Check for bad RAM...
    if (replyPacket.plcStatus.ramInvalid != 0)
    {
        printf("\nProcessor has bad RAM so we cannot continue.");
        exit(1);
    }
}
}

/*****
/***** WRITE_FILEPACKET_TO_PLC *****/
/*****
void write_filepacket_to_plc(FILE_PACKET_TYPE *filePacket, UWORD writeCounter)
{
    // Write the file packet to the PLC.

    PLC540V_STATUS_TYPE status;
    PLC540V_PCCC_WBP_RPY_TYPE replyPacket;

    // Display the address we are writing...
    printf("\n\tCnt: %d, Downloading Address: 0x%08.8lx, Size: %u",
        writeCounter, filePacket->plcAddress, filePacket->plcDataLength);

    // Send the write command and wait for the reply
    plc540v_pccc_write_bytes_physical(kvmeSlaveAddress,
        kplc540vUla,
        kVME_D16_DATA_WIDTH,
        kVME_A24_ADDR_SPACE,
        filePacket->plcAddress,
        &filePacket->plcData[0],
        filePacket->plcDataLength,
        &replyPacket,
        &status);

    if (status.plc540vStatus != 0)
    {
        printf("\n%s %s 0x%08.8lx",
            "Write Bytes Physical reply failed",
            "at address:",
            filePacket->plcAddress);
        exit(1);
    }
}

/*****
/***** DOWNLOAD_IS_COMPLETE *****/
/*****
void download_is_complete(void)
{
    // Tell the processor that the download is now completed.

```

```

PLC540V_PCCC_DLC_RPY_TYPE replyPacket;
PLC540V_STATUS_TYPE status;

plc540v_pccc_download_complete(kvmeSlaveAddress,
                               kplc540vUla,
                               kvME_D16_DATA_WIDTH,
                               kvME_A24_ADDR_SPACE,
                               &replyPacket,
                               &status);

if(status.plc540vStatus != 0)
{
    printf("\nDownload Complete command failed.");
    exit(1);
}
}

/*****/
/***** DOWNLOAD_ALL *****/
/*****/
void download_all(void)
{
    // Issue the download all request.

    PLC540V_STATUS_TYPE status;
    PLC540V_PCCC_DLA_RPY_TYPE replyPacket;

    plc540v_pccc_download_all(kvmeSlaveAddress,
                              kplc540vUla,
                              kvME_D16_DATA_WIDTH,
                              kvME_A24_ADDR_SPACE,
                              &replyPacket,
                              &status);

    if(status.plc540vStatus != 0)
    {
        printf("\nDownload All command failed.");
        exit(1);
    }
}

```

## DOWNLOAD.MAK

```

.AUTODEPEND

#           *Translator Definitions*
CC = bcc +DOWNLOAD.CFG
TASM = TASM
TLIB = tlib
TLINK = tlink
LIBPATH = C:\BORLANDC\LIB
INCLUDEPATH = C:\BORLANDC\INCLUDE

#           *Implicit Rules*
.c.obj:
    $(CC) -c {< }

.cpp.obj:
    $(CC) -c {< }

#           *List Macros*

```

```

EXE_dependencies = \
p40vdla.obj \
p40vdlc.obj \
p40vwbp.obj \
p40vihas.obj \
p40vapc.obj \
p40vrer.obj \
p40vger.obj \
common.obj \
p40vspcc.obj \
download.obj \
{$(LIBPATH)}bmclib.lib \
p40vscm.obj

#               *Explicit Rules*
download.exe: download.cfg $(EXE_dependencies)
    $(TLINK) /v/x/n/P-/L$(LIBPATH) @&&|
c0l.obj+
p40vdla.obj+
p40vdlc.obj+
p40vwbp.obj+
p40vihas.obj+
p40vapc.obj+
p40vrer.obj+
p40vger.obj+
common.obj+
p40vspcc.obj+
download.obj+
p40vscm.obj
download
    # no map file

bmclib.lib+
emu.lib+
mathl.lib+
cl.lib
|

#               *Individual File Dependencies*
p40vdla.obj: download.cfg p40vdla.c

p40vdlc.obj: download.cfg p40vdlc.c

p40vwbp.obj: download.cfg p40vwbp.c

p40vihas.obj: download.cfg p40vihas.c

p40vapc.obj: download.cfg p40vapc.c

p40vrer.obj: download.cfg p40vrer.c

p40vger.obj: download.cfg p40vger.c

common.obj: download.cfg common.c

p40vspcc.obj: download.cfg p40vspcc.c

download.obj: download.cfg download.cpp

p40vscm.obj: download.cfg p40vscm.c

```

```
#                *Compiler Configuration File*
download.cfg: download.mak
    copy &&|
-m1
-v
-y
-vi
-w-ret
-w-nci
-w-inl
-wpin
-wamb
-wamp
-w-par
-wasm
-wcln
-w-cpt
-wdef
-w-dup
-w-pia
-wsig
-wnod
-w-ill
-w-sus
-wstv
-wucp
-wuse
-w-ext
-w-ias
-w-ibc
-w-pre
-w-nst
-IS $(INCLUDEPATH)
-L $(LIBPATH)
-P
| download.cfg
```

## Sample Application Programming Interface Modules

### Appendix Objectives

Read this appendix to understand how to write an application programming interface (API) module to interact with your PLC-5/VME processor.

The modules in this appendix are C-language programs that interact with the PLC-5/VME processor.



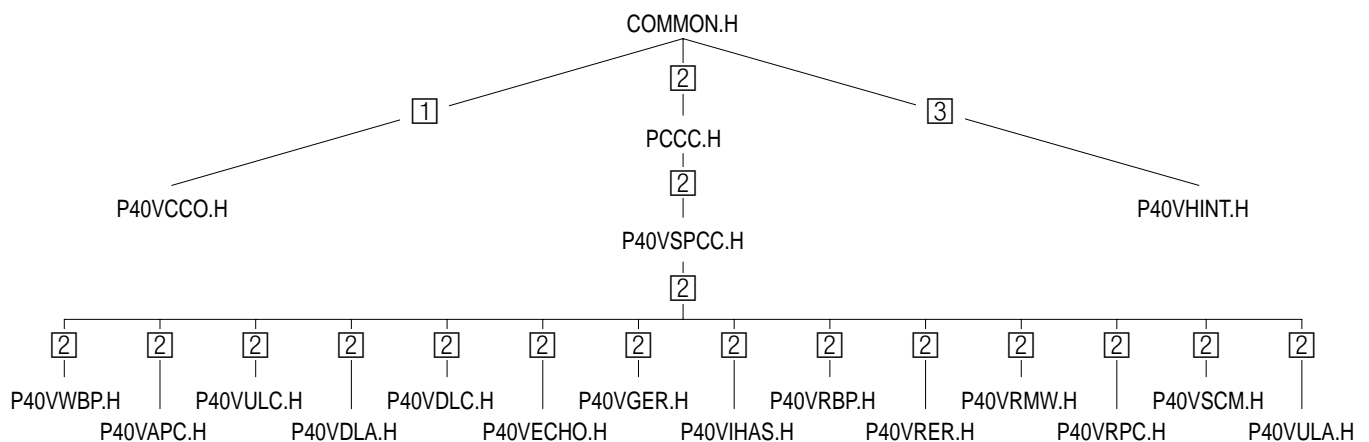
**ATTENTION:** Because of the variety of uses for the functions in these sample applications, the user and those responsible for applying this information must satisfy themselves that all the necessary steps have been taken to ensure that the application of this information meets all performance and safety requirements. In no event shall Allen-Bradley Company, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this information.

These sample applications are intended solely to illustrate the principles of using PCCC commands, Radisys VME Driver, and C programming. Allen-Bradley Company, Inc. cannot assume responsibility or liability (to include intellectual property liability) for actual use based on these samples.

**Note:** These sample API modules are also available on the Allen-Bradley SuppotPlus Bulletin Board [(216) 646-6728]. Download file VMEAPI.ZIP. This file also contains three sample applications.

For this header file:	Refer to page:	For this source file:	Refer to page:
COMMON.H	B-3	COMMON.C	B-5
P40VCCO.H	B-17	P40VCCO.C	B-18
PCCC.H	B-30	PCCC.C	B-32
P40VHINT.H	B-32	P40VHINT.C	B-33
P40VSPCC.H	B-39	P40VSPCC.C	B-40
P40VWBP.H	B-43	P40VWBP.C	B-44
P40VAPC.H	B-46	P40VAPC.C	B-47
P40VULC.H	B-49	P40VULC.C	B-50
P40VDLA.H	B-52	P40VDLA.C	B-53
P40VDLC.H	B-55	P40VDLC.C	B-56
P40VECHO.H	B-58	P40VECHO.C	B-59
P40VGER.H	B-61	P40VGER.C	B-62
P40VIHAS.H	B-64	P40VIHAS.C	B-67
P40VRBP.H	B-69	P40VRBP.C	B-70
P40VRER.H	B-72	P40VRER.C	B-73
P40VRMW.H	B-75	P40VRMW.C	B-76
P40VRPC.H	B-80	P40VRPC.C	B-81
P40VSCM.H	B-83	P40VSCM.C	B-84
P40VULA.H	B-86	P40VULA.C	B-87

**Figure B.1**  
**API Module Dependencies**



- 1 Dependencies for continuous-copy commands
- 2 Dependencies for PCCC commands
- 3 Dependencies for handling VME interrupt commands



## COMMON.H

```
#ifndef COMMON_H
#define COMMON_H 1

//////////////////////////////////////
//          Definitions for the COMMON USE THROUGHOUT THE API          //
//////////////////////////////////////

/* Macros to access the high and low word of an unsigned long. */
#define HIWORD(a) ((unsigned short) ((unsigned long) a >> 16))
#define LOWORD(a) ((unsigned short) ((unsigned long) a & 0x0000FFFF))

// Common type definitions...
typedef unsigned char  UBYTE;
typedef signed char    SBYTE;
typedef unsigned short UWORD;
typedef signed short   SWORD;
typedef unsigned long  ULONG;
typedef signed long    SLONG;

typedef unsigned char BOOL;
#define kTRUE 1
#define kFALSE 0

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
typedef enum
{
    kPLC540V_SUCCESS=0,
    kPLC540V_FAILURE=257,
    kPLC540V_READ_REGISTER_FAILED=258,
    kPLC540V_WRITE_REGISTER_FAILED=259,
    kPLC540V_NOT_READY=260,
    kPLC540V_NOT_PASSED=261,
    kPLC540V_COPY_CMDBLK_TO_VME_FAILED=262,
    kPLC540V_CMDCTRL_WRDY_TIMEOUT=263,
    kPLC540V_RESPONSE_TIMEOUT=264,
    kPLC540V_COPY_PCCC_PACKET_TO_VME_FAILED=265,
    kPLC540V_GET_REPLYBLK_FROM_VME_FAILED=266,
    kPLC540V_ELEMENT_COUNT_TOO_LARGE=267,
    kPLC540V_ILLEGAL_PCCC_DATA_ID=268,
} PLC540V_LIBRARY_STATUS_TYPE;

typedef enum
{
    kPLC540V_STATUS=0,
    kEPC_STATUS=1,
    kPCCC_STATUS=2,
} STATUS_CATEGORY_TYPE;

typedef union
{
    UBYTE value;
    struct
    {
        UBYTE localError:4;
        UBYTE remoteError:4;
    }statusFields;
} PCCC_STATUS_FIELDS_TYPE;
```

```
typedef struct
{
    /* Indicates which type of error status is being returned.  There are
       three sources: EPC, PCCC or this library of routines.
    */
    STATUS_CATEGORY_TYPE statusCategory;

    /* EPC Status Code */
    int epcStatus;

    /* PCCC Status Code */
    PCCC_STATUS_FIELDS_TYPE pcccStatus;

    /* PLC540V Library Status Codes */
    PLC540V_LIBRARY_STATUS_TYPE plc540vStatus;
} PLC540V_STATUS_TYPE;

// Register offsets in the PLC-5/40V
typedef enum
{
    kPLC540V_ID_REG=0x0,
    kPLC540V_DT_REG=0x2,
    kPLC540V_SC_REG=0x4,
    kPLC540V_OF_REG=0x6,
    kPLC540V_CC_REG=0x8,
    kPLC540V_CCL_REG=0xA,
    kPLC540V_CH_REG=0xC,
    kPLC540V_CL_REG=0xE,
} PLC540V_REGISTER_TYPE;

// PLC-5/40V VME interrupt levels
typedef enum
{
    kVME_NO_INT_LEVEL= 0x0,
    kVME_INT_LEVEL_1 = 0x1,
    kVME_INT_LEVEL_2 = 0x2,
    kVME_INT_LEVEL_3 = 0x3,
    kVME_INT_LEVEL_4 = 0x4,
    kVME_INT_LEVEL_5 = 0x5,
    kVME_INT_LEVEL_6 = 0x6,
    kVME_INT_LEVEL_7 = 0x7,
} VME_INTERRUPT_LEVEL_TYPE;

/* An array to hold the base address of each PLC-5/40V in VME space. */
/* The maximum number of installed PLC-5/40V's permitted */
#define kINSTALLED_PLC540V_LIMIT      8
typedef ULONG LOCATED_PLC540V_ARRAY_TYPE[kINSTALLED_PLC540V_LIMIT];

// Types of VME address modifiers supported by the PLC-5/40V
typedef enum
{
    kVME_A16_ADDR_SPACE=0x2d,
    kVME_A24_ADDR_SPACE=0x3d,
} VME_ADDRESS_MODIFIER_TYPE;

// Standard VME data widths supported by the PLC-5/40V processor
typedef enum
{
    kVME_D16_DATA_WIDTH=0,
    kVME_D08_DATA_WIDTH=1,
} VME_DATA_WIDTH_TYPE;
#pragma pack()
```

```

////////////////////////////////////
// Common set of functions that are useful throughout the API...
////////////////////////////////////
void find_all_plc540v_in_VME(    LOCATED_PLC540V_ARRAY_TYPE plcList,
                                PLC540V_STATUS_TYPE *status);
void read_plc540v_register(      UWORD baseAddress,
                                PLC540V_REGISTER_TYPE targetRegister,
                                UWORD *registerValue,
                                PLC540V_STATUS_TYPE *status);
void write_plc540v_register(     UWORD baseAddress,
                                PLC540V_REGISTER_TYPE targetRegister,
                                UWORD registerValue,
                                PLC540V_STATUS_TYPE *status);
void plc540v_self_tested_ok(     UWORD baseAddress,
                                PLC540V_STATUS_TYPE *status);
void poll_plc540v_until_response(ULONG vmeCmdBlkAddr,
                                VME_ADDRESS_MODIFIER_TYPE addrSpace,
                                PLC540V_STATUS_TYPE *status);
void plc540v_send_cmd(          ULONG baseAddress,
                                ULONG vmeCmdBlkAddr,
                                VME_ADDRESS_MODIFIER_TYPE addrSpace,
                                PLC540V_STATUS_TYPE *status);
void plc540v_enable_shared_memory(ULONG baseAddress,ULONG vmeSharedRAMAddr,
                                PLC540V_STATUS_TYPE *status);
void plc540v_disable_shared_memory(ULONG baseAddress,
                                ULONG vmeSharedRAMAddr,
                                PLC540V_STATUS_TYPE *status);

#endif

```

## COMMON.C

```

#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "common.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
/* The manufacturer id for our PLC-5/40V. */
#define kPLC540V_MANUFACTURE_ID          0x0CFEC

/* The device type for our PLC-5/40V. */
#define kPLC540V_DEVICE_TYPE             0x7FE8

/* Minimum and Maximum base addresses for the PLC-5/40V's */
#define kPLC540V_MINIMUM_BASE_ADDRESS    0xFC00
#define kPLC540V_MAXIMUM_BASE_ADDRESS    0xFDC0

/* The size (in kBytes) of the global memory on the PLC-5/40V. */
#define kPLC540V_GLOBAL_MEMORY_SIZE      0x0040

/* The PLC-5/40V status bits */
#define kPLC540V_READY                    0x0008
#define kPLC540V_PASSED                    0x0004

/* Timeout value for waiting for the PLC-5/40V to complete a command. */
#define kTIMEOUT_COUNT                     16384

/* Mask for the command control register's write ready bit. */
#define kCMDCTRL_WRDY                      0x8000

```

## Appendix B

### Sample API Modules

```
/* Mask for the command control register's error bit. */
#define kCMDCTRL_ERR 0x2000

#define kPLC540V_DEFAULT_RESPONSE 0x0000

#define kPLC540V_ENABLE_STATCTRL_SLE 0x8000
#define kPLC540V_DISABLE_STATCTRL_SLE 0x7FFF

/* Offset Register Defines */
#define MK_OFFSET(a) ((unsigned short) (((unsigned long) a & 0x00FF0000) >> 8))

static void poll_plc540v_cmdctrl_bits(ULONG baseAddress,
                                      UWORD andMask,
                                      PLC540V_STATUS_TYPE *status);
/*****
 *
 * PURPOSE: This function will poll the specified bits (in the andMask)
 *           in the command control register of the PLC-5/40V until they
 *           are set or a timeout.
 *
 * INPUT:    ULONG baseAddress contains the base address of the PLC-5/40V.
 *
 *           UWORD andMask contains the bitmask which will be ANDed with
 *           the command control register in order to determine if the
 *           bits are set.
 *
 * OUTPUT:    PLC540V_STATUS_TYPE *status will contain the final status
 *           of requesting this function. This status could be and EPC
 *           or PLC-5/40V value.
 *
 * RETURNS:   Nothing.
 *
 * EXAMPLE:
 *
 *           ULONG baseAddress = 0xFC00;
 *           UWORD andMask = 0x1;
 *           PLC540V_STATUS_TYPE *status;
 *           poll_plc540v_cmdctrl_bits(baseAddress,
 *                                     andMask,
 *                                     &status);
 *
 *           Copyright Allen-Bradley Company, Inc. 1993
 *
 *****/
static void poll_plc540v_cmdctrl_bits(ULONG baseAddress,
                                      UWORD andMask,
                                      PLC540V_STATUS_TYPE *status)
{
    /* A loop counter. */
    ULONG i;

    /* The value read from the command control register. */
    UWORD cmdctlReg = 0;

    /* Let's initialize the status variable to success. */
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));
```

```

/* Loop until we timeout or the bits are set. */
for (i=0;
    ((i<kTIMEOUT_COUNT) && (status->plc540vStatus == kPLC540V_SUCCESS));
    i++)
{
    read_plc540v_register(baseAddress, kPLC540V_CC_REG,
                          &cmdctlReg, status);
    if (status->plc540vStatus == kPLC540V_SUCCESS)
    {
        /* Determine if the bit is set. */
        if (cmdctlReg & andMask)
            break;
    }
}

if (i > kTIMEOUT_COUNT)
{
    /* Signal that we timed out. */
    status->plc540vStatus = kPLC540V_CMDCTRL_WRDY_TIMEOUT;
    status->statusCategory = kPLC540V_STATUS;
}
}

/*****
 *
 * PURPOSE:    This function will examine the entire VME memory space to
 *             locate all the PLC-5/40V's which are installed.
 *
 * INPUT:      None
 *
 * OUTPUT:     LOCATED_PLC540V_ARRAY_TYPE *plcList will contain the base
 *             addresses of each located PLC-5/40V. Any entries in this
 *             array which don't have a PLC-5/40V will be zero.
 *
 *             PLC540V_STATUS_TYPE *status will contain the final status
 *             of requesting this function. This status could be and EPC
 *             or PLC-5/40V value.
 *
 * RETURNS:    Nothing.
 *
 * EXAMPLE:
 *
 *             LOCATED_PLC540V_ARRAY_TYPE plcList;
 *             PLC540V_STATUS_TYPE *status;
 *             find_all_plc540v_in_VME(plcList, &status);
 *
 *             Copyright Allen-Bradley Company, Inc. 1993
 *
 *****/
void find_all_plc540v_in_VME(LOCATED_PLC540V_ARRAY_TYPE plcList,
                             PLC540V_STATUS_TYPE *status)
{
    /* The current base address which we are examining in VME space. */
    UWORD baseAddress;

    /* The current array entry to write an address into. */
    UBYTE arrayIndex;

    /* The manufacturer id for a located PLC-5/40V */
    UWORD manId = 0;

    /* The PLC-5/40V device type for a located PLC-5/40V */
    UWORD devType = 0;

    /* Let's initialize the array to have no located PLC-5/40V's. */
    memset((char *) plcList, 0x0, sizeof(LOCATED_PLC540V_ARRAY_TYPE));

```

```
/* Let's initialize the status variable to success. */
memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

/* Let's loop through the range of base addresses and see if a PLC-5/40V
   is located. If one is found, then we will add it to the array.
*/
for (baseAddress = kPLC540V_MINIMUM_BASE_ADDRESS, arrayIndex = 0;
     ((baseAddress <= kPLC540V_MAXIMUM_BASE_ADDRESS) &&
      (status->plc540vStatus == kPLC540V_SUCCESS));
     baseAddress += kPLC540V_GLOBAL_MEMORY_SIZE)
{
    /* Read the manufacture-ID */
    read_plc540v_register(baseAddress, kPLC540V_ID_REG, &manId, status);

    /* If we successfully read the manufacturer id, then we'll attempt to
       read the PLC-5/40V's device type.
    */
    if (status->plc540vStatus == kPLC540V_SUCCESS)
    {
        /* Read the PLC-5/40V's device type. */
        read_plc540v_register(baseAddress, kPLC540V_DT_REG, &devType, status);

        if (status->plc540vStatus == kPLC540V_SUCCESS)
        {
            /* Determine if this device is a PLC-5/40V */
            if ((manId == kPLC540V_MANUFACTURE_ID) &&
                (devType == kPLC540V_DEVICE_TYPE))
            {
                /* We've located a PLC-5/40V so let's
                   save its base address
                */
                plcList[arrayIndex++] = baseAddress;
            }
        }
    }
}
}
```

```

/*****
*
* PURPOSE:      This function will read a PLC-5/40V's A16 configuration and
*               control register.
*
* INPUT:        UWORD baseAddress will contain the base address of the
*               PLC-5/40V.
*
*               PLC540V_REGISTER_TYPE targetRegister will contain the
*               particular PLC-5/40V register that will be read.
*
* OUTPUT:       UWORD *registerValue will contain the value read from the
*               specified target register.
*
*               PLC540V_STATUS_TYPE *status will contain the final status
*               of requesting this function. This status could be and EPC
*               or PLC-5/40V value.
*
* RETURNS:      Nothing.
*
* EXAMPLE:
*
*               UWORD *regValue;
*               PLC540V_STATUS_TYPE status;
*               read_plc540v_register(0x0FC00,
*                                   kPLC540V_ID_REG,
*                                   &regValue,
*                                   &status);
*
*               Copyright Allen-Bradley Company, Inc. 1993
*
*****/

void read_plc540v_register(UWORD baseAddress,
                          PLC540V_REGISTER_TYPE targetRegister,
                          UWORD *registerValue,
                          PLC540V_STATUS_TYPE *status)
{
    /* Let's initialize the status variable to success. */
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's read the word from the PLC-5/40V's register. */
    status->epcStatus=EpcFromVmeAm((BM_MBO|A16S), BM_W16,
                                   baseAddress+targetRegister,
                                   (char far *) registerValue,
                                   sizeof(UWORD));

    if (status->epcStatus < 0)
    {
        status->statusCategory = kEPC_STATUS;
        status->plc540vStatus = kPLC540V_READ_REGISTER_FAILED;
    }
}

```

```

/*****
*
*  PURPOSE:      This function will write to a PLC-5/40V's A16 configuration or
*                control register.
*
*  INPUT:        UWORD baseAddress will contain the base address of the
*                PLC-5/40V.
*
*                PLC540V_REGISTER_TYPE targetRegister will contain the
*                particular PLC-5/40V register that will be written.
*
*                UWORD registerValue will contain the value to be written
*                to the specified target register.
*
*  OUTPUT:       PLC540V_STATUS_TYPE *status will contain the final status
*                of requesting this function. This status could be and EPC
*                or PLC-5/40V value.
*
*  RETURNS:      Nothing.
*
*  EXAMPLE:
*
*                UWORD regValue = 0x1234;
*                PLC540V_STATUS_TYPE status;
*                read_plc540v_register(0x0FC00,
*                                     kPLC540V_OF_REG,
*                                     regValue,
*                                     &status);
*
*                Copyright Allen-Bradley Company, Inc. 1993
*
*****/
void write_plc540v_register(UWORD baseAddress,
                           PLC540V_REGISTER_TYPE targetRegister,
                           UWORD registerValue,
                           PLC540V_STATUS_TYPE *status)
{
    /* Let's initialize the status variable to success. */
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's write the word to the PLC-5/40V's register. */
    status->epcStatus=EpcToVmeAm((BM_MBO|A16S), BM_W16,
                                (char far *) &registerValue,
                                baseAddress+targetRegister,
                                sizeof(UWORD));

    if (status->epcStatus < 0)
    {
        status->statusCategory = kEPC_STATUS;
        status->plc540vStatus = kPLC540V_WRITE_REGISTER_FAILED;
    }
}

```



```

/*****
 *
 * PURPOSE:      This function will determine if a PLC-5/40V has successfully
 *                completed its startup diagnostics validation routine.  The
 *                PLC-5/40V's STATUS/CONTROL register contains two flag bits:
 *                RDY and PASSED.  If both of these are asserted (high),
 *                then the PLC-5/40V has passed its internal self-test.  If
 *                either or both of these bits are clear, then the PLC-5/40V
 *                has detected internal faults and may not work properly.
 *
 * INPUT:        UWORD baseAddress will contain the base address of the
 *                PLC-5/40V.
 *
 * OUTPUT:       PLC540V_STATUS_TYPE *status will contain the final status
 *                of requesting this function.  This status could be and EPC
 *                or PLC-5/40V value.
 *
 * RETURNS:      Nothing.
 *
 * EXAMPLE:
 *
 *                PLC540V_STATUS_TYPE status;
 *                plc540v_self_tested_ok(0x0FC00, &status);
 *
 *                Copyright Allen-Bradley Company, Inc. 1993
 *
 *****/
void plc540v_self_tested_ok(UWORD baseAddress,
                           PLC540V_STATUS_TYPE *status)
{
    /* The status/control register contents. */
    UWORD statCtrl = 0;

    /* Let's initialize the status variable to success. */
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Lets obtain the status bits from the specified PLC-5/40V. */
    read_plc540v_register(baseAddress, kPLC540V_SC_REG, &statCtrl, status);

    if (status->plc540vStatus == kPLC540V_SUCCESS)
    {
        /* Let's determine if the READY and PASSED bits are set. */
        if ((statCtrl & kPLC540V_READY) == kPLC540V_READY)
        {
            if ((statCtrl & kPLC540V_PASSED) != kPLC540V_PASSED)
            {
                /* The PLC-5/40V didn't pass its self-test. */
                status->plc540vStatus = kPLC540V_NOT_PASSED;
                status->statusCategory = kPLC540V_STATUS;
            }
        }
        else
        {
            /* The PLC-5/40V is not ready to accept commands. */
            status->plc540vStatus = kPLC540V_NOT_READY;
            status->statusCategory = kPLC540V_STATUS;
        }
    }
}

```

```

/*****
 *
 *  PURPOSE:      This function will continually poll the command block's
 *                response word to determine when the PLC-5/40V has completed
 *                processing a command.  When the response word becomes
 *                non-zero OR if we time out then this function will return
 *                to the caller.
 *
 *  INPUT:        ULONG vmeCmdBlkAddr contains the VME address of the command
 *                block.
 *                VME_ADDRESS_MODIFIER_TYPE addrSpace contains an indicator
 *                as to which address space contains the command block.
 *
 *  OUTPUT:        PLC540V_STATUS_TYPE *status will contain the final status
 *                of requesting this function.  This status could be and EPC
 *                or PLC-5/40V value.
 *
 *  RETURNS:      Nothing.
 *
 *  EXAMPLE:      ULONG vmeCmdBlkAddr = 0x80000;
 *                VME_ADDRESS_MODIFIER_TYPE addrSpace = kVME_A24_ADDR_SPACE;
 *                PLC540V_STATUS_TYPE *status;
 *                poll_plc540v_until_response(vmeCmdBlkAddr,
 *                                           addrSpace,
 *                                           &status);
 *
 *                Copyright Allen-Bradley Company, Inc. 1993
 *
 *****/
void poll_plc540v_until_response(ULONG vmeCmdBlkAddr,
                                VME_ADDRESS_MODIFIER_TYPE addrSpace,
                                PLC540V_STATUS_TYPE *status)
{
    /* Poll the response word until it is non-zero. */
    ULONG i;

    /* The value read from the response word in the command block. */
    UWORD response = 0;

    /* Let's initialize the status variable to success. */
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Loop until we timeout or the response word is non-zero. */
    for (i=0;
        ((i<kTIMEOUT_COUNT) && (status->plc540vStatus == kPLC540V_SUCCESS));
        i++)
    {
        status->epcStatus = EpcFromVmeAm((UWORD) (BM_MBO|addrSpace),
                                         BM_W16,
                                         vmeCmdBlkAddr+2,
                                         (char far *) &response,
                                         sizeof(UWORD));

        if (status->plc540vStatus == kPLC540V_SUCCESS)
        {
            /* Determine if the reponse word has been changed. */
            if (response != kPLC540V_DEFAULT_RESPONSE)
                break;
        }
    }

    if (i > kTIMEOUT_COUNT)
    {
        /* Signal that we timed out. */
        status->plc540vStatus = kPLC540V_RESPONSE_TIMEOUT;
        status->statusCategory = kPLC540V_STATUS;
    }
}

```

```

/*****
 *
 * PURPOSE:      This function will transmit notification of a new command
 *               block awaiting processing by the PLC-5/40V. Prior to calling
 *               this function, the programmer must copy the command block
 *               into VME memory.
 *
 * INPUT:        ULONG baseAddress contains the base address of the PLC-5/40V.
 *
 *               ULONG vmeCmdBlkAddr contains the VME address of the command
 *               block.
 *
 *               VME_ADDRESS_MODIFIER_TYPE addrSpace contains an indicator
 *               as to which address space contains the command block.
 *
 * OUTPUT:       PLC540V_STATUS_TYPE *status will contain the final status
 *               of requesting this function. This status could be and EPC
 *               or PLC-5/40V value.
 *
 * RETURNS:      Nothing.
 *
 * EXAMPLE:
 *
 *               ULONG baseAddress = 0xFC00;
 *               ULONG vmeCmdBlkAddr = 0x80000;
 *               VME_ADDRESS_MODIFIER_TYPE addrSpace = kVME_A24_ADDR_SPACE;
 *               PLC540V_STATUS_TYPE *status;
 *               plc540v_send_cmd(baseAddress,
 *                               vmeCmdBlkAddr,
 *                               addrSpace,
 *                               &status);
 *
 *               Copyright Allen-Bradley Company, Inc. 1993
 *
 *****/
void plc540v_send_cmd(ULONG baseAddress,
                     ULONG vmeCmdBlkAddr,
                     VME_ADDRESS_MODIFIER_TYPE addrSpace,
                     PLC540V_STATUS_TYPE *status)
{
    /* The command word. */
    ULONG command = 0;

    /* The value read from the command control register. */
    UWORD cmdctlReg = 0;

    /* Let's initialize the status variable to success. */
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Build the command word. */
    if (addrSpace == kVME_A24_ADDR_SPACE)
        command = 0x00000000L | (vmeCmdBlkAddr & 0x0FFFFFFFL);
    else
        command = 0x01000000L | (vmeCmdBlkAddr & 0x0000FFFFL);
}

```

```

/* The PLC-5/40V's command/control register WRITE-READY bit
   indicates when it is ready to accept a new command. We
   will poll this bit until it is set or we timeout.
*/
poll_plc540v_cmdctrl_bits(baseAddress, kCMDCTRL_WRDY, status);
if (status->plc540vStatus == kPLC540V_SUCCESS)
{
    /* The PLC-5/40V command word is 32 bits wide. However, the VME
       interface to the command word is only 16 bits wide so we must
       write the command word as two 16 bit chunks. These words must
       be written MSW and then LSW.
    */
    write_plc540v_register(baseAddress, kPLC540V_CH_REG,
                           HIWORD(command), status);
    write_plc540v_register(baseAddress, kPLC540V_CL_REG,
                           LOWORD(command), status);

    poll_plc540v_cmdctrl_bits(baseAddress, kCMDCTRL_WRDY, status);
    if (status->plc540vStatus == kPLC540V_SUCCESS)
    {
        /* The PLC-5/40V has now started processing the command word.
           We will check the command control register's ERROR bit to
           see if this command word caused any PLC-5/40V errors. If
           so, we will extract the 8 bit error code from the command
           control register.
        */
        read_plc540v_register(baseAddress, kPLC540V_CC_REG,
                              &cmdctlReg, status);

        if (status->plc540vStatus == kPLC540V_SUCCESS)
        {
            /* Determine if the bit is set. */
            if (cmdctlReg & kCMDCTRL_ERR)
            {
                /* Extract the error code. */
                status->plc540vStatus = cmdctlReg & 0x00FF;
                status->statusCategory = kPLC540V_STATUS;
            }
        }
    }
}
}
}
}
}

```

```

/*****
 *
 * PURPOSE:      This function will enable the 64K of shared RAM that is
 *                  present on the PLC-5/40V.
 *
 * INPUT:        ULONG baseAddress contains the base address of the PLC-5/40V.
 *
 *                ULONG vmeSharedRAMAddr contains the VME address of the
 *                  shared ram on the PLC-5/40V that is
 *                  specified in the baseAddress field.
 *
 * OUTPUT:       PLC540V_STATUS_TYPE *status will contain the final status
 *                  of requesting this function. This status could be and EPC
 *                  or PLC-5/40V value.
 *
 * RETURNS:      Nothing.
 *
 * EXAMPLE:
 *
 *                ULONG baseAddress = 0xFC00;
 *                  ULONG vmeSharedRAMAddr = 0x60000;
 *                PLC540V_STATUS_TYPE *status;
 *                plc540v_enable_shared_memory(baseAddress,
 *                  vmeSharedRAMAddr,
 *                  &status);
 *
 *                Copyright Allen-Bradley Company, Inc. 1993
 *
 *****/
void plc540v_enable_shared_memory(ULONG baseAddress,
                                  ULONG vmeSharedRAMAddr,
                                  PLC540V_STATUS_TYPE *status)
{
    UWORD offsetReg = 0;
    UWORD statCtrlReg = 0;

    /* Convert the VME shared RAM address to the OFFSET register format. */
    offsetReg = MK_OFFSET(vmeSharedRAMAddr);

    /* Write this value into the PLC-5/40V's OFFSET register. */
    write_plc540v_register(baseAddress,
                           kPLC540V_OF_REG,
                           offsetReg,
                           status);

    if (status->plc540vStatus == kPLC540V_SUCCESS)
    {
        /* Now we must enable the PLC-5/40V's shared memory. This is done
           by setting the SLAVE ENABLE bit in the PLC-5/40V's
           STATUS/CONTROL register.
        */
        read_plc540v_register(baseAddress, kPLC540V_SC_REG,
                              &statCtrlReg, status);
        if (status->plc540vStatus == kPLC540V_SUCCESS)
        {
            statCtrlReg |= kPLC540V_ENABLE_STATCTRL_SLE;
            write_plc540v_register(baseAddress,
                                   kPLC540V_SC_REG,
                                   statCtrlReg,
                                   status);
        }
    }
}

```

```

/*****
 *
 * PURPOSE:      This function will disable the 64K of shared RAM that is
 *               present on the PLC-5/40V.
 *
 * INPUT:        ULONG baseAddress contains the base address of the PLC-5/40V.
 *
 *               ULONG vmeSharedRAMAddr contains the VME address of the
 *               shared ram on the PLC-5/40V that is specified in the
 *               baseAddress field.
 *
 * OUTPUT:       PLC540V_STATUS_TYPE *status will contain the final status
 *               of requesting this function. This status could be and EPC
 *               or PLC-5/40V value.
 *
 * RETURNS:      Nothing.
 *
 * EXAMPLE:
 *
 *               ULONG baseAddress = 0xFC00;
 *               ULONG vmeSharedRAMAddr = 0x60000;
 *               PLC540V_STATUS_TYPE *status;
 *               plc540v_disable_shared_memory(baseAddress,
 *               vmeSharedRAMAddr,
 *               &status);
 *
 *               Copyright Allen-Bradley Company, Inc. 1993
 *
 *****/
void plc540v_disable_shared_memory(ULONG baseAddress,
                                   ULONG vmeSharedRAMAddr,
                                   PLC540V_STATUS_TYPE *status)
{
    UWORD offsetReg = 0;
    UWORD statCtrlReg = 0;

    /* Convert the VME shared RAM address to the OFFSET register format. */
    offsetReg = MK_OFFSET(vmeSharedRAMAddr);

    /* Write this value into the PLC-5/40V's OFFSET register. */
    write_plc540v_register(baseAddress,
                           kPLC540V_OF_REG,
                           offsetReg,
                           status);

    if (status->plc540vStatus == kPLC540V_SUCCESS)
    {
        /* Now we must enable the PLC-5/40V's shared memory. This is done
         by setting the SLAVE ENABLE bit in the PLC-5/40V's
         STATUS/CONTROL register.
         */
        read_plc540v_register(baseAddress, kPLC540V_SC_REG,
                              &statCtrlReg, status);
        if (status->plc540vStatus == kPLC540V_SUCCESS)
        {
            statCtrlReg &= kPLC540V_DISABLE_STATCTRL_SLE;
            write_plc540v_register(baseAddress,
                                   kPLC540V_SC_REG,
                                   statCtrlReg,
                                   status);
        }
    }
}

```

## P40VCC0.H

```
#ifndef P40VCCO_H
#define P40VCCO_H 1

////////////////////////////////////
//      Definitions for the CONTINUOUS COPY COMMAND STRUCTURE      //
////////////////////////////////////

#include "common.h"

#pragma pack(1)
/***** INTEL VERSION OF DEFINITIONS *****/
typedef struct
{
    UWORD addressModifier:8;
    UWORD width:1;
    UWORD reserved1:6;
    UWORD enable:1;
} PLC540V_CC_TRANSFER_TYPE;

typedef struct
{
    UWORD    commandWord;
    UWORD    responseWord;
    UWORD    cmdIntLevel;
    UWORD    cmdStatusId;
    UWORD    reserved1[3];
    PLC540V_CC_TRANSFER_TYPE transferInfo;
    UWORD    dataAddressHigh;
    UWORD    dataAddressLow;
    UWORD    dataSize;
    UWORD    fileNumber;
    UWORD    elementNumber;
    UWORD    operationIntLevel;
    UWORD    operationStatusId;
    UWORD    reserved2;
} PLC540V_CONT_COPY_CMD_TYPE;

#pragma pack()

void plc540v_init_cont_copy_to_VME( ULONG vmeDataAddr,
                                     UWORD vmeDataSize,
                                     ULONG vmeCmdBlkAddr,
                                     UWORD baseAddress,
                                     VME_DATA_WIDTH_TYPE width,
                                     VME_ADDRESS_MODIFIER_TYPE addrMod,
                                     UWORD fileNumber,
                                     UWORD elementNumber,
                                     VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                     UBYTE cmdStatusId,
                                     VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                     UBYTE operationStatusId,
                                     PLC540V_STATUS_TYPE *status);
```

```
void plc540v_halt_cont_copy_to_VME( ULONG vmeDataAddr,
                                     UWORD vmeDataSize,
                                     ULONG vmeCmdBlkAddr,
                                     UWORD baseAddress,
                                     VME_DATA_WIDTH_TYPE width,
                                     VME_ADDRESS_MODIFIER_TYPE addrMod,
                                     UWORD fileName,
                                     UWORD elementNumber,
                                     VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                     UBYTE cmdStatusId,
                                     VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                     UBYTE operationStatusId,
                                     PLC540V_STATUS_TYPE *status);

void plc540v_init_cont_copy_from_VME( ULONG vmeDataAddr,
                                       UWORD vmeDataSize,
                                       ULONG vmeCmdBlkAddr,
                                       UWORD baseAddress,
                                       VME_DATA_WIDTH_TYPE width,
                                       VME_ADDRESS_MODIFIER_TYPE addrMod,
                                       UWORD fileName,
                                       UWORD elementNumber,
                                       VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                       UBYTE cmdStatusId,
                                       VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                       UBYTE operationStatusId,
                                       PLC540V_STATUS_TYPE *status);

void plc540v_halt_cont_copy_from_VME( ULONG vmeDataAddr,
                                       UWORD vmeDataSize,
                                       ULONG vmeCmdBlkAddr,
                                       UWORD baseAddress,
                                       VME_DATA_WIDTH_TYPE width,
                                       VME_ADDRESS_MODIFIER_TYPE addrMod,
                                       UWORD fileName,
                                       UWORD elementNumber,
                                       VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                       UBYTE cmdStatusId,
                                       VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                       UBYTE operationStatusId,
                                       PLC540V_STATUS_TYPE *status);

#endif
```

## P40VCC0.C

```
#include <string.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vcco.h"

/*****
***** PRIVATE DEFINITIONS *****/
/*****
/* The maximum number of bytes which can be transfered at one time to/from
VME and the PLC-5/40V.
*/
#define kPLC540V_MAX_TRANSFER_SIZE 248
```



```

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
typedef enum
{
    kPLC540V_CONT_COPY_TO_VME=0x0001,
    kPLC540V_CONT_COPY_FROM_VME=0x0002,
} PLC540V_CONT_COPY_COMMAND;

typedef enum
{
    kPLC540V_CONT_COPY_DISABLE=0x0,
    kPLC540V_CONT_COPY_ENABLE=0x1,
} PLC540V_CONT_COPY_MODE;

/*****
/***** PRIVATE FUNCTIONS *****/
/*****
void plc540v_cont_copy(PLC540V_CONT_COPY_COMMAND ccCmd,
                      PLC540V_CONT_COPY_MODE ccMode,
                      ULONG vmeDataAddr,
                      WORD vmeDataSize,
                      ULONG vmeCmdBlkAddr,
                      WORD baseAddress,
                      VME_DATA_WIDTH_TYPE width,
                      VME_ADDRESS_MODIFIER_TYPE addrMod,
                      WORD fileNumber,
                      WORD elementNumber,
                      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                      UBYTE cmdStatusId,
                      VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                      UBYTE operationStatusId,
                      PLC540V_STATUS_TYPE *status);

/*****
*
* PURPOSE: This function configures the PLC-5/40V to continuously copy
* processor file memory to VME memory once per scan cycle in
* the processor.
*
* INPUT: ULONG vmeDataAddr contains the VME address where the
* processor file memory will be written into.
*
* WORD vmeDataSize contains the number of 16 bit words which
* will be written.
*
* ULONG vmeCmdBlkAddr contains the VME address where the
* command block will be copied to so the PLC-5/40V can
* access its information.
*
* WORD baseAddress contains the base address of the
* PLC-5/40V.
*
* VME_DATA_WIDTH_TYPE width contains the data width that
* should be used for the copy operations. It can be D16
* or D08.
*
* VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
* in which the VME data is accessed. It can be A16 or A24.
*
* WORD fileNumber contains the PLC-5/40V data file number
* which will be continuously read from for the data transfer.
*
*

```

```

*          UWORD elementNumber contains the element number in the
*          PLC-5/40V data table file at which the data transfer is to
*          begin.
*
*          VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*          interrupt to be generated by the PLC-5/40V AFTER storing
*          its response in the response word of the command block AFTER
*          COMMAND completion. If kVME_NO_INT_LEVEL is specified, then
*          no VME bus interrupts will be generated.
*
*          UBYTE cmdStatusId contains a unique value which will be used
*          by the interrupted host processor to run a specific
*          interrupt service routine. This variable must be set to
*          zero if you are NOT using any command interrupts.
*
*          VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*          bus interrupt to be generated by the PLC-5/40V AFTER each
*          copy OPERATION. If kVME_NO_INT_LEVEL is specified, then
*          no VME bus interrupts will be generated.
*
*          UBYTE operationStatusId contains a unique value which will
*          be used by the interrupted host processor to run a specific
*          interrupt service routine. This variable must be set to
*          zero if you are NOT using any operation interrupts.
*
*  OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function. This status could be and EPC
*           or PLC-5/40V value.
*
*  RETURNS: Nothing.
*
*  EXAMPLE:
*
*          ULONG vmeDataAddr          = 0x80000;
*          UWORD vmeDataSize          = 0x100;
*          ULONG vmeCmdBlkAddr        = 0x90000;
*          UWORD baseAddress          = 0xFC00;
*          VME_DATA_WIDTH_TYPE width  = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A16_ADDR_SPACE;
*          UWORD fileName            = 11;
*          UWORD elementNumber        = 20;
*          VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*          UBYTE cmdStatusId          = 0;
*          VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_NO_INT_LEVEL;
*          UBYTE operationStatusId    = 0;
*          PLC540V_STATUS_TYPE status;
*          plc540v_init_cont_copy_to_VME(
*
*              vmeDataAddr,
*              vmeDataSize,
*              vmeCmdBlkAddr,
*              baseAddress,
*              width,
*              addrMod,
*              fileName,
*              elementNumber,
*              cmdIntLevel,
*              cmdStatusId,
*              operationIntLevel,
*              operationStatusId,
*              &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
*          *****/

```

```
void plc540v_init_cont_copy_to_VME(ULONG vmeDataAddr,
                                   UWORD vmeDataSize,
                                   ULONG vmeCmdBlkAddr,
                                   UWORD baseAddress,
                                   VME_DATA_WIDTH_TYPE width,
                                   VME_ADDRESS_MODIFIER_TYPE addrMod,
                                   UWORD fileName,
                                   UWORD elementNumber,
                                   VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                   UBYTE cmdStatusId,
                                   VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                   UBYTE operationStatusId,
                                   PLC540V_STATUS_TYPE *status)
{
    plc540v_cont_copy(kPLC540V_CONT_COPY_TO_VME,
                     kPLC540V_CONT_COPY_ENABLE,
                     vmeDataAddr,
                     vmeDataSize,
                     vmeCmdBlkAddr,
                     baseAddress,
                     width,
                     addrMod,
                     fileName,
                     elementNumber,
                     cmdIntLevel,
                     cmdStatusId,
                     operationIntLevel,
                     operationStatusId,
                     status);
}
```

```

/*****
*
* PURPOSE:   This function configures the PLC-5/40V to stop the
*            continuously copy of processor file memory to VME memory.
*            The input parameters MUST be identical to the ones used in
*            the plc540v_init_cont_copy_to_VME() function call.
*
* INPUT:     ULONG vmeDataAddr contains the VME address where the
*            processor file memory will be written into.
*
*            UWORD vmeDataSize contains the number of 16 bit words which
*            will be written.
*
*            ULONG vmeCmdBlkAddr contains the VME address where the
*            command block will be copied to so the PLC-5/40V can
*            access its information.
*
*            UWORD baseAddress contains the base address of the
*            PLC-5/40V.
*
*            VME_DATA_WIDTH_TYPE width contains the data width that
*            should be used for the copy operations. It can be D16
*            or D08.
*
*            VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*            in which the VME data is accessed. It can be A16 or A24.
*
*            UWORD fileName contains the PLC-5/40V data file number
*            which will be continuously read from for the data transfer.
*
*            UWORD elementNumber contains the element number in the
*            PLC-5/40V data table file at which the data transfer is to
*            begin.
*
*****/
```

```

*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*      interrupt to be generated by the PLC-5/40V AFTER storing
*      its response in the response word of the command block AFTER
*      COMMAND completion. If kVME_NO_INT_LEVEL is specified, then
*      no VME bus interrupts will be generated.
*
*      UBYTE cmdStatusId contains a unique value which will be used
*      by the interrupted host processor to run a specific
*      interrupt service routine. This variable must be set to
*      zero if you are NOT using any command interrupts.
*
*      VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*      bus interrupt to be generated by the PLC-5/40V AFTER each
*      copy OPERATION. If kVME_NO_INT_LEVEL is specified, then
*      no VME bus interrupts will be generated.
*
*      UBYTE operationStatusId contains a unique value which will
*      be used by the interrupted host processor to run a specific
*      interrupt service routine. This variable must be set to
*      zero if you are NOT using any operation interrupts.
*
*  OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*            of requesting this function. This status could be and EPC
*            or PLC-5/40V value.
*
*  RETURNS:  Nothing.
*
*  EXAMPLE:
*
*      ULONG vmeDataAddr          = 0x80000;
*      UWORD vmeDataSize          = 0x100;
*      ULONG vmeCmdBlkAddr        = 0x90000;
*      UWORD baseAddress          = 0xFC00;
*      VME_DATA_WIDTH_TYPE width  = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A16_ADDR_SPACE;
*      UWORD fileNumber           = 11;
*      UWORD elementNumber        = 20;
*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*      UBYTE cmdStatusId          = 0;
*      VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_NO_INT_LEVEL;
*      UBYTE operationStatusId     = 0;
*      PLC540V_STATUS_TYPE status;
*      plc540v_halt_cont_copy_to_VME(
*
*          vmeDataAddr,
*          vmeDataSize,
*          vmeCmdBlkAddr,
*          baseAddress,
*          width,
*          addrMod,
*          fileNumber,
*          elementNumber,
*          cmdIntLevel,
*          cmdStatusId,
*          operationIntLevel,
*          operationStatusId,
*          &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
*  *****/

```

```

void plc540v_halt_cont_copy_to_VME(ULONG vmeDataAddr,
                                     UWORD vmeDataSize,
                                     ULONG vmeCmdBlkAddr,
                                     UWORD baseAddress,
                                     VME_DATA_WIDTH_TYPE width,
                                     VME_ADDRESS_MODIFIER_TYPE addrMod,
                                     UWORD fileName,
                                     UWORD elementNumber,
                                     VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                     UBYTE cmdStatusId,
                                     VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                     UBYTE operationStatusId,
                                     PLC540V_STATUS_TYPE *status)
{
    plc540v_cont_copy(kPLC540V_CONT_COPY_TO_VME,
                     kPLC540V_CONT_COPY_DISABLE,
                     vmeDataAddr,
                     vmeDataSize,
                     vmeCmdBlkAddr,
                     baseAddress,
                     width,
                     addrMod,
                     fileName,
                     elementNumber,
                     cmdIntLevel,
                     cmdStatusId,
                     operationIntLevel,
                     operationStatusId,
                     status);
}

/*****
 *
 * PURPOSE:      This function configures the PLC-5/40V to continuously copy
 *               from VME memory to processor file memory once per scan cycle
 *               in the processor.
 *
 * INPUT:        ULONG vmeDataAddr contains the VME address where the
 *               VME memory will be read from.
 *
 *               UWORD vmeDataSize contains the number of 16 bit words which
 *               will be read.
 *
 *               ULONG vmeCmdBlkAddr contains the VME address where the
 *               command block will be copied to so the PLC-5/40V can
 *               access its information.
 *
 *               UWORD baseAddress contains the base address of the
 *               PLC-5/40V.
 *
 *               VME_DATA_WIDTH_TYPE width contains the data width that
 *               should be used for the copy operations.  It can be D16
 *               or D08.
 *
 *               VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
 *               in which the VME data is accessed.  It can be A16 or A24.
 *
 *               UWORD fileName contains the PLC-5/40V data file number
 *               which will be continuously read from for the data transfer.
 *
 *               UWORD elementNumber contains the element number in the
 *               PLC-5/40V data table file at which the data transfer is to
 *               begin.
 *
 *****/

```

```

*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*      interrupt to be generated by the PLC-5/40V AFTER storing
*      its response in the response word of the command block AFTER
*      COMMAND completion.  If kVME_NO_INT_LEVEL is specified, then
*      no VME bus interrupts will be generated.
*
*      UBYTE cmdStatusId contains a unique value which will be used
*      by the interrupted host processor to run a specific
*      interrupt service routine.  This variable must be set to
*      zero if you are NOT using any command interrupts.
*
*      VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*      bus interrupt to be generated by the PLC-5/40V AFTER each
*      copy OPERATION.  If kVME_NO_INT_LEVEL is specified, then
*      no VME bus interrupts will be generated.
*
*      UBYTE operationStatusId contains a unique value which will
*      be used by the interrupted host processor to run a specific
*      interrupt service routine.  This variable must be set to
*      zero if you are NOT using any operation interrupts.
*
*  OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function.  This status could be and EPC
*           or PLC-5/40V value.
*
*  RETURNS:  Nothing.
*
*  EXAMPLE:
*
*      ULONG vmeDataAddr          = 0x80000;
*      UWORD vmeDataSize          = 0x100;
*      ULONG vmeCmdBlkAddr        = 0x90000;
*      UWORD baseAddress          = 0xFC00;
*      VME_DATA_WIDTH_TYPE width  = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A16_ADDR_SPACE;
*      UWORD fileNumber           = 11;
*      UWORD elementNumber        = 20;
*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*      UBYTE cmdStatusId          = 0;
*      VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_NO_INT_LEVEL;
*      UBYTE operationStatusId     = 0;
*      PLC540V_STATUS_TYPE status;
*      plc540v_init_cont_copy_from_VME(
*
*                                     vmeDataAddr,
*                                     vmeDataSize,
*                                     vmeCmdBlkAddr,
*                                     baseAddress,
*                                     width,
*                                     addrMod,
*                                     fileNumber,
*                                     elementNumber,
*                                     cmdIntLevel,
*                                     cmdStatusId,
*                                     operationIntLevel,
*                                     operationStatusId,
*                                     &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
*      *****/

```

```

void plc540v_init_cont_copy_from_VME(ULONG vmeDataAddr,
                                     UWORD vmeDataSize,
                                     ULONG vmeCmdBlkAddr,
                                     UWORD baseAddress,
                                     VME_DATA_WIDTH_TYPE width,
                                     VME_ADDRESS_MODIFIER_TYPE addrMod,
                                     UWORD fileName,
                                     UWORD elementNumber,
                                     VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                     UBYTE cmdStatusId,
                                     VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                     UBYTE operationStatusId,
                                     PLC540V_STATUS_TYPE *status)
{
    plc540v_cont_copy(kPLC540V_CONT_COPY_FROM_VME,
                     kPLC540V_CONT_COPY_ENABLE,
                     vmeDataAddr,
                     vmeDataSize,
                     vmeCmdBlkAddr,
                     baseAddress,
                     width,
                     addrMod,
                     fileName,
                     elementNumber,
                     cmdIntLevel,
                     cmdStatusId,
                     operationIntLevel,
                     operationStatusId,
                     status);
}

/*****
 *
 * PURPOSE:   This function configures the PLC-5/40V to stop the
 *            continuously copy of VME memory to processor file memory.
 *            The input parameters MUST be identical to the ones used in
 *            the plc540v_init_cont_copy_from_VME() function call.
 *
 * INPUT:     ULONG vmeDataAddr contains the VME address where the
 *            VME memory will be read from.
 *
 *            UWORD vmeDataSize contains the number of 16 bit words which
 *            will be written.
 *
 *            ULONG vmeCmdBlkAddr contains the VME address where the
 *            command block will be copied to so the PLC-5/40V can
 *            access its information.
 *
 *            UWORD baseAddress contains the base address of the
 *            PLC-5/40V.
 *
 *            VME_DATA_WIDTH_TYPE width contains the data width that
 *            should be used for the copy operations. It can be D16
 *            or D08.
 *
 *            VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
 *            in which the VME data is accessed. It can be A16 or A24.
 *
 *            UWORD fileName contains the PLC-5/40V data file number
 *            which will be continuously read from for the data transfer.
 *
 *            UWORD elementNumber contains the element number in the
 *            PLC-5/40V data table file at which the data transfer is to
 *            begin.
 *
 *****/

```

```

*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*      interrupt to be generated by the PLC-5/40V AFTER storing
*      its response in the response word of the command block AFTER
*      COMMAND completion.  If kVME_NO_INT_LEVEL is specified, then
*      no VME bus interrupts will be generated.
*
*      UBYTE cmdStatusId contains a unique value which will be used
*      by the interrupted host processor to run a specific
*      interrupt service routine.  This variable must be set to
*      zero if you are NOT using any command interrupts.
*
*      VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*      bus interrupt to be generated by the PLC-5/40V AFTER each
*      copy OPERATION.  If kVME_NO_INT_LEVEL is specified, then
*      no VME bus interrupts will be generated.
*
*      UBYTE operationStatusId contains a unique value which will
*      be used by the interrupted host processor to run a specific
*      interrupt service routine.  This variable must be set to
*      zero if you are NOT using any operation interrupts.
*
*  OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function.  This status could be and EPC
*           or PLC-5/40V value.
*
*  RETURNS:  Nothing.
*
*  EXAMPLE:
*
*      ULONG vmeDataAddr          = 0x80000;
*      UWORD vmeDataSize          = 0x100;
*      ULONG vmeCmdBlkAddr        = 0x90000;
*      UWORD baseAddress          = 0xFC00;
*      VME_DATA_WIDTH_TYPE width  = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A16_ADDR_SPACE;
*      UWORD fileNumber           = 11;
*      UWORD elementNumber        = 20;
*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*      UBYTE cmdStatusId          = 0;
*      VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_NO_INT_LEVEL;
*      UBYTE operationStatusId     = 0;
*      PLC540V_STATUS_TYPE status;
*      plc540v_halt_cont_copy_from_VME(
*
*                                     vmeDataAddr,
*                                     vmeDataSize,
*                                     vmeCmdBlkAddr,
*                                     baseAddress,
*                                     width,
*                                     addrMod,
*                                     fileNumber,
*                                     elementNumber,
*                                     cmdIntLevel,
*                                     cmdStatusId,
*                                     operationIntLevel,
*                                     operationStatusId,
*                                     &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
*  *****/

```



```

void plc540v_halt_cont_copy_from_VME(ULONG vmeDataAddr,
                                     UWORD vmeDataSize,
                                     ULONG vmeCmdBlkAddr,
                                     UWORD baseAddress,
                                     VME_DATA_WIDTH_TYPE width,
                                     VME_ADDRESS_MODIFIER_TYPE addrMod,
                                     UWORD fileNumber,
                                     UWORD elementNumber,
                                     VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                                     UBYTE cmdStatusId,
                                     VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                                     UBYTE operationStatusId,
                                     PLC540V_STATUS_TYPE *status)
{
    plc540v_cont_copy(kPLC540V_CONT_COPY_FROM_VME,
                     kPLC540V_CONT_COPY_DISABLE,
                     vmeDataAddr,
                     vmeDataSize,
                     vmeCmdBlkAddr,
                     baseAddress,
                     width,
                     addrMod,
                     fileNumber,
                     elementNumber,
                     cmdIntLevel,
                     cmdStatusId,
                     operationIntLevel,
                     operationStatusId,
                     status);
}

/*****
 * PURPOSE:   This function configures the PLC-5/40V to continuously copy.
 *            This function is private to this file and is common to all
 *            the continuous copy functions: Initiate continous copy to VME,
 *            Initiate continuous copy from VME, Halt continuous copy to
 *            VME and Halt continuous copy from VME.
 *
 * INPUT:     PLC540V_CONT_COPY_COMMAND ccCmd contains the continuous copy
 *            command which should be issued to the PLC-5/40V: continuous
 *            copy to VME or continuous copy from VME.
 *
 *            PLC540V_CONT_COPY_MODE ccMode contains the mode of the
 *            continous copy command which is being sent to the PLC-5/40V:
 *            enable or disable continous copy.
 *
 *            ULONG vmeDataAddr contains the VME address where the
 *            processor file memory will be written into.
 *
 *            UWORD vmeDataSize contains the number of 16 bit words which
 *            will be written.
 *
 *            ULONG vmeCmdBlkAddr contains the VME address where the
 *            command block will be copied to so the PLC-5/40V can
 *            access its information.
 *
 *            UWORD baseAddress contains the base address of the
 *            PLC-5/40V.
 *
 *            VME_DATA_WIDTH_TYPE width contains the data width that
 *            should be used for the copy operations. It can be D16
 *            or D08.
 *
 *            VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
 *            in which the VME data is accessed. It can be A16 or A24.
 *****/

```

```

*          UWORD fileName contains the PLC-5/40V data file number
*          which will be continuously read from for the data transfer.
*
*          UWORD elementNumber contains the element number in the
*          PLC-5/40V data table file at which the data transfer is to
*          begin.
*
*          VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*          interrupt to be generated by the PLC-5/40V AFTER storing
*          its response in the response word of the command block AFTER
*          COMMAND completion. If kVME_NO_INT_LEVEL is specified, then
*          no VME bus interrupts will be generated.
*
*          UBYTE cmdStatusId contains a unique value which will be used
*          by the interrupted host processor to run a specific
*          interrupt service routine. This variable must be set to
*          zero if you are NOT using any command interrupts.
*
*          VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*          bus interrupt to be generated by the PLC-5/40V AFTER each
*          copy OPERATION. If kVME_NO_INT_LEVEL is specified, then
*          no VME bus interrupts will be generated.
*
*          UBYTE operationStatusId contains a unique value which will
*          be used by the interrupted host processor to run a specific
*          interrupt service routine. This variable must be set to
*          zero if you are NOT using any operation interrupts.
*
* OUTPUT:   PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function. This status could be and EPC
*           or PLC-5/40V value.
*
* RETURNS:  Nothing.
*
* EXAMPLE:
*
*          PLC540V_CONT_COPY_COMMAND ccCmd=kPLC540V_CONT_COPY_TO_VME;
*          PLC540V_CONT_COPY_MODE ccMode=kPLC540V_CONT_COPY_ENABLE;
*          ULONG vmeDataAddr          = 0x80000;
*          UWORD vmeDataSize          = 0x100;
*          ULONG vmeCmdBlkAddr        = 0x90000;
*          UWORD baseAddress          = 0xFC00;
*          VME_DATA_WIDTH_TYPE width  = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A16_ADDR_SPACE;
*          UWORD fileName            = 11;
*          UWORD elementNumber        = 20;
*          VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*          UBYTE cmdStatusId          = 0;
*          VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_NO_INT_LEVEL;
*          UBYTE operationStatusId    = 0;
*          PLC540V_STATUS_TYPE status;
*          plc540v_cont_copy(ccCmd,
*                           ccMode,
*                           vmeDataAddr,
*                           vmeDataSize,
*                           vmeCmdBlkAddr,
*                           baseAddress,
*                           width,
*                           addrMod,
*                           fileName,
*                           elementNumber,
*                           cmdIntLevel,
*                           cmdStatusId,
*                           operationIntLevel,
*                           operationStatusId,
*                           &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*          *****/

```

```
static void plc540v_cont_copy(PLC540V_CONT_COPY_COMMAND ccCmd,
                             PLC540V_CONT_COPY_MODE ccMode,
                             ULONG vmeDataAddr,
                             WORD vmeDataSize,
                             ULONG vmeCmdBlkAddr,
                             WORD baseAddress,
                             VME_DATA_WIDTH_TYPE width,
                             VME_ADDRESS_MODIFIER_TYPE addrMod,
                             WORD fileName,
                             WORD elementNumber,
                             VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
                             BYTE cmdStatusId,
                             VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
                             BYTE operationStatusId,
                             PLC540V_STATUS_TYPE *status)
{
    /* The continuous copy command block. */
    static PLC540V_CONT_COPY_CMD_TYPE ccCmdBlk;

    /* The continuous copy to VME buffer. */
    static BYTE toVMEBuf[kPLC540V_MAX_TRANSFER_SIZE];

    /* Let's initialize the continuous copy command block to be empty. */
    memset((char *) &ccCmdBlk, 0x0, sizeof(PLC540V_CONT_COPY_CMD_TYPE));

    /* Let's initialize the continuous copy to VME buffer. */
    memset((char *) &toVMEBuf, 0x0, kPLC540V_MAX_TRANSFER_SIZE);

    /* Let's initialize the status variable to success. */
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Build the command block. */
    ccCmdBlk.commandWord = ccCmd;
    ccCmdBlk.responseWord = 0;
    ccCmdBlk.cmdIntLevel = cmdIntLevel;
    ccCmdBlk.cmdStatusId = cmdStatusId;
    ccCmdBlk.transferInfo.addressModifier = addrMod;
    ccCmdBlk.transferInfo.width = width;
    ccCmdBlk.transferInfo.enable = ccMode;
    ccCmdBlk.dataAddressHigh = HIWORD(vmeDataAddr);
    ccCmdBlk.dataAddressLow = LOWORD(vmeDataAddr);
    ccCmdBlk.dataSize = vmeDataSize;
    ccCmdBlk.fileName = fileName;
    ccCmdBlk.elementNumber = elementNumber;
    ccCmdBlk.operationIntLevel = operationIntLevel;
    ccCmdBlk.operationStatusId = operationStatusId;

    /* Copy the command block to VME memory. */
    status->epcStatus = EpcToVmeAm((BM_MBO|A24SD),
                                   BM_W16,
                                   (char far *) &ccCmdBlk,
                                   vmeCmdBlkAddr,
                                   sizeof(PLC540V_CONT_COPY_CMD_TYPE));
    if (status->epcStatus == EPC_SUCCESS)
    {
        /* Send the command block address to the PLC-5/40V's command
           register.
        */
        plc540v_send_cmd(baseAddress, vmeCmdBlkAddr, kVME_A24_ADDR_SPACE,
                        status);
    }
}
```

```

if (status->plc540vStatus == kPLC540V_SUCCESS)
{
    /* If sending the command block address didn't fail, then the
       PLC-5/40V has started processing the command.

       If the user of this function hasn't set up any VME interrupts
       to be generated, then we will poll the PLC-5/40V until the
       its done processing the command. This is indicated by a
       non-zero value in the response word of the command block.

       If the user has set up VME interrupts, then we will simply
       return to the caller.
    */
    if ((cmdIntLevel == kVME_NO_INT_LEVEL) &&
        (operationIntLevel == kVME_NO_INT_LEVEL))
    {
        /* Let's poll the PLC-5/40V until its done. */
        poll_plc540v_until_response(vmeCmdBlkAddr,
                                    kVME_A24_ADDR_SPACE,
                                    status);
    }
}
else
{
    /* Signal that we have an EPC error. */
    status->plc540vStatus = kPLC540V_COPY_CMDBLK_TO_VME_FAILED;
    status->statusCategory = kEPC_STATUS;
}
}

```

## PCCC.H

```

#ifndef PCCC_H
#define PCCC_H

////////////////////////////////////////
//          Common definitions for the ALLEN-BRADLEY PCCC COMMANDS          //
////////////////////////////////////////

#include "common.h"

typedef unsigned char BOOL;
const BOOL kFalse = 0;
const BOOL kTrue = 1;

```

```

/*
**
** Structure of the Send PCCC Command Block. This is used to communicate
** any PCCC command to the PLC.
*/
#pragma pack(1)
typedef struct
{
    unsigned short  commandWord;           /* 0      : command word */
    unsigned short  responseWord;          /* 1      : command response */
    unsigned short  interruptLevel;         /* 2      : completion intr */
    unsigned short  interruptStatusID;      /* 3      : completion statid */
    unsigned short  reserved0[3];           /* 4-6    : unused */
    unsigned short  transfer_info;          /* 7      : xfer parameters */
    unsigned short  packetAddrHigh;         /* 8      : packet address hi */
    unsigned short  packetAddrLow;          /* 9      : packet address lo */
    unsigned short  packetSize;             /* 10     : packet size */
    unsigned short  reserved2[4];           /* 11-14  : unused */
    unsigned short  reserved1;              /* 15     : unused */
}PCCC_SEND_CMD_TYPE;

/*
**
** Structure of Command Packet. This packet contains command specific
** information which is attached to a PCCC_SEND_CMD_TYPE.
*/
typedef struct
{
    unsigned char  dstCmdPkt;               /* Reserved */
    unsigned char  psn1CmdPkt;              /* Reserved */
    unsigned char  srcCmdPkt;               /* Reserved */
    unsigned char  psn2CmdPkt;              /* Reserved */
    unsigned char  command;                 /* packet command */
    unsigned char  sts;                     /* Reserved */
    unsigned short tns;
    unsigned char  functionCode;            /* extended function code */
    unsigned char  optionalData[243];        /* packet data */
}PCCC_CMD_PKT_TYPE;

/*
**
** Structure of Reply Packet
**
*/

typedef struct
{
    unsigned char  lnHFirstByte;            /* reply packet length high */
    unsigned char  lnHSecondByte;          /* reply packet length low */
    unsigned char  dstRpyPkt;               /* Reserved */
    unsigned char  psn1RpyPkt;              /* Reserved */
    unsigned char  srcRpyPkt;               /* Reserved */
    unsigned char  psn2RpyPkt;              /* Reserved */
    unsigned char  command;                 /* packet command */
    unsigned char  remoteError;             /* packet return code */
    unsigned short tns;                     /* sequence number */
    unsigned char  extSts;                  /* extended status */
    unsigned char  optionalData[243];        /* packet data */
}PCCC_RPY_PKT_ES_TYPE;

```

```
typedef struct
{
    unsigned char    lnhFirstByte;    /* reply packet length high */
    unsigned char    lnhSecondByte;   /* reply packet length low */
    unsigned char    dstRpyPkt;       /* Reserved */
    unsigned char    psnlRpyPkt;      /* Reserved */
    unsigned char    srcRpyPkt;       /* Reserved */
    unsigned char    psn2RpyPkt;      /* Reserved */
    unsigned char    command;          /* packet command */
    unsigned char    remoteError;      /* packet return code */
    unsigned short   tns;              /* sequence number */
    unsigned char    optionalData[243]; /* packet data */
}PCCC_RPY_PKT_TYPE;

#pragma pack()

// The size of each of these pccc types
const unsigned long kPCCC_SEND_CMD_SIZE      = sizeof(PCCC_SEND_CMD_TYPE);
const unsigned long kPCCC_CMD_PKT_SIZE      = sizeof(PCCC_CMD_PKT_TYPE);
const unsigned long kPCCC_RPY_PKT_SIZE      = sizeof(PCCC_RPY_PKT_TYPE);
const unsigned long kPCCC_RPY_PKT_ES_SIZE = sizeof(PCCC_RPY_PKT_ES_TYPE);

// The offset to each of these pccc types in the VME image
const unsigned long kPCCC_SEND_CMD_OFF      = 0X0L;
const unsigned long kPCCC_CMD_PKT_OFF       = kPCCC_SEND_CMD_SIZE;
const unsigned long kPCCC_RPY_PKT_OFF       = kPCCC_SEND_CMD_SIZE +
                                             kPCCC_CMD_PKT_SIZE;
const unsigned long kPCCC_RPY_PKT_ES_OFF = kPCCC_SEND_CMD_SIZE +
                                             kPCCC_CMD_PKT_SIZE;

#endif
```

## P40VHINT.H

```
#ifndef P40VHINT_H
#define P40VHINT_H 1

//////////////////////////////////////
//          Definitions for the HANDLE INTERRUPTS COMMAND STRUCTURE          //
//////////////////////////////////////

#include "common.h"

#pragma pack(1)
/*****
/***** INTEL VERSION OF DEFINITIONS *****/
/*****/
typedef struct
{
    UWORD reserved:15;
    UWORD enable:1;
} PLC540V_HINT_TRANSFER_TYPE;
```

```
typedef struct
{
    UWORD    commandWord;
    UWORD    responseWord;
    UWORD    cmdIntLevel;
    UWORD    cmdStatusId;
    UWORD    reserved1[3];
    PLC540V_HINT_TRANSFER_TYPE transferInfo;
    UWORD    reserved2[5];
    UWORD    operationIntLevel;
    UWORD    operationStatusId;
    UWORD    reserved3;
} PLC540V_HINT_CMD_TYPE;

#pragma pack()

void plc540v_init_handle_interrupts(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
    UBYTE operationStatusId,
    PLC540V_STATUS_TYPE *status);

void plc540v_halt_handle_interrupts(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
    UBYTE operationStatusId,
    PLC540V_STATUS_TYPE *status);

#endif
```

## P40VHINT.C

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vhint.h"

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****/
typedef enum
{
    kPLC540V_HANDLE_INTERRUPTS=0x0003,
} PLC540V_HINTS_COMMAND;

typedef enum
{
    kPLC540V_HINTS_DISABLE=0x0,
    kPLC540V_HINTS_ENABLE=0x1,
} PLC540V_HINTS_MODE;
```

```

/*****
/***** PRIVATE FUNCTIONS *****/
/*****
static void plc540v_handle_interrupts(
    PLC540V_HINTS_COMMAND hintCmd,
    PLC540V_HINTS_MODE hintMode,
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
    UBYTE operationStatusId,
    PLC540V_STATUS_TYPE *status);

/*****
*
* PURPOSE:      This function configures the PLC-5/40V to recognize the
*               specified VME interrupts.
*
* INPUT:        ULONG vmeCmdBlkAddr contains the VME address where the
*               command block will be copied to so the PLC-5/40V can
*               access its information.
*
*               UWORD baseAddress contains the base address of the
*               PLC-5/40V.
*
*               VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*               interrupt to be generated by the PLC-5/40V AFTER storing
*               its response in the response word of the command block AFTER
*               COMMAND completion.  If kVME_NO_INT_LEVEL is specified, then
*               no VME bus interrupts will be generated.
*
*               UBYTE cmdStatusId contains a unique value which will be used
*               by the interrupted host processor to run a specific
*               interrupt service routine.  This variable must be set to
*               zero if you are NOT using any command interrupts.
*
*               VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*               bus interrupt to be generated by the PLC-5/40V AFTER each
*               copy OPERATION.  If kVME_NO_INT_LEVEL is specified, then
*               an error is generated.
*
*               UBYTE operationStatusId contains a unique value which will
*               be used by the interrupted host processor to run a specific
*               interrupt service routine.  This variable must be set to
*               zero if you are NOT using any operation interrupts.
*
* OUTPUT:       PLC540V_STATUS_TYPE *status will contain the final status
*               of requesting this function.  This status could be and EPC
*               or PLC-5/40V value.
*
* RETURNS:      Nothing.
*
* EXAMPLE:
*
*               ULONG vmeCmdBlkAddr           = 0x90000;
*               UWORD baseAddress              = 0xFC00;
*               VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*               UBYTE cmdStatusId              = 0;
*               VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_INT_LEVEL_3;
*               UBYTE operationStatusId        = 234;
*               PLC540V_STATUS_TYPE status;

```



```

*      plc540v_init_handle_interrupts(
*
*      vmeCmdBlkAddr,
*      baseAddress,
*      cmdIntLevel,
*      cmdStatusId,
*      operationIntLevel,
*      operationStatusId,
*      &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
*****
void plc540v_init_handle_interrupts(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
    UBYTE operationStatusId,
    PLC540V_STATUS_TYPE *status)
{
    plc540v_handle_interrupts(
        kPLC540V_HANDLE_INTERRUPTS,
        kPLC540V_HINTS_ENABLE,
        vmeCmdBlkAddr,
        baseAddress,
        cmdIntLevel,
        cmdStatusId,
        operationIntLevel,
        operationStatusId,
        status);
}

/*****
*
*  PURPOSE:      This function configures the PLC-5/40V to not recognize the
*                 specified VME interrupts.
*
*  INPUT:        ULONG vmeCmdBlkAddr contains the VME address where the
*                 command block will be copied to so the PLC-5/40V can
*                 access its information.
*
*                 UWORD baseAddress contains the base address of the
*                 PLC-5/40V.
*
*                 VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*                 interrupt to be generated by the PLC-5/40V AFTER storing
*                 its response in the response word of the command block AFTER
*                 COMMAND completion.  If kVME_NO_INT_LEVEL is specified, then
*                 no VME bus interrupts will be generated.
*
*                 UBYTE cmdStatusId contains a unique value which will be used
*                 by the interrupted host processor to run a specific
*                 interrupt service routine.  This variable must be set to
*                 zero if you are NOT using any command interrupts.
*
*                 VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*                 bus interrupt to be generated by the PLC-5/40V AFTER each
*                 copy OPERATION.  If kVME_NO_INT_LEVEL is specified, then
*                 ALL VME interrupts will be disabled.
*
*****/

```

```

*          UBYTE operationStatusId contains a unique value which will
*          be used by the interrupted host processor to run a specific
*          interrupt service routine. This variable must be set to
*          zero if you are NOT using any operation interrupts.
*
* OUTPUT:   PLC540V_STATUS_TYPE *status will contain the final status
*          of requesting this function. This status could be and EPC
*          or PLC-5/40V value.
*
* RETURNS:  Nothing.
*
* EXAMPLE:
*          ULONG vmeCmdBlkAddr          = 0x90000;
*          UWORD baseAddress            = 0xFC00;
*          VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*          UBYTE cmdStatusId            = 0;
*          VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_INT_LEVEL_3;
*          UBYTE operationStatusId      = 234;
*          PLC540V_STATUS_TYPE status;
*          plc540v_halt_handle_interrupts(
*
*                                  vmeCmdBlkAddr,
*                                  baseAddress,
*                                  cmdIntLevel,
*                                  cmdStatusId,
*                                  operationIntLevel,
*                                  operationStatusId,
*                                  &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
*          *****/
void plc540v_halt_handle_interrupts(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
    UBYTE operationStatusId,
    PLC540V_STATUS_TYPE *status)
{
    plc540v_handle_interrupts(
        kPLC540V_HANDLE_INTERRUPTS,
        kPLC540V_HINTS_DISABLE,
        vmeCmdBlkAddr,
        baseAddress,
        cmdIntLevel,
        cmdStatusId,
        operationIntLevel,
        operationStatusId,
        status);
}
/*****/
*
* PURPOSE:  This function configures the PLC-5/40V to recognize the
*          specified VME interrupts.
*
* INPUT:    ULONG vmeCmdBlkAddr contains the VME address where the
*          command block will be copied to so the PLC-5/40V can
*          access its information.
*
*          UWORD baseAddress contains the base address of the
*          PLC-5/40V.

```

```

*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*      interrupt to be generated by the PLC-5/40V AFTER storing
*      its response in the response word of the command block AFTER
*      COMMAND completion.  If kVME_NO_INT_LEVEL is specified, then
*      no VME bus interrupts will be generated.
*
*      UBYTE cmdStatusId contains a unique value which will be used
*      by the interrupted host processor to run a specific
*      interrupt service routine.  This variable must be set to
*      zero if you are NOT using any command interrupts.
*
*      VME_INTERRUPT_LEVEL_TYPE operationIntLevel contains the VME
*      bus interrupt to be generated by the PLC-5/40V AFTER each
*      copy OPERATION.  If kVME_NO_INT_LEVEL is specified, then
*      ALL VME interrupts will be disabled.
*
*      UBYTE operationStatusId contains a unique value which will
*      be used by the interrupted host processor to run a specific
*      interrupt service routine.  This variable must be set to
*      zero if you are NOT using any operation interrupts.
*
*  OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function.  This status could be and EPC
*           or PLC-5/40V value.
*
*  RETURNS:  Nothing.
*
*  EXAMPLE:
*
*           PLC540V_HINTS_COMMAND hintCmd=kPLC540V_HANDLE_INTERRUPTS;
*           PLC540V_HINTS_MODE hintMode=kPLC540V_HINTS_ENABLE;
*           ULONG vmeCmdBlkAddr      = 0x90000;
*           UWORD baseAddress        = 0xFC00;
*           VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*           UBYTE cmdStatusId        = 0;
*           VME_INTERRUPT_LEVEL_TYPE operationIntLevel=kVME_INT_LEVEL_3;
*           UBYTE operationStatusId   = 432;
*           PLC540V_STATUS_TYPE status;
*           plc540v_handle_interrupts(hintCmd,
*                                     hintMode,
*                                     vmeCmdBlkAddr,
*                                     baseAddress,
*                                     cmdIntLevel,
*                                     cmdStatusId,
*                                     operationIntLevel,
*                                     operationStatusId,
*                                     &status);
*
*           Copyright Allen-Bradley Company, Inc. 1993
*
* *****/
static void plc540v_handle_interrupts(
    PLC540V_HINTS_COMMAND hintCmd,
    PLC540V_HINTS_MODE hintMode,
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_INTERRUPT_LEVEL_TYPE operationIntLevel,
    UBYTE operationStatusId,
    PLC540V_STATUS_TYPE *status)
{
    /* The handle interrupts command block. */
    static PLC540V_HINT_CMD_TYPE hintCmdBlk;

    /* Let's initialize the handle interrupts command block to be empty. */
    memset((char *) &hintCmdBlk, 0x0, sizeof(PLC540V_HINT_CMD_TYPE));

```

```

/* Let's initialize the status variable to success. */
memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

/* Build the command block. */
hintCmdBlk.commandWord = hintCmd;
hintCmdBlk.responseWord = 0;
hintCmdBlk.cmdIntLevel = cmdIntLevel;
hintCmdBlk.cmdStatusId = cmdStatusId;
hintCmdBlk.transferInfo.enable = hintMode;
hintCmdBlk.operationIntLevel = operationIntLevel;
hintCmdBlk.operationStatusId = operationStatusId;

/* Copy the command block to VME memory. */
status->epcStatus = EpcToVmeAm((BM_MBO|A24SD),
                               BM_W16,
                               (char far *) &hintCmdBlk,
                               vmeCmdBlkAddr,
                               sizeof(PLC540V_HINT_CMD_TYPE));

if (status->epcStatus == EPC_SUCCESS)
{
    /* Send the command block address to the PLC-5/40V's command
       register.
    */
    plc540v_send_cmd(baseAddress, vmeCmdBlkAddr,
                     kVME_A24_ADDR_SPACE,
                     status);
    if (status->plc540vStatus == kPLC540V_SUCCESS)
    {
        /* If sending the command block address didn't fail, then the
           PLC-5/40V has started processing the command.

           If the user of this function hasn't set up any VME interrupts
           to be generated, then we will poll the PLC-5/40V until the
           its done processing the command. This is indicated by a
           non-zero value in the response word of the command block.

           If the user has set up VME interrupts, then we will simply
           return to the caller.
        */
        if ((cmdIntLevel == kVME_NO_INT_LEVEL) &&
            (operationIntLevel == kVME_NO_INT_LEVEL))
        {
            /* Let's poll the PLC-5/40V until its done. */
            poll_plc540v_until_response(vmeCmdBlkAddr,
                                         kVME_A24_ADDR_SPACE,
                                         status);
        }
    }
}
else
{
    /* Signal that we have an EPC error. */
    status->plc540vStatus = kPLC540V_COPY_CMDBLK_TO_VME_FAILED;
    status->statusCategory = kEPC_STATUS;
}
}

```

## P40VSPCC.H

```
#ifndef P40VSPCC_H
#define P40VSPCC_H 1

////////////////////////////////////
//          Definitions for the SEND PCCC COMMAND STRUCTURE          //
////////////////////////////////////

#include "pccc.h"

#pragma pack(1)
/***** INTEL VERSION OF DEFINITIONS *****/
/***** INTEL VERSION OF DEFINITIONS *****/
#define kPLC540V_PCCC_MAX_CMD_DATA 243
typedef UBYTE PLC540V_PCCC_DATA_TYPE[kPLC540V_PCCC_MAX_CMD_DATA];

/* A generic pointer to a PCCC command packet. */
typedef void far *PLC540V_PCCC_PACKET_TYPE;

/* A generic pointer to a PCCC reply packet. */
typedef void far *PLC540V_PCCC_REPLY_TYPE;

typedef struct
{
    UWORD addressModifier:8;
    UWORD width:1;
    UWORD reserved1:7;
} PLC540V_SPPCC_TRANSFER_TYPE;

typedef struct
{
    UWORD    commandWord;
    UWORD    responseWord;
    UWORD    cmdIntLevel;
    UWORD    cmdStatusId;
    UWORD    reserved1[3];
    PLC540V_SPPCC_TRANSFER_TYPE transferInfo;
    UWORD    packetAddressHigh;
    UWORD    packetAddressLow;
    UWORD    packetSize;
    UWORD    reserved2[5];
} PLC540V_SPPCC_CMD_TYPE;

#pragma pack()
void plc540v_send_pccc_command(
    ULONG vmeCmdBlkAddr,
    PLC540V_PCCC_PACKET_TYPE pcccCommandPacket,
    UWORD pcccCommandPacketSize,
    PLC540V_PCCC_REPLY_TYPE pcccReplyPacket,
    UWORD pcccReplyPacketSize,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_STATUS_TYPE *status);

#endif
```

## P40VSPCC.C

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vspcc.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
typedef enum
{
    kPLC540V_SEND_PCCC=0xFFFF,
} PLC540V_SPCCC_COMMAND;

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
*
* PURPOSE:      This function sends a PCCC command to the PLC-5/40V for
*               processing.
*
* INPUT:        ULONG vmeCmdBlkAddr contains the VME address where the
*               command block will be copied to so the PLC-5/40V can
*               access its information.
*
*               PLC540V_PCCC_PACKET_TYPE pcccCommandPacket contains a pointer
*               to the PCCC command packet which will be sent to the processor.
*
*               UWORD pcccCommandPacketSize contains the size of the PCCC
*               command packet in bytes.
*
*               PLC540V_PCCC_REPLY_TYPE pcccReplyPacket contains a pointer to
*               the PCCC reply packet which will be returned from the
*               processor.
*
*               UWORD pcccReplyPacketSize contains the size of the PCCC reply
*               packet in bytes.
*
*               UWORD baseAddress contains the base address of the
*               PLC-5/40V.
*
*               VME_INTERRUPT_LEVEL_TYPE cmdIntLevel contains the VME bus
*               interrupt to be generated by the PLC-5/40V AFTER storing
*               its response in the response word of the command block AFTER
*               COMMAND completion.  If kVME_NO_INT_LEVEL is specified, then
*               no VME bus interrupts will be generated.
*
*               UBYTE cmdStatusId contains a unique value which will be used
*               by the interrupted host processor to run a specific
*               interrupt service routine.  This variable must be set to
*               zero if you are NOT using any command interrupts.
*
*               VME_DATA_WIDTH_TYPE width contains the data width that
*               should be used for the copy operations.  It can be D16
*               or D08.
*
*****/
```

```

*
*      VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*      in which the VME data is accessed.  It can be A16 or A24.
*
* OUTPUT:      PLC540V_STATUS_TYPE *status will contain the final status
*              of requesting this function.  This status could be and EPC
*              or PLC-5/40V value.
*
* RETURNS:     Nothing.
*
* EXAMPLE:
*
*      ULONG vmeCmdBlkAddr          = 0x90000;
*      PLC540V_PCCC_PACKET_TYPE commandPacket= &pcccPacket;
*      UWORD commandPacketSize      = 0x200;
*      PLC540V_PCCC_REPLY_TYPE replyPacket  = &pcccReply;
*      UWORD replyPacketSize        = 0x100;
*      UWORD baseAddress            = 0xFC00;
*      VME_INTERRUPT_LEVEL_TYPE cmdIntLevel = kVME_NO_INT_LEVEL;
*      VME_DATA_WIDTH_TYPE width      = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod  = kVME_A24_ADDR_SPACE;
*      UBYTE cmdStatusId             = 0;
*
*      PLC540V_STATUS_TYPE status;
*      plc540v_send_pccc_command(
*
*          vmeCmdBlkAddr,
*          commandPacket,
*          packetSize,
*          replyPacket,
*          replyPacketSize,
*          baseAddress,
*          cmdIntLevel,
*          cmdStatusId,
*          width,
*          addrMod,
*          &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
* *****/
void plc540v_send_pccc_command(
    ULONG vmeCmdBlkAddr,
    PLC540V_PCCC_PACKET_TYPE pcccCommandPacket,
    UWORD pcccCommandPacketSize,
    PLC540V_PCCC_REPLY_TYPE pcccReplyPacket,
    UWORD pcccReplyPacketSize,
    UWORD baseAddress,
    VME_INTERRUPT_LEVEL_TYPE cmdIntLevel,
    UBYTE cmdStatusId,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_STATUS_TYPE *status)
{
    /* The VME location of the PCCC packet.  It will be placed directly
       after the PCCC command block in memory.
    */
    ULONG vmeCommandPacketAddr = (vmeCmdBlkAddr +
        sizeof(PLC540V_SPCCC_CMD_TYPE));

    /* The VME location of the reply packet.  It must always be appended
       after the PCCC command packet.
    */
    ULONG vmeReplyPacketAddr = vmeCommandPacketAddr + pcccCommandPacketSize;

    /* The continuous send PCCC command block. */
    static PLC540V_SPCCC_CMD_TYPE pcccCmdBlk;

```

```

/* Let's initialize the send PCCC command block to be empty. */
memset((char *) &pcccCmdBlk, 0x0, sizeof(PLC540V_SPCCC_CMD_TYPE));

/* Let's initialize the send PCCC reply packet to be empty. */
memset((char *) pcccReplyPacket, 0x0, pcccReplyPacketSize);

/* Let's initialize the status variable to success. */
memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

/* Copy the PCCC command packet to VME memory. */
status->epcStatus = EpcToVmeAm((BM_MBO|A24SD),
                               BM_W8,
                               (char far *) pcccCommandPacket,
                               vmeCommandPacketAddr,
                               pcccCommandPacketSize);
if (status->epcStatus == EPC_SUCCESS)
{
    /* Build the command block. */
    pcccCmdBlk.commandWord = kPLC540V_SEND_PCCC;
    pcccCmdBlk.responseWord = 0;
    pcccCmdBlk.cmdIntLevel = cmdIntLevel;
    pcccCmdBlk.cmdStatusId = cmdStatusId;
    pcccCmdBlk.transferInfo.addressModifier = addrMod;
    pcccCmdBlk.transferInfo.width = width;
    pcccCmdBlk.packetAddressHigh = HIWORD(vmeCommandPacketAddr);
    pcccCmdBlk.packetAddressLow = LOWORD(vmeCommandPacketAddr);
    pcccCmdBlk.packetSize = pcccCommandPacketSize;

    /* Copy the command block to VME memory. */
    status->epcStatus = EpcToVmeAm((BM_MBO|A24SD),
                                   BM_W16,
                                   (char far *) &pcccCmdBlk,
                                   vmeCmdBlkAddr,
                                   sizeof(PLC540V_SPCCC_CMD_TYPE));
    if (status->epcStatus == EPC_SUCCESS)
    {
        /* Send the command block address to the PLC-5/40V's command
           register.
        */
        plc540v_send_cmd(baseAddress, vmeCmdBlkAddr, kVME_A24_ADDR_SPACE,
                        status);
        if (status->plc540vStatus == kPLC540V_SUCCESS)
        {
            /* If sending the command block address didn't fail, then the
               PLC-5/40V has started processing the command.

               If the user of this function hasn't set up any VME interrupts
               to be generated, then we will poll the PLC-5/40V until the
               its done processing the command. This is indicated by a
               non-zero value in the response word of the command block.

               If the user has set up VME interrupts, then we will simply
               continue by retrieving the PCCC reply packet.
            */
            if (cmdIntLevel == kVME_NO_INT_LEVEL)
            {
                /* Let's poll the PLC-5/40V until its done. */
                poll_plc540v_until_response(vmeCmdBlkAddr,
                                             kVME_A24_ADDR_SPACE,
                                             status);
            }
        }
    }
}

```



```

/* Let's retrieve the reply packet. */
status->epcStatus=EpcFromVmeAm((BM_MBO|A24SD),
                                BM_W8,
                                vmeReplyPacketAddr,
                                (char far *) pcccReplyPacket,
                                pcccReplyPacketSize);

if (status->epcStatus != EPC_SUCCESS)
{
    /* Signal that we have an EPC error. */
    status->plc540vStatus =
        kPLC540V_GET_REPLYBLK_FROM_VME_FAILED;
    status->statusCategory = kEPC_STATUS;
}
}
else
{
    /* Signal that we have an EPC error. */
    status->plc540vStatus = kPLC540V_COPY_CMDBLK_TO_VME_FAILED;
    status->statusCategory = kEPC_STATUS;
}
}
else
{
    /* Signal that we have an EPC error copying the PCCC packet to VME.*/
    status->plc540vStatus = kPLC540V_COPY_PCCC_PACKET_TO_VME_FAILED;
    status->statusCategory = kEPC_STATUS;
}
}
}

```

## P40VWBP.H

```

#ifndef P40VWBP_H
#define P40VWBP_H 1

/////////////////////////////////////////////////////////////////
// Definitions for the PCCC WRITE BYTES PHYSICAL COMMAND AND REPLY PACKETS //
/////////////////////////////////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

// The maximum number of bytes which can be written in one operation.
#define kPLC540V_PCCC_MAX_WBP_DATA 238
typedef UBYTE PLC540V_PCCC_WBP_DATA_TYPE[kPLC540V_PCCC_MAX_WBP_DATA];

/* The PCCC Write Bytes Physical command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
    ULONG addr;
    PLC540V_PCCC_WBP_DATA_TYPE data;
} PLC540V_PCCC_WBP_CMD_TYPE;
#define kPLC540V_PCCC_WBP_CMD_SIZE (sizeof(PLC540V_PCCC_WBP_CMD_TYPE))

```

```

/* The PCCC Write Bytes Physical reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extsts;
} PLC540V_PCCC_WBP_RPY_TYPE;
#define kPLC540V_PCCC_WBP_RPY_SIZE (sizeof(PLC540V_PCCC_WBP_RPY_TYPE))
#pragma pack()

void plc540v_pccc_write_bytes_physical(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    ULONG plcAddress,
    PLC540V_PCCC_WBP_DATA_TYPE data,
    UBYTE dataLength,
    PLC540V_PCCC_WBP_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif

```

## P40VWBP.C

```

#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vwbp.h"

/***** PRIVATE DEFINITIONS *****/
#define kPLC540V_PCCC_WBP_CMD 0x0F
#define kPLC540V_PCCC_WBP_FNC 0x18

/***** PRIVATE TYPE DEFINITIONS *****/

/***** PRIVATE FUNCTIONS *****/

/*****
 *
 * PURPOSE:      This function sends the PCCC Write Bytes Physical command to
 *               the PLC-5/40V.
 *
 * INPUT:        ULONG vmeCmdBlkAddr contains the VME address where the
 *               command block will be copied to so the PLC-5/40V can
 *               access its information.
 *
 *               UWORD baseAddress contains the base address of the
 *               PLC-5/40V.
 *
 *****/

```

```

*      VME_DATA_WIDTH_TYPE width contains the data width that
*      should be used for the copy operations.  It can be D16
*      or D08.
*
*      VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*      in which the VME data is accessed.  It can be A16 or A24.
*
*      ULONG plcAddress contains the physical address to write to
*      in the processor.
*
*      PLC540V_PCCC_WBP_DATA_TYPE data contains the data to write
*      to the processor.
*
*      UBYTE dataLength contains the number of bytes to write.
*
*      PLC540V_PCCC_WBP_RPY_TYPE reply contains PCCC's Write Bytes
*      Physical command specific reply packet.
*
* OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*          of requesting this function.  This status could be and EPC
*          or PLC-5/40V value.
*
* RETURNS:  Nothing.
*
* EXAMPLE:
*          ULONG vmeCmdBlkAddr          = 0xE0F100;
*          UWORD baseAddress             = 0XFC00;
*          VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*          ULONG plcAddress;
*          PLC540V_PCCC_WBP_DATA_TYPE data;
*          UBYTE dataLength;
*          PLC540V_PCCC_WBP_RPY_TYPE reply;
*          PLC540V_STATUS_TYPE status;
*          void plc540v_pccc_write_bytes_physical(
*              vmeCmdBlkAddr,
*              baseAddress,
*              width,
*              addrMod,
*              plcAddress,
*              data,
*              dataLength,
*              &reply,
*              &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
* *****/
void plc540v_pccc_write_bytes_physical(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    ULONG plcAddress,
    PLC540V_PCCC_WBP_DATA_TYPE data,
    UBYTE dataLength,
    PLC540V_PCCC_WBP_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Write Bytes Physical command packet. */
    PLC540V_PCCC_WBP_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_WBP_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_WBP_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

```

```

/* Let's establish the command packet contents... Note that
   since we set this block with zeros originally, we don't
   need to explicitly set them here.
*/
cmdPacket.cmd = kPLC540V_PCCC_WBP_CMD;
cmdPacket.fnc = kPLC540V_PCCC_WBP_FNC;
cmdPacket.addr = plcAddress;
memmove((char *) cmdPacket.data, (char *) data, dataLength);

plc540v_send_pccc_command(
    vmeCmdBlkAddr,
    &cmdPacket,
    kPLC540V_PCCC_WBP_CMD_SIZE,
    reply,
    kPLC540V_PCCC_WBP_RPY_SIZE,
    baseAddress,
    kVME_NO_INT_LEVEL,
    0,
    width,
    addrMod,
    status);
}

```

## P40VAPC.H

```

#ifndef P40VAPC_H
#define P40VAPC_H 1

/////////////////////////////////////////////////////////////////
//      Definitions for the PCCC APPLY PORT CONFIG COMMAND AND REPLY PACKETS      //
/////////////////////////////////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Apply Port Configuration command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
    PLC540V_PCCC_DATA_TYPE data;
} PLC540V_PCCC_APC_CMD_TYPE;
#define kPLC540V_PCCC_APC_CMD_SIZE (sizeof(PLC540V_PCCC_APC_CMD_TYPE))

```

```

/* The PCCC Apply Port Configuration reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    PLC540V_PCCC_DATA_TYPE data;
} PLC540V_PCCC_APC_RPY_TYPE;
#define kPLC540V_PCCC_APC_RPY_SIZE (sizeof(PLC540V_PCCC_APC_RPY_TYPE))
#pragma pack()

void plc540v_pccc_apply_port_config(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_APC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif

```

## P40VAPC.C

```

#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vapc.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_APC_CMD 0x0F
#define kPLC540V_PCCC_APC_FNC 0x8F

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
*
* PURPOSE: This function sends the PCCC Apply Port Configuration command
* to the PLC-5/40V.
*
* INPUT: ULONG vmeCmdBlkAddr contains the VME address where the
* command block will be copied to so the PLC-5/40V can
* access its information.
*
*****/

```

```

*          UWORD baseAddress contains the base address of the
*          PLC-5/40V.
*
*          VME_DATA_WIDTH_TYPE width contains the data width that
*          should be used for the copy operations. It can be D16
*          or D08.
*
*          VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*          in which the VME data is accessed. It can be A16 or A24.
*
*          PLC540V_PCCC_APC_RPY_TYPE reply contains PCCC's Apply Port
*          Configuration command specific reply packet.
*
* OUTPUT:   PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function. This status could be and EPC
*           or PLC-5/40V value.
*
* RETURNS:  Nothing.
*
* EXAMPLE:
*
*          ULONG vmeCmdBlkAddr          = 0xE0F100;
*          UWORD baseAddress             = 0xFC00;
*          VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*          PLC540V_PCCC_APC_RPY_TYPE reply;
*          PLC540V_STATUS_TYPE status;
*          void plc540v_pccc_apply_port_config(
*              vmeCmdBlkAddr,
*              baseAddress,
*              width,
*              addrMod,
*              &reply,
*              &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
*          *****/
void plc540v_pccc_apply_port_config(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_APC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Apply Port Configuration command packet. */
    PLC540V_PCCC_APC_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_APC_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_APC_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_APC_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_APC_FNC;

```

```

plc540v_send_pccc_command(
    vmeCmdBlkAddr,
    &cmdPacket,
    kPLC540V_PCCC_APC_CMD_SIZE,
    reply,
    kPLC540V_PCCC_APC_RPY_SIZE,
    baseAddress,
    kVME_NO_INT_LEVEL,
    0,
    width,
    addrMod,
    status);
}

```

## P40VULC.H

```

#ifndef P40VULC_H
#define P40VULC_H 1

////////////////////////////////////
//      Definitions for the PCCC UPLOAD COMPLETE COMMAND AND REPLY PACKETS      //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
/***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Upload Complete command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
} PLC540V_PCCC_ULC_CMD_TYPE;
#define kPLC540V_PCCC_ULC_CMD_SIZE (sizeof(PLC540V_PCCC_ULC_CMD_TYPE))

/* The PCCC Upload Complete reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extsts;
} PLC540V_PCCC_ULC_RPY_TYPE;
#define kPLC540V_PCCC_ULC_RPY_SIZE (sizeof(PLC540V_PCCC_ULC_RPY_TYPE))
#pragma pack()

void plc540v_pccc_upload_complete(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_ULC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif

```

## P40VULC.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vulc.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_ULC_CMD 0x0F
#define kPLC540V_PCCC_ULC_FNC 0x55

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
*
* PURPOSE: This function sends the PCCC Upload Complete command to the
*          PLC-5/40V.
*
* INPUT:   ULONG vmeCmdBlkAddr contains the VME address where the
*          command block will be copied to so the PLC-5/40V can
*          access its information.
*
*          UWORD baseAddress contains the base address of the
*          PLC-5/40V.
*
*          VME_DATA_WIDTH_TYPE width contains the data width that
*          should be used for the copy operations. It can be D16
*          or D08.
*
*          VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*          in which the VME data is accessed. It can be A16 or A24.
*
*          PLC540V_PCCC_ULC_RPY_TYPE reply contains PCCC's Upload Complete
*          command specific reply packet.
*
* OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*          of requesting this function. This status could be and EPC
*          or PLC-5/40V value.
*
* RETURNS: Nothing.
*
* EXAMPLE:
*          ULONG vmeCmdBlkAddr          = 0xE0F100;
*          UWORD baseAddress             = 0XFC00;
*          VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*          PLC540V_PCCC_ULC_RPY_TYPE reply;
*          PLC540V_STATUS_TYPE status;
```



```

*          void plc540v_pccc_upload_complete(
*
*                      vmeCmdBlkAddr,
*                      baseAddress,
*                      width,
*                      addrMod,
*                      &reply,
*                      &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
*****/
void plc540v_pccc_upload_complete(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_ULC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Upload Complete command packet. */
    PLC540V_PCCC_ULC_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_ULC_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_ULC_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_ULC_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_ULC_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_ULC_CMD_SIZE,
        reply,
        kPLC540V_PCCC_ULC_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VDLA.H

```
#ifndef P40VDLA_H
#define P40VDLA_H 1

////////////////////////////////////
//      Definitions for the PCCC DOWNLOAD ALL COMMAND AND REPLY PACKETS      //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Download All command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
} PLC540V_PCCC_DLA_CMD_TYPE;
#define kPLC540V_PCCC_DLA_CMD_SIZE (sizeof(PLC540V_PCCC_DLA_CMD_TYPE))

/* The PCCC Download All reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extsts;
} PLC540V_PCCC_DLA_RPY_TYPE;
#define kPLC540V_PCCC_DLA_RPY_SIZE (sizeof(PLC540V_PCCC_DLA_RPY_TYPE))
#pragma pack()

void plc540v_pccc_download_all(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_DLA_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

# P40VDLA.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vdl_a.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_DLA_CMD 0x0F
#define kPLC540V_PCCC_DLA_FNC 0x50

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
/*****
/***** PRIVATE FUNCTIONS *****/
/*****
/*****
*
* PURPOSE: This function sends the PCCC Download All command to the
* PLC-5/40V.
*
* INPUT: ULONG vmeCmdBlkAddr contains the VME address where the
* command block will be copied to so the PLC-5/40V can
* access its information.
*
* UWORD baseAddress contains the base address of the
* PLC-5/40V.
*
* VME_DATA_WIDTH_TYPE width contains the data width that
* should be used for the copy operations. It can be D16
* or D08.
*
* VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
* in which the VME data is accessed. It can be A16 or A24.
*
* PLC540V_PCCC_DLA_RPY_TYPE reply contains PCCC's Download All
* command specific reply packet.
*
* OUTPUT: PLC540V_STATUS_TYPE *status will contain the final status
* of requesting this function. This status could be and EPC
* or PLC-5/40V value.
*
* RETURNS: Nothing.
*
*****/
```

```

*   EXAMPLE:
*
*       ULONG vmeCmdBlkAddr           = 0xE0F100;
*       UWORD baseAddress             = 0XFC00;
*       VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*       VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*       PLC540V_PCCC_DLA_RPY_TYPE reply;
*       PLC540V_STATUS_TYPE status;
*       void plc540v_pccc_download_all(
*           vmeCmdBlkAddr,
*           baseAddress,
*           width,
*           addrMod,
*           &reply,
*           &status);
*
*       Copyright Allen-Bradley Company, Inc. 1993
*
* *****/

void plc540v_pccc_download_all(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_DLA_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Download All command packet. */
    PLC540V_PCCC_DLA_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_DLA_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_DLA_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_DLA_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_DLA_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_DLA_CMD_SIZE,
        reply,
        kPLC540V_PCCC_DLA_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VDLC.H

```
#ifndef P40VDLC_H
#define P40VDLC_H 1

////////////////////////////////////
//      Definitions for the PCCC DOWNLOAD COMPLETE COMMAND AND REPLY PACKETS      //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Download Complete command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
} PLC540V_PCCC_DLC_CMD_TYPE;
#define kPLC540V_PCCC_DLC_CMD_SIZE (sizeof(PLC540V_PCCC_DLC_CMD_TYPE))

/* The PCCC Download Complete reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extsts;
} PLC540V_PCCC_DLC_RPY_TYPE;
#define kPLC540V_PCCC_DLC_RPY_SIZE (sizeof(PLC540V_PCCC_DLC_RPY_TYPE))
#pragma pack()

void plc540v_pccc_download_complete(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_DLC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

## P40VDLC.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vdlc.h"

/*****
***** PRIVATE DEFINITIONS *****/
/*****
***** PRIVATE TYPE DEFINITIONS *****/
/*****
***** PRIVATE FUNCTIONS *****/

/*****
*
* PURPOSE:      This function sends the PCCC Download Complete command to the
*               PLC-5/40V.
*
* INPUT:        ULONG vmeCmdBlkAddr contains the VME address where the
*               command block will be copied to so the PLC-5/40V can
*               access its information.
*
*               UWORD baseAddress contains the base address of the
*               PLC-5/40V.
*
*               VME_DATA_WIDTH_TYPE width contains the data width that
*               should be used for the copy operations.  It can be D16
*               or D08.
*
*               VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*               in which the VME data is accessed.  It can be A16 or A24.
*
*               PLC540V_PCCC_DLC_RPY_TYPE reply contains PCCC's Download Complete
*               command specific reply packet.
*
* OUTPUT:       PLC540V_STATUS_TYPE *status will contain the final status
*               of requesting this function.  This status could be and EPC
*               or PLC-5/40V value.
*
* RETURNS:      Nothing.
*
*****/
```

```

* EXAMPLE:
*
*      ULONG vmeCmdBlkAddr          = 0xE0F100;
*      UWORD baseAddress            = 0XFC00;
*      VME_DATA_WIDTH_TYPE width    = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*      PLC540V_PCCC_DLC_RPY_TYPE reply;
*      PLC540V_STATUS_TYPE status;
*      void plc540v_pccc_download_complete(
*          vmeCmdBlkAddr,
*          baseAddress,
*          width,
*          addrMod,
*          &reply,
*          &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
* *****/
void plc540v_pccc_download_complete(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_DLC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Download Complete command packet. */
    PLC540V_PCCC_DLC_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_DLC_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_DLC_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_DLC_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_DLC_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_DLC_CMD_SIZE,
        reply,
        kPLC540V_PCCC_DLC_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VECHO.H

```
#ifndef P40VECHO_H
#define P40VECHO_H 1

////////////////////////////////////
//          Definitions for the PCCC ECHO COMMAND AND REPLY PACKETS          //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/***** INTEL VERSION OF DEFINITIONS *****/
/***** INTEL VERSION OF DEFINITIONS *****/

/* The PCCC Echo command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
    PLC540V_PCCC_DATA_TYPE data;
} PLC540V_PCCC_ECHO_CMD_TYPE;
#define kPLC540V_PCCC_ECHO_CMD_SIZE (sizeof(PLC540V_PCCC_ECHO_CMD_TYPE))

/* The PCCC Echo reply packet structure. */
typedef struct
{
    UBYTE lnHi;
    UBYTE lnLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    PLC540V_PCCC_DATA_TYPE data;
} PLC540V_PCCC_ECHO_RPY_TYPE;
#define kPLC540V_PCCC_ECHO_RPY_SIZE (sizeof(PLC540V_PCCC_ECHO_RPY_TYPE))
#pragma pack()

void plc540v_pccc_echo(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_DATA_TYPE data,
    UBYTE dataLength,
    PLC540V_PCCC_ECHO_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```



## P40VECHO.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vecho.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_ECHO_CMD 0x6
#define kPLC540V_PCCC_ECHO_FNC 0x0

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
*
* PURPOSE: This function sends the PCCC Echo command to the PLC-5/40V.
*
* INPUT: ULONG vmeCmdBlkAddr contains the VME address where the
* command block will be copied to so the PLC-5/40V can
* access its information.
*
* UWORD baseAddress contains the base address of the
* PLC-5/40V.
*
* VME_DATA_WIDTH_TYPE width contains the data width that
* should be used for the copy operations. It can be D16
* or D08.
*
* VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
* in which the VME data is accessed. It can be A16 or A24.
*
* PLC540V_PCCC_DATA_TYPE data Contains the data which should
* be sent to the processor and echoed back.
*
* UBYTE dataLength contains the length of the data being sent
* in bytes.
*
* PLC540V_PCCC_ECHO_RPY_TYPE reply contains PCCC's ECHO command
* specific reply packet.
*
* OUTPUT: PLC540V_STATUS_TYPE *status will contain the final status
* of requesting this function. This status could be and EPC
* or PLC-5/40V value.
*
* RETURNS: Nothing.
*
* EXAMPLE:
*          ULONG vmeCmdBlkAddr          = 0xE0F100;
*          UWORD baseAddress             = 0xFC00;
*          VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*          PLC540V_PCCC_DATA_TYPE data   = "Hello There";
*          UBYTE dataLength              = 11;
*          PLC540V_PCCC_ECHO_RPY_TYPE reply;
```

```

*          PLC540V_STATUS_TYPE status;
*          void plc540v_pccc_echo(
*
*              vmeCmdBlkAddr,
*              baseAddress,
*              width,
*              addrMod,
*              data,
*              dataLength,
*              &reply,
*              &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
*          *****/
void plc540v_pccc_echo(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_DATA_TYPE data,
    UBYTE dataLength,
    PLC540V_PCCC_ECHO_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The ECHO command packet. */
    PLC540V_PCCC_ECHO_CMD_TYPE cmdPacket;

    /* Let's initialize these packet to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_ECHO_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_ECHO_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_ECHO_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_ECHO_FNC;
    memmove((char *) cmdPacket.data, (char *) data, dataLength);

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_ECHO_CMD_SIZE,
        reply,
        kPLC540V_PCCC_ECHO_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VGER.H

```
#ifndef P40VGER_H
#define P40VGER_H 1

////////////////////////////////////
//      Definitions for the PCCC GET EDIT RESOURCE COMMAND AND REPLY PACKETS      //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Get Edit Resource command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
} PLC540V_PCCC_GER_CMD_TYPE;
#define kPLC540V_PCCC_GER_CMD_SIZE (sizeof(PLC540V_PCCC_GER_CMD_TYPE))

/* The PCCC Get Edit Resource reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extsts;
} PLC540V_PCCC_GER_RPY_TYPE;
#define kPLC540V_PCCC_GER_RPY_SIZE (sizeof(PLC540V_PCCC_GER_RPY_TYPE))
#pragma pack()

void plc540v_pccc_get_edit_resource(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_GER_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

# P40VGER.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vger.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_GER_CMD 0x0F
#define kPLC540V_PCCC_GER_FNC 0x11

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
/***** PRIVATE FUNCTIONS *****/
/*****
/*****
*
* PURPOSE: This function sends the PCCC Get Edit Resource command to the
*          PLC-5/40V.
*
* INPUT:   ULONG vmeCmdBlkAddr contains the VME address where the
*          command block will be copied to so the PLC-5/40V can
*          access its information.
*
*          UWORD baseAddress contains the base address of the
*          PLC-5/40V.
*
*          VME_DATA_WIDTH_TYPE width contains the data width that
*          should be used for the copy operations. It can be D16
*          or D08.
*
*          VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*          in which the VME data is accessed. It can be A16 or A24.
*
*          PLC540V_PCCC_GER_RPY_TYPE reply contains PCCC's Get Edit
*          Resource command specific reply packet.
*
* OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*          of requesting this function. This status could be and EPC
*          or PLC-5/40V value.
*
* RETURNS: Nothing.
*
```

```

* EXAMPLE:
*
*      ULONG vmeCmdBlkAddr          = 0xE0F100;
*      UWORD baseAddress            = 0XFC00;
*      VME_DATA_WIDTH_TYPE width    = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*      PLC540V_PCCC_GER_RPY_TYPE reply;
*      PLC540V_STATUS_TYPE status;
*      void plc540v_pccc_get_edit_resource(
*          vmeCmdBlkAddr,
*          baseAddress,
*          width,
*          addrMod,
*          &reply,
*          &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
* *****/
void plc540v_pccc_get_edit_resource(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_GER_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Get Edit Resource command packet. */
    PLC540V_PCCC_GER_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_GER_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_GER_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_GER_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_GER_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_GER_CMD_SIZE,
        reply,
        kPLC540V_PCCC_GER_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VIHAS.H

```
#ifndef P40VIHAS_H
#define P40VIHAS_H 1

////////////////////////////////////
// Definitions for the PCCC ID HOST AND STATUS COMMAND AND REPLY PACKETS //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Identify Host and Status command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
} PLC540V_PCCC_IHAS_CMD_TYPE;
#define kPLC540V_PCCC_IHAS_CMD_SIZE (sizeof(PLC540V_PCCC_IHAS_CMD_TYPE))

/* The operating status information */
typedef struct
{
    UBYTE keyswitchMode:3; /* Byte 1, Operating Status */
#define kPLC540V_PROGRAM_LOAD 0x0
#define kPLC540V_RUN 0x2
#define kPLC540V_REMOTE_PROGRAM_LOAD 0x4
#define kPLC540V_REMOTE_TEST 0x5
#define kPLC540V_REMOTE_RUN 0x6

    UBYTE majorFault:1;
#define kPLC540V_NO_MAJOR_FAULT 0x0
#define kPLC540V_MAJOR_FAULT 0x1

    UBYTE downloadMode:1;
#define kPLC540V_NOT_DOWNLOADING 0x0
#define kPLC540V_DOWNLOADING 0x1

    UBYTE uploadMode:1;
#define kPLC540V_NOT_UPLOADING 0x0
#define kPLC540V_UPLOADING 0x1

    UBYTE testEditMode:1;
#define kPLC540V_NOT_TESTING_EDITS 0x0
#define kPLC540V_TESTING_EDITS 0x1

    UBYTE editsExist:1;
#define kPLC540V_NO_EDITS 0x0
#define kPLC540V_EDITS 0x1

    UBYTE interfaceType:4; /* Byte 2, Processor Type */
#define kPLC5_FAMILY 0xB

    UBYTE controllerType:4;
#define kEXAMINE_PROCESSOR_EXPANSION 0xE

```

```

    UBYTE expansionType;          /* Byte 3, Processor Expansion Type */
#define kPLC540V_PROCESSOR      0x37

    ULONG memorySize;            /* Byte 4, Processor Memory Size(WRDS)*/

    UBYTE revision:5;            /* Byte 8, Processor Revision & Series*/
#define kPLC540V_REVISION_A     0x0
#define kPLC540V_REVISION_B     0x1

    UBYTE series:3;
#define kPLC540V_SERIES_A       0x0
#define kPLC540V_SERIES_B       0x1

    UBYTE stationNumber:6;        /* Byte 9, Processor station number */
    UBYTE reserved1:2;

    UBYTE adapterAddress;         /* Byte 10, Processor Adapter Address */
#define kPLC540V_IS_SCANNER     0xFD

    UBYTE doubleDensity:1;        /* Byte 11, I/O & Comm Params */
#define kPLC540V_DOUBLE_DENSITY 0x0
#define kPLC540V_NOT_DOUBLE_DENSITY 0x1

    UBYTE adapterMode:1;
#define kPLC540V_NOT_ADAPTER_MODE 0x0
#define kPLC540V_ADAPTER_MODE   0x1

    UBYTE moduleGroupForTopHalf:1;
#define kPLC540V_MODULE_GRP_NOT_TOP 0x0
#define kPLC540V_MODULE_GRP_TOP   0x1

    UBYTE reserved2:2;
    UBYTE adapterIsHalfRack:1;
#define kPLC540V_ADAPTER_NOT_HALF_RACK 0x0
#define kPLC540V_ADAPTER_IS_HALF_RACK 0x1

    UBYTE pclAt115KBaud:1;
#define kPLC540V_PCL_NOT_115K 0x0
#define kPLC540V_PCL_IS_115K 0x1

    UBYTE reserved3:1;

    UWORD dataTableFileCount;     /* Byte 12, Data Table File Count; This
                                   value is the highest assigned file
                                   number plus one.
                                   */
    UWORD programFileCount;       /* Byte 14, Program File Count; This
                                   value is the highest assigned file
                                   number plus one.
                                   */

    UBYTE forcingActive:1;        /* Byte 16, Forcing Status */
#define kPLC540V_FORCING_NOT_ACTIVE 0x0
#define kPLC540V_FORCING_IS_ACTIVE 0x1

    UBYTE reserved4:3;
    UBYTE forcesPresent:1;
#define kPLC540V_FORCES_NOT_PRESENT 0x0
#define kPLC540V_FORCES_ARE_PRESENT 0x1

```

```

    UBYTE reserved5:2;
    UBYTE forcesSFC2Enabled:1;
#define kPLC540V_SFC2_FORCES_DISABLED 0x0
#define kPLC540V_SFC2_FORCES_ENABLED 0x1

    UBYTE memoryProtected;          /* Byte 17, Memory Protected; If this
                                     is zero, then it is not protected.
    */
#define kPLC540V_MEMORY_NOT_PROTECTED 0x0

    UBYTE ramInvalid;               /* Byte 18, Bad RAM; If this is zero
                                     then RAM is valid.
    */
#define kPLC540V_RAM_IS_VALID 0x0

    UBYTE debugMode;               /* Byte 19, Debug Mode; If this is
                                     zero, then debug mode is off.
    */
#define kPLC540V_DEBUG_MODE_OFF 0x0

    UWORD holdPointFile;           /* Byte 20, Hold Point File; This
                                     will contain the hold point file
                                     if debug mode is on (non-zero).
    */

    UWORD holdPointElement;        /* Byte 22, Hold Point Element; This
                                     will contain the hold point
                                     element if debug mode is on (non-zero).
    */

    UWORD editTimeStampSec;        /* Byte 24, Edit Time Stamp Second */
    UWORD editTimeStampMin;        /* Byte 26, Edit Time Stamp Minute */
    UWORD editTimeStampHour;       /* Byte 28, Edit Time Stamp Hour */
    UWORD editTimeStampDay;        /* Byte 30, Edit Time Stamp Day */
    UWORD editTimeStampMonth;      /* Byte 32, Edit Time Stamp Month */
    UWORD editTimeStampYear;       /* Byte 34, Edit Time Stamp Year */

    UBYTE portNumber;             /* Byte 36, Port number that this
                                     command was received on.
    */
} PLC540V_PCCC_IHAS_STATUS_TYPE;

/* The PCCC Identify Host and Status reply packet structure. */
typedef struct
{
    UBYTE lnHi;
    UBYTE lnLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    PLC540V_PCCC_IHAS_STATUS_TYPE plcStatus;
} PLC540V_PCCC_IHAS_RPY_TYPE;
#define kPLC540V_PCCC_IHAS_RPY_SIZE (sizeof(PLC540V_PCCC_IHAS_RPY_TYPE))
#pragma pack()

```



```
void plc540v_pccc_id_host_and_status(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_IHAS_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

## P40VIHAS.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vihas.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_ID_HOST_STATUS_CMD 0x6
#define kPLC540V_PCCC_ID_HOST_STATUS_FNC 0x3

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
*
* PURPOSE: This function sends the PCCC Identify Host and Some Status
* command to the PLC-5/40V.
*
* INPUT: ULONG vmeCmdBlkAddr contains the VME address where the
* command block will be copied to so the PLC-5/40V can
* access its information.
*
* UWORD baseAddress contains the base address of the
* PLC-5/40V.
*
* VME_DATA_WIDTH_TYPE width contains the data width that
* should be used for the copy operations. It can be D16
* or D08.
*
* VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
* in which the VME data is accessed. It can be A16 or A24.
*
* PLC540V_PCCC_IHAS_RPY_TYPE reply contains PCCC's Identify
* Host and Some Status command specific reply packet.
*
* OUTPUT: PLC540V_STATUS_TYPE *status will contain the final status
* of requesting this function. This status could be and EPC
* or PLC-5/40V value.
*
*****/
```

```

*
* RETURNS:      Nothing.
*
* EXAMPLE:
*
*      ULONG vmeCmdBlkAddr          = 0xE0F100;
*      UWORD baseAddress            = 0XFC00;
*      VME_DATA_WIDTH_TYPE width    = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*      PLC540V_PCCC_IHAS_RPY_TYPE reply;
*      PLC540V_STATUS_TYPE status;
*      void plc540v_pccc_IHAS(
*
*          vmeCmdBlkAddr,
*          baseAddress,
*          width,
*          addrMod,
*          &reply,
*          &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
*****/
void plc540v_pccc_id_host_and_status(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_IHAS_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Id Host & Status command packet. */
    PLC540V_PCCC_IHAS_CMD_TYPE cmdPacket;

    /* Let's initialize these packet to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_IHAS_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_IHAS_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_ID_HOST_STATUS_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_ID_HOST_STATUS_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_IHAS_CMD_SIZE,
        reply,
        kPLC540V_PCCC_IHAS_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VRBP.H

```
#ifndef P40VRBP_H
#define P40VRBP_H 1

////////////////////////////////////
// Definitions for the PCCC READ BYTES PHYSICAL COMMAND AND REPLY PACKETS //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
*****/

/* The PCCC Read Bytes Physical command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
    ULONG addr;
    UBYTE size;
} PLC540V_PCCC_RBP_CMD_TYPE;
#define kPLC540V_PCCC_RBP_CMD_SIZE (sizeof(PLC540V_PCCC_RBP_CMD_TYPE))

// The maximum number of bytes which can be read in one operation. This
// maximum value is really 244, but I will set it to match the maximum
// value for Write Bytes Physical so we can use the same bucket sizes...
#define kPLC540V_PCCC_MAX_RBP_DATA 238

/* The PCCC Read Bytes Physical reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE data[kPLC540V_PCCC_MAX_RBP_DATA];
} PLC540V_PCCC_RBP_RPY_TYPE;
#define kPLC540V_PCCC_RBP_RPY_SIZE (sizeof(PLC540V_PCCC_RBP_RPY_TYPE))
#pragma pack()

void plc540v_pccc_read_bytes_physical(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    ULONG plcAddress,
    UBYTE readSize,
    PLC540V_PCCC_RBP_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

**P40VRBP.C**

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vrbp.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_RBP_CMD 0x0F
#define kPLC540V_PCCC_RBP_FNC 0x17

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
*
* PURPOSE: This function sends the PCCC Read Bytes Physical command to the
* PLC-5/40V.
*
* INPUT: ULONG vmeCmdBlkAddr contains the VME address where the
* command block will be copied to so the PLC-5/40V can
* access its information.
*
* UWORD baseAddress contains the base address of the
* PLC-5/40V.
*
* VME_DATA_WIDTH_TYPE width contains the data width that
* should be used for the copy operations. It can be D16
* or D08.
*
* VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
* in which the VME data is accessed. It can be A16 or A24.
*
* ULONG plcAddress contains the physical address to write to
* in the processor.
*
* UBYTE dataLength contains the number of bytes to write.
*
* PLC540V_PCCC_RBP_RPY_TYPE reply contains PCCC's Read Bytes
* Physical command specific reply packet.
*
* OUTPUT: PLC540V_STATUS_TYPE *status will contain the final status
* of requesting this function. This status could be and EPC
* or PLC-5/40V value.
*
* RETURNS: Nothing.
*
*

```

```

* EXAMPLE:
*
*      ULONG vmeCmdBlkAddr          = 0xE0F100;
*      UWORD baseAddress            = 0XFC00;
*      VME_DATA_WIDTH_TYPE width    = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*      ULONG plcAddress;
*      UBYTE dataLength;
*      PLC540V_PCCC_RBP_RPY_TYPE reply;
*      PLC540V_STATUS_TYPE status;
*      void plc540v_pccc_read_bytes_physical(
*          vmeCmdBlkAddr,
*          baseAddress,
*          width,
*          addrMod,
*          plcAddress,
*          dataLength,
*          &reply,
*          &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
*****/
void plc540v_pccc_read_bytes_physical(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    ULONG plcAddress,
    UBYTE dataLength,
    PLC540V_PCCC_RBP_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Read Bytes Physical command packet. */
    PLC540V_PCCC_RBP_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_RBP_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_RBP_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_RBP_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_RBP_FNC;
    cmdPacket.addr = plcAddress;
    cmdPacket.size = dataLength;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_RBP_CMD_SIZE,
        reply,
        kPLC540V_PCCC_RBP_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VRER.H

```
#ifndef P40VRER_H
#define P40VRER_H 1

////////////////////////////////////
// Definitions for the PCCC RETURN EDIT RESOURCE COMMAND AND REPLY PACKETS //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
*****/

/* The PCCC Return Edit Resource command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
} PLC540V_PCCC_RER_CMD_TYPE;
#define kPLC540V_PCCC_RER_CMD_SIZE (sizeof(PLC540V_PCCC_RER_CMD_TYPE))

/* The PCCC Return Edit Resource reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extsts;
} PLC540V_PCCC_RER_RPY_TYPE;
#define kPLC540V_PCCC_RER_RPY_SIZE (sizeof(PLC540V_PCCC_RER_RPY_TYPE))
#pragma pack()

void plc540v_pccc_return_edit_resource(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_RER_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

# P40VRER.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vrer.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_RER_CMD 0x0F
#define kPLC540V_PCCC_RER_FNC 0x12

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
/***** PRIVATE FUNCTIONS *****/
/*****

*
* PURPOSE: This function sends the PCCC Return Edit Resource command to
*           the PLC-5/40V.
*
* INPUT:    ULONG vmeCmdBlkAddr contains the VME address where the
*           command block will be copied to so the PLC-5/40V can
*           access its information.
*
*           UWORD baseAddress contains the base address of the
*           PLC-5/40V.
*
*           VME_DATA_WIDTH_TYPE width contains the data width that
*           should be used for the copy operations. It can be D16
*           or D08.
*
*           VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*           in which the VME data is accessed. It can be A16 or A24.
*
*           PLC540V_PCCC_RER_RPY_TYPE reply contains PCCC's Return Edit
*           Resource command specific reply packet.
*
* OUTPUT:   PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function. This status could be and EPC
*           or PLC-5/40V value.
*
* RETURNS:  Nothing.
*
```

```

*   EXAMPLE:
*
*       ULONG vmeCmdBlkAddr           = 0xE0F100;
*       UWORD baseAddress             = 0XFC00;
*       VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*       VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*       PLC540V_PCCC_RER_RPY_TYPE reply;
*       PLC540V_STATUS_TYPE status;
*       void plc540v_pccc_return_edit_resource(
*           vmeCmdBlkAddr,
*           baseAddress,
*           width,
*           addrMod,
*           &reply,
*           &status);
*
*       Copyright Allen-Bradley Company, Inc. 1993
*
* *****/
void plc540v_pccc_return_edit_resource(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_RER_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Return Edit Resource command packet. */
    PLC540V_PCCC_RER_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_RER_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_RER_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_RER_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_RER_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_RER_CMD_SIZE,
        reply,
        kPLC540V_PCCC_RER_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```



## P40VRMW.H

```
#ifndef P40VRMW_H
#define P40VRMW_H 1

////////////////////////////////////
//      Definitions for the PCCC READ-MODIFY-WRITE COMMAND AND REPLY PACKETS      //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The structure of a system address with its associated AND and OR masks. */
typedef struct
{
    PCCC_LOGBIN_SYSTEM_ADDRESS_TYPE sysAddr;
    UWORD andMask;
    UWORD orMask;
} PLC540V_RMW_ADDRMASK_TYPE;

/* An array of the maximum number of system address, AND and OR masks that
   can be operated upon in one operation. The user MUST be certain to
   initialize this array properly by calling plc540v_init_addrmasks().
*/
#define kPLC540V_MAX_RMW_ADDRMASKS_BYTES      242
#define kPLC540V_MAX_RMW_ADDRMASKS (kPLC540V_MAX_RMW_ADDRMASKS_BYTES /
sizeof(PLC540V_RMW_ADDRMASK_TYPE))

typedef PLC540V_RMW_ADDRMASK_TYPE
    PLC540V_RMW_ADDRMASKS_TYPE[kPLC540V_MAX_RMW_ADDRMASKS];

/* The PCCC RMW command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
    PLC540V_RMW_ADDRMASKS_TYPE addrMasks;
} PLC540V_PCCC_RMW_CMD_TYPE;
#define kPLC540V_PCCC_RMW_CMD_SIZE (sizeof(PLC540V_PCCC_RMW_CMD_TYPE))

/* The PCCC RMW reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extSts;
} PLC540V_PCCC_RMW_RPY_TYPE;
#define kPLC540V_PCCC_RMW_RPY_SIZE (sizeof(PLC540V_PCCC_RMW_RPY_TYPE))
#pragma pack()

void plc540v_init_addrmasks(PLC540V_RMW_ADDRMASKS_TYPE addrMasks);
```

```
void plc540v_add_addrmasks(UBYTE arrayIndex,
                          UWORD fileName,
                          UWORD elementNumber,
                          UWORD andMask,
                          UWORD orMask,
                          PLC540V_RMW_ADDRMASKS_TYPE addrMasks,
                          PLC540V_STATUS_TYPE *status);

void plc540v_pccc_rmw(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_RMW_ADDRMASKS_TYPE addrMasks,
    PLC540V_PCCC_RMW_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

## P40VRMW.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vrmw.h"

/*****
***** PRIVATE DEFINITIONS *****/
/*****
***** PRIVATE TYPE DEFINITIONS *****/
/*****
***** PRIVATE FUNCTIONS *****/

*****
* PURPOSE:      This function initialized the system address mask data
*               structure. Currently, it simply sets the entire structure
*               to zero.
*
* INPUT:        PLC540V_RMW_ADDRMASKS_TYPE addrMasks
*
* OUTPUT:       Nothing.
*
* RETURNS:      Nothing.
*
* EXAMPLE:
*               PLC540V_RMW_ADDRMASKS_TYPE addrMasks;
*               plc540v_init_addr_masks(PLC540V_RMW_ADDRMASKS_TYPE addrMasks);
*
*               Copyright Allen-Bradley Company, Inc. 1993
*****
void plc540v_init_addrmasks(PLC540V_RMW_ADDRMASKS_TYPE addrMasks)
{
    memset((char *) &addrMasks[0], 0x0, sizeof(PLC540V_RMW_ADDRMASKS_TYPE));
}
```

```

/*****
*
*  PURPOSE:      This function adds an system address and its corresponding
*                AND and OR masks to a data structure which will then be used
*                by the plc540v_pccc_rmw() function.  It is imperative that
*                this data structure be initialized prior to using this
*                function by calling plc540v_init_addrmasks().
*
*                UWORD arrayOffset contains the index into the array.  Since
*                we are using C arrays, this value is within the range of
*                0 <= x < kPLC540V_MAX_RMW_ADDRMASKS.
*
*                UWORD fileName is the data table file number that we will
*                be accessing for the read-modify-write operation.
*
*                UWORD elementNumber is the data table file's element number
*                that we will be accessing for the read-modify-write operation.
*
*                UWORD andMask contains the AND mask which will be used on the
*                value read from the data table file's element.  A zero in the
*                AND mask resets the corresponding bit in the addressed word to
*                zero.  A one in the AND mask leaves the corresponding bit
*                unchanged.
*
*                UWORD orMask contains the OR mask which will be used on the
*                value read from the data table file's element.  A one in the
*                OR mask sets the corresponding bit in the addressed word to
*                one.  A zero in the OR mask leaves the corresponding bit
*                unchanged.
*
*                PLC540V_RMW_ADDRMASKS_TYPE addrMasks contains system
*                addresses and their corresponding AND and OR masks.
*                This structure MUST be initialized by calling
*                plc540v_init_addrmasks() function before using it
*                with this function.
*
*  OUTPUT:      PLC540V_STATUS_TYPE *status will contain the final status
*                of requesting this function.  This status could be and EPC
*                or PLC-5/40V value.
*
*  RETURNS:     Nothing.
*
*  EXAMPLE:
*
*                PLC540V_STATUS_TYPE status;
*                PLC540V_RMW_ADDRMASKS_TYPE addrMasks;
*                register int addrCount          = 0;
*                UWORD fileName                  = 7;
*                UWORD elementNumber             = 20;
*                UWORD andMask                   = 0xFF00;
*                UWORD orMask                    = 0x00AA;
*                plc540v_init_addrmasks(addrMasks);
*                for (addrCount=0; addrCount<5; addrCount++,elementNumber++)

```

## Appendix B

### Sample API Modules

```

*****
*
*   PURPOSE:      This function sends the PCCC Read-Modify-Write command (26H)
*                  to the PLC-5/40V.  This function will read the data from the
*                  specified data table file element(s), apply the AND mask,
*                  apply the OR mask and then return the results to the same
*                  location.
*
*
*   IMPORTANT:
*
*   The controller may change the states of the original bits in
*   memory before this command can write the word back to memory.
*   Therefore, some data bits may be unintentionally overwritten.
*   To prevent this from happening, we suggest that you use this
*   command to write into the storage area of the data table file
*   and have the controller read the word only AND NOT CONTROL IT!
*
*   INPUT:        ULONG vmeCmdBlkAddr contains the VME address where the
*                  command block will be copied to so the PLC-5/40V can
*                  access its information.
*
*
*                  UWORD baseAddress contains the base address of the
*                  PLC-5/40V.
*
*
*                  VME_DATA_WIDTH_TYPE width contains the data width that
*                  should be used for the copy operations.  It can be D16
*                  or D08.
*
*
*                  VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*                  in which the VME data is accessed.  It can be A16 or A24.
*
*****

```

```

*      PLC540V_RMW_ADDRMASKS_TYPE addrMasks contains system
*      addresses and their corresponding AND and OR masks.
*      This structure MUST be initialized by calling
*      plc540v_init_addrmasks() and each system address must
*      be added to this data structure by calling the
*      plc540v_add_addrmasks() function before using this function.
*
*      PLC540V_PCCC_RMW_RPY_TYPE reply contains PCCC's RMW command
*      specific reply packet.
*
* OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*          of requesting this function. This status could be and EPC
*          or PLC-5/40V value.
*
* RETURNS: Nothing.
*
* EXAMPLE:
*          ULONG vmeCmdBlkAddr          = 0xE0F100;
*          UWORD baseAddress             = 0xFC00;
*          VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*          PLC540V_PCCC_RMW_RPY_TYPE reply;
*          PLC540V_STATUS_TYPE status;
*          PLC540V_RMW_ADDRMASKS_TYPE addrMasks;
*          register int addrCount        = 0;
*          UWORD fileNumber              = 7;
*          UWORD elementNumber           = 20;
*          UWORD andMask                 = 0xFF00;
*          UWORD orMask                  = 0x00AA;
*          plc540v_init_addrmasks(addrMasks);
*          for (addrCount=0; addrCount<5; addrCount++,elementNumber++)
*          {
*              plc540v_add_addrmasks(addrCount,
*                                   fileNumber,
*                                   elementNumber,
*                                   andMask,
*                                   orMask,
*                                   addrMasks,
*                                   &status);
*          }
*          plc540v_pccc_rmw(
*              vmeCmdBlkAddr,
*              baseAddress,
*              width,
*              addrMod,
*              addrMasks,
*              &reply,
*              &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
*          *****/
void plc540v_pccc_rmw(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_RMW_ADDRMASKS_TYPE addrMasks,
    PLC540V_PCCC_RMW_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The RMW command packet. */
    PLC540V_PCCC_RMW_CMD_TYPE cmdPacket;

```

```

/* Let's initialize these packet to nothing. */
memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_RMW_CMD_SIZE);
memset((char *) reply, 0x0, kPLC540V_PCCC_RMW_RPY_SIZE);
memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

/* Let's establish the command packet contents... Note that
   since we set this block with zeros originally, we don't
   need to explicitly set them here.
*/
cmdPacket.cmd = kPLC540V_PCCC_RMW_CMD;
cmdPacket.fnc = kPLC540V_PCCC_RMW_FNC;
memmove((char *) &cmdPacket.addrMasks[0],
        (char *) &addrMasks[0],
        sizeof(PLC540V_RMW_ADDRMASKS_TYPE));

plc540v_send_pccc_command(
    vmeCmdBlkAddr,
    &cmdPacket,
    kPLC540V_PCCC_RMW_CMD_SIZE,
    reply,
    kPLC540V_PCCC_RMW_RPY_SIZE,
    baseAddress,
    kVME_NO_INT_LEVEL,
    0,
    width,
    addrMod,
    status);
}

```

## P40VRPC.H

```

#ifndef P40VRPC_H
#define P40VRPC_H 1

// Definitions for the PCCC RESTORE PORT CONFIG COMMAND AND REPLY PACKETS //
//////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
/***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Restore Port Configuration command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
    PLC540V_PCCC_DATA_TYPE data;
} PLC540V_PCCC_RPC_CMD_TYPE;
#define kPLC540V_PCCC_RPC_CMD_SIZE (sizeof(PLC540V_PCCC_RPC_CMD_TYPE))

```

```

/* The PCCC Restore Port Configuration reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    PLC540V_PCCC_DATA_TYPE data;
} PLC540V_PCCC_RPC_RPY_TYPE;
#define kPLC540V_PCCC_RPC_RPY_SIZE (sizeof(PLC540V_PCCC_RPC_RPY_TYPE))
#pragma pack()

void plc540v_pccc_restore_port_config(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_RPC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif

```

## P40VRPC.C

```

#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vrpc.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_RPC_CMD 0x0F
#define kPLC540V_PCCC_RPC_FNC 0x90

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
* PURPOSE: This function sends the PCCC Restore Port Configuration command
* to the PLC-5/40V.
*
* INPUT: ULONG vmeCmdBlkAddr contains the VME address where the
* command block will be copied to so the PLC-5/40V can
* access its information.
*
* UWORD baseAddress contains the base address of the
* PLC-5/40V.
*
* VME_DATA_WIDTH_TYPE width contains the data width that
* should be used for the copy operations. It can be D16 or D08.
*
* VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
* in which the VME data is accessed. It can be A16 or A24.
*****/

```

```

*          PLC540V_PCCC_RPC_RPY_TYPE reply contains PCCC's Restore Port
*          Configuration command specific reply packet.
*
* OUTPUT:   PLC540V_STATUS_TYPE *status will contain the final status
*           of requesting this function. This status could be and EPC
*           or PLC-5/40V value.
*
* RETURNS:  Nothing.
*
* EXAMPLE:  ULONG vmeCmdBlkAddr          = 0xE0F100;
*           UWORD baseAddress            = 0xFC00;
*           VME_DATA_WIDTH_TYPE width    = kVME_D16_DATA_WIDTH;
*           VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*           PLC540V_PCCC_RPC_RPY_TYPE reply;
*           PLC540V_STATUS_TYPE status;
*           void plc540v_pccc_restore_port_config(
*               vmeCmdBlkAddr,
*               baseAddress,
*               width,
*               addrMod,
*               &reply,
*               &status);
*
*           Copyright Allen-Bradley Company, Inc. 1993
*
*****/
void plc540v_pccc_restore_port_config(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_RPC_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Restore Port Configuration command packet. */
    PLC540V_PCCC_RPC_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_RPC_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_RPC_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_RPC_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_RPC_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_RPC_CMD_SIZE,
        reply,
        kPLC540V_PCCC_RPC_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```



## P40VSCM.H

```
#ifndef P40VSCM_H
#define P40VSCM_H 1

#include "p40vspcc.h"

#pragma pack(1)
/*****
/***** INTEL VERSION OF DEFINITIONS *****/
/*****/

// Set CPU control and mode flags.
typedef struct
{
    UBYTE modeSelect:2;
#define kPLC540V_SCM_PROGRAM_LOAD_MODE      0X0
#define kPLC540V_SCM_TEST_MODE              0X1
#define kPLC540V_SCM_RUN_MODE               0X2
#define kPLC540V_SCM_NOCHANGE_MODE         0X3

    UBYTE lock:1;
#define kPLC540V_SCM_NO_LOCK_OUT_OTHERS     0X0
#define kPLC540V_SCM_LOCK_OUT_OTHERS       0X1
    UBYTE unused:5;
} PLC540V_PCCC_SCM_CTLMODE_TYPE;

/* The PCCC Set CPU Mode command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
    PLC540V_PCCC_SCM_CTLMODE_TYPE ctlMode;
} PLC540V_PCCC_SCM_CMD_TYPE;
#define kPLC540V_PCCC_SCM_CMD_SIZE (sizeof(PLC540V_PCCC_SCM_CMD_TYPE))

/* The PCCC Set CPU Mode reply packet structure. */
typedef struct
{
    UBYTE lnHHi;
    UBYTE lnHLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE extsts;
} PLC540V_PCCC_SCM_RPY_TYPE;
#define kPLC540V_PCCC_SCM_RPY_SIZE (sizeof(PLC540V_PCCC_SCM_RPY_TYPE))
#pragma pack()

void plc540v_pccc_set_cpu_mode(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_SCM_CTLMODE_TYPE ctlmode,
    PLC540V_PCCC_SCM_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

## P40VSCM.C

```
#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vscm.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_SCM_CMD 0x0F
#define kPLC540V_PCCC_SCM_FNC 0x3A

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****

/*****
/***** PRIVATE FUNCTIONS *****/
/*****

/*****
*
* PURPOSE: This function sends the PCCC Set CPU Mode command to the
*          PLC-5/40V.
*
* INPUT:   ULONG vmeCmdBlkAddr contains the VME address where the
*          command block will be copied to so the PLC-5/40V can
*          access its information.
*
*          UWORD baseAddress contains the base address of the
*          PLC-5/40V.
*
*          VME_DATA_WIDTH_TYPE width contains the data width that
*          should be used for the copy operations. It can be D16
*          or D08.
*
*          VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*          in which the VME data is accessed. It can be A16 or A24.
*
*          PLC540V_PCCC_SCM_CTLMODE_TYPE defines the desired cpu mode
*          and whether locking should be applied.
*
*          PLC540V_PCCC_SCM_RPY_TYPE reply contains PCCC's Set CPU
*          Mode command specific reply packet.
*
* OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*          of requesting this function. This status could be and EPC
*          or PLC-5/40V value.
*
* RETURNS: Nothing.
*
* EXAMPLE:
*          ULONG vmeCmdBlkAddr          = 0xE0F100;
*          UWORD baseAddress             = 0XFC00;
*          VME_DATA_WIDTH_TYPE width     = kVME_D16_DATA_WIDTH;
*          VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*          PLC540V_PCCC_SCM_CTLMODE_TYPE ctlmode.modeSelect
*
*          = kPLC540V_SCM_RUN_MODE;
```

```

*          PLC540V_PCCC_SCM_RPY_TYPE reply;
*          PLC540V_STATUS_TYPE status;
*          void plc540v_pccc_set_cpu_mode(
*
*              vmeCmdBlkAddr,
*              baseAddress,
*              width,
*              addrMod,
*              ctlmode,
*              &reply,
*              &status);
*
*          Copyright Allen-Bradley Company, Inc. 1993
*
*          *****/
void plc540v_pccc_set_cpu_mode(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_SCM_CTLMODE_TYPE ctlMode,
    PLC540V_PCCC_SCM_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Set CPU Mode command packet. */
    PLC540V_PCCC_SCM_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_SCM_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_SCM_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_SCM_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_SCM_FNC;
    cmdPacket.ctlMode = ctlMode;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_SCM_CMD_SIZE,
        reply,
        kPLC540V_PCCC_SCM_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## P40VULA.H

```
#ifndef P40VULA_H
#define P40VULA_H 1

////////////////////////////////////
//      Definitions for the PCCC UPLOAD ALL COMMAND AND REPLY PACKETS      //
////////////////////////////////////

#include "p40vspcc.h"

#pragma pack(1)
/*****
***** INTEL VERSION OF DEFINITIONS *****/
/*****/

/* The PCCC Upload All command packet structure. */
typedef struct
{
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    UBYTE fnc;
} PLC540V_PCCC_ULA_CMD_TYPE;
#define kPLC540V_PCCC_ULA_CMD_SIZE (sizeof(PLC540V_PCCC_ULA_CMD_TYPE))

/* The PCCC Upload All reply packet structure. */
typedef struct
{
    UBYTE lnhHi;
    UBYTE lnhLo;
    UBYTE reserved[4];
    UBYTE cmd;
    UBYTE sts;
    UWORD tns;
    PLC540V_PCCC_DATA_TYPE data;
    UBYTE extsts;
} PLC540V_PCCC_ULA_RPY_TYPE;
#define kPLC540V_PCCC_ULA_RPY_SIZE (sizeof(PLC540V_PCCC_ULA_RPY_TYPE))
#pragma pack()

void plc540v_pccc_upload_all(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_ULA_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status);

#endif
```

# P40VULA.C

```

#include <stdio.h>
#include <stdlib.h>
#include <mem.h>
#include "epc_obm.h"
#include "epc_err.h"
#include "busmgr.h"
#include "p40vula.h"

/*****
/***** PRIVATE DEFINITIONS *****/
/*****
#define kPLC540V_PCCC_ULA_CMD 0x0F
#define kPLC540V_PCCC_ULA_FNC 0x53

/*****
/***** PRIVATE TYPE DEFINITIONS *****/
/*****
/***** PRIVATE FUNCTIONS *****/
/*****
/*****
*
* PURPOSE: This function sends the PCCC Upload All command to the
*          PLC-5/40V.
*
* INPUT:   ULONG vmeCmdBlkAddr contains the VME address where the
*          command block will be copied to so the PLC-5/40V can
*          access its information.
*
*          UWORD baseAddress contains the base address of the
*          PLC-5/40V.
*
*          VME_DATA_WIDTH_TYPE width contains the data width that
*          should be used for the copy operations. It can be D16
*          or D08.
*
*          VME_ADDRESS_MODIFIER_TYPE addrMod defines the address space
*          in which the VME data is accessed. It can be A16 or A24.
*
*          PLC540V_PCCC_ULA_RPY_TYPE reply contains PCCC's Upload All
*          command specific reply packet.
*
* OUTPUT:  PLC540V_STATUS_TYPE *status will contain the final status
*          of requesting this function. This status could be and EPC
*          or PLC-5/40V value.
*
* RETURNS: Nothing.
*
*****/

```

```

* EXAMPLE:
*
*      ULONG vmeCmdBlkAddr          = 0xE0F100;
*      UWORD baseAddress            = 0xFC00;
*      VME_DATA_WIDTH_TYPE width    = kVME_D16_DATA_WIDTH;
*      VME_ADDRESS_MODIFIER_TYPE addrMod = kVME_A24_ADDR_SPACE;
*      PLC540V_PCCC_ULA_RPY_TYPE reply;
*      PLC540V_STATUS_TYPE status;
*      void plc540v_pccc_upload_all(
*
*          vmeCmdBlkAddr,
*          baseAddress,
*          width,
*          addrMod,
*          &reply,
*          &status);
*
*      Copyright Allen-Bradley Company, Inc. 1993
*
* *****/
void plc540v_pccc_upload_all(
    ULONG vmeCmdBlkAddr,
    UWORD baseAddress,
    VME_DATA_WIDTH_TYPE width,
    VME_ADDRESS_MODIFIER_TYPE addrMod,
    PLC540V_PCCC_ULA_RPY_TYPE *reply,
    PLC540V_STATUS_TYPE *status)
{
    /* The Upload All command packet. */
    PLC540V_PCCC_ULA_CMD_TYPE cmdPacket;

    /* Let's initialize these packets to nothing. */
    memset((char *) &cmdPacket, 0x0, kPLC540V_PCCC_ULA_CMD_SIZE);
    memset((char *) reply, 0x0, kPLC540V_PCCC_ULA_RPY_SIZE);
    memset((char *) status, 0x0, sizeof(PLC540V_STATUS_TYPE));

    /* Let's establish the command packet contents... Note that
       since we set this block with zeros originally, we don't
       need to explicitly set them here.
    */
    cmdPacket.cmd = kPLC540V_PCCC_ULA_CMD;
    cmdPacket.fnc = kPLC540V_PCCC_ULA_FNC;

    plc540v_send_pccc_command(
        vmeCmdBlkAddr,
        &cmdPacket,
        kPLC540V_PCCC_ULA_CMD_SIZE,
        reply,
        kPLC540V_PCCC_ULA_RPY_SIZE,
        baseAddress,
        kVME_NO_INT_LEVEL,
        0,
        width,
        addrMod,
        status);
}

```

## Specifications

### Environmental Specifications

Characteristic		Value
Temperature	Operating	0-65° C at point of entry of forced air with 200 LFM of air flow across the circuit board. Derated 2° C per 1000 ft (300m) over 6600 ft (2000m). 2° C per min max excursion gradient
	Storage	-40° -85° C 5 C per min max excursion gradient
Humidity	Operating	0-90% noncondensing
	Storage	0-95% noncondensing
Altitude	Operating	0-10,000 ft (3000 m)
	Storage	0-40,000 ft (12,000 m)
Processor Weight		21 ounces (595 grams) PLC-5/V30 24 ounces (680 grams) (PLC-5/V40, -5/V40L, -5/V80)
Vibration	Operating	0.015 inch (0.38 mm) P-P displacement with 2.5 g peak (max) acceleration over 5-2000 Hz
	Storage	0.030 inch (0.76 mm) P-P displacement with 5.0 g peak (max) acceleration over 5-2000 Hz
Shock	Operating	30 g, 11 ms duration, half-sine shock pulse
	Storage	50 g, 11 ms duration, half-sine shock pulse
Power	Maximum	21 watts
	Typical	16 watts
Current	+ 5V	4.0 A (max), 3.2 A (typical)
Agency Certification (when product or packaging is marked)		CE marked for all applicable directives

## VMEbus Specifications

Characteristic (Revision C.1)	Value
Master address	A16, A24
Master transfer	D08(E0), D16
Slave address	A16, A24
Slave transfer	D08(E0), D16
Interrupter	I(1–7), D08(O)
Interrupt handler	IH(1–7), D08(O)
Requester	ROR,RWD
System controller	SYSCLK, IACK daisy chain, bus timer, SGL arbiter
ACFAIL	Input required for PLC-5/VME processor to maintain ladder and data files integrity. VME power must assert ACFAIL at least 9 ms before the +5VDC supply drops below 4.75VDC.

## PLC-5/VME™ Battery Specifications (1770-WV/A)

Battery used in this processor:      At this temperature:		Worst-case Battery Life Estimates		Battery Duration after the LED lights ①
		Power off 100%:	Power off 50%:	
PLC-5/V30, -5/V40, -5/V80	60°C	180 days	360 days	~6 days @ 80µA
	25°C	290 days	580 days	~9 days @ 50µA

① The battery indicator (BATT) warns you when the battery is low. These durations are based on the battery supplying the only power to the processor (power to the chassis is off) once the LED first lights.



PLC-5/VME™ Processor Specifications		PLC-5/V30™ (1785-V30B)	PLC-5/V40™ (1785-V40B)	PLC-5/V40L™ (1785-V40L)	PLC-5/V80™ (1785-V80B)
Maximum User Memory Words		32 K	48 K ①		100 K ①
Maximum Total I/O	Any Mix	896	1920		2944
	Complementary	896 in and 896 out	1920 in and 1920 out		2944 in and 2944 out
Maximum Analog I/O		896	1920		2944
Program Scan Time		0.5 ms per K word (bit logic) 2 ms per K word (typical)			
I/O Scan Time		0.5 ms (extended local) 10 ms per rack @ 57.6 kbps 7 ms per rack @ 115.2 kbps 3 ms per rack @ 230 kbps			
RIO Transmission Rate		57.6 kbps 115.2 kbps 230 kbps			
Maximum Number of MCPs		16			
Number of Data Highway Plus™ (DH+™) or Remote I/O Ports (Adapter or Scanner)		2	4	2	4
Number of Extended-Local I/O Ports		N/A	N/A	1	N/A
Maximum Number of I/O Racks		7	15		23
Maximum Number of I/O Chassis	Extended Local	N/A	N/A	16	N/A
	Remote	28	60		92
Number of RS-232 Ports		1			
Backplane Current Load	Maximum	3.0 A	3.3 A	3.5 A	3.3 A
	Typical	2.4 A	2.7 A	2.9 A	2.7 A
Weight		0.56 kg (1.25 lbs)	0.67 kg (1.5 lbs)		

① The PLC-5/V40, -5/V40L, and -5/V80 processors have a limit of 32K words per data-table file.

## Troubleshooting

### Appendix Objectives

Read this appendix when you troubleshoot the PLC-5/VME processor. For the PLC-5/VME processor to maintain integrity of the ladder program and data files, the VME power supply must assert ACFAIL at least 9 ms in advance of the +5 VDC supply dropping beneath 4.75V. If power is removed and re-applied to the VME system and the PLC-5/VME powers up faulted after previously having a good program in it, it may be the result of not having ACFAIL properly asserted on the VME backplane.

### VME Backplane Jumpers

The VMEbus contains several daisy-chained control signals. Almost all VMEbus backplanes contain jumpers for these control signals to allow systems to operate with empty slots. Failing to install these jumpers properly is a common source of problems in configuring a new VMEbus system.

See Chapter 2 for detailed information on setting these jumpers.

### VME LEDs

The LEDs on the front panel have the following meaning:

When you see this light on:	It means that:
Battery low	The battery output is weak; the battery needs to be replaced.
Proc run/fault	If green, the processor is in run mode and has not faulted. If red, the processor has faulted.
Force	Continuous on denotes forces enabled. Blinking denotes forces present but not enabled.
Ch0 status	Data is being transmitted or received on channel 0.
SYSFAIL	The processor is driving the VMEbus SYSFAIL signal.
Master access	The processor is performing a VMEbus access.
Slave access	Another VMEbus master is performing an access to the processor.

## Message Completion and Status Bits Error Codes

For unrecognizable messages, ER is set along with an error code. The error codes are:

Code	Explanation
0000H	Success
0001H	Invalid ASCII message format
0002H	Invalid file type
0003H	invalid file number
0004H	Invalid file element
0005H	Invalid VME address
0006H	Invalid VME transfer width
0007H	Invalid number of elements requested for transfer
0008H	Invalid VME interrupt level
0009H	Invalid VME interrupt status-id value
000AH	VMEbus transfer error (bus error)
000BH	Unable to assert requested interrupt (already pending)
000CH	Raw data transfer setup error
000DH	Raw data transfer crash (PLC switched out of run mode)
000EH	Unknown message type (message type not ASCII)

## Continuous-Copy Error Codes

Code	Explanation
01H	VMEbus transfer error (bus error)
07H	Bad data address
FDH	Bad data transfer length
FEH	Unacknowledged end-of-copy interrupt

## Command-Protocol Error Codes

These are the command-protocol codes placed in the error-code field of the command control register when the ERR bit is 1.

Code	Explanation
00H	No error
01H	Invalid value in command register
02H	Cannot access first word of command block (usually a VMEbus bus error)
03H	Cannot access other than first word of command block
04H	Cannot write response word in command block

## Response-Word Error Codes

These are errors reported in the response word of the command block when the command cannot be carried out successfully. The even byte of the response word describes the type of error and the odd byte describes the time or situation of occurrence.

Code	Explanation
00FFH	Command successfully completed
0200H	Bad address modifier in command block
0300H	Bad VME address in command block
0400H	Bad command word (word 0)
0500H	Bad data/packet size (word 10)
0600H	Local PCCC queue overflow; PCCC not processed
8000H	VMEbus error

## PCCC Command Status Codes

The STS field contains errors found by the remote node receiving the command. The following table contains error codes (in hex) that you may find in the STS field and a general description of each.

Code (hex)	Explanation
00	No error
10	Illegal command or format
20	Host has a problem and will not communicate
30	Remote node host is missing, disconnected, or shut down
40	Host could not complete function due to hardware fault
50	Addressing problem or memory protect rungs
60	Function disallowed due to command protection selection
70	Processor is in program mode
80	Compatibility mode file missing or communication zone problem
90	Remote node cannot buffer command
A0	Not used
B0	Remote node problem due to download
C0	Cannot execute command due to active IPBs
D0	Not used
E0	Not used
F0	There is an error code in the EXT STS byte

The codes returned in the EXT STS (extended status) field when the remote error (STS) is F0H are listed below:

Code (hex)	Explanation
0	Not used
1	A field has an illegal value
2	Less levels specified in address than minimum for any address
3	More levels specified in address than system supports
4	Symbol not found
5	Symbol is of improper format
6	Address does not point to something usable
7	File is wrong size
8	Cannot complete request, situation has changed since start of command
9	Data or file is too large
A	Transaction size plus word address is too large
B	Access denied, improper privilege
C	Condition cannot be generated—resource is not available
D	Condition already exists—resource is already available
E	Command cannot be executed
F	Histogram overflow
10	No access
11	Illegal data type
12	Invalid parameter or invalid data
13	Address reference exists to deleted area
14	Command execution failure for unknown reason
15	Data conversion error
16	Scanner not able to communicate with 1771 rack adapter
17	Adapter cannot communicate with module
18	1771 module response was not valid
19	Duplicated label
1A	File is open; another node owns it
1B	Another node is the program owner
1C TO FF	Not used

If you receive a code other than the above, you are using a PCCC not described in this manual and should consult the documentation you are using to understand that PCCC and its specific error codes.

## Avoiding Multiple Watchdog Faults

If you continue to encounter the hardware error, call your Allen-Bradley representative.



## Inserting Ladder Rungs at the 56K-Word Limit

This consideration applies to PLC-5/V80 processors when you are editing a program file that approaches the maximum file limit of 57,344 words.

If you encounter a hardware error or watchdog major fault, it may be because multiple watchdog faults occurred while the processor was busy servicing a ladder-related major fault. The hardware error occurs when the fault queue, which stores a maximum of six faults, becomes full and cannot store the next fault.

Before calling a service representative when you encounter either a hardware error or multiple watchdog faults, try executing the following techniques:

If you encounter a:

Then:

watchdog error and a fault bit	Extend the watchdog timer so that the real run-time error is not masked. Check your major fault bits. Ignore the watchdog faults and use any remaining fault bits to help indicate the source of the processor fault.
hardware error	<ol style="list-style-type: none"><li>4. Power down; then power up the processor.</li><li>5. Reload the program.</li><li>6. Set the watchdog timer to a value = <math>10 \times</math> current setting</li><li>7. Run the program again.</li></ol>

Performing run-time or program-mode editing of ladder files that approach the maximum program file size of 57,344 words could:

- prevent the rung from being inserted
- cause suspension of the operation by 6200 Series PLC-5 Programming Software (release 4.3 and later)

To avoid this problem, segment your program file by using modular programming design practices, such as main control programs (MCPs), sequential function charts (SFCs), and the jump to subroutine (JSR) instruction.

If you cannot segment your program file, save the file often while editing it.

If you encounter the error “Memory Unavailable for Attempted Operation” while performing online edits, then use your programming software package to clear memory and restore the last-saved version of your program.

## Recovering from Possible Memory Corruption



---

**ATTENTION:** Processor memory could become altered without indication if you lose power while performing any of the following online editing operations:

- creating a rung
  - assembling online edits
  - creating and/or deleting data table space
- 

If you lose power while editing your program, use your programming software package to clear potentially altered memory and restore the last-saved version of your program.

## Examining Fault Codes

Fault routines execute when a PLC-5 processor encounters a run-time error (major fault) during program execution.

A fault routine processes the major fault bit found in S:11 and determines the course of program execution based on the fault bit present. Fault routines provide a means to either:

- systematically shut down a process or control operation
  - log and clear the fault and continue normal operation
- 



**ATTENTION:** Clearing a major fault does **not** correct the cause of the fault. Be sure to examine the fault bit and correct the cause of the fault before clearing it.

For example, if a major fault is encountered, causing bit S:11/2 to be set, which indicates a *programming error*, **do not** use a fault routine to clear the fault until you correct your program.

---

For more information about fault codes, see your programming software documentation set.

## Avoiding Run-time Errors when Executing FBC and DDT Instructions

To avoid encountering a possible run-time error when executing FBC and DDT instructions, add a ladder rung that clears S:24 (indexed addressing offset) immediately before a FBC or DDT instruction.

## Cable Connections

### Cable Connections for Communication Boards

Table E.A lists the cables that you use if you have an Allen-Bradley communication board in your programming terminal.

**Table E.A**  
**Allen-Bradley Communication Board Cables**

If you have this communication board:	Use this cable:
1784-KT	1784-CP
1784-KL	1784-CP6 or
1784-KT2	1784-CP with 1784-CP7 adapter
1784--KL/B	1784-CP8 adapter
1784-KTK1	1784-CP5 with 1785-CP7 adapter

For pinouts for these Allen-Bradley cables, see pages E-11 and E-12.

### Cable Connections for Serial-Port Communications

The diagrams in this section show the cable connections for serial-port communications.

For these wiring diagrams:	See page:
Cables 1 through 6	E-6
Allen-Bradley cables	E-7



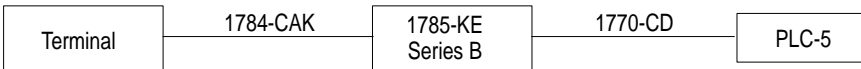
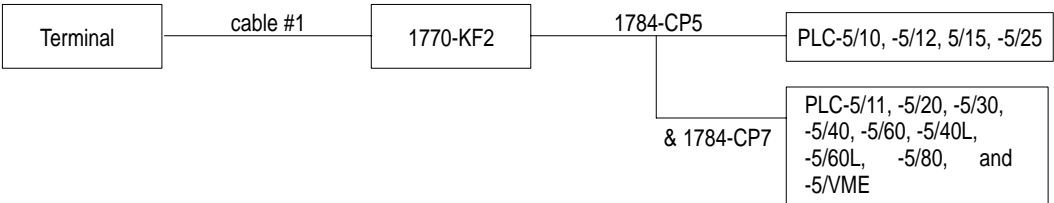
## Front Panel

The channel 0 connector on the front panel is an RS-232C serial port. It is a 25-pin D-shell connector whose pins are defined in the following table.

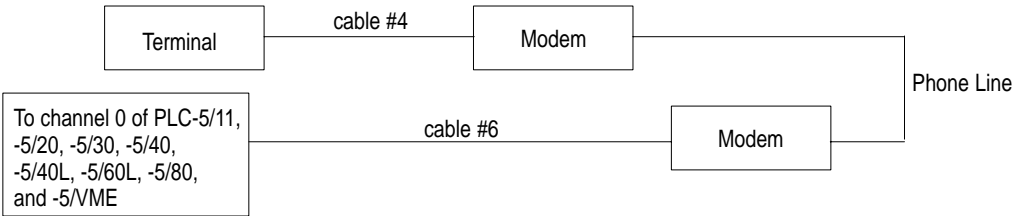
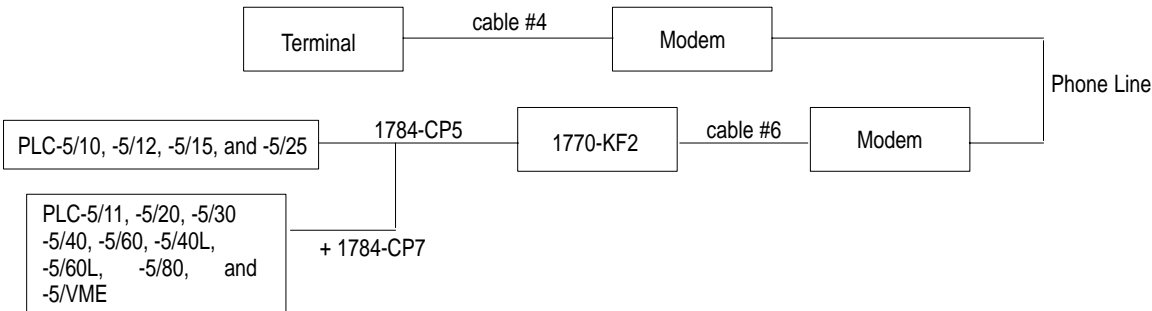
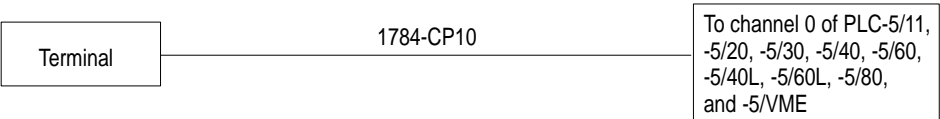
Pin	Signal	Pin	Signal
1	shield	13	ground
2	transmit data	14	ground
3	receive data	15	shield
4	request to send	16	no connect
5	clear to send	17	no connect
6	data set ready	18	ground
7	ground	19	ground
8	carrier detect	20	data terminal ready
9	ground	21	no connect
10	no connect	22	ground
11	no connect	23	ground
12	no connect	25	no connect

**9-Pin Serial Port**

**1784-T50**  
**1784-T53**  
**6160-T60**  
**6160-T70**  
**IBM PC/AT**



Note: 1785-KE series A uses 1784-CP5 with PLC-5/10, -5/12, -5/15, and -5/25 processors and 1785-CP5 with 1785-CP7 adapter with PLC-5/11, -5/20, -5/30, -5/40, -5/60, -5/40L, and 5/60L processors.



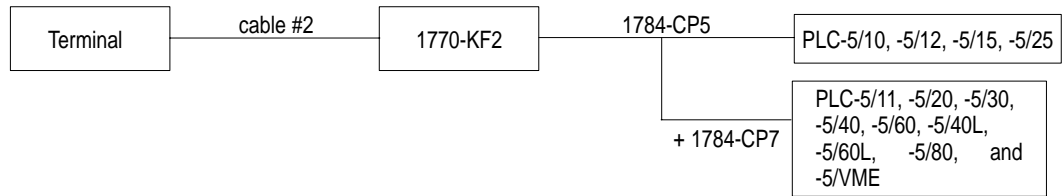
## 25-Pin Serial Port

**1784-T47**

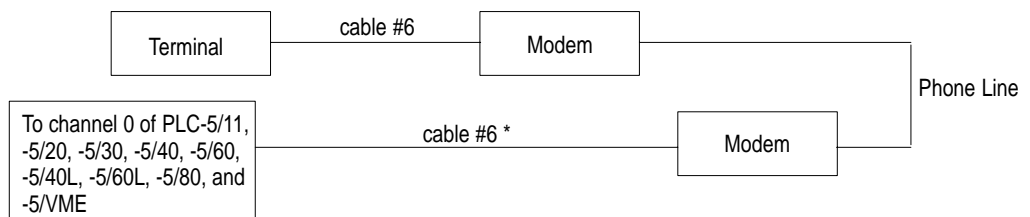
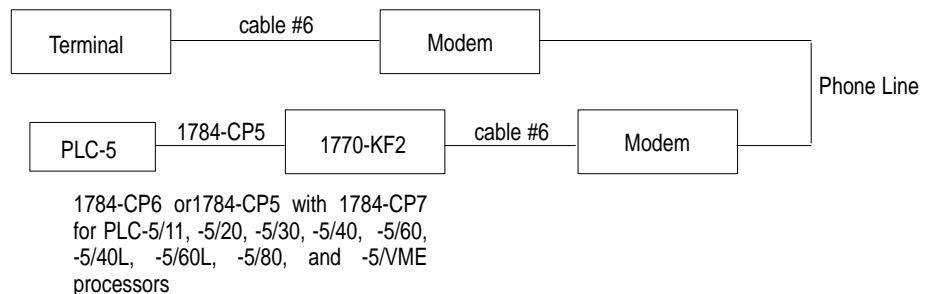
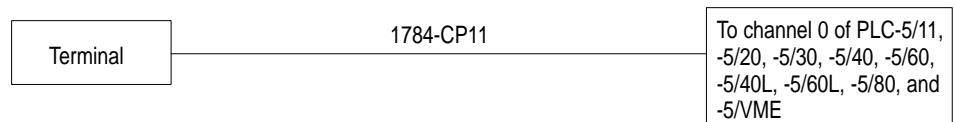
**IBM XT**

**IBM PS/2 Model 30**

**IBM PS/2 Model 60**



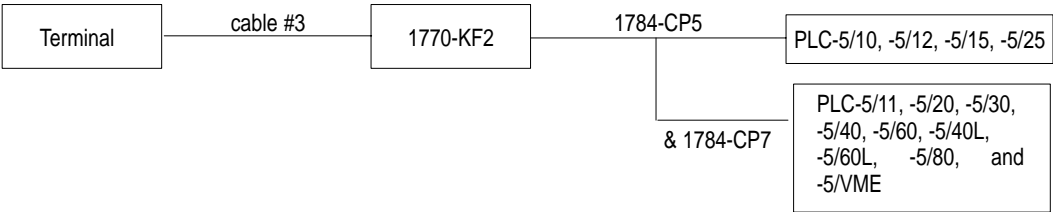
Note: 1785-KE Series A uses 1784-CP5 with PLC-5/10, -5/12, -5/15, and -5/25 processors and 1785-CP5 with 1785-CP7 adapter with PLC-5/11, -5/20, -5/30, -5/40, -5/60, -5/40L, -5/60L, and 5/80 processors.



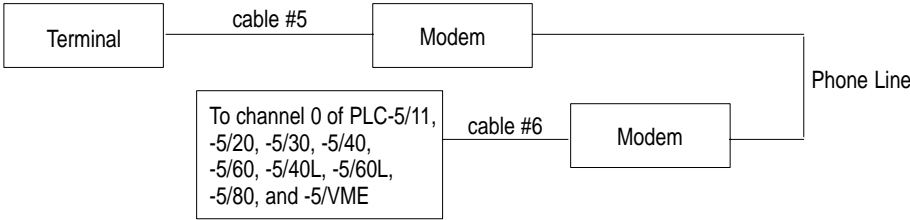
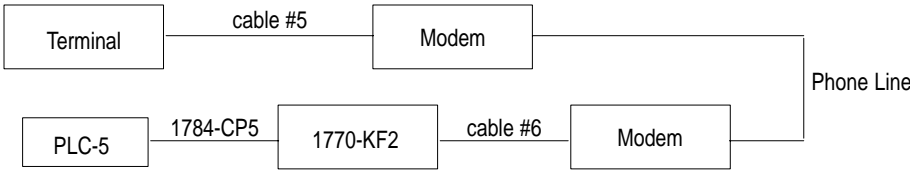
\* Requires either a gender changer or one end of cable #2 fitted with a male 25-pin plug.

**9-Pin Serial Port**

6120  
6122

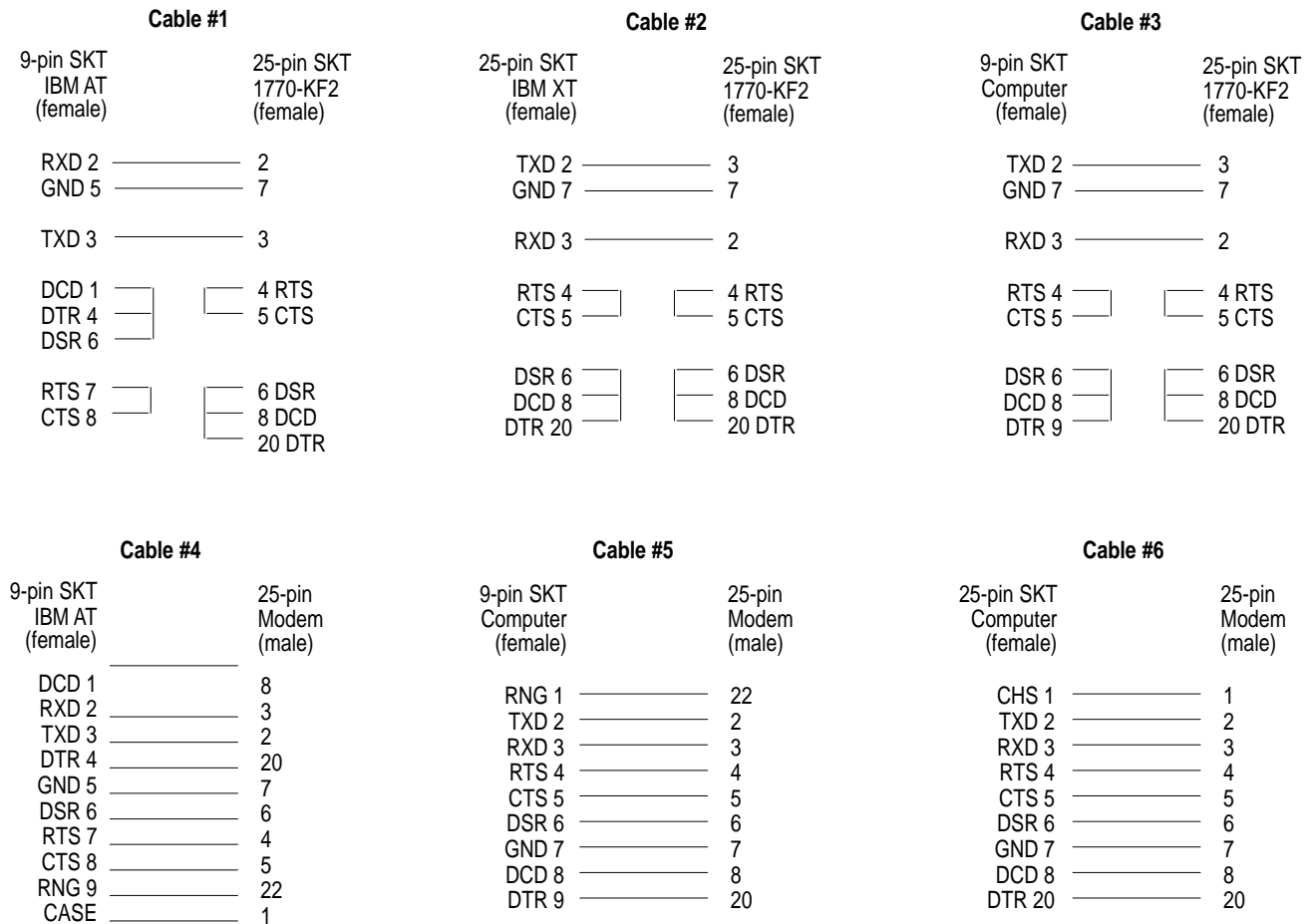


Note: 1785-KE series A uses 1784-CP5 with PLC-5/10, -5/12, -5/15, and -5/25 processors and 1785-CP5 with 1785-CP7 adapter with PLC-5/11, -5/20, -5/30, -5/40, -5/60, -5/40L, 5/60L, -5/80, and -5/VME processors.



## Cable Pin Assignments

The following diagrams show the pin assignments for the cables that you need for serial-port communications.



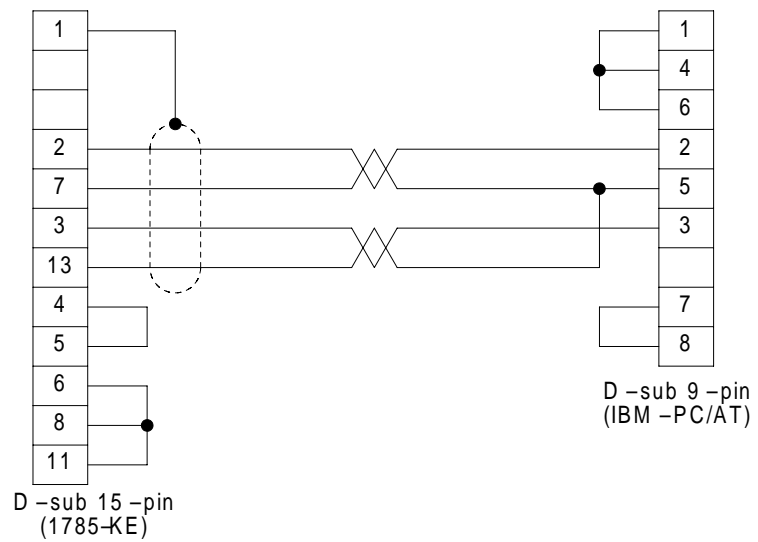
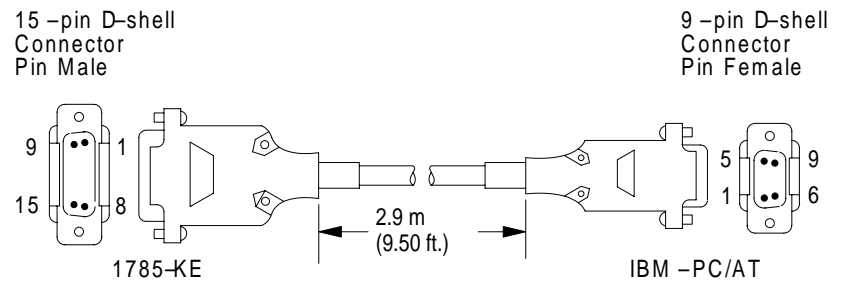
## Cable Specifications

The specifications for each Allen-Bradley cable used for communications are shown on the following pages. See Table E.B.

**Table E.B**  
**Cable Specifications**

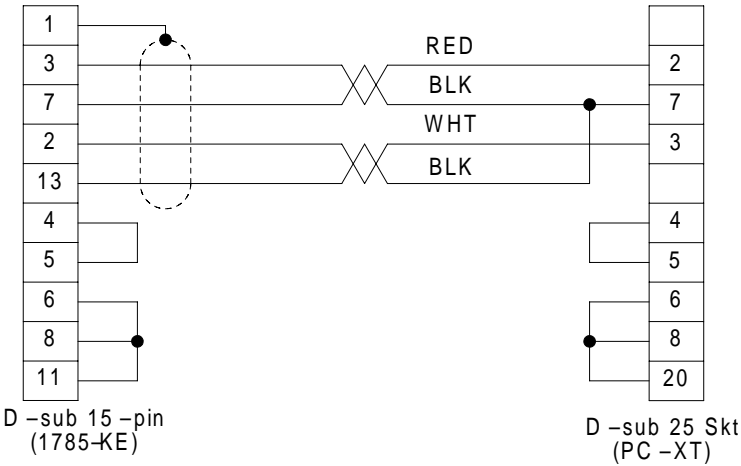
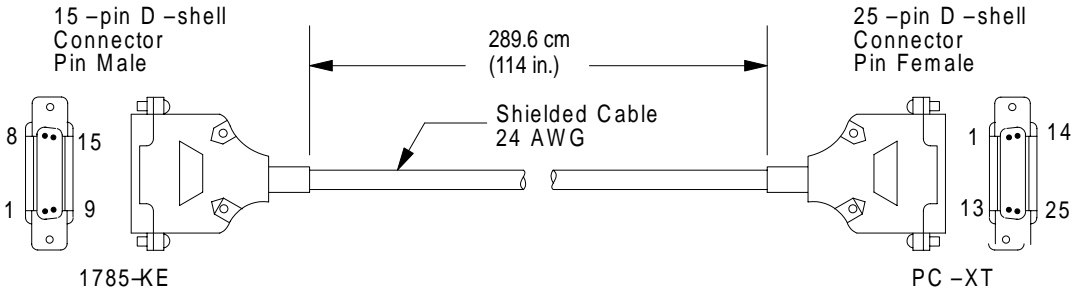
For:	To:	Use This Cable:	See Page:
6160-T53 6160-T60 6160-T70 6121 IBM PC/AT	1785-KE	1784-CAK	E-8
1784-T45 IBM XT	1785-KE	1784-CXK	E-9
6120 6122	1785-KE	1784-CYK	E-10
PLC-5/10, -5/12, -5/15, -5/25 Processors	Terminal (using a 1784-KTK1)	1784-CP5	E-11
	Terminal (using a 1784-KT, -KT2, or -KL, -KL/B)	1784-CP	E-12
PLC-5/11, -5/20, -5/30, -5/40, -5/60, -5/40L, -5/60L, -5/80, -5/VME Processors	Terminal (using a 1784-KT or -KT2, or -KL, -KL/B)	1784-CP6	E-13
	Terminal (using a 1784-KTK1)	1784-CP5 with a 1785-CP7 adapter	E-14

**Figure E.1**  
**Interconnect Cable—1784-CAK**  
**6160-T53, -T60, -T70, 6121, IBM PC/AT to 1785-KE**



14936

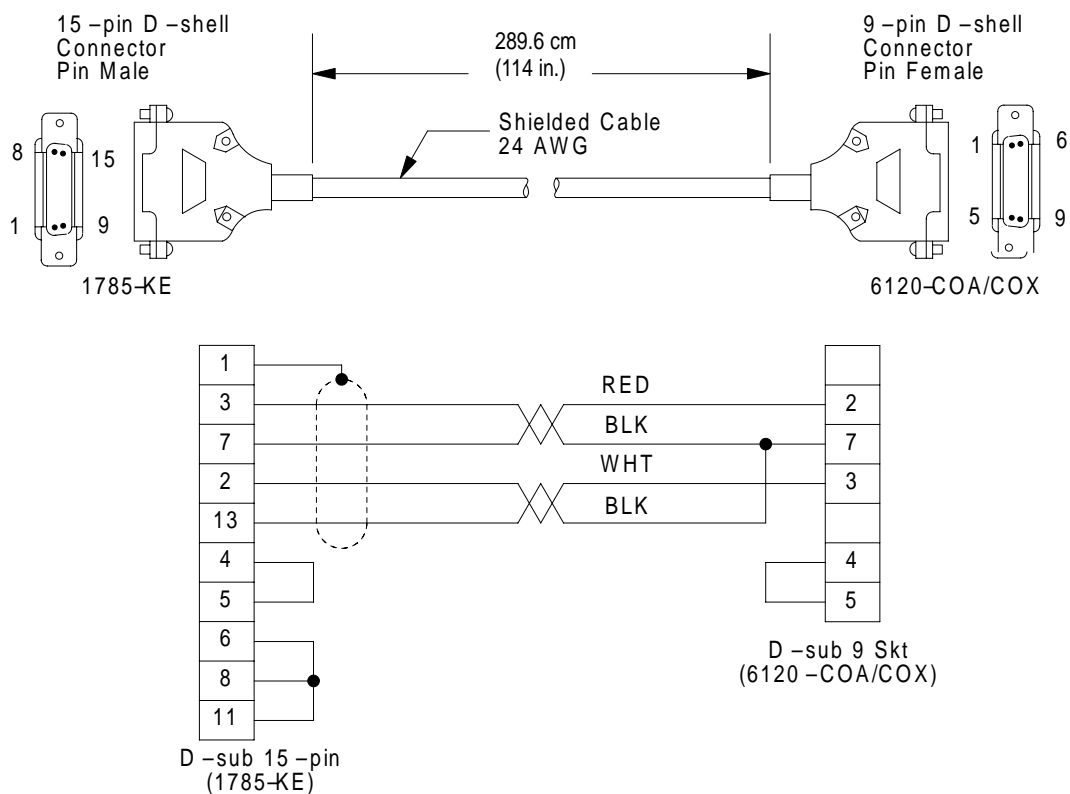
Figure E.2  
Interconnect Cable—1784-CXK  
1784-T45, IBM XT to 1785-KE



12727

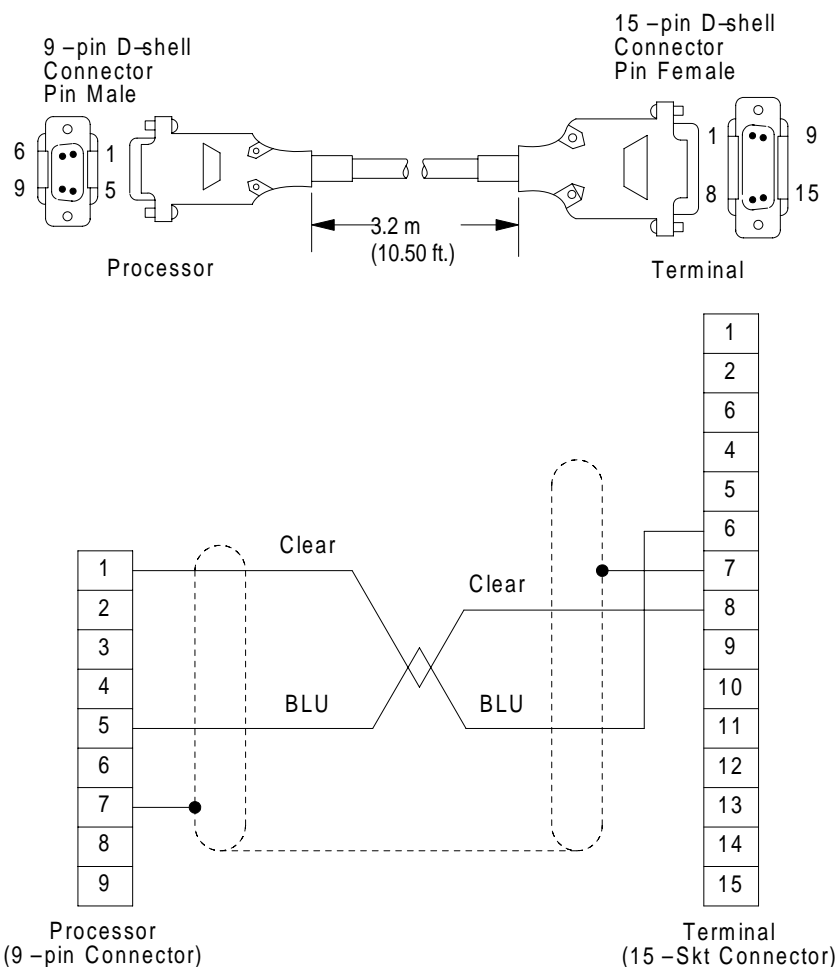


**Figure E.3**  
**Interconnect Cable—1784-CYK**  
**6120, 6122 to 1785-KE**



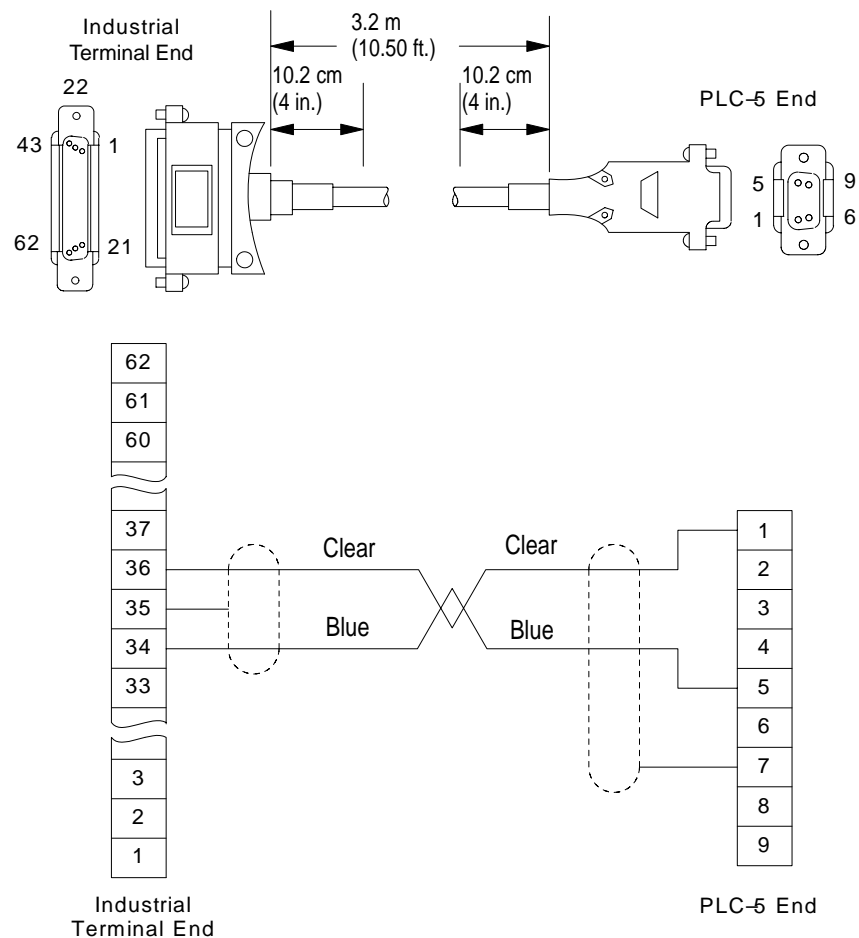
12726

**Figure E.4**  
**Interconnect Cable—1784-CP5**  
**Processor to Terminal (using a 1784-KTK1)**



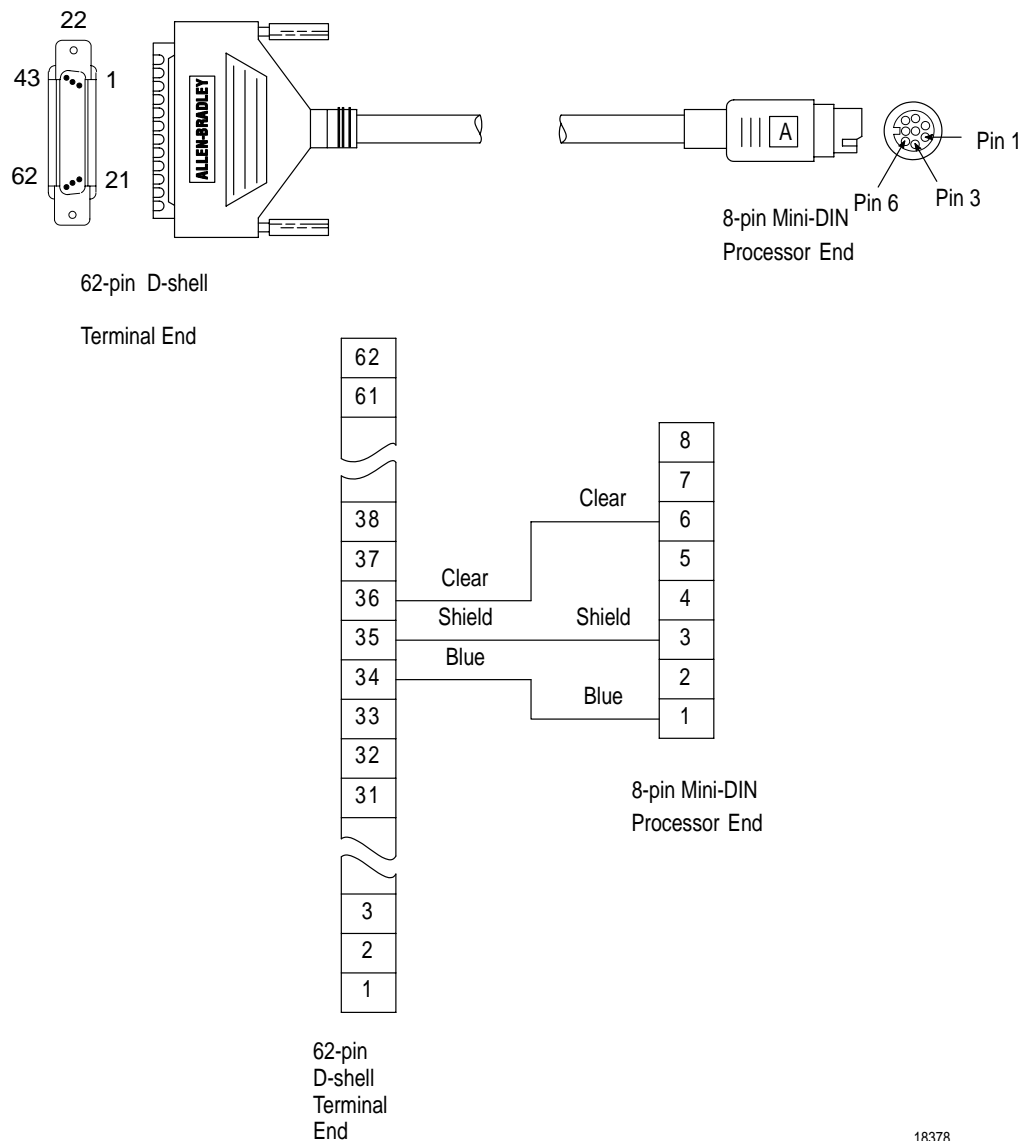
14938

**Figure E.5**  
**Interconnect Cable—1784-CP**  
**Processor to Terminal (using a 1784-KT or 1784-KL)**



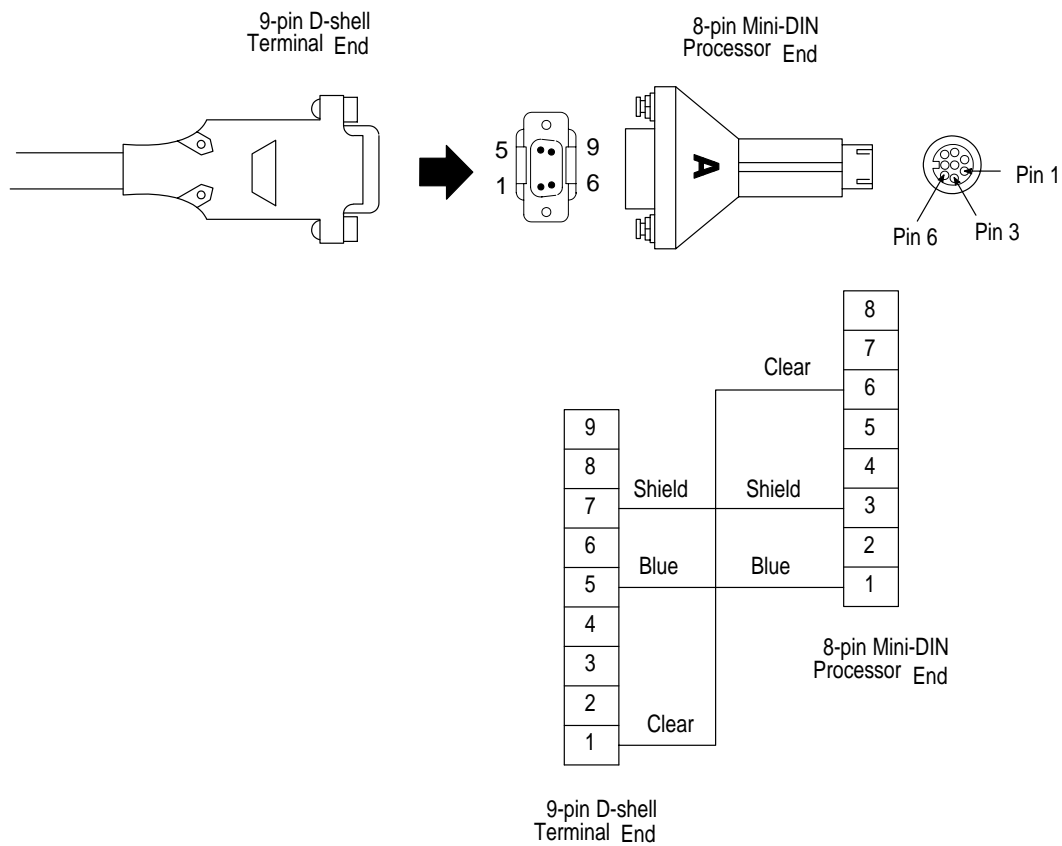
16860a

**Figure E.6**  
**Interconnect Cable—1784-CP6**  
**PLC-5/30, -5/40, -5/60, or -5/80 Processor to Terminal (using 1784-KT,**  
**1784-KL, 1784-KL/B, or 1784-KT2)**



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**Figure E.7**  
**1784-CP7 Adapter —Interconnect Cable Adapter to 1784-CP Connects**  
**PLC-5/30, -5/40, -5/60, -5/80 or -5/VME Processor to Terminal (using**  
**1784-KT, 1784-KL, 1784-KL/B, 1784-KTK1, or 1784-KT2)**



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