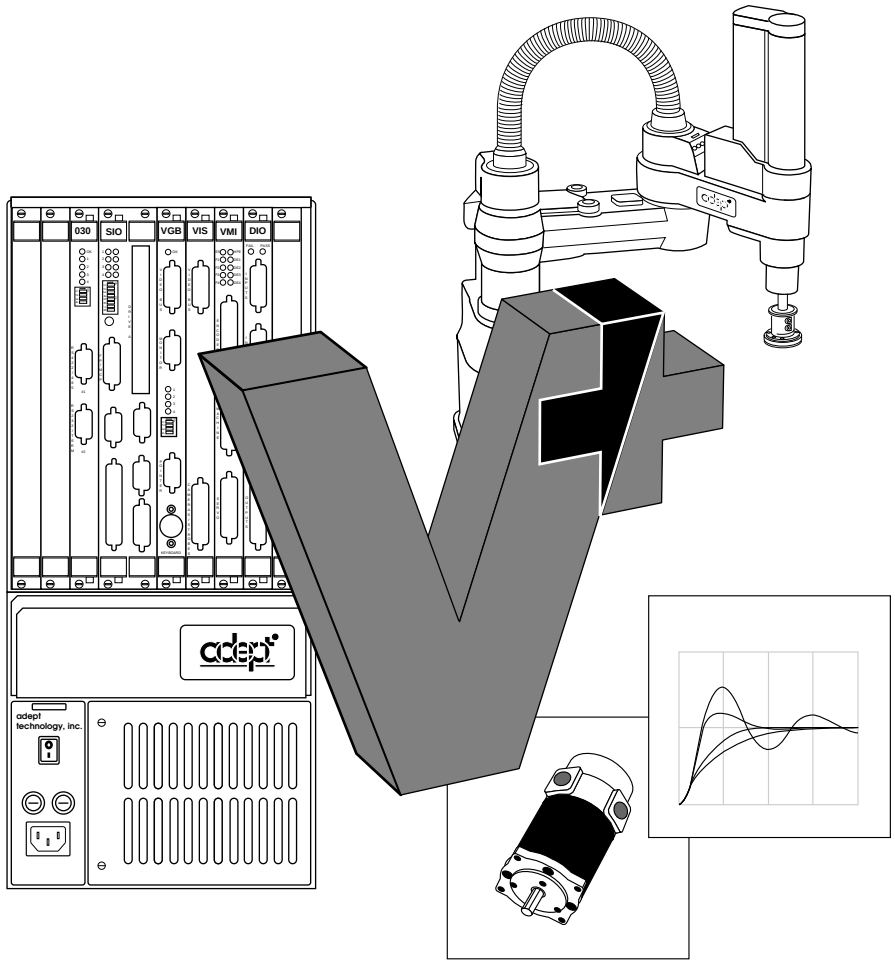
V+ Version 11.4

Release Notes

Incorporating the Release Notes
for V+ Versions 11.0 Through 11.4



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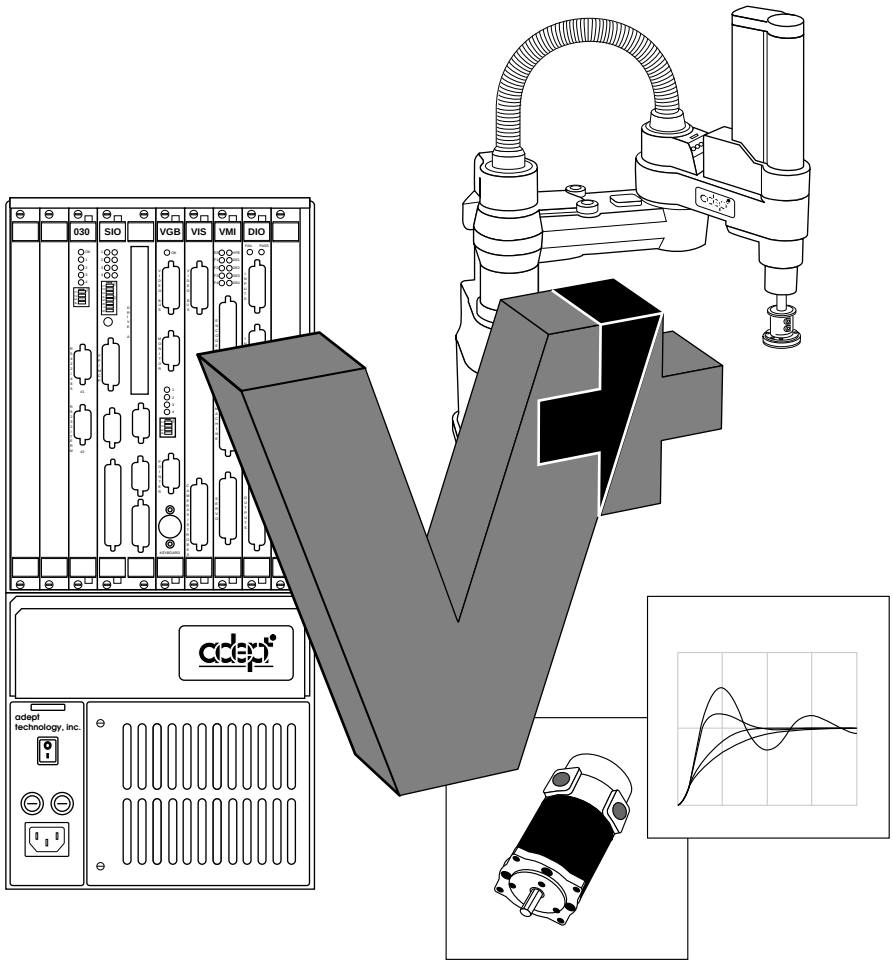

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adept technology, inc.

150 Rose Orchard Way • San Jose, CA 95134 • USA • Phone (408) 432-0888 • Fax (408) 432-8707
Otto-Hahn-Strasse 23 • 44227 Dortmund • Germany • Phone 0231/75 89 40 • Fax 0231/75 89 450
11, Voie la Cardon • 91126 • Palaiseau • France • Phone (1) 69.19.16.16 • Fax (1) 69.32.04.62
1-2, Aza Nakahara, Mitsuya-Cho • Toyohashi, Aichi-Ken • 441-31 • Japan • (0532) 65-2391 • Fax (0532) 65-2390

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Table of Contents TOC

1 Introduction

1.1 Overview

This manual describes the changes to the V+ Operating System and Language from version 11.0 that have not yet been described in related manuals. It incorporates material from the *Release Notes* for versions 11.0, 11.1, 11.2, and 11.3. The manual also provides guidelines for upgrading your systems from these earlier versions and summarizes changes to Adept utility programs.

You receive the *Instructions for Adept Utility Programs* with your V+ 11.4 system, and most of this information is still valid. These V+ 11.4 release notes and the *Robot Instruction Handbook* that came with your system update this information.

This introduction discusses the following topics:

- Book parts
- Related manuals
- Conventions
- Summary of changes to the V+ language and operating system

1.2 Book Parts

This manual is divided into four parts. Part 1 covers material for the release of V+ version 11.4. Part 2 extracts material from the *V+ Version 11.3 Release Notes* that does not yet appear in related manuals. Similarly, Part 3 and Part 4 extract material from the *V+ Version 11.2 Release Notes* and the *V+ Version 11.1 Release Notes* respectively, that does not yet appear in related manuals.

1.3 Related Manuals

Adept products come with a set of documentation that is appropriate for the products you have ordered. In addition, there are optional manuals available if you are going to be programming the Adept system. These release notes refer to both the standard and optional manuals. The following sections give brief descriptions of the contents and organization of the Adept documentation set.

Standard Manuals

In addition to these release notes, the following manuals are shipped with each Adept MV controller:

Manual	Material Covered
Adept MV Controller User's Guide	Details of the installation, configuration, and maintenance of your Adept controller.
V+ Operating System User's Guide	Loading, storing, and executing programs with the V+ operating system.
Instructions for Adept Utility Programs	The collection of Adept utility programs for configuring and calibrating various features of your Adept system.

Other Adept Product Manuals

When you order AdeptVision VME, AdeptMotion VME, AdeptForce VME, any AIM software product, or an Adept robot, you receive manuals that cover those products. Also, optional hardware such as the Manual Control Pendant come with a manual. A partial list follows.

Manual	Material Covered
AdeptVision VME User's Guide	Concepts and strategies for programming the AdeptVision VME system. (See also the optional *AdeptVision Reference Guide* below.)
AdeptMotion VME Developer's Guide	Installation, configuration, and tuning of an AdeptMotion VME system.
AdeptForce VME User's Guide	Installation, operation, and programming of the AdeptForce VME product.
Manual Control Pendant User's Guide	Basic use and programming of the manual control pendant.
AdeptNet User's Guide	Use and programming of the AdeptNet products.

Optional V+ Developer's Manuals

If you will be programming V+ applications, you should order the optional V+ developer's manuals (first three in the list below). These manuals contain a complete description of the commands, instructions, functions, and other features available in the V+ language and operating system. These manuals are essential for advanced applications programming.

If you will be programming vision applications, you should order the *AdeptVision Reference Guide* (in addition to the V+ developer's manuals).

Manual	Material Covered
V+ Operating System Reference Guide	Descriptions of the V+ operating system commands (known as monitor commands).
V+ Language User's Guide	Programming principles for creating programs in the V+ high-level language.
V+ Language Reference Guide	Complete descriptions of the keywords in the basic V+ language system.
AdeptVision Reference Guide	Descriptions of the additional V+ keywords available with the AdeptVision VME option.

1.4 Conventions

This section discusses:

- Notes, cautions, and warnings
- Typographic conventions
- Keyboard conventions
- Selecting, choosing, and pressing items
- Abbreviations

Notes, Cautions, and Warnings

Three levels of special notation are used in this manual. In descending order of importance, they are:

WARNING: If the actions indicated in a *warning* are not complied with, injury or major equipment damage could result. A warning typically describes the potential hazard, its possible effect, and the measures that must be taken to reduce the hazard.

CAUTION: If the action specified in a *caution* is not complied with, damage to your equipment or loss of data could result.

NOTE: A *note* provides supplementary information, emphasizes or supplements a point or procedure, or gives a tip for easier operation.

Typographic Conventions

The following typographic conventions are used throughout this manual:

This	Represents
ALL CAPITALS	V+ file names, directory names, commands, keywords, and attributes; also acronyms.
`monospace`	Screen displays, code examples, non-placeholder terms in formal syntax definitions, and case-sensitive words required for a UNIX-like setting associated with the AdeptNet product.
`italic monospace`	Placeholders for information that you provide in formal syntax definitions. You must replace such a placeholder written in ***`bold`*** weight but need not replace an optional one, which is written in `regular` weight.
bold	In a typing or entering instruction, anything that you type exactly as it appears. For example, if you are asked to type **execute 1 a.diskcopy**, you type all the bold characters exactly as they are printed. What you type is shown in lowercase letters unless it must be typed in uppercase letters to work properly. You may always substitute a currently valid shortcut form when typing a V+ command. In order for the V+ system to process your typing, you must conclude your entry by pressing the ENTER, or RETURN, key. Bold type is used for lowercase names such as subroutine names, variable names, and program names; for example, **a.diskcopy**. Bold type also is used for window items that you choose and window items that do not have initial capital letters in all principal words.
italic	Placeholders that you must provide in typed input. This font also indicates new terms and other emphasized words.

This	Represents
SMALL CAPITALS	The name of a *physical* key or button that you must press, such as the ENTER key and the PROGRAM START button. Similarly, this font style is also used for the setting of a physical switch, such as the TERMINAL setting of the VFP keyswitch.
Initial Capitals	The name of an object such as a window, screen, menu, button, dialog box, or dialog box component. Examples are the Display menu and the Task Profiler window. The *logical* names of physical function keys or buttons use regular font and follow the interface's capitalization, which usually has initial capital letters in all principal words. Examples are the Go To key in the SEE editor and the CMD1 button on the manual control pendant.

Keyboard Conventions

Key combinations appear in the following format:

Notation	Meaning
KEY1+KEY2	A plus sign (+) between keys means that you must press the keys at the same time. For example, "Press CTRL+Z" means that you press CTRL and hold it down while you press Z.

Selecting, Choosing, Pressing, and Performing

In a context using windows, the terms *select, choose,* and *press* have different and specific meanings. Selecting an item usually means marking or highlighting it, as in selecting a radio button. Selecting alone does not initiate an action.

Choosing an item carries out an action. For example, choosing a menu item might open a window or carry out a command. You can also initiate an action by choosing a command button (a push button or a standard button). You often need to select an item before you can choose it.

Often you can use a combination of keyboard and mouse techniques for selecting and choosing.

Pressing refers to *physical* keys and buttons. For example, you press the SAVE key and the PROGRAM START button. By contrast, you select or choose a window button.

Performing refers to carrying out a sequence of steps that are defined in an AIM menu-instruction line.

Abbreviations

The following abbreviations may appear in this manual:

Abbreviation	Meaning
CE	European Certification
DAC	Digital-to-Analog Converter
K	Kilobyte (1024 8-bit bytes)
MB	Megabyte (1,048,576 8-bit bytes)
MCP	Manual Control Pendant
MMSP	Manual Mode Safety Package
VFP	VME (external) Front Panel

1.5 Summary of Changes

This section summarizes in table form the changes to:

- V+ monitor commands
- V+ programming keywords
- V+ keywords for the AdeptVision product

In the tables the term *enhanced* implies compatibility with previous releases so that you can ignore the change if you wish. By contrast, the term *altered* implies incompatibility with previous releases so that you need to investigate the change further.

Changes to V+ Monitor Commands

Table 1-1 shows changes to V+ monitor commands.

Table 1-1. Changed Monitor Commands

Command	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
CALIBRATE			Enhanced		
CD			New		
COPY				Enhanced	
DEBUG			Enhanced		
DIRECTORY	Enhanced	Enhanced			
DISABLE POWER		Altered			

Table 1-1. Changed Monitor Commands (Continued)

Command	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
DO				Enhanced	
ENABLE POWER				Altered	
ESTOP		New			
EXECUTE	Altered		Enhanced	Enhanced	
FCOPY	Enhanced	Enhanced			
FORMAT	Altered	Altered			
FSET	Enhanced		Enhanced[a]		
ID	Enhanced		Enhanced	Enhanced	
INSTALL	New				
IO	Altered		Enhanced		
LISTR/LISTS/LISTL		Enhanced			
LOAD	Enhanced	Enhanced	Enhanced		
MDIRECTORY		Enhanced			
NET			Altered[a]	Enhanced	Enhanced
PASSTHRU	Altered				
PING			New[a]		
PRIME	Altered				
PROCEED				Enhanced	
RETRY				Enhanced	
SEE		Enhanced	Enhanced		
SELECT	Enhanced				
SPEED	Altered				
SSTEP	Altered			Enhanced	
STATUS	Enhanced				
XSTEP	Altered			Enhanced	
ZERO	Enhanced				

[a] The *AdeptNet User's Guide* describes this command.

Changes to V+ Programming Keywords

Table 1-2 shows changes to V+ programming keywords.

Table 1-2. Changed V+ Programming Keywords

Keyword	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
ACCEL program instruction	Enhanced				
ACCEL real-valued function	Enhanced	Enhanced	Enhanced		
AIO.IN real-valued function	New				
AIO.INS real-valued function	New				
AIO.OUT program instruction	New				
ALTER program instruction	New				
AMOVE program instruction	Deleted				
ATTACH program instruction	Enhanced	Enhanced	Enhanced[a]		
AUTO program instruction	Enhanced				
AUTO.POWER.OFF system switch				New	
BMASK real-valued function	New				
CALIBRATE program instruction			Enhanced		
CALLP program instruction			New		
CLEAR.EVENT program instruction	Altered				
CONFIG real-valued function	Enhanced	Enhanced			
DBLB real-valued function	New				
$DBLB string function	New				
$DECODE string function			Enhanced		

Table 1-2. Changed V+ Programming Keywords (Continued)

Keyword	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
DEFBELT program instruction	Enhanced				
DEF.DIO program instruction			New		
DEVICE program instruction	Enhanced		Altered		
DISABLE POWER program instruction		Altered			
DOUBLE variable type	New				
DRIVE program instruction		Altered			
DURATION program instruction	Altered				
ENABLE POWER program instruction				Altered	
ERROR real-valued function			Enhanced		Altered
ESTOP program instruction		New			
EXECUTE program instruction	Altered		Enhanced		
EXIT program instruction	New				
FCLOSE program instruction			Enhanced		
FCMND program instruction	Enhanced	Enhanced	Enhanced[a]		
FOPEN program instruction			Enhanced[a]		
FORCE system switch	Deleted				
FSET program instruction	Enhanced		Enhanced		
GAIN.SET program instruction			New		
GGET.LINE program instruction	Enhanced				
GGETLINE program instruction	New				
GLOBAL program instruction	New				

Table 1-2. Changed V+ Programming Keywords (Continued)

Keyword	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
GTRANS program instruction	New				
HOUR.METER real-valued function			Enhanced		
ID real-valued function	Enhanced	Enhanced	Enhanced[a]		
$ID string function	New	Enhanced			
INSTALL program instruction	New				
INT.EVENT program instruction	New				
IOGET_ real-valued functions	New				
$IOGETS string function	New				
IOPUT_ program instructions	New				
IOSTAT real-valued function			Enhanced[a]		
IOTAS real-valued function	New				
KEYMODE program instruction	Enhanced				
LATCHED real-valued function	Altered		Altered		
LOCAL program instruction	Enhanced				
MCS program instruction	Enhanced				
MONITORS system switch	New				
MOVESF program instruction				Enhanced	
NETWORK real-valued function			New[a]		
NEXT program instruction	New				
NOOVERLAP program instruction		New			
NOT.CALIBRATED	Altered	Enhanced	Altered		

Table 1-2. Changed V+ Programming Keywords (Continued)

Keyword	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
OUTSIDE real-valued function	New				
OVERLAP program instruction		New			
PAYLOAD program instruction				Altered	
#PLATCH precision-point function	Altered				
READ program instruction			Enhanced[a]		Enhanced
RELEASE program instruction	Altered		Enhanced		
ROBOT.OPR program instruction			Enhanced	Enhanced	
SCALE.ACCEL system switch	New	Enhanced			
SEE program instruction		Enhanced	Enhanced		
SELECT program instruction and real-valued function	Enhanced		Enhanced		
SET.EVENT program instruction	Altered				
#SET.POINT location-valued function		New			
SPEED program instruction	Enhanced				
SPEED real-valued function	Changed	Enhanced			
SPIN program instruction		New			
STATE real-valued function	Enhanced	Enhanced	Enhanced	Enhanced	
STRDIF string function			New		
$SYMBOL string function			New		
SYMBOL.PTR real-valued function			New		

Table 1-2. Changed V+ Programming Keywords (Continued)

Keyword	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
TIMER real-valued function			Enhanced		
UNIDIRECT program instruction			New		
WRITE program instruction			Enhanced[a]		

[a] The *AdeptNet User's Guide* describes some or all features of this keyword.

Changes to V+ Keywords for the AdeptVision Product

Table 1-3 shows changes to V+ keywords for the AdeptVision product. The 11.3 release has no changes for this product.

Table 1-3. Changes for the AdeptVision Product

Keyword	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
VCONVOLVE program instruction	Altered				
VCORRELATE program instruction	Enhanced	Enhanced			
VDISPLAY program instruction	Enhanced				
VFEATURE real-valued function	Enhanced				
VGETCAL program instruction	Enhanced				
V.MAX.TIME parameter			Enhanced		
VPUTCAL program instruction	Altered				
VRULERI program instruction	Enhanced				
VTRAIN command and program instruction	Enhanced				
VTRAIN.MODEL program instruction	Enhanced	Enhanced			
VWAIT program instruction	Enhanced				

Table 1-3. Changes for the AdeptVision Product (Continued)

Keyword	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3	V+ 11.4
VWINDOWB program instruction	New				

Part 1

Notes for V+ Version 11.4

This part describes the changes to the V+ operating system and language from version 11.4. This part also provides guidelines for upgrading your systems from versions 11.0, 11.1, 11.2, and 11.3 and summarizes changes to Adept utility programs.

2 How to Upgrade

This chapter discusses the compatibility of V+ version 11.4 with previous versions and provides instructions for upgrading from them. If you bought V+ version 11.4 as part of a new system, then Adept has already installed the software for you and you need to read only Section 2.1.

2.1 Compatibility Issues

The main difference between V+ version 11.4 and previous version-11 systems is the implementation of a new internal FIFO buffer. This buffer receives all asynchronous errors resulting from a robot shutdown. See "New Functionality" on page 31 for more information.

V+ 11.4 is designed for use with either the External Front Panel (VFP) model without the Manual Mode Safety Package (MMSP) or the model with the MMSP. If you are using an older VFP, keyswitch settings do not match current software messages, and you are unable to use the two-step process to enable high power. The old VFP does not have the HIGH POWER ON/OFF button.

V+ 11.4 is designed also for use with the new Manual Control Pendant (MCP) model. It has the new DIS PWR and STEP buttons described in Chapter 4. On older model MCPs, these buttons have different labels and functions.

If you are familiar with V+ version 11.0, 11.1, 11.2, or 11.3 review Table 1-1, Table 1-2, and Table 1-3, which summarize the keyword changes. Pay attention to items marked "altered." This term indicates a possibile incompatibility with previous versions of the V+ software.

> **NOTE:** Adept strives to maintain backward compatibility of the V+ system, but sometimes the benefits of a change outweigh the disadvantage of a resulting incompatibility.

The *V+ Language Reference Guide* and the *V+ Operating System Reference Guide* are the primary sources of information about keywords. However, you can find detailed information in Chapter 3 of these release notes for the keywords that have been altered, enhanced, or added in V+ version 11.4. Refer to Part 2 through Part 4, drawn from previous version-11 release notes, for corresponding information about changes in their respective versions.

You can find information about the programs on the Adept Utility Disk in the *Instructions for Adept Utility Programs* manual.

2.2 Upgrading to V+ Version 11.4

The process of installing a new V+ system involves three parts:

- saving current robot and encoder configuration data
- installing the new V+ version
- applying saved robot and encoder configuration data

If your Adept system does not control a robot and does not use external encoders, all you have to do is install the new V+ version.

In order to complete the installation process you need the following items:

1. Your current V+ system disk
2. Your current Adept Utility Disk
3. Your V+ version 11.4 system disk
4. Your new Adept Utility Disk
5. Up to five blank, high-density diskettes, at least one of which is already formatted

For additional information about the programs used during the installation process, refer to the *Instructions for Adept Utility Programs* manual.

Saving Current Configuration Data–Version 11.0

Use this section to upgrade to V+ version 11.4 if you are currently running V+ version 11.0. If your Adept system does not control a robot and does not use external encoders, you can skip this section and refer to "Installing the New V+ Version 11.4 System" on page 29

In order to have your robot and encoder configuration data carried over to your new V+ system, you need to save that data for all the devices controlled by your Adept system. To do this, follow the steps below.

1. Start your *current* V+ system.
2. Make a note of the robot number and the device-module ID number for each of the robots controlled by your Adept system.

   System identification information is displayed after the V+ system has started. The device-module ID number is the last value displayed on the line for each robot. For example, in the following line for robot number 1 the device-module ID number is 6:

   ```
   Robot 1:  100-123 0 6
   ```

3. Load the file SPEC.V2 from your *current* version of the Adept Utility Disk by typing the command:

   load a:spec

4. Put a formatted data diskette in the floppy drive.
5. Type the following command to create a subdirectory on the diskette:

   fdirectory/c a:\config_c

6. Change the default disk and directory to access the new directory by typing the command:

   default d=a:\config_c

7. Verify that the (empty) directory exists, and is being accessed as the default disk location, by typing the command:

   fdirectory

8. Run the SPEC utility program by typing the command:

   execute 1 a.spec

   NOTE: If the program reports an incompatibility with the current version of the V+ system, then you need a different version of the SPEC program. 7Complete the following steps for *each* robot controlled by your Adept system:

   a. Select the next robot to be processed.

   b. Select the menu item **Save robot specifications to a disk file**.

   c. Enter **b** to request a Binary data file.

   d. Enter a file name in the form **cfg***rr_mm*, where *rr* is the robot number displayed at the top of the screen (for example, 01, 02), and *mm* is the corresponding device-module ID number that you noted in step 2 above.

      For example, if robot number 1 has device-module ID 6, you must enter **cfg01_06** (with spacing and zeros as shown).

   e. After the file has been written, press ENTER to return to the main menu.

   f. Repeat steps a through e for the next robot, if any.

9. Complete the following steps if your Adept system accesses external encoders:

   a. Select **Edit external encoder specification** from the main menu.

   b. Select the menu item **Save encoder specifications to a disk file**.

   c. Enter **b** to request a Binary data file.

   d. Enter the file name **cfg00_07**.

   e. After the file has been written, press ENTER to return to the main menu.

10. Remove the diskette and label it as containing robot and/or encoder configuration data for your system.

11. Turn off your Adept controller.

Go to "Installing the New V+ Version 11.4 System" on page 29 to continue the installation process.

Saving Current Configuration Data–Versions 11.1, 11.2, and 11.3

Use this section to upgrade to V+ version 11.4 if you are currently running V+ version 11.1, 11.2, or 11.3. If your Adept system does not control a robot and does not use external encoders, you can skip this section and refer to "Installing the New V+ Version 11.4 System" on page 29.

In order to have your robot and encoder configuration data carried over to your new V+ system, you need to save that data for all the devices controlled by your Adept system. To do this, follow the steps below.

1. Start your *current* V+ system.
2. Put the Adept Utility Disk into the floppy drive.
3. Load the file CONFIG_C.V2 from your *current* version of the Adept Utility Disk with the command:

   load a:config_c

4. Run the program CONFIG_C by typing the command:

   execute 1 a.config_c

5. Choose the menu item **V+ Installation**.

   NOTE: If your edition of the CONFIG_C program does not provide that menu item, use the steps listed in the section "Saving Current Configuration Data–Version 11.0" on page 26.

6. Put a data diskette in the floppy drive.
7. Select **SAVE current ROBOT DATA**.

   NOTE: If the program reports an incompatibility with the current V+ system, you need to use a different version of the program CONFIG_C. If you do not have a compatible version of the program, you need to use the steps listed in the section "Saving Current Configuration Data–Version 11.0" on page 26.

8. Enter **a** to indicate that your robot data files are to be stored on a diskette.
9. When all the data files have been created, turn off your Adept controller.
10. Remove the diskette and label it as containing robot and/or encoder configuration data for your system.

Go to "Installing the New V+ Version 11.4 System" on page 29 to continue the installation process.

Installing the New V+ Version 11.4 System

This part of the installation process copies your new V+ version 11.4 system to the disk drive you normally start from and transfers your controller configuration information to the new system disk.

1. Start your new V+ version 11.4 system from the distribution diskette.
2. Load the file CONFIG_C.V2 from the V+ version 11.4 Adept Utility Disk by typing the command

   load a:config_c

3. Run the program CONFIG_C by typing

   execute 1 a.config_c

4. Choose the menu item **V+ Installation**.
5. Choose **INSTALL a NEW V+ SYSTEM**.

   Follow the program prompts to perform this part of the installation process. Adept recommends that you make backup disks as suggested by the installation program.

6. Turn off your Adept controller when you have completed all the installation steps.

If your Adept system does not control a robot and does not use external encoders, the installation process is done and you can now start your Adept system from the newly configured system disk.

If your Adept system controls a robot or uses external encoders, see "Applying Saved Robot and Encoder Configuration Data" on page 30 to continue the installation process.

Applying Saved Robot and Encoder Configuration Data

This part of the installation process loads your saved robot and encoder configuration data into your new V+ version 11.4 system.

1. Start your new V+ version 11.4 system from the disk you configured in "Installing the New V+ Version 11.4 System" on page 29 of the installation process.
2. Load the file CONFIG_C.V2 from the V+ version 11.4 Adept Utility Disk by typing the command:

   load a:config_c

3. Insert the diskette containing the robot and/or encoder configuration data for your system (see "Saving Current Configuration Data–Version 11.0" on page 26 and "Saving Current Configuration Data–Versions 11.1, 11.2, and 11.3" on page 28).
4. Run the program CONFIG_C by typing the command:

   execute 1 a.config_c

5. Choose the menu item **V+ Installation**.
6. Select **APPLY saved ROBOT DATA**.
7. Enter **a** to indicate that your robot data files are on a diskette.

   If the program cannot find the data file for one of your devices, you may have to repeat the steps in "Saving Current Configuration Data–Version 11.0" on page 26 and "Saving Current Configuration Data–Versions 11.1, 11.2, and 11.3" on page 28 to create the missing file. (Note, however that you must be running your *current* V+ system to do so.)

8. After all the robot and encoder data have been loaded into system memory, you must have the program write the data to your new V+ system disk. Otherwise, the data will not be used the next time the V+ system is started.
9. Adept strongly recommends that you make a backup copy of the fully configured V+ system disk, as suggested by the installation program.

After the program returns to the Installation menu, your new V+ system is fully configured and ready for use. You do not need to power down the Adept controller and restart the V+ system.

Changes to the V+ Operating System and Language Version 11.4

3

This chapter discusses the updates made to version 11.4 of the V+ operating system, language, and documentation. You will find:

- New functionality
- New robot module
- Networking enhancements
- Clarification of event triggers
- Correction to the GAIN.SET instruction

3.1 New Functionality

Version 11.4 of the V+ operating system and language allows a V+ task to access any errors that cause the robot to shutdown. These errors include asynchronous messages that, in earlier versions of V+, were only displayed on the monitor.

To do this, a new internal FIFO buffer was added that receives all asynchronous errors that occur from the time the robot is turned on (with the ENABLE POWER command or through the MCP) to the time the robot is disabled. You can access this new FIFO buffer through the ERROR( ) real-valued function, as shown below.

ERROR (**source**, *select*)

The **source** parameter represents a real value, variable, or expression (interpreted as an integer) whose value determines the source of the error code.

Definitions of the source parameter are shown in Table 3-1.

.

Table 3-1. Source Parameter Error Code Description

Source Parameter Code	Description
-1	Returns the number of the most recent error from the program in which the ERROR function is executed.
0	Returns the number of the most recent error from the program executing as task #0.
0< source ≤ max-task	Returns the number of the most recent error from the program executing as the corresponding task number.
>1000	Returns the number of the most recent asynchronous FIFO element. A zero is returned if no more FIFO elements exist.

The *select* parameter represents an optional real value, variable, or expression (interpreted as an integer) that determines the error information to be returned. If you omit this parameter, a value of zero is assumed. Select parameter code definitions are shown in Table 3-2

Table 3-2. select Parameter Error Code Description

Select Parameter Code	Description
0	Returns the error number of the most recent program execution error for the specified program task (excluding I/O errors). Refer to the IOSTAT function in the *V+ Language Reference Guide*.
1	Returns the variable portion of the corresponding error message. Zero is returned if the error did not have a variable portion in its message. If the most recent error for the specified program task had an error code less than or equal to -1000 (that is, -1000, -1001, etc.). The value returned should be interpreted as a 6-bit numeric value. See the *V+ Language Reference Guide* for more information.
2	Returns the error number of the most recent error from an MCS instruction executed by the specified program task.
3	Returns the number of the robot associated with the most recent error for the specified program task. Zero is returned if the error was not associated with a specific robot.
4	Returns the error code corresponding to any pending RSC errors for the robot selected by the specified user task. See the *V+ Language Reference Guide* for more details.

The asynchronous FIFO buffer is not valid when the robot is in an initialization state. Be sure to wait until STATE(1) <> 0 before calling ERROR( ) with source >1000.

3.2 New Robot Module

A new *omi* robot module has been added for a gantry robot with an Omni Wrist. An Omni Wrist has five coupled, mechanical joints that logically implement a yaw, pitch, and roll rotary axis. A Z offset exists between the four coupled axis that implement the pitch and yaw.

The omi robot module ID is 31, and has the following startup message.

```
Gantry with Omni Wrist Robot Module
```

The omi robot module is an enhanced kinematic module since it supports a split x-axis, thus it requires the enhanced Kinematics software license.

3.3 Networking Changes

You will find the following networking changes in V+ Version 11.4.

- The NET command now displays the number of available TCP connections.
- When the instruction READ (**lun**, *record_num*, *mode*) is executed and the function IOSTAT (lun) returns a negative value (indicating an error occurred), the value of *record_num* is not valid.
- When you want to terminate a server connection, you must execute an FCMND (lun, 600) instruction. A good time to do this is when the client has closed its connection to the server and the server returns an I/O status of +101 (using READ(lun) and IOSTAT(lun)), indicating the client has closed its connection.

3.4 Clarification of Event Triggers

There are many possible sources of an event in V+; you can usually determine the source by looking at the context. For example, if you know that your task does not have a disk, window, or serial logical unit attached to it to cause an I/O event *and* you have used the INT.EVENT command to enable a digital I/O event, the event triggered was probably a digital I/O event. However, it is good practice to verify this because the resulting event could also be another system event (such as a triggered REACT condition).

For this reason, be sure to test for a desired condition after executing a WAIT.EVENT instruction, as described below.

- For I/O

  Repeat a no-wait I/O operation or use the IOSTAT( ) function (refer to the *V+ Language Reference Guide* for more information).

- For a SET.EVENT command

  Define and verify a global variable. See the *V+ Language User's Guide* for more information on global variables.

- For an INT.EVENT command
  - *Fast digital inputs (1001, 1002, 1003).* Within the V+ routine where the INT.EVENT and WAIT.EVENT instructions are issued, read the digital I/O signal directly using a SIG( ) function. Refer to the *V+ Language Reference Guide* for details on the SIG function.

    NOTE: Be sure to specify enough time to run your routine and trigger the INT.EVENT.

  - *VME bus interrupts.* Use the IOPUT_ and the IOGET_ keywords to communicate with the third-party boards you expect to issue an interrupt. For example, program the board to place a flag in the shared memory area of your system processor before it issues a vectored interrupt. You can then use the IOGET_ function to read the flag after the event occurs. Refer to Chapter 13, "Multiple V+ **Systems,"** for a description of shared memory access.

3.5 Correction to the GAIN.SET Instruction

There is a correction to the *V+ Language Reference Guide* Version 11.3, Revision B on page 216. For the GAIN.SET instruction it says, "This instruction changes some servo-tuning values, specifically those for feedforward gain, for certain axis."

It should read, "This instruction changes the feedback gains."

3.6 Miscellaneous Changes

- When the VFP keyswitch is set to MANUAL or the MCP is in comp mode, be sure to set the speed at 10 or less to avoid tripping the accelerometer.
- Whenever the controller NVRAM is set to *No Cat*, V+ will not check for the CE certified robot bit in the robot option word.

Part 2

Notes for V+ Version 11.3

This section incorporates the original *V+ Version 11.3 Release Notes* but drops much of the material that has already been transferred to subsequent manuals. In particular, for changes to the V+ language, refer to the *V+ Language Reference Guide, Rev. B.*

Changes to the V+ Operating System and Language Version 11.3

4

This chapter discusses version 11.3 changes to the V+ Operating System and Language, first by general changes and then by changes specific to systems or products.

4.1 General Changes

Enhanced COPY and EDIT Monitor Commands

Programs created with the COPY and EDIT monitor commands now are put into the **global** program module.

Clarification of the PROFILE Switch

One of the switches that the SWITCH monitor command displays is PROFILE. This switch is for Adept use only, and end users should not enable it. Improper enabling of this switch can adversely affect system performance.

Increased Number of Menu Bar Items

The maximum number of menu bar items has increased from 10 to 20.

4.2 Changes for European Certification (CE)

New Terminology Relating to the VFP and MCP

Buttons and switches on the VME (external) Front Panel (VFP) have changed and have been renamed. Buttons and overlay names on the Manual Control Pendant (MCP) also have changed. For details, refer to your *Robot Instruction Handbook*. In error messages, terms have changed as follows:

New Term	Old Term
Auto	Terminal
Manual	Pendant

New Startup Messages

On startup, V+ may display a new message that depends on the system's configuration, as follows:

- If CE-compatible Adept robots or non-Adept robots are configured and the EN954 Safety Category 3 license for the MMSP is installed:

```
*Configured as Category 3 Robot System per ISO 10218
and EN954*
```

- If CE-compatible Adept robots or non-Adept robots are configured and the EN954 Safety Category 1 license (without the MMSP) is installed:

```
*Configured as Category 1 Robot System per ISO 10218
and EN954*
```

- If CE-compatible Adept robots are configured and neither EN954 Safety Category license is installed:

```
*Incompatible robot and safety ID*
```

  High power is inhibited from being enabled.

- If non-CE-compatible Adept robots are configured and neither EN954 Safety Category license is installed, no message is displayed. This is a valid combination.

- If non-CE-compatible Adept robots are configured and either EN954 Safety Category license is installed:

```
*Incompatible robot and safety ID*
```

  High power is inhibited from being enabled.

Enabling High Power

Enabling high power is now a two-step process. After you have issued the ENABLE POWER command from the keyboard or pressed the COMP/ PWR button on the MCP, V+ blinks the HIGH POWER ON/OFF light on the VFP and waits for at most *x* seconds for you to press the HIGH POWER ON/OFF button on the VFP. The default is 10 seconds, which is set by the new POWER_TIMEOUT statement in the CONFIG_C data. If a timeout occurs, the following message appears:

```
*HIGH POWER button on VFP not pressed*
```

For information on setting the timeout period with the POWER_TIMEOUT statement, refer to "Changes to the CONFIG_C Utility" on page 52.

As in V+ 11.2, ENABLE POWER can be executed at any time, independent of whether the VFP switch is set to AUTO or MANUAL.

Refer to Table 4-1 for the steps and messages that occur when you enable high power on Category 1 systems. The first column indicates the possibilities for the first step, and the second or third column indicates the following steps, depending on the switch setting on the VFP.

Table 4-1. Enabling High Power on Category 1 Systems

First Steps	VFP in AUTO Mode	VFP in MANUAL Mode
Type **enable power** to use the monitor command.	The HIGH POWER ON/OFF button flashes. The message `*Press HIGH POWER button to enable power*` appears on both the monitor screen and the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, the message `*HIGH POWER button on VFP not pressed*` appears on the monitor screen.	The HIGH POWER ON/OFF button flashes. The message `*Press HIGH POWER button to enable power*` appears on both the monitor screen and the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, the message `*HIGH POWER button on VFP not pressed*` appears on both the MCP display and the monitor screen.
Run a program that uses the ENABLE POWER program instruction.	The HIGH POWER ON/OFF button flashes. The message `*Press HIGH POWER button to enable power*` appears on the MCP display.[a] Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, no error message appears.	The HIGH POWER ON/OFF button flashes. The message `*Press HIGH POWER button to enable power*` appears on the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, no error message appears.
Press and hold the HOLD-TO-RUN switch on the MCP. Then press the COMP/PWR button on the MCP.	The HIGH POWER ON/OFF button flashes. The message `*Press HIGH POWER button to enable power*` appears on the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, no error message appears.	The HIGH POWER ON/OFF button flashes. The message `*Press HIGH POWER button to enable power*` appears on the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, no error message appears.

[a] For an ENABLE POWER program instruction, the message `*Press HIGH POWER button to enable power*` does not appear on the monitor screen. If desired, however, an application program can use a TYPE or WRITE instruction to display a message there. If a timeout occurs, a program error is generated with the appropriate error code, which a REACTE subroutine can trap.

Refer to Table 4-2 for the steps and messages that occur when you enable high power on Category 3 systems. The first column indicates the possibilities for the first step, and the second or third column indicates the following steps, depending on the switch setting on the VFP.

Table 4-2. Enabling High Power on MMSP (Category 3) Systems

First Steps	VFP in AUTO Mode	VFP in MANUAL Mode
Type **enable power** to use the monitor command.	The HIGH POWER ON/OFF button flashes. The `*Press HIGH POWER button to enable power*` message appears on both the monitor screen and the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, the message `*HIGH POWER button on VFP not pressed*` appears on the monitor screen.	The messages `*Release then press Hold-to-run button*` and `*Press HIGH POWER button when blinking*` appear on the monitor screen. Release then press the HOLD-TO-RUN switch on the MCP. If you do not respond within 10 seconds, the message `*Timeout: Hold-to-Run not toggled*` appears on both the monitor screen and the MCP display. After a delay, the message `*Press HIGH POWER button to enable power*` appears on the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, the message `*HIGH POWER button on VFP not pressed*` appears on both the monitor screen and the MCP display:
Run a program that uses the ENABLE POWER program instruction.	The HIGH POWER ON/OFF button flashes. The `*Press HIGH POWER button to enable power*` message appears on the MCP display.[a] Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, no message appears.	Release then press the HOLD-TO-RUN switch on the MCP. If you do not respond within 10 seconds, the `*Timeout: Hold-to-run not toggled*` message appears on both the monitor screen and the MCP display. After a delay the `*Press HIGH POWER button to enable power*` message appears on the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, no message appears.

Table 4-2. Enabling High Power on MMSP (Category 3) Systems

First Steps	VFP in AUTO Mode	VFP in MANUAL Mode
Press and hold the HOLD-TO-RUN switch on the MCP. Then press the COMP/PWR button on the MCP.	The HIGH POWER ON/OFF button flashes. The `*Press HIGH POWER button to enable power*` message appears on the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, no error message appears.	The red E-STOP LED on the MCP starts to blink. Release then press the HOLD-TO-RUN switch on the MCP. If you do not respond within 10 seconds, the `*Timeout: Hold-to-Run not toggled*` message appears on both the monitor screen and the MCP display. The `*Press HIGH POWER button to enable power*` message appears on the MCP display. Press the HIGH POWER ON/OFF button on the VFP. If a timeout occurs, the following message appears on both the monitor screen and the MCP display: `*HIGH POWER button on VFP not pressed*`.

[a] For an ENABLE POWER program instruction, the `*Press HIGH POWER button to enable power*` message does not appear on the monitor screen. If desired, however, an application program can use a TYPE or WRITE instruction to display a message there. If a timeout occurs, a program error is generated with the appropriate error code, which can be trapped by a REACTE subroutine.

Disabling High Power

There are three ways to disable high power:

- **The HIGH POWER ON/OFF Button on the VFP.** Pressing the new HIGH POWER ON/OFF button on the VFP disables high power.
- **The DIS PWR Button on the MCP.** Pressing the new DIS PWR button on the MCP disables high power.
- **The VFP AUTO/MANUAL switch.** V+ disables power when the VFP switch moves from MANUAL to AUTO or vice versa. This change applies to all safety categories (Category 1, Category 3, or no safety category) and is not backwards compatible with V+ 11.2. When switching into AUTO, the following message appears (on the monitor screen):

  ```
  *Power disabled: Manual/Auto changed*
  ```

  If a program has attached a robot, the program is stopped, and the new error message appears on the screen and can be trapped by a REACTE subroutine.

  When switching into MANUAL, the message appears on both the monitor screen and the MCP display.

V+ disables power by performing an orderly powerdown in a manner consistent with the DISABLE POWER monitor command and unlike pushing the EMERGENCY STOP button. That is, it decelerates all robots, sets the brakes, and then disables the power to the amplifiers.

Enhanced ID Monitor Command

The ID monitor command has been enhanced to display the new configuration startup messages that are described in a preceding section.

New AUTO.POWER.OFF System Switch

Because the HIGH POWER ON/OFF button can no longer be used by itself to enable power, Adept has sought to reduce the number of instances that high power is disabled during normal program execution. Making this improvement allows programs to continue to recover automatically from errors without manual intervention, that is, without requiring the operator to press the HIGH POWER ON/OFF button. A new V+ system switch, AUTO.POWER.OFF, cancels the effect of this change. By default this switch is disabled. Enabling it restores the original functionality as it was in V+ version 11.2.

Adept has reviewed all automatic mode errors that disabled high power in V+ version 11.2 and determined which could be changed simply to decelerate the robot and generate an error without compromising the safe operation of the system. Examples of particular importance are errors such as nulling timeout and envelope errors that often occur during the normal operation of the system. In some cases, Adept has modified internal software to ensure the continued safe operation of your system.

The disabling of high power remains unchanged during manual mode; that is, all errors that disabled high power in V+ version 11.2 continue to do so during manual control mode in V+ version 11.3.

Hard and Soft Envelope Errors

Hard and soft envelope errors have been added. If the hard envelope is exceeded, high power is shut down immediately, and V+ displays the message `*Hard envelope error*`. This response differs from that for a soft envelope error, for which a controlled motion stop occurs immediately when the position tracking error exceeds a soft envelope limit. In this latter case high power stays on, and V+ displays the message `*Soft envelope error*`. For related information, refer to Section 5.11, "Changes to the SPEC Utility."

Changes in Manual Mode

When the VFP keyswitch is set to MANUAL or the MCP is in manual mode:

- The maximum speed of the robot tool has been reduced to 250mm/sec.
- For the AdeptThree robot, the maximum joint pendant speed has been reduced, and the maximum world/tool translation speed has been reduced from 76.2 mm/sec to 40mm/sec.
- For non-Adept robots, the maximum torque is limited to values of a new parameter that you specify with the SPEC utility. For details about setting these values, refer to Section 5.11. (Adept robots have factory-set values.)
- V+ terminates the execution of any robot motions caused by a DEVICE program instruction and generates an error message for any subsequent DEVICE instructions that require the robot to move.

The STEP Button and Limits to Program-Controlled Motion

When the VFP keyswitch is set to MANUAL, V+ programs cannot initiate motions unless you press the STEP button and speed bar on the MCP. To continue the motion once it has started, you can release the STEP button but must continue to press the speed bar. Failure to operate the STEP button and the speed bar properly results in the following error message (with error code –620):

```
*Speed pot or STEP not pressed*
```

Once a motion has started in this mode, releasing the speed bar also terminates any belt tracking or motion defined by an ALTER program instruction.

Motions started in this mode have their maximum speeds limited to those defined for manual control mode.

As an additional safeguard, when high power is enabled and the VFP switch is set to MANUAL, the MCP is set to OFF mode, not COMP or MANUAL mode.

Elimination of Program Interlocks

Enhanced DO, EXECUTE, PROCEED, RETRY, and WAIT.START Monitor Commands

V+ no longer contains interlocks that prohibited user programs from being started or continued from the terminal or the MCP based upon the setting of the VFP keyswitch.

Prior to version 11.3, V+ attempted to interlock the starting and proceeding of user programs with the VFP keyswitch and the PROGRAM START button in order to comply with Robotic Industries Association (RIA) safety standards. Now, in version 11.3, V+ interlocks the enabling of arm power and the movement of a robot to comply with both CE and RIA safety standards. Therefore, it is no longer necessary to interlock program execution. This change has the following consequences:

- Monitor commands can start or resume program execution regardless of the keyswitch setting. These commands include EXECUTE, DO, PROCEED, and RETRY. In V+ 11.2 and earlier, these commands are allowed only when the keyswitch is set to the TERMINAL position.
- Pendant function buttons can initiate program execution regardless of the keyswitch setting. These function buttons include AUTO-START, CALIB, CMD1, CMD2, and START. In V+ 11.2 and earlier, the commands from these keys are allowed only when the VFP keyswitch is set to the PENDANT position.
- The keyswitch setting is no longer checked when the RETRY system switch is enabled and the PROGRAM START button is pressed to issue a retry of task 0. In V+ 11.2 and earlier, the VFP keyswitch must be set to the TERMINAL position for the button press to be recognized.
- Because the VFP keyswitch no longer interlocks program execution, the WAIT.START command no longer checks the keyswitch setting. In V+ 11.2 and earlier, WAIT.START requires the keyswitch to be set to the TERMINAL position and the PROGRAM START button to be pressed before it continues. With V+ 11.3 WAIT.START waits only for a positive transition on the PROGRAM START button.

New SAFE_UTL Utility for Category 3 Systems

The new SAFE_UTL utility program tests safety hardware in Category 3 systems only. You cannot enable high power in such systems until you have used this utility. For details, refer to the *AdeptOne-MV/AdeptThree-MV Robot Instruction Handbook*.

Enhanced STATE Function

The STATE real-valued function has been enhanced to return information on the new states for VFP switches and buttons.

When ***select*** equals 4, the function reports the state of the VFP HIGH POWER ON/OFF button with bit 4 (mask value 8) of the returned value.

When ***select*** equals 5, the function returns the following values:

Value	Interpretation (***select*** = 5)
1	Both AUTO and LOCAL are set.
2	Both MANUAL and LOCAL are set.
3	Both AUTO and REMOTE are set.
4	Both MANUAL and REMOTE are set.

Reserved Digital Signals

On systems with the options for safety Category 3 hardware and software, user programs cannot use the following digital signals:

Input	1011, 1012
Output	6, 7, 8

4.3 General Motion Changes

Clarification of the GAIN.SET Program instruction

Previous documentation of the GAIN.SET program instruction refers to a robot *joint* parameter. All such references actually should be to a robot *motor*. Thus the correct syntax is:

GAIN.SET *set, motor*

This instruction affects the robot currently selected with a SELECT program instruction. The GAIN.SET instruction takes effect immediately and is not synchronized with robot motion segments. A task does not have to be attached to the robot to issue this instruction.

You can use the PAYLOAD instruction to adjust feedforward gains in a predetermined way, just as you can use the GAIN.SET instruction to adjust feedback gains in a predetermined way. Because GAIN.SET does not affect the feedforward, there is no conflict between these two instructions; that is, the order of their execution is unimportant.

Altered PAYLOAD Program Instruction

The previous functionality of the PAYLOAD program instruction had been superseded. It now adjusts the feedforward compensation for a specified motor by setting a percentage of the maximum payload assumed for that motor. For details, refer to the *V+ Language Reference Guide*, *Rev. B* or later.

New Range for the Encoder Roll-Over Value

In order to avoid a new overflow condition for continuous-turn joints, the encoder roll-over value set in the SPEC utility should correspond to an encoder count between 256 and 8388608 (8 to 23 bits). Formerly, the allowable range was 256 to 16777216 counts (8 to 24 bits). The roll-over range was reduced in order to accommodate a change that was made to improve the performance of the servos.

> **NOTE:** This modification is not backwards compatible and may cause improper operation of continuous-turn joints that have formerly been configured with very large roll-over counts.

4.4 Changes for the AdeptMotion VME Product

Change to the Robot Option Word (All Modules)

Robot option bit 12 (counting from 1) modifies the deceleration of the robot when an error occurs and high power has been disabled. Normally in this situation the commanded robot motion is instantly stopped. If this bit is set, however, the standard deceleration profile is used instead. This bit is off by default. This feature has been added for robot systems that delay the disable signal to the amplifiers to allow time for the brakes to engage.

Enhanced 5/6-Axis PUMA Robot Module (EPU)

There is a new enhanced PUMA robot module. This new module is identical in functionality to the standard PUMA module except that it also supports linear compensation on motors 1, 2, and 3. The following notes describe this new enhanced module:

- The module ID is 28.
- The robot module's abbreviated name is EPU.
- In order to operate this module, the Enhanced Kinematic license must be installed.
- The default robot startup message is `Enhanced 5/6-Axis PUMA Robot Module`.

- In order to enable linear compensation, bit 2 (counting from 1) in the robot option word must be enabled. (Enabling this bit in the non-enhanced PUMA module generates an error at startup time.)
- When the compensation option is enabled, linear compensation is provided on *motors* 1, 2, and 3. In the SPEC utility you must specify the linear compensation in units of encoder counts, not joint angles. Then compensation can be applied to correct non-linearities in the drive train even for robots with coupling between joints 2 and 3.
- When the compensation option is enabled, the HERE command, instruction, and function no longer return the position specified by the encoder counters. Instead, they return the robot's joint position specified by the set-point buffer.
- The number of elements in the linear compensation tables and their definitions are the same as those for the linear compensation provided with the enhanced gantry (EGN) robot module and the enhanced X/Y/Z/T (EXY) robot module. For details on setting linear compensation, refer to Appendix B.
- This module does not support backlash compensation.

New Coupled-Axes X/Y/Z/Theta Robot Module (CAR)

A Coupled-Axes X/Y/Z/Theta robot module has been added that implements an X/Y/Z/Theta configuration. It is similar to the existing XYZ and EXY robot modules except for the following points:

- The module ID is 22.
- The robot module's abbreviated name is CAR.
- Skew compensation is provided between the X and Y axes.
- The Z and theta axes can be coupled.
- All four axes must always be configured.
- The default robot-startup message is `Coupled-Axes X/Y/Z/Theta Robot Module`.

Enhanced T12 Robot Module (T12)

The T12 robot module has been enhanced to support a third linear axis mounted at the end of the first two joints.

Enhanced X/Y/3(Z/Theta) Robot Module (XY3)

Z/Theta Heads Increased from 3 to 4

The X/Y/3(Z/Theta) robot module has been enhanced by increasing the maximum number of Z/Theta heads from 3 to 4. This enhancement has the following consequences:

- The number of values in the link dimension array has been increased from 6 to 8. That is, one more pair of X-Y offsets has been added for the new fourth head.
- The default number of configured joints has been increased from 8 to 10.
- The number of arguments for the ROBOT.OPR instruction has been increased to include the new fourth head.

Optional Split-Axis Capability for the y-axis

This robot now supports an optional split-axis capability for the y-axis. When enabled, the slaved motor for the split axis must be the last motor for the robot. Although the SPEC parameters include placeholders for the motor-to-joint and joint-to-motor scaling factors for the slaved split-axis motor, these can be set to 0. This is because the same joint-to-motor scaling factors are used for both motor 2 and the slaved motor to properly account for X-Y skew. Also, when the robot position is read, only the encoder position of motor 2 is used to determine the Y position of the robot. To enable the split-axis capability for the y-axis, set the first bit in the robot option word.

Collision Detection and Avoidance

The X/Y/3(Z/Theta) robot module has been enhanced to provide a simple form of collision detection and avoidance for the special case of two X/Y/3(Z/Theta) robots mounted above the same work surface. For this configuration it is assumed that the two robots share a common y-axis and that the Y axes have the same origin (the same physical zero position) and direction.

In order to enable collision detection, use the SPEC utility to set the fifth robot option bit in *both* X/Y/3(Z/Theta) robot modules. Once you have set this robot option bit, you can use the SPEC utility to edit the parameters that define the clearance zones for collision detection. A new menu item, **Collision detection clearance distances**, appears in the **General motion specs** menu. This item allows you to view and modify six values for clearance distance. Of these six parameters, the X/Y/3(Z/Theta) robot module utilizes only the second value. The absolute value of the second parameter specifies a desired clearance zone to be maintained between the two robots along the y-axis. This clearance distance must be set in both robot modules.

4.5 Changes for the FlexFeeder Product

New FlexFeeder robot modules have been added to the AS, AS2, and AS3 standard kinematic modules. Each FlexFeeder requires two robots and their corresponding robot modules. The module types are a belt module (ID = 29) and a lifter module (ID = 30). The belt robot controls the vision conveyor belt and uses a modified joints (JTS) module with a single axis configured for continuous-rotation operation. The lifter robot controls the motion of the recirculation bucket and uses a modified X/Y/Z/Theta module configured with a single x-axis.

The AS_ kinematic modules can control two FlexFeeder units (that is, four independent robots). These robot modules are backwards compatible with the custom FlexFeeder modules that have been previously shipped. The startup messages for these robot modules are as follows:

- FlexFeeder Generation III (Belt) Robot Module
- FlexFeeder Generation III (Lift) Robot Module
- FlexFeeder Generation III (Belt) Robot Module #2
- FlexFeeder Generation III (Lift) Robot Module #2

Although the current generation of the FlexFeeder product uses an RSC, the FlexFeeder robot modules do not require one. This will enable a single VJI to control two feeders in the future. Consequently, the FlexFeeder does not automatically configure based upon stored RSC information, but can either be explicitly configured or auto-configured by turning on NVRAM option bits and specifying -1 for the specified robot. The standard system configuration file has been modified to specify -1 for the first six robots. Currently, the first feeder must be connected to VJI #2, and the second feeder must be connected to VJI #4.

4.6 Changes for the AdeptVision Product

This release has no changes to the AdeptVision Product.

4.7 Changes for the AdeptNet Product

Increased Number of NFS Mounts

The total possible number of NFS mounts has been increased from 4 to 10. The total number configurable with the CONFIG utility is still 2.

Enhanced NET Command

The NET command now displays the local IP address. This address appears only if the hardware and options are properly installed.

5 Changes to the Utility Disk

This chapter discusses changes to the Adept utility programs, first by a table of changes and then by sections for each utility.

5.1 Table of Changes

Table 5-1 shows the update status of the Adept utility programs through the V+ releases. For details about the utilities, refer to the manual titled *Instructions for Adept Utility Programs*.

In the table the term *enhanced* implies compatibility with previous releases so that you can ignore the change if you wish. By contrast, the term *altered* implies incompatibility with previous releases so that you need to investigate the change further.

> **NOTE:** Always use the latest editions of the utility programs for your version of the V+ system.

Table 5-1. Utility Program Changes

File Name	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3
ADV_CAL	Altered		Enhanced	Enhanced
ADV_USER	Altered			
AREACAL	Deleted			
AUTO22	Deleted			
BELT_CAL		Altered	Enhanced	
COLORS	Deleted			
CONFIG_C	Altered	Altered	Altered[a]	Enhanced[a]
CONFIG_R		Altered	Deleted[b]	
DISKCOPY		Altered	Enhanced	Enhanced
DM_UTIL	Altered	Deleted[c]		
EDITICON	Deleted		Added	
format file FORMAT	Altered			Enhanced
FTP_CLNT			New	Enhanced
FTP_SRVR			New	Enhanced
LOADAREA	Altered			
LOADBELT		Altered		

Table 5-1. Utility Program Changes (Continued)

File Name	V+ 11.0	V+ 11.1	V+ 11.2	V+ 11.3
LOADFILE	Deleted			
LOADICON	Deleted		Added	
LOADTCH	Enhanced			
PROFILER	New		Altered	Enhanced
SAFE_UTL				New[d]
SECURE	New			Enhanced
SET_GAIN	Deleted			
SFUTIL	Deleted		Added[a]	Altered[a]
SPEC		Altered	Altered[a]	Altered[a]
TOUCHCAL	Enhanced			Enhanced
VSAMPLE	Deleted			
VTOOLDEF	Deleted			
XMODEM	New			

[a] This program cannot be used with all editions of V+.
[b] SPEC version 11.2 and later provides the functionality of CONFIG_R.
[c] CONFIG_C version 11.2 and later provides the functionality of DM_UTIL.
[d] The *AdeptOne-MV/AdeptThree-MV Robot Instruction Handbook* documents this program.

5.2 Changes to the ADV_CAL Utility

New Robot Module Supported

The latest edition of ADV_CAL can be used with a robot that is controlled by the new CAR robot module.

5.3 Changes to the CONFIG_C Utility

Compatibility Change

Version 11.3 of CONFIG_C is required for the installation of, and use with V+ 11.3. Also, some of the features of the program cannot be used with previous V+ systems.

New POWER_TIMEOUT Statement

The POWER_TIMEOUT statement applies only to systems with the option for EN954 Safety Category 1 or 3. It specifies how many seconds the V+ system waits for the operator to press the HIGH POWER ON/OFF button on the VFP before canceling the first step for manually enabling robot power. You can set the time by modifying the POWER_TIMEOUT statement in the SYSTEM section of the CONFIG_C configuration data:

```
POWER_TIMEOUT = "10"
```

The default is 10 seconds, and the value can range from 1 to 32767.

If a timeout occurs, the following message appears:

```
*HIGH POWER button on VFP not pressed*
```

New Checking for TASKS Statements

When the latest edition of CONFIG_C is used to edit a statement in the TASKS section of the configuration data, a check is done to make sure there is at least one priority value greater than zero.

Updated Built-In Copy of DISKCOPY

Version 11.3E (and later) of CONFIG.C includes the latest edition of the DISKCOPY utility, which corrects a potentially serious problem described later.

Recognition of New System Options

The latest edition of CONFIG.C recognizes the new options for EN954 Safety Category 1 and 3 when displaying the contents of the controller NVRAM.

5.4 Changes to the DISKCOPY Utility

Correction to Copying Protected Files

Editions of DISKCOPY prior to 11.2E contain a potentially serious error when copying a protected file from a secured floppy disk to a large-capacity hard disk. The problem, which occurs if the user responds to the program that it is okay to secure the hard disk, causes the hard disk to be totally unreadable. (Contact Adept Customer Service for more detailed information about this potential problem.) You can use version 11.2E of DISKCOPY, which corrects the error, with all editions of V+ version 11.

Correction to Copying/Deleting Files with No Date Information

When attempting to copy or delete files, the previous edition of the DISKCOPY utility ignores files that do not have date or time information. That has been corrected in the new edition.

5.5 Changes to the FORMAT Utility

Change to Format for Very Large Hard Drives

The latest edition of the FORMAT utility uses different format parameters for hard drives with more than 400 megabytes of capacity. A drive that is formatted with the new parameters has improved performance for some V+ operations. For example, the FDIRECTORY command completes more quickly.

5.6 Changes to the FTP Utilities

Improvements to the FTP_CLNT Utility

The FTP_CLNT utility has been made more tolerant of unusual situations that could have caused the previous edition not to be able to process commands or to "freeze".

Improvements to the FTP_SRVR Utility

If a previous edition of the FTP_SRVR utility is already running on an Adept controller, and an attempt is made to execute the program in another task, the global data structures used by the utility are corrupted. The new edition of the utility prevents this from happening.

5.7 Changes to the PROFILER Utility

Version 11.3 of the PROFILER utility cannot be used with V+ systems prior to version 11.3. Older versions of the utility can be used with V+ 11.3.

The following minor enhancements have been made to the utility:

- Support for a new system task (EC Cat 3) has been added.
- The labels for inactive user tasks appear dimmed.
- Display of the Help windows is no longer dependent on the size of the PROFILER main window.

5.8 New SAFE_UTL Utility

The SAFE_UTL utility tests the proper operation of the safety features of a robot system with the option for EN954 Safety Category 1 or 3. For details refer to the *AdeptOne-MV/ AdeptThree-MV Robot Instruction Handbook*.

5.9 Changes to the SUCURE Utility

Editions of SECURE prior to 10.4B contain a potentially serious error with respect to securing a large-capacity hard disk. The problem, which occurs if the user responds to the program that it is okay to secure the hard disk, causes the hard disk to be totally unreadable. (Contact Adept Customer Service for more detailed information about this potential problem.) You can use version 10.4B of SECURE, which corrects the error, with all editions of V+ versions 8 through 11.

5.10 Changes to the SFUTIL Utility

Compatibility Change

Version 11.3 of the SFUTIL utility is required for use with V+ 11.3. Furthermore, the program cannot be used with previous V+ systems.

5.11 Changes to the SPEC Utility

Compatibility Change

Version 11.3 of the SPEC utility is required for use with V+ 11.3. Furthermore, the program cannot be used with previous V+ systems.

New Menu Item for Acceleration Feedforward

The **Robot/Motor Servo Tuning** menu now has two new items for entering the maximum and minimum acceleration feedforward. These items support the PAYLOAD instruction.

Joint-4 Tuning for Adept Robots

The **Robot/Motor Servo Tuning** menu now applies to joint-4 for AdeptOne, AdeptThree, and PackOne robots. This allows you to customize tuning of joint-4 with different payloads in order to optimize arm performance.

Removal of Data Items

Two of the Stop-on-Force parameters, the nulling tolerance and the envelope-error limit, have been removed because they are no longer needed. Using different values for the FINE and COARSE parameters in the **Joint motion specs** menu achieves the same effect previously achieved by the nulling tolerance. The introduction of hard and soft envelope errors eliminates the need for the envelope-error limit.

New Menu Item for Maximum Torque in Manual Mode

For non-Adept robots, the maximum torque in manual mode is limited to values of new parameters that you specify with **Maximum DAC output in Manual mode**, which appears on the **Motor amp/encoder specs** menu. The suggested initial value is less than or equal to the value specified for **Maximum DAC value.**

New Menu Item for Collision Detection

If collision detection have been enabled in the robot option word for the X/Y/3(Z/Theta) robot, a new menu item, **Collision detection clearance distances**, appears in the **General Motion Specs** menu. This item allows you to view and modify the six values in the clearance distance data array.

New and Modified System Messages

A

This appendix includes the new system messages for V+ version 11.3. It does not include the old messages that are modified due to changes in names of switch positions in the hardware released with this version. In such messages the term *terminal* is now *auto*, and the term *pendant* is now *manual*. The *V+ Language Reference Guide*, *Rev. B* contains the modified messages.

Calibration program not loaded (–425)

Explanation: A program required for calibration has not been loaded from disk. This error usually occurs if some of the calibration programs have not been loaded into memory, and the CALIBRATE command or instruction is issued with a input mode that does not allow them to be loaded automatically.

User Action: Reissue the CALIBRATE command or instruction with the proper mode. The default mode of zero causes CALIBRATE to automatically load the required programs from disk, perform the calibration, and then delete the programs.

Cat3 diagnostic error* Code *n (–1108)

Because these message codes are related primarily to hardware, refer to your *Robot Instruction Handbook* as your primary source of information. If it does not answer your questions, contact Adept Customer Service. The following table summarizes information about the codes.

WARNING: The test procedures for these messages are for skilled or instructed personnel only. Dangerous voltages are present, including those on the Security Panel. Failure to exercise care can result in death or injury.

Code *n*	Explanation	User action
0	ESTOP board hardware not responding, or Parity error.	Check that the AC supply to the Security Panel is on and that the DC power supply is configured correctly.
1	Hardware state 1 error. An error has occurred in the communication or test sequence.	Try again. If the problem persists, it may be caused by a faulty ESTOP board. Make a note of the error message and code number, and contact Adept Customer Service.

Code *n*	Explanation	User action
2	Hardware state 2 error. An error has occurred in the communication or test sequence.	Try again. If the problem persists, it may be caused by a faulty ESTOP board. Make a note of the error message and code number, and contact Adept Customer Service.
3	Hardware arm power contactor AP1 error.	Consult your *Robot Instruction Handbook* or contact Adept Customer Service.
4	Hardware arm power contactor AP2 error.	Consult your *Robot Instruction Handbook* or contact Adept Customer Service.
5	Hardware cyclic check relay, channel 1 (SR8) error. An error has occurred in the communication or test sequence.	Try again. If the problem persists, it may be caused by a faulty ESTOP board. Consult your *Robot Instruction Handbook* or contact Adept Customer Service. Make a note of the error message and code number before contacting Adept Customer Service.
6	Hardware cyclic check relay, channel 2 (SR9) error. An error has occurred in the communication or test sequence.	Try again. If the problem persists, it may be caused by a faulty ESTOP board. Consult your *Robot Instruction Handbook* or contact Adept Customer Service. Make a note of the error message and code number before contacting Adept Customer Service.

*** Cat-3 external E-STOP* Code *n*** (–1111)

Because these message codes are related to hardware, refer to your *Robot Instruction Handbook* as your primary source of information. If it does not answer your questions, contact Adept Customer Service. The following table summarizes information about the codes.

Code *n*	Explanation	User action
0	Adept E-stop, channel 1 error	Consult your *Robot Instruction Handbook*.
1	Adept E-stop, channel 2 error	Consult your *Robot Instruction Handbook*.
2	Customer E-stop, channel 1 error	Consult your *Robot Instruction Handbook*.
3	Customer E-stop, channel 2 error	Consult your *Robot Instruction Handbook*.

Cat3 external sensor fault* Code *n (–1109)

Because these message codes are related to hardware, refer to your *Robot Instruction Handbook* as your primary source of information. If it does not answer your questions, contact Adept Customer Service.

If one of these message codes occurs, stand away from the robot and attempt to enable power again. If the same error code occurs again for no apparent reason, there may be a fault with the sensor. The following table summarizes information about the message codes.

WARNING: The test procedures for these messages are for skilled or instructed personnel only. Dangerous voltages are present, including those on the Security Panel. Failure to exercise care can result in death or injury.

Code *n*	Explanation	User action
0	Accelerometer, channel 1 error. The robot (joint 1 or 2) is moving or accelerating too fast, there is a fault with the accelerometer system, or the accelerometer's built-in test function failed.	If the error occurred while a program was moving the robot, try changing the program to move the robot less quickly or with a lower rate of acceleration or deceleration. For faults with cables or sensors, consult your *Robot Instruction Handbook* or contact Adept Customer Service.
1	Accelerometer, channel 2 error. The robot (joint 1 or 2) is moving or accelerating too fast, there is a fault with the accelerometer system, or the accelerometer's built-in test function failed.	If the error occurred while a program was moving the robot, try changing the program to move the robot less quickly or with a lower rate of acceleration or deceleration. For faults with cables or sensors, consult your *Robot Instruction Handbook* or contact Adept Customer Service.
2	Amplifier 3 voltage restrict sensor, channel 1 error. The robot (joint 3) is moving or accelerating too fast, there is a fault with the voltage restrict sensor, or the voltage restrict sensor's built-in test function failed.	If the error occurred while a program was moving the robot, try changing the program to move the robot less quickly or with a lower rate of acceleration or deceleration. For hardware faults, consult your *Robot Instruction Handbook* or contact Adept Customer Service.
3	Amplifier 3 voltage restrict sensor, channel 2 error. The robot (joint 3) is moving or accelerating too fast, there is a fault with the voltage restrict sensor, or the voltage restrict sensor's built-in test function failed.	If the error occurred while a program was moving the robot, try changing the program to move the robot less quickly or with a lower rate of acceleration or deceleration. For hardware faults, consult your *Robot Instruction Handbook* or contact Adept Customer Service.

Code *n*	Explanation	User action
4	Amplifier 4 voltage restrict sensor, channel 1 error. The robot (joint 4) is moving or accelerating too fast, there is a fault with the voltage restrict sensor, or the voltage restrict sensor's built-in test function failed.	If the error occurred while a program was moving the robot, try changing the program to move the robot less quickly or with a lower rate of acceleration or deceleration. For hardware faults, consult your *Robot Instruction Handbook* or contact Adept Customer Service.
5	Amplifier 4 voltage restrict sensor, channel 2 error. The robot (joint 4) is moving or accelerating too fast, there is a fault with the voltage restrict sensor, or the voltage restrict sensor's built-in test function failed.	If the error occurred while a program was moving the robot, try changing the program to move the robot less quickly or with a lower rate of acceleration or deceleration. For hardware faults, consult your *Robot Instruction Handbook* or contact Adept Customer Service.
6	Total E-stop, channel 1 (SR5) error	Consult your *Robot Instruction Handbook* or contact Adept Customer Service.
7	Total E-stop, channel 2 (SR4) error	Consult your *Robot Instruction Handbook* or contact Adept Customer Service.

Collision avoidance dead-lock (–647)

Explanation: Two robots with collision detection enabled are simultaneously blocking each other's path. That is, neither robot can perform its next motion until the other robot moves out of the way.

User action: Change the application program to prevent the dead-lock situation.

Hard envelope error* Mtr *n (–1027)

Explanation: The indicated motor was not tracking the commanded position with sufficient accuracy, indicating a failure in the hardware servo system or something impeding the path of the robot. Because this is considered a serious error, high power was turned off.

User Action: Turn on high power and try to perform the motion at a slower speed. Make sure that nothing is obstructing the robot's motion. If the error recurs, contact Adept Customer Service.

HIGH POWER button on VFP not pressed (–646)

Explanation: You failed to press the HIGH POWER ON/OFF button on the VFP before the timeout period expired.

User action: If working from the keyboard, reissue the ENABLE POWER monitor command and promptly press the HIGH POWER ON/OFF button when instructed to do so. If working from the MCP, follow the procedure appropriate for enabling high power for the safety category of your system. Promptly press the HIGH POWER ON/OFF button when instructed

to do so. If the timeout period is too short, adjust it by using the CONFIG_C utility to change the POWER_TIMEOUT statement in the V+ configuration data.

This message also can result from a faulty cable, VFP, or SIO.

Incompatible robot and safety ID (–644)

Explanation: The robot and controller do not have the same safety options.

User action: Make sure that the correct robot and controller are being used together. Install (or remove) the appropriate EN954 Safety Category license in the controller.

Power disabled: Manual/Auto changed (–645)

Explanation: V+ disables power when the VFP switch moves from MANUAL to AUTO or vice versa.

User action: Use any valid method to enable high power.

Press HIGH POWER button to enable power (57)

Explanation: The HIGH POWER ON/OFF button on the front panel must be pressed to complete the process of enabling high power.

User action: When the HIGH POWER ON/OFF button on the VFP blinks, promptly press the button to complete the two-step process of enabling high power. (You must press the button within the time period specified in the V+ configuration data.)

Robot module not enabled (–900)

Explanation: The indicated robot module is present in memory, but it was not enabled for use due to an error (which is reported by a separate message).

User action: Use the CONFIG_C and/or SPEC utilities to correct the module configuration.

Soft envelope error (–1006)

Explanation: The indicated motor was not tracking the commanded position with sufficient accuracy, indicating a failure in the hardware servo system or something impeding the path of the robot. Because this was not considered a serious error, a controlled motion stop occurred, and high power remains on.

User Action: Try to perform the motion at a slower speed. Make sure that nothing is obstructing the robot's motion. If the error recurs, contact Adept Customer Service.

Timeout enabling power **(–675)**

Explanation: High power did not enable within the allowed amount of time, and the servos reported no other error during the timeout period.

User action: For non-Adept robots, use the SPEC utility to increase the value of the high power timeout.

For Adept robots, double-check your installation (cabling, AC power line voltages, circuit breakers, amplifier retaining screws, cables, and contactors). For information about the correct configuration for installation, refer to your *Robot Instruction Handbook*. Make sure that the amplifier chassis is properly connected to a power source and is turned on. Try again. If the problem persists, contact Adept Customer Service.

Timeout: Hold-to-run not toggled (–649)

Explanation: V+ did not enable high power because you failed to toggle properly the HOLD-TO-RUN switch on the manual control pendant.

User action: Do one or more of the following: (1) when toggling the HOLD-TO-RUN switch, release it for a minimum of about two seconds and a maximum of ten seconds, and then press it back in; and (2) make sure that you are pressing the HOLD-TO-RUN switch and not the RUN/HOLD button by mistake.

User has not tested Cat3 system (–648)

Explanation: A system with the EN954 Safety Category 3 option—the Manual Mode Safety Package (MMSP)—has not been successfully commissioned with the SAFE_UTL utility program.

User action: Test the MMSP with the SAFE_UTL utility before enabling power for the first time. Adept recommends that you rerun the utility program every three months. If you have connected the robot to a different controller or replaced the controller or the SIO module, repeat the test. (For information on the use of SAFE_UTL, refer to the *AdeptOne-MV/ AdeptThree-MV Robot Instruction Handbook*.)

Linear Compensation for the Enhanced PUMA Robot Module

B

For the Enhanced PUMA (EPU) robot module, with linear compensation it is possible to map motors 1, 2, and 3 of the robot to correct for linearity errors. Each axis is mapped separately using, for example, a laser interferometer to determine precise positions equidistant along the axis. An array of error corrections is then stored in a linear-compensation table. There is one linear-compensation table for each axis. During a robot motion, regardless whether commanded by program control or the Manual Control Pendant (MCP), V+ uses the error correction information to correct each point on the motion path. These corrections are applied by the V+ trajectory generator. (The default trajectory generation interval is 16ms.)

Each linear-compensation table contains a series of correction values that are specified at even intervals within a range of motor travel. For example, the first correction factor in the table contains the value that must be added to the commanded motor position in order to accurately position the motor at the lowest position in the corrected range of travel. Simply put:

correction value = actual (measured) motor position – commanded motor position

Likewise, the last entry in the table contains the value that must be added to the motor commanded position when the motor is commanded to the highest position in the corrected range. All of the intermediate table values correspond to the corrections that must be added at evenly-spaced intervals between the low and the high ends of the corrected range of travel. Up to 1001 points may be entered for each axis. The first and last correction values must be zero if the joint can move up to, or beyond the corrected range of travel. If these values are not zero there will be a jerk when entering or exiting the corrected range, or when nearing the end of the corrected range. In general, Adept advises that you always ensure that the first and last values of the correction table are zero.

The exact contents of the linear-compensation table are defined in Table B-1. Each value is stored as a floating-point number, and the motor positions are in units of encoder counts, specifiable to 7.5 decimal digits of significance.

Table B-1. Linear Compensation Table

Index	Description
1	Lowest motor position (in encoder counts) for which correction data is provided. When the motor is positioned below this value, no correction is added.
2	Highest motor position (in encoder counts) for which correction data is provided. When the motor is positioned above this value, no correction is added. If this value is lower than the value stored at index 1, the compensation for this axis is disabled.
3	Change in motor position (in encoder counts) between subsequent correction values stored in the table.
4	Reserved for future use. Should be set to 0.
5	Reserved for future use. Should be set to 0.
6	Reserved for future use. Should be set to 0.
7	Reserved for future use. Should be set to 0.
8	Reserved for future use. Should be set to 0.
9	Reserved for future use. Should be set to 0.
10	First motor correction value. This is the motor offset that is added when the motor is commanded to be positioned at the location specified by the value contained at index 1.
10+1	Second motor correction value in encoder counts. This is the motor offset that is added when the motor is commanded to be positioned at the location specified by the sum of the values contained at indexes 1 and 3.
10+1000	Last possible value that can contain correction data. If fewer than 1001 values are needed to represent the corrected range of travel, this value and all previous unnecessary values are ignored.

In order to initialize the linear-compensation tables, the correction values must be experimentally determined. Use a laser interferometer, or other accurate position measurement device to determine correction values in even increments along a range of joint (and motor) travel. The correction values can then be manually entered into the SPEC program or can be read from a disk file.

To enter the data manually, choose the **Linear compensation** menu item in the Motor/ Amplifier Specifications menu. You are prompted to enter all the data from the preceding Table B-1.

The values can also be read in from a disk file using the SPEC program menu item **Load robot specifications from a disk file**. The file must have the following format:

The first line in the file must be:

```
.HEADER Robot Specification Data            Version 1.3
```

(There must be exactly 29 spaces between `Data` and `Version`.)

Next, the robot model number, robot serial number (not the controller serial number), robot option words, and device module number must be specified. If you get an error or warning message when you load your file, save an ASCII copy of all your robot parameters to a disk file, look at it using the FLIST command, and use that as your model for the correct format.

In the following example the robot model is 100, the robot serial number is 123, the robot option words are 2 and 0, and the device module number is 28:

```
Robot 1: 100-123 2-0 28
```

The title of the module is:

```
Title: "Enhanced 5/6-Axis PUMA Robot Module"
```

The linear compensation values are listed in the data section of the file. Each motor has its own data number:

```
.DATA_SECTION
.DATA 301  ;Motor 1 linear compensation
.DATA 302  ;Motor 2 linear compensation
.DATA 303  ;Motor 3 linear compensation
```

Within the data section for each motor, the compensation table values must be entered in the order they are listed in Table B-1.

In the following example data file, compensation values are entered for motors 1 and 2 only. Compensation for the EPU module is specified using encoder values. For both motors, the range of travel is -50000 encoder counts to +50000 encoder counts. A compensation value is measured every 1000 encoder counts (101 values for each motor). Remember that index values 4, 5, 6, 7, 8, and 9 are always zero. (The points at which new lines are started are not significant.)

.HEADER Robot Specification Data Version 1.3

Robot 1: 100-42 2-0 28

Title: "Enhanced 5/6-Axis PUMA Robot Module."

.DATA_SECTION

.DATA 301 ;Motor 1 linear compensation

-50000, 50000, 1000, , , , , ,

20, 49, 29, 33, 22, 37, 19, 43, 12, 18,

30, 8, 11, 16, 5, 17, 2, 15, 33, 15,

34, 5, 10, 29, 45, 33, 11, 44, 37, 16,

30, 6, 22, 21, 26, 27, 27, 50, 37, 7,

```
11, 49, 6, 18, 46, 19, 12, 48, 11, 42,
24, 14, 46, 25, 10, 27, 20, 48, 15, 32,
14, 33, 43, 49, 10, 17, 9, 34, 48, 46,
50, 1, 47, 25, 50, 2, 30, 31, 25, 26,
23, 47, 24, 9, 4, 43, 41, 2, 26, 36,
35, 3, 47, 49, 24, 10, 18, 44, 27, 22,
46
.DATA 302                    ;Motor 2 linear compensation
-50000, 50000, 1000, , , , , , ,
6, 30, 16, 7, 0, 9, 26, 26, 34, 17,
43, 24, 34, 34, 19, 20, 39, 26, 43, 50,
0, 20, 23, 46, 45, 46, 30, 34, 5, 28,
8, 33, 9, 0, 45, 27, 30, 32, 9, 45,
5, 13, 40, 1, 8, 1, 10, 5, 43, 38,
45, 25, 46, 19, 11, 23, 49, 33, 2, 43,
5, 10, 8, 19, 34, 35, 30, 43, 19, 18,
17, 46, 24, 34, 10, 39, 23, 24, 49, 19,
35, 1, 50, 40, 29, 29, 32, 39, 42, 8,
18, 30, 49, 23, 40, 14, 11, 7, 14, 40,
22
.END
```

Licenses C

Table C-1. Licenses for V+ Version 11.3

License (part number)	License Name	Functionality	Notes/Compatibility
09961-00001	V+ Operating System	7 user tasks SEE screen editor/DEBUG Alternate velocity profiles Single mechanism support (up to 12 axes) CPU Profiler Utility	Included with all Adept MV controllers Profiler utility is included in base V+ package. *V+Version 11 Extensions* license was required in V+11.0 and 11.1.
09961-00002	V+ Version 11 Extensions	28 user tasks per processor Multiple V+ OS instances (one per processor) Multiple mechanism support (up to 15 mechanisms with up to 24 axes) Fast interrupt handling using INT.EVENT Belt Tracking	No longer enables the use of IOGET and IOPUT. Customers upgrading from V+ 11.0 or 11.1 need *Third-Party Board Support* license. No longer enables the use of ALTER. Customers upgrading from V+ 11.0 or 11.1 need *Enhanced Trajectory Control* license.
09961-00003	OEM Option		For OEM customers only.

Table C-1. Licenses for V+ Version 11.3 (Continued)

License (part number)	License Name	Functionality	Notes/Compatibility
09961-00004	Kinematic Modules	Required for access to the following kinematic modules: • GNT: 5 or 6-axis Gantry • PUM: 6-axis PUMA • SCA: 4 or 5-axis SCARA • CYL: 4-axis cylindrical robot • SC2: secondary SCARA • SC6: 3-link SCARA • T12: 2-axis parallelogram arm • V4R: 4-axis rotary palletizer with 2 linear drives • 2ZT: 6-axis Cartesian with dual Z axes • EXY: 4-axis XYZ-theta • *XZ: XZ* stacker • *CAR: 4-axis Cartesian with J3/4 coupling*	New modules are in italic.
09961-00005	Integrated Motion & Vision	Allows co-existence of AdeptVision VME with Adept Robot or AdeptMotion VME.	Included with AdeptVision VME (Guidance) Previously called *Guidance Vision* license. Enables use of vision (inspection or guidance) with integrated motion. Customers with Inspection Vision applications that require integrated AdeptMotion or Robot should separately purchase the Guidance Vision Package, AIM VisionWare, and licenses.
09961-00006	Vision	Allows use of single or dual AdeptVision VME system	Included with Inspection Vision or Guidance Vision package. Previously called *Inspection Vision* license. Required with any system using AdeptVision

Table C-1. Licenses for V+ Version 11.3 (Continued)

License (part number)	License Name	Functionality	Notes/Compatibility
09961-00007	Enhanced Kinematic Modules	Required for access to the following kinematic modules: • EGN: 5 or 6-axis Gantry • XY4: 7-axis, 4-headed Cartesian • XY3: 8-axis, 3-headed Cartesian • *EPU: 5- or 6-axis PUMA with linear compensation*	New modules are in italic.
09961-00008	AIM	Enables use of basic AIM packages: • AIM MotionWare (no vision) • AIM VisionWare • AIM PCB (no vision)	
09961-00009	AIM Extensions	Allows use of AIM loadable modules: • Vision module for MotionWare • Vision module for PCB	Customers with Inspection Vision applications using VisionWare need this license if using an Adept Robot or AdeptMotion VME. The same licenses are required for AIM versions 2.3 and 3.0.
09961-00010	Adept Robot	Allows use of Adept Robot	Required for all Adept robots
09961-00011	GEM & SECS-I/II Applications	Allows use of AdeptGEM and access to SECS-I/II protocols	Previously *SECS-I Applications* license
09961-00013	Enhanced Trajectory Control	Advanced trajectory-control features: • ALTER instruction • Configurable trajectory rate • Access to the Advanced Servo Library utility	Customers upgrading from V+ 11.0 or 11.1 and using ALTER require this license with their upgrade. Customers upgrading from version 11.2 of the Advanced Servo Library need this license and the Advanced Servo Library media and documentation, part number 90961-03800.

Table C-1. Licenses for V+ Version 11.3 (Continued)

License (part number)	License Name	Functionality	Notes/Compatibility
09961-00014	AdeptTCP/IP Protocol Access	Allows V+ access to TCP/IP protocol	Included with the AdeptNet product
09961-00015	AdeptNFS Client	Allows access to Adept Network File System client protocol.	
09961-00016	AdeptFTP Client/Server	Allows access to Adept File Transfer Protocol server and client utilities	FTP utilities are on the V+11.3 utility disk (FTP_SRVR.V2 & FTP_CLNT.V2)
09961-00017	Multiple Adept Robots	Enables the use of multiple Adept Robots	Currently for Dual Adept 550 robot product ONLY. Dual Adept 550 system also requires the V+ *Version 11 Extension* license to enable multiple mechanism support.
09961-00018	Third-Party Board Support	Activates the use of V+ features for support of third-party boards including: • IOGET, IOPUT • DEF.DIO	Customers upgrading from V+ 11.0 or 11.1 and using third-party boards require this license with their upgrade. One *Third-Party Board Support* license activates use of all third-party boards in the chassis.
09961-00019	EN954 Safety Category 1	Enables EN954 Safety Category 1 features	New with V+ 11.3 Requires new Category 1 VFP Front Panel
09961-00020	EN954 Safety Category 3	Enables EN954 Safety Category 3 features	New with V+ 11.3 Requires new Category 3 VFP Security Panel

Part 3

Notes for V+ Version 11.2

This section incorporates text from the original *V+ Version 11.2 Release Notes* but drops much of the material that has already been transferred to subsequent manuals.

Enhancements to the V+ Operating System and Language Version 11.2

6

This chapter discusses version 11.2 enhancements to the V+ Operating System and Language first by general enhancements and then by enhancements specific to systems or products.

6.1 General Enhancements

Single Boot Disk

Information for General Users

With V+ version 11.2, all the system configurations listed below can be booted from the same system disk. That ability can simplify your operations if you have different types of Adept systems.

- Non-robot system
- System with an AdeptOne-MV robot
- System with an AdeptThree-MV robot
- System with an Adept 550 robot
- System with two Adept 550 robots

Note, however, that the V+ system configuration data is stored on the system disk. Thus, the same configuration data is used by all the different systems that boot from the same system disk.

Information for Advanced Users

Boot-time self configuration of Adept robot systems is achieved by having the V+ system access robot-specific information in the Robot Signature Card (RSC) located in the base of your Adept robot. The V+ system knows to do that when the V+ configuration data contains a statement in the .ROBOT section with the following form:

```
ROBOT 1 = "/MODULE -1"
```

The special module ID number –1 tells the V+ system to access the robot RSC to determine the type of robot connected to the system. The Adept system functions correctly if the configuration data contains an actual robot module ID instead of this special value. That could happen, for example, when you modify the configuration of your V+ system to control additional robot devices with AdeptMotion VME.

The actual robot module ID numbers for the Adept robots are as follows:

AdeptOne-MV robot	1
AdeptThree-MV robot	1
Adept 550 robot	6

New CD Monitor Command

The new CD monitor command has been added as a convenience for changing the default disk and/or directory path to be accessed by the V+ system. Now, instead of typing **default disk=***path* to set a new default disk directory path, you can simply type **cd** *path***.** See the new dictionary page for CD in Appendix D for more information.

Enhanced DEBUG command

The DEBUG monitor command has been enhanced to accept an optional program step number. The new syntax for the command is as follows:

DEBUG *task program, step*

If the step number is specified, that program step is displayed when the program is opened.

Enhanced SEE Command

The SEE monitor command has been enhanced to accept an optional program step number. The new syntax for the command is as follows:

SEE *program, step*

If the step number is specified, when the program is opened, that program step is displayed with the cursor positioned on it.

6.2 General Motion Enhancements

New Calibration System

The internal implementation of the CALIBRATE program instruction and monitor command has been changed. Calibration is now implemented using a V+ program instead of being hard-coded in the V+ system. For most users the change is not noticeable. The new method allows system customizers to change the calibration sequence for a custom mechanism.

As described below, the syntax and usage of the CALIBRATE monitor command and program instruction have been changed. However, the changes do not affect most system users except that you may notice the following difference:

- When you issue the CALIBRATE program instruction and monitor command, the disk drive LED comes on briefly as the calibration routines and utility are automatically loaded from disk. Also, on the VFP front panel, the blue program-running light comes on.
- An error results if the calibration files cannot be found. (The following directories are accessed to locate the files: the current default directory, \CALIB\ on the disk drive from which the V+ system was booted, and C:\CALIB\.)
- The CALIBRATE command cannot be used when task 0 is in use.
- The CALIBRATE program instruction can no longer be executed by the DO monitor command.

The calibration sequence for Adept robots is protected and cannot be changed by users. AdeptMotion users may customize the calibration routine; however most users do not need to customize the routine.

The following error messages have been added to support the new CALIBRATE command and instruction:

- *Calibration program not loaded*
- *Can't find calibration program file*

The operation of the NOT.CALIBRATED system parameter has been modified. Formerly, this parameter value could be modified only when robot power was disabled. Now, this parameter value can be changed at any time. However, the following rules describe how the new asserted value is treated:

1. If the new value asserts that a robot is not calibrated, the V+ system acts as if the robot is not calibrated whether or not the servo software believes that the robot is not calibrated.
2. If the new value asserts that a robot is calibrated, the servo software is checked and V+ tracks the calibrated/not calibrated state indicated by the servo software.

Change to the CALIBRATE Monitor Command

A new, optional parameter has been added to the CALIBRATE monitor command to control the calibration process. Normally this parameter does not need to be specified. See the dictionary page for the CALIBRATE monitor command in Appendix D for details.

EXECUTE/C Monitor Command and Program Instruction

An optional qualifier,/C, has been added to the EXECUTE monitor command and program instruction as in

```
EXECUTE/C ....
```

The /C qualifier is relevant only when starting the execution of Task 0. When specified with Task 0, EXECUTE/C conditionally attaches the selected robot. As in previous versions of V+, when /C is not specified, EXECUTE fails if the robot cannot be attached. In order to attach the robot, the robot must be calibrated and power must be enabled (or the DRY.RUN switch must be enabled). When /C is specified, EXECUTE attaches the robot if the robot can be attached. Otherwise the robot is not attached, and no error is signaled.

Parameters for S-Curve Trajectories

The default S-curve profile number is 0, not 1 as printed in the *V+ Version 11.1 Release Notes*. AdeptMotion VME users can use the SPEC.V2 utility to define S-curve parameters. S-curve parameters are predefined for Adept robots. Refer to the user's guide for your robot for a complete table of S-curve definitions.

New Algorithm for Tolerance Checking

The servo code for the AdeptOne-MV, AdeptThree-MV, and the AdeptMotion VME products incorporates a new end-of-motion tolerance checking algorithm. The new algorithm is more robust and accurate, giving improved indication of the end of a robot motion after a motion break with FINE nulling.[1]

You may experience longer delays at the ends of motions due to this new algorithm. This will be especially apparent with motions using the default nulling tolerance selection FINE. In order to gain performance comparable to older Multibus-controlled robots and mechanisms, you may wish to consider raising the FINE nulling tolerance by 50% coding the instruction

```
FINE 150 ALWAYS
```

at the beginning of your robot program. Alternatively, you can change the default values for the FINE tolerance using the SPEC utility.

6.3 Changes Specific to Adept Robot Systems

This section applies the AdeptOne-MV and AdeptThree-MV robots.

New Digital I/O Signals

New digital I/O signals 3001 to 3008 are output bits for the currently selected Adept robot. A new argument, 3, for the IO monitor command displays the 3000 series of I/O signals.

[1] A motion break occurs when the V+ BREAK instruction is used explicitly after a motion instruction, when Continuous Path mode is disabled with the CP switch or CPOFF instruction, or when some other instruction that breaks continuous path is executed.

NOTE: The control pendant does *not* display the 3000 series of I/O signals.

It is necessary to use the SELECT ROBOT command/instruction to select the proper robot before accessing the signals or using the IO 3 monitor command. If there is no such robot or no Robot Signature Card (RSC) for that robot, attempts to set these bits are ignored, and the bits always read as set to 0.

The old default signals and their corresponding new ones are as follows:

Signal number in V+ 10.x	Signal number in V+ 11.2	Meaning
2030	3001	Activate hand solenoid #2
2031	3002	Activate hand solenoid #1
2025	3003	Activate spare solenoid driver #1
2026	3004	Activate spare solenoid driver #2

SIG.INS always returns TRUE for these bits.

You can use the SPEC.V2 utility to change the output signals for the grippers. For details refer to the manual titled *Instructions for Adept Utility Programs*.

The special treatment of soft signals 2025 through 2032 has been removed. They are now implemented as ordinary soft signals. (Formerly signal 2032 controlled the brake-release solenoid. A DEVICE instruction now performs that function.)

Enhancements to the ID Monitor Command and Real-Valued Function

A second 16-bit robot option word has been added to the Adept system. The ID monitor command (and the Manual Control Pendant display) has been enhanced to display the new robot option word (*opt2* below):

```
Robot n:  model-serial opt1-opt2 module_id
```

The ID real-valued function has been enhanced so that ID(11,8) and ID(11,10+*robot*) return the second option word for the selected and specified robot, respectively.

The following bits are currently defined in the new second robot option word:

Bit	Mask	Interpretation if set
1	1	Adept robot with an RSC
2	2	Robot has an extended-length quill.
3	4	Robot has the cleanroom option.
4	8	Robot has the HyperDrive option.

The ID function has been enhanced so that ID(12,8) and ID(12,10+*robot*) return a flag-bits word containing information for the specified robot module. Currently, only bit 1 (mask 1) is defined. If set, this bit indicates that the specified robot is an Adept robot.

Changes to the SCA Robot Module

The module ID for the general SCARA module has been changed from 6 to 24, and all of the SPEC data in the module has been set to standard default values rather than reflecting the values required for the Adept 550 robot. When SPEC data for an old general SCARA module is loaded into a new module, the change in the module ID causes a warning message to be displayed, but the SPEC data can be successfully loaded by continuing the operation. (Previously, the same robot module was used for the Adept 550, Adept 1850, and Adept 1850XP robots. Those robots are now controlled by their own specific modules. The current module IDs for those Adept robots are 6, 25, and 25, respectively.)

6.4 Changes Specific to the AdeptMotion VME Product

Customizing the Calibration Routine

The following information is required only if you need to customize the calibration sequence. Most AdeptMotion users do not need to do this.

When a CALIBRATE command or instruction is processed, the V+ system loads the file CAL_UTIL.V2 (see the dictionary page for the CALIBRATE command for details) and executes a program contained in that file. The main calibration program then examines the SPEC data for the robot to determine the name of the disk file that contains the specific calibration program for the current robot, and the name of that program.

The standard routine used for AdeptMotion devices is stored on the system disk in \CALIB\STANDARD.CAL (and the routine is named **a.standard.cal**). That file is protected and thus cannot be viewed. However, a read-only copy of the file is provided, in \CALIB\STANDARD.V2, as a basis for developing a custom calibration routine that can then be substituted for the standard file. (The name of the robot-specific calibration file and program can be changed using the SPEC utility program.)

Enhancement to the JTS Robot Module

For systems that use the JTS (joints) robot module to control continuous-turn joints, the new UNIDIRECT program instruction can be used to control the behavior of the joint when it reaches its roll-over value. See the new dictionary page for the UNIDIRECT instruction in Appendix D for details.

Enhancements to the PUMA Robot Module

The PUMA robot module has been enhanced to support both 5- and 6-axis robots. The 5-axis robot can be thought of as a 6-axis robot with joint 4 always positioned at 0 degrees (and joints 5 & 6 renumbered to 4 and 5). The following changes have been made in connection with supporting 5-axis PUMA robots:

- The title of the default robot module has been changed to "5/6-Axis PUMA Robot Module."
- The number of joints can now be either 5 or 6.
- For 6-axis robots, there is a 2x2 coupling matrix for the encoder-to-motor scaling factors for joints 2 and 3, and a 3x3 matrix for joints 4, 5, and 6. For 5-axis robots, there is a 2x2 coupling matrix for the encoder-to-motor scaling factors for joints 2 and 3, and a 2x2 matrix for joints 4 and 5.
- For 5-axis robots, the FLIP and NOFLIP configuration instructions are ignored because the robot's tool orientation implicitly specifies the FLIP or NOFLIP state.
- The 5-axis PUMA module supports all other features of the 6-axis version, such as extended joint-1 travel, applicability of the OVERLAP/NOOVERLAP test, and link shoulder offsets.

Changes to the SPEC Utility

Changes for the T12 Robot Module

The link parameters necessary for the T12 robot module have been modified. Formerly, in addition to the four parameters that the operator could edit, four parameters were automatically computed and stored by SPEC. Now the V+ system computes these additional four values. For backwards compatibility, the same number of link dimension values are read from the SPEC data file, but the values of the computed elements are ignored.

> **NOTE:** You can use old data files on a new module; however, a SPEC data file created by a new system cannot be used on an old robot module.

Modified ROBOT.OPR Instruction

The ROBOT.OPR instruction has been enhanced with a new mode for the XY3Z3T robot module. Formerly, this instruction was only used to select the primary and slaved axes. The new mode is used to define position offset values that are added to the commanded Z and RZ positions for each slave axis. The syntax for the new mode is as follows:

```
ROBOT.OPR (1) Z_slave1, RZ_slave1, Z_slave2, RZ_slave2
```

Any unspecified offset values at the end of the list are assumed to be 0. As with the old form of this instruction, the following requirements apply to this new mode:

- Executing ROBOT.OPR (1) breaks CP motion.
- The application code must guarantee that the slave axes are correctly positioned relative to the master (taking into consideration the specified offsets) at the time the ROBOT.OPR instruction is executed to select any slaved axis. This is required to ensure that the slave joints do not suddenly jump if the ROBOT.OPR instruction is followed by a straight-line motion. (If the ROBOT.OPR instruction is followed by a joint-interpolated motion, the motion automatically corrects any errors in relative position and no jump occurs.)

As a safety precaution, ROBOT.OPR (1) cancels the selection of any slaved axes. Consequently, after ROBOT.OPR (1) is executed, ROBOT.OPR () must be executed to select the desired slave axes.

The offset values specified by ROBOT.OPR (1) stay in effect until another ROBOT.OPR (1) instruction is executed.

6.5 Enhancements for the AdeptVision Product

The following enhancements for the AdeptVision product were made in version 11.2:

- Changed the initial position of the vision window from the center of the screen to the upper-right corner of the screen.
- The DEVICE instruction (with the command parameter set to 1) now re-enables menu events.
- Expanded the V.MAX.TIME limit for correlation to include levels 0 and 1. It was also changed it so that a value of 0 means that there is no time limit.

New and Modified Keywords D

This appendix details the new and modified keywords for V+ version 11.2. Pages that have partial information about keywords altered or enhanced in this version have the sentence "THIS IS A SUPPLEMENTAL PAGE" printed at the top. Place copies of such pages with the primary pages for their keywords in the binders for your *V+ Operating System Reference Guide*. Do *not* discard the primary pages for such keywords. A later V+ release will contain new primary pages that combine the primary and supplemental information.

Syntax

CALIBRATE *mode*

Usage Considerations

Normally the command is issued with no mode specified.

Parameter

mode An optional real value, variable, or expression that indicates what part of the calibration process is to be performed:

Value of *mode*	Interpretation
0 (or omitted)	Optionally load the calibration program, execute the calibration program (with load, execute, delete, and monitor flags set), and delete the calibration program if it was loaded.
1	Optionally load the calibration program, and execute the calibration program (with load and monitor flags set).
2	Execute the calibration program (with execute and monitor flags set).
3	Execute the calibration program (with delete and monitor flags set), and then delete the calibration program.

Details

The CALIBRATE command loads the disk file CAL_UTIL.V2. For convenience, the loading operation searches for the file in the following directories in the following order: (1) the default directory, (2) \CALIB\ on the disk drive from which the V+ system was booted, and (3) C:\CALIB\.

CALIBRATE always tries to load the user calibration program and determine the proper load path even if your program is already in memory, in case your program needs to load other files from the disk.

The calibration program is executed in task 0. If task 0 is already active, the CALIBRATE command fails.

Syntax

CD *path*

Function

Display or change the default path for the disk directory.

Parameter

path	Optional string specifying the disk-directory path of interest. Normally this parameter contains file names and backslash (\) characters. For disk devices, the V+ system adds a backslash if one is not included at the end of a path specification.

Details

This command is a synonym for typing **default disk =**. Refer to the DEFAULT command for information about specifying the path for a disk directory.

Examples

To display the default path:

- Type **cd**

To change the default path to C:\TEST\JOBS\:

- Type **cd c:\test\jobs**

Related Keyword

DEFAULT (monitor command)

Part 4

Notes for V+ Version 11.1

This section incorporates text from the original *V+ Version 11.1 Release Notes* but drops much of the material that has already been transferred to subsequent manuals.

7 Manual Updates

This chapter summarizes new information that is not in the V+ version 11.0, Rev. A manuals.

7.1 V+ Language User's Guide

Inter-Processor Communication on the VMEbus

"Multiple-Processor Systems" on page 145 discusses inter-processor and inter-system communication on the VMEbus.

S-Curve Trajectory Generation

Robot moves can now follow an "S-Curve" speed profile as well as the traditional trapezoidal speed profile. See "S-Curve Trajectory Generation" on page 169.

Changes in Floating-Point Implementation

On older Adept systems, floating-point calculations were implemented in software, using the "Motorola Fast Floating Point" representation. On the Adept MV controllers, floating-point calculations are generated by either the 68882 coprocessor or the 68040, which use the IEEE floating-point format.

In some cases, programs written for V/V+ 10.x and earlier will not work identically on an MV system. In the code below, for example, the loop executes seven times on an older system, but only six times on an MV system.

```
lo = 100
hi = 300
FOR i = lo TO hi STEP (hi-lo)/6
     ...
END
```

This difference is caused by the floating-point representation for 200/6, which happens on 10.x and older systems to be slightly smaller than the exact value, but slightly larger on the MV systems.

Writing code that depends on the floating-point representation is always a dangerous practice. A much more robust loop is:

```
lo = 100
hi = 300
step = (hi-lo)/6
FOR j = 0 to 6
     i = lo+j*step
     ...
END
```

7.2 V+ Language Reference Guide

For details, refer to the *V+ Language Reference Guide*.

7.3 Instructions for Adept Utility Programs

For details, refer to *Instructions for Adept Utility Programs*.

Changes to V+: 10.x to 11.0 8

This chapter summarizes the new features in V+ version 11.0. Detailed descriptions of each change can be found in the cross-references provided.

Note that all AIM applications running on V+ version 11.0 (or 11.1) require AIM version 2.3.

8.1 Summary of Changes

General System-Level Additions

1. The system processor now has a battery-backed clock and calendar (TIME monitor command and program instruction).
    1. High-density (1.44Mb) floppy disks are now supported (IBM compatible). 5-1/4" floppy disks are no longer supported (FORMAT monitor command).
    2. Seven tasks (0-6) are standard. Twenty-eight tasks are available with the V+ Extensions license.
    3. A CPU activity profiler for 28 task systems is available with the V+ Extensions license (PROFILER.V2 utility).
    4. A "Software License" feature has been added, whereby software options are stored in each controller. Software options are enabled at the factory if the license is ordered with the system. Software option upgrades can be user-installed using the INSTALL command and an Adept-supplied password (printed on the software license document).
    5. Multiple processors is an option. Auxiliary processors can be configured to off-load vision or servo processing, or to add additional V+ runtime environments (requires V+ Extensions license).
    6. Task priority is now determined by a task/time-slice matrix (CONFIG_C.V2 utility, EXECUTE program instruction, PRIME monitor command). See "User Task Configuration" in the *V+ Language User's Guide* for details.
    7. The AdeptMotion tuning program (SPEC.V2) can now save plot files in the "TIFF" format.
    8. The vision system functionality has been enhanced.
    9. The standard pointer interface is now a two-button mouse (although the three-button mouse is still supported). For a two-button mouse:

- The left button returns the same event as the middle button on a three-button mouse.

- The right button returns the same event as the right button on a three-button mouse.
- A left-button event cannot be returned by a two-button mouse.

When using the trackball on the Adept keyboard:

- The upper-left button returns the same event as the left button on a two-button mouse.
- The upper-right button returns the same event as the right button on a two button mouse.
- The lower-left button locks the left button on/off.
- The lower-right button does not return an event.

1. The V+ major cycle is now divided into 16 equal 1ms time slices.

General Programming Language Additions

1. The "V" version of the language has been discontinued. All systems have V+ as standard. The V+ Extensions license is required for a system to support the following features:
   Multiple mechanisms (more than one robot)
   Belt tracking
   CPU Profiler
   Fast Digital I/O interrupts
   28 V+ tasks
   Third-party board support
   Multiple V+ systems
   ALTER instruction
2. Standard instructions for reading/writing to qualified third-party VMEbus boards have been added.
3. "S-Curve" acceleration and deceleration profiles may now be defined. Previously, only the duration of the acceleration and deceleration phases of a motion could be changed. Now the maximum rate of change during acceleration, as well as the maximum acceleration reached, can be specified.
4. Motion acceleration is now decoupled from motion speed (if the SCALE.ACCEL switch is off).
5. The SPEED monitor command no longer affects the path. See the "SPEED Monitor Command" on page 173 for more details.
6. Some system timers are now updated every 1ms rather than every 2ms. Therefore, they are more precise, but they begin to lose accuracy more quickly.
7. The new ALTER program instruction allows you to specify the magnitude of the real-time path modification that is to be applied to the robot path during the next trajectory computation.
8. Double-precision real-valued variables are now supported.
9. An explicit GLOBAL declaration is now available.
10. You can now print by FCOPYing from a disk to a serial port.
11. Tasks are not allocated stack memory until they are actually used.

12. Six belt encoders are now supported (requires V+ Extensions license).

Command Line

1. Up to 20 monitor commands are now stored in a history buffer. (To prevent line wrapping, each command in the history buffer is limited to the first 78 characters entered.) These commands can be recalled with the cursor keys, edited, and re-executed.

13. On A-Series systems, menu selections can be made without using the trackball or mouse. Alt+5 displays the first pull-down menu. Subsequent Alt+5s display the next available pull-down menu. The cursor keys cycle through the menus and menu items. The Enter key makes a selection.

Digital I/O

The digital 64-channel I/O boards in the Adept MV controllers are self-sensing and do not need to be configured with the CONFIG_C utility. Input and output signal numbers are no longer exclusive—for example, you can use both signal 25 and signal 1025. Each board has two selectable output voltage ranges. For details, see the *V+ Language User's Guide*.

Analog I/O

The Adept MV controller supports 16 differential or 32 single-ended inputs per analog I/O board, and 4 outputs per board. For details, see the *Adept MV Controller User's Guide*.

8.2 Changes to Monitor Commands

See the *V+ Operating System Reference Guide* for details.

New Commands

FSET	Monitor Command	Set or modify attributes of the monitor window or a serial line.
INSTALL	Monitor Command	Install or remove a system option, using software license password.

Altered Commands

These commands are generally backward compatible with the 10.X syntax.

DIRECTORY	Monitor Command	DIRECTORY –1 lists only non-executable programs. (See page 132 for the changes in V+ 11.1)
EXECUTE	Monitor Command	Now accepts a priority argument based on the task matrix.
FCOPY	Monitor Command	Can now redirect output to a serial line. (See page 133 for the changes in V+ 11.1)

FORMAT	Monitor Command	Accepts new qualifier "J" for high density formatting. The 5-1/4" disk options are removed. (See page 133 for the changes in V+ 11.1)
ID	Monitor Command	Returns additional information.
IO	Monitor Command	Displays soft signals only when specifically requested.
LOAD	Monitor Command	Allows qualifier switch "/Q" to suppress monitor output of loading file names. Reports errors if lines are too long. (See page 134 for the changes in V+ 11.1)
PASSTHRU	Monitor Command	Now accepts device names.
PRIME	Monitor Command	Now accepts a priority argument based on the task matrix.
SELECT	Monitor Command	Now accepts VISION and FORCE as optional arguments.
SPEED	Monitor Command	Now limited to 100%. Does not alter path of robot, unlike SPEED program instruction. Takes effect immediately.
STATUS	Monitor Command	MAX SIZE now shows the stack space requested by a CALL that failed due to insufficient stack space.
SSTEP	Monitor Command	Now accepts a priority argument based on the task matrix.
XSTEP	Monitor Command	Now accepts a priority argument based on the task matrix.
ZERO	Monitor Command	Is more selective in what memory is zeroed.

8.3 Changes to V+ Programming Keywords

See the *V+ Language Reference Guide* for details.

8.4 Compatibility Issues

The following changed instructions and functions may cause compatibility problems when upgrading pre-11.0 code. All other changed instructions are backward compatible.

See Chapter 9 for changes in AdeptVision instructions and functions.

ACCEL	No longer automatically scales with SPEED. If your pre-11.0 code used speeds in excess of 100, you may need to increase ACCEL to match. (ACCEL may now exceed 100 percent.) See "ACCEL Program Instruction" on page 171 for details.
ADC AIO DAC	Replaced by AIO.IN, AIO.INS, and AIO.OUT. See "Analog I/O" on page 103.
EXECUTE PRIME SSTEP XSTEP	These instructions now accept a priority argument based on the task matrix. They are incompatible only if the priority argument is used.
FORCE	Replaced by FORCE.FRAME, FORCE.MODE, FORCE.OFFSET, and FORCE.READ (see the *AdeptForce VME User's Guide*).
FOR ... END	Loop counter comparison is now made with double-precision. Rounding errors with single-precision variables or expressions may change loop execution. See "Changes in Floating-Point Implementation" on page 89.
IF ... GOTO GOTO	V+ now checks for undefined IF ... GOTO and GOTO labels when programs are loaded or edited. If a label is undefined, the program is not executable. Thus, programs that previously executed despite undefined labels will no longer work.
FCMND	No longer is used to configure serial lines (see FSET)
$INT	Removed, identical to $INTB.
PCABORT PCEND PCEXECUTE PCKILL	The "PC" instructions have been removed. The difference between robot and process control tasks was eliminated in version 10.0. (These instructions were retained in 10.x for compatibility only.)
SPEED	No longer affects acceleration. (See the "SPEED Monitor Command" on page 173 for more details.)

Changes to AdeptVision:10.x to 11.0 9

This chapter summarizes the major changes that took place from version 10.x vision systems to version 11.0 systems.

For complete details, see the *AdeptVision VME User's Guide* and the *AdeptVision Reference Guide*.

9.1 Image Region Changes

The default image size has increased from 512x484 to 640x480 pixels.

The physical frame stores can now be divided into virtual frame buffers that are 256x240, 320x240, 512x480, or 640x480 pixels. This effectively increases the number of images you can acquire and hold at one time. CONFIG_C can be used to set the default. New arguments to the DEVICE instruction allow you to specify the size of your virtual frame buffers.

An "area of interest" (AOI) concept has been introduced that will allow you to define image processing regions independent of a vision tool instruction. Multiple tools can use the same area of interest definition. The area of interest definition is independent of the virtual frame buffer so it can be combined with different virtual frame buffers to place vision tools relative to different frame buffers. This feature will make it easier to define vision tools, move groups of vision tools, and place part-relative tools. The new instruction VDEF.AOI defines an area of interest. Additionally, all image processing functions can now have separate source and destination AOIs, within different frames.

New instructions have been added that allow you to define a transformation that will transform all tools placed within the vision window. For example, if you want all tools to be relative to a part frame, a transformation can easily be defined that will move all tools this way. The new instruction VDEF.TRANS defines (or disables) the transformation. The new instruction VGET.TRANS returns the value of the vision transformation currently defined.

The vision hardware now has a display frame store in addition to the two physical frame stores. Live video is no longer destructive to the frame stores because of this separate display frame store.

9.2 New Vision Tool Features

The processing speed of VEDGE, VTHRESHOLD, VCONVOLVE, VCOPY, VADD, VCORRELATE, VSUBTRACT, VMORPH, and VWINDOWI (orthogonal AOIs only) operations has been increased significantly.

VMORPH, VEDGE, VTHRESHOLD, VCONVOLVE, VCOPY, VADD, and VSUBTRACT can be submitted for execution without vision being idle (like a ruler).

VCONVOLVE The performance of CONVOLVE has been improved. The default convolutions have been improved.

VCORRELATE A hierarchical search option has been added to the VCORRELATE instruction. This option makes correlation operations much faster and effective by identifying the areas most likely to produce a match and concentrating the search in those areas.

VDISPLAY Zoom, pan, and scroll features have been added to the VDISPLAY instruction.

VFEATURE Additional items have been added to the VFEATURE array.

VGETCAL and VPUTCAL These commands can now associate a field-of-view to robot ("to.cam") transformation with a calibration.

VRULERI Two new features have been added.

This instruction now allows you to indicate the desired edge color (light-to-dark, or dark-to-light, or both).

There is a new type value, type #3, which is similar to type #2 (fine-edge). This type of ruler, which we call "fine-pitch", detects grayscale edges with sub-pixel resolution, just like type #2. However, the edge-detection algorithm has been altered to allow it to perform better in situations where the edges are tightly spaced, such as detecting leads of fine-pitch electronic components. These new rulers are not as robust, however, when the ruler is cast at a skewed angle with respect to the edges it is meant to detect.

VSELECT VSELECT has a new argument that can select a frame store to be invalidated, making it available as scratch frame storage for use by templates.

VTRAIN VTRAIN has new modes. Certain prototype attributes such as effort level and camera associations can be changed directly from a V+ program. Picture taking can be suppressed.

VWAIT VWAIT can now: Wait for the vision system to become idle (the default); wait for the acquire into frame "aoi" to complete; or wait for the acquire into frame "aoi" to start.

VWINDOWB The new VWINDOWB instruction computes the following blob statistics: centroid, area, bounding box, and perimeter. (This hardware operation is fast and its speed is independent of the complexity of the scene.)

9.3 General Performance Enhancements

The speed of edge-based prototype recognition has been improved significantly.

Two standard vision systems can be installed in a single controller.

Other New Features

Asynchronous shuttered cameras and non-interlaced cameras at speeds up to 60 frames per second are now supported for certain cameras.

The memory allocation for many of the vision data structures can now be configured with either the CONFIG_C.V2 utility program or the DEVICE instruction.

9.4 Compatibility Issues

This section summarizes the changes that may create incompatibilities between version 10.x and version 11.0 vision systems.

The maximum value for V.LAST.LINE is now 480 instead of 484.

The system parameters V.FIRST.COL, V.LAST.COL, V.FIRST.LINE, and V.LAST.LINE are no longer used as a clipping window for VOCR.

V.FIRST.COL, etc. no longer define the AOI for the following instructions: VADD, VAUTOTHR, VCOPY, VCONVOLVE, VEDGE, VHISTOGRAM, VMORPH, VSUBTRACT, and VTHRESHOLD. V.FIRST.COL, etc. are now used only with VPICTURE and VWINDOW.

On controllers with only one processor, vision tool graphics require more processor time than before. This heavily impacts AIM VisionWare execution when you select the "Runtime Graphics" pulldown at runtime.

The "type" argument to VGETPIC and VPUTPIC has values of 1 and 2 only. Types 3 and 4 are now disabled. Also, VPUTPIC now strips the binary out of averaged images. Type #0 stores both grayscale and binary. Maximum width which may be VGETPIC'd is 512 in grayscale mode.

Default value of V.OFFSET is 255 instead of 127.

The standard vision system now accepts 4 cameras instead of 8 (the maximum physical camera number is now 4 instead of 8).

VCONVOLVE on the standard system is now limited to 3x3 convolutions. Custom convolutions must now be centered in a 7x7 array with zeros in the unused elements.

The calibration array for VPUTCAL and VGETCAL is now different. Backwards compatibility has been maintained for VGETCAL, but not for VPUTCAL. Six new elements have been added, of which three are currently used. Most importantly, some key old elements are now ignored and their values computed from the new values for the sake of VGETCAL compatibility. VPUTCAL reads cal[15] and cal[16] as mm/pixel in the X and Y directions, respectively, and computes cal[4], cal[12], and cal[14] (the former y.scale and xy.ratio values). Also, cal[17] must now be set to 1 if using a Panasonic CD-40 camera (to avoid a black band on the left of image).

VPUTCAL is no longer allowed when the vision system is busy. You must first do a VWAIT.

VLOAD will not load pre-11.0 files.

Summary of Incompatible Syntaxes

The syntax of most version 10.x instructions is backward compatible. The most notable exceptions are the finders. These have a new shape argument immediately following the "=" for consistency with the other instructions. The syntax forms that are incompatible are:

Old:VADD (type) dest_frame = src1_frame, src2_frame
New:VADD (cam, type, dmode) dest_ibr = src1_ibr, srd2_ibr

Old:VCONVOLVE (type) dest_frame = src_frame
New:VCONVOLVE (cam, type, dmode) dest_ibr = src_ibr

Old:VEDGE (type, thresh) frame
New:VEDGE (cam, type, dmode) dest_ibr = src_ibr

Old: VFIND.ARC (cam, mode, dmode, effort, type) data[ ] = xc, yc, r, rr, ang0, angn
New:VFIND.ARC (cam, mode, dmode, effort, type) data[ ] = {1}, xc, yc, r, rr, ang0, angn
New:VFIND.ARC (cam, mode, dmode, effort, type) data[ ] = ibr

Old:VFIND.LINE (cam, pos, dmode, effort, type) data[ ] = xc, yc, len, wid, ang
New:VFIND.LINE (cam, pos, dmode, effort, type) data[i] = {1}, xc, yc, len, wid, ang
New:VFIND.LINE (cam, pos, dmode, effort, type) data[ ] = ibr

Old:VFIND.POINT (cam, pos, dmode, effort, type) data[ ] = xc, yc, len, wid, ang
New:VFIND.POINT (cam, pos, dmode, effort, type) data[i] = {1}, xc, yc, len, wid, ang
New:VFIND.POINT (cam, pos, dmode, effort, type) data[ ] = ibr

Old:VMORPH (type) frame
New:VMORPH (cam, type, dmode, thresh) dest_ibr, count = src_ibr

Old:VSUBTRACT (type) dest_frame = src1_frame, src2_frame
New:VSUBTRACT (cam, type, dmode) dest_ibr = src1_ibr, src2_ibr

Old:VTHRESHOLD (type, thr1, thr2) frame
NewVTHRESHOLD (cam, type, dmode) dest_ibr = src_ibr

Spelling Correction, V.SYNC.STROBE

The V.SYNC.STROBE system parameter was misspelled the Version 10.3 Rev A and Version 11.0 Rev P1 *AdeptVision Reference Guides*. It had an H after the C that was incorrect. You should use the spelling that is shown here: V.SYNC.STROBE (**not** V.SYNCH.STROBE). V+ programs with the incorrect spelling will not load. The spelling has been corrected in the *AdeptVision Reference Guide*, Version 11.0 Rev A.

Changes to AdeptMotion: 10.x to 11.0 10

This chapter is applicable only to users of AdeptMotion VME.

10.1 Changes to AdeptMotion Servo Parameters

Changes to Loop Gain

The Integral Gain loop has been changed so that the Max Integrated Value is now specified in torque units instead of motor counts.

The Proportional Gain parameter has been redefined. It is now specified in terms of DC gain, and is therefore unaffected by changes in pole and zero. (The 10.4 version of SPEC had an option to automatically recalculate the proportional gain after changing Pole and Zero. This program option is no longer required, and has been eliminated.)

Split-axis modules (EXY, EGN, etc.): The Velocity Feedforward Gain loop has been simplified. The 1/256 factor has been eliminated. The user-specified scale factor has also been eliminated from the Skew-Error Gain loop.

Changes to Drive Enable Sequence

The servo software now posts the Drive Enable to V^+ as soon as the Drive Fault signal is clear, even if the fault delay (user-configurable on the VMI) is still active. Subsequent drive faults will still be immediately reported to V^+ even if the fault delay is active. This means the time between enabling the drive and servoing the axis is controlled by the amplifier removing its drive fault, and not by the length of the fault delay. The reason for this change is to minimize the time that the amplifier is enabled before V^+ is able to send servo commands to the amplifier.

Changes to Processing of Error *Duty Cycle Exceeded*

The "averaging" torque calculation previously used has been replaced with an average torque-squared calculation. The servo code now posts everything internally as squares, and maintains backward compatibility by squaring the maximum value upon input. The change is backward compatible in the sense that the inputs have the same units as before. The limit is now a limit of RMS torque, not average torque. The RMS DAC value must be greater than the limit, not greater or equal, to cause a trip.

The new calculation method makes the system more sensitive to certain types of overload. In some cases, the user may need to adjust the value of the Duty Cycle Exceeded DAC Limit parameter to prevent unwanted error messages.

Duty-cycle Exceeded DAC Limit

The description in the User Guide will be updated to say "...during operation the DAC output is squared and averaged over time. If the square root of this average ever exceeds the value of this parameter, a *Duty-cycle exceeded* error is generated and high power disabled. For systems in which the DAC output is proportional to current in the motor, this parameter allows the user to control the amount of power due to I^2R losses dissipated in the motor. Typically, this value is set to 66% of the maximum DAC output, and it can be disabled by setting it to zero."

Duty-cycle exceeded Filter Parameter

The description in the User Guide will be updated to say "...through which the square of the DAC output is fed..." and "By filtering the square of the DAC output,..."

User-Selectable Servo Rate

The servo loop rate may be set to either 500Hz or 1000Hz. The default, 1000Hz, is recommended for most applications. Using 500Hz reduces the processor workload. The rate is configured using the CONFIG_C program.

Changes to Calibration Parameters

Calibration speeds now need to be specified in units of counts/millisecond, instead of counts/second.

Several new parameters have been added to the calibration sequence. See the *AdeptMotion User's Guide* for details.

10.2 Changes to Device Modules

Device Module Distribution and Licenses

The Device Module files are now distributed on the V^+ system disk, in the \SYSTEM\ subdirectory. You no longer need to obtain a separate disk for each module that you want to use. As in 10.x, you use DM_UTIL and SPEC to install and configure the modules that you need. However, you can only use modules for which you have purchased a Software License. The XYZ and JTS modules continue to be available to all AdeptMotion users without the purchase of additional licenses. Other modules are enabled by either the "Kinematics License" or the "Enhanced Kinematics License". If you install a module for which you do not have a license, an "*Option not installed*" message is displayed when the system is booted.

Device Module Documentation

Documentation for the XYZ, JTS, and Encoder Device Modules is in the *AdeptMotion VME User's Guide.* Documentation for all other device modules is available on request.

Changes to PUMA Device Module (ID=14)

As a result of customer requests, several enhancements have been made to the V+ version 11.0 PUMA module. The ID and module names are unchanged (ID=14, Name=PUM). The changes are as follows:

1. The kinematic model has been enhanced to allow an offset (a1) between the axis of joint 1 and the axis of joint 2. When the shoulder is moved forward, a1 is a positive number. That is, when joint 1 is at its zero position, if the shoulder is shifted along the positive world X axis, a1 will be a positive number.

   For "standard" PUMA-style robots (for example, the 560, 760, and RX-90), the value of a1 should be zero (0).

2. A new general facility has been added to V+ that eliminates the need for the user to input dependent (computed) link dimensions via SPEC. For example, formerly, S2+S3 and $(S2+S3)^2$ had to be defined via SPEC. Now, only S2+S3 needs to be defined.

For the PUMA module, the new list of link dimensions is as follows:

Table 10-1. Puma Link Dimensions

New index	Old index	Symbolic name
1	none	a1
2	1	a2
3	2	a3
4	3	s4
5	4	s2+s3
not used	5 to 11	see original documentation

3. A 2-by-2 matrix must now be defined to specify the joint-to-motor scaling factors for joints/motors 2 and 3. For example, when entering the encoder scaling factors for joint 2, SPEC will prompt for a scaling factor for both encoder 2 and encoder 3. If there is no coupling, a zero (0) value should be entered as appropriate. For "standard" PUMA-style robots (for example, the 560, 760, and RX-90), motors 2 and 3 are not kinematically coupled.

4. A new robot option bit has been added to the PUMA module. When bit 4 (counting from 1) is asserted in the robot option word, joint 6 is assumed to have several turns. During all normal motions, including moving to the READY position, joint 6 is moved to the desired position on the closest turn rather than attempting to keep joint 6 close to the 0 position. If the option bit is set, the final Z-axis rotation is allowed to turn many (>100) turns. This affects limit checking, READY, and calibration.

Note for customers upgrading existing PUMA robots:

Due to the above changes, old SPEC data files for the PUMA robot will now be partially incompatible with the new robot module. After an older SPEC data file is loaded with the new module, all link dimensions and all joint/motor scaling factors should be manually edited and verified using the SPEC program to correct for the incompatibilities.

Adept recommends that a copy of the old SPEC data file be retained for reference.

Change to SCARA Device Module (ID=6)

A 2-by-2 matrix must now be defined to specify the joint-to-motor scaling factors for joints/motors 3 and 4. For example, when entering the encoder scaling factors for joint 3, SPEC will prompt for a scaling factor for both encoder 3 and encoder 4. If there is no coupling between joints 3 and 4, a zero (0) value should be entered as appropriate.

Note for customers upgrading existing robots:

Due to the above changes, old SPEC data files for a SCARA robot will now be partially incompatible with the new robot module. After an older SPEC data file is loaded with the new module, all joint/motor scaling factors should be manually edited and verified using the SPEC program to correct for the incompatibilities.

Adept recommends that a copy of the old SPEC data file be retained for reference.

Change to Theta-Parallelogram Device Module (T12, ID=10)

A 2-by-2 matrix must now be defined to specify the joint-to-motor scaling factors for joints/motors 1 and 2. For example, when entering the encoder scaling factors for joint 1, SPEC will prompt for a scaling factor for both encoder 1 and encoder 2. If there is no coupling between joints 1 and 2, a zero (0) value should be entered as appropriate.

Note for customers upgrading existing robots:

Due to the above changes, old SPEC data files for a T12 robot will now be partially incompatible with the new robot module. After an older SPEC data file is loaded with the new module, all joint/motor scaling factors should be manually edited and verified using the SPEC program to correct for the incompatibilities.

Adept recommends that a copy of the old SPEC data file be retained for reference.

Changes to Enhanced Gantry Module (EGN, ID=19)

The ID number has been changed to distinguish it from the standard gantry module (ID = 3).

Linear compensation has been added for the three wrist axes of the enhanced gantry module (EGN). The data structure for this compensation is identical to the existing compensation for linear axes.

The wrist linear compensation will be applied in either joint or motor space, depending upon the setting of a bit in the robot option word. (The compensation on X,Y, and Z is always in joint space.) This enhancement will also be available in V^+ 10.5. If bit 4 (counting from 1) is clear, the wrist compensation will be applied in joint space and is interpreted as a joint-angle correction in degrees. If this bit is set, the wrist compensation will be applied in motor space and is interpreted as an encoder value. Like all linear compensation, to enable this feature: (1) you must have the enhanced gantry module, (2) you must turn on compensation, and (3) you have to initialize the table of linear compensation values.

Changes to Coordinated-Joint-Control Module (JTS, ID=15)

This module now supports up to 12 joints.

The default title of the kinematic module has been changed:

Old:6-Axis Coordinated-Joint-Control Robot
New:Coordinated-Joint-Control Robot

Changes to Enhanced XYZ Module (EXY, ID = 18)

The ID number has been changed to distinguish this module from the standard XYZ module (ID = 3). See page 140 for the changes in V+ 11.1.

10.3 Changes to V+ Functions and Parameters

[For details, refer to the *V+ Language Reference Guide*.]

10.4 Changes to the SPEC.V2 program

[For details, refer to the *AdeptMotion VME Developer's Guide*.]

10.5 Changes to AdeptMotion Device Module Documents

Documentation Correction, Rotational Axes

The following additional information applies to all AdeptMotion Device Modules that include rotary axes. (It does not affect Adept robots, which have the axis ranges set correctly.)

All non-wrist rotary joints must have a total travel of less than 360 degrees.

If a wrist joint is *not* noted in the Device Module Documentation as being affected by the V+ SINGLE/MULTIPLE switch, it should also have a total travel of less than 360 degrees. The joint limits should be set accordingly, using the SPEC.V2 utility program. In most cases, the limits must be symmetrical, that is, –179.9 to 179.9 degrees (or the mechanical limit of the robot, whichever is less).

Joints 4 and 6 of the PUMA and Gantry device modules, and Joint 4 of the CYL, SCARA, XYZ, EXY, 2ZT, XY3, XY4 and V4R device modules are implemented as "two-turn" axes, and supported by the V+ SINGLE/MULTIPLE switch. Their range is limited to ± 359 degrees, and the joint limits should be set accordingly (–359.9 to +359.9 degrees, or the mechanical limit of the joint, whichever is less). The only exception is the PUMA module which has a special "multi-turn" option, controlled by a bit in the robot option word, that allows joint 6 to exceed ±359.

If a robot joint has its software limits set beyond the correct range, and if such an axis is moved to beyond the correct range (via a joint-interpolated motion or the MCP), and then a straight-line motion is executed (or the robot is moved in WORLD or TOOL mode), the axis will rotate at high speed back to be within the correct range.

Enhanced Gantry Robot Device Module Document and Enhanced XYZ/

Theta Device Module Document

The existing description of the Linear Compensation option should clarified as follows (new text is bolded):

> The first and last correction values must be zero if the joint can move **up to, or** beyond the corrected range of travel. If these values are not zero, there will be a jerk when entering or exiting the corrected range, **or when nearing the end of the corrected range. In general, we advise that you always ensure that the first and last values of the correction table are zero**.

10.6 Miscellaneous Motion Changes

1. Change to Default Minimum Cartesian Motion Time

   The default minimum Cartesian motion time has been reduced from 2 ticks to 1 tick in all robot modules. This default value may be changed in SPEC, using the appropriate menu option or by loading an existing SPEC data file.

2. Maximum acceleration and deceleration percentages are now specified by the SPEC utility.
3. Maximum program speed can now be specified by SPEC.
4. The system parameter "NOT.CALIBRATED" may no longer be modified unless robot power is off. An attempt to modify it with power on will fail with the error: –627 "*Robot power on*".
5. Delay added to DETACH(0) instruction. A 1-cycle (16-ms) delay has been added when detaching the robot, to allow the robot state machine to cycle. (This change should be transparent to most users.)
6. A new 3-link (6-axis) SCARA robot module is available (SC6).
7. A new XY-ZT-ZT-ZT (8-axis) robot module is available (XY3).
8. The ID numbers for the EXY and EGN device modules have been changed to distinguish them from the XYZ and GNT modules. The new ID numbers are 18 and 19, respectively.

10.7 New and Changed Error Messages

For complete explanations, see Appendix B "System Messages" in the *V+ Language Reference Guide*. See page 135 for information on changes in V+ 11.1.

Changes in V+ 11.1 11

This chapter provides detailed descriptions of the changes between V+ Version 11.0 and V+ Version 11.1:

- Changes to the V+ Operating System and Language.

  Changes to Monitor commands.

  Changes to Programming Keywords.
- Changes to Error messages.
- Changes to AdeptVision.
- Changes Affecting Adept Robot Users
- Changes to AdeptMotion.
- Changes to the Adept Utility Programs.
- Programming Notes. These describe the programming implications of the changes introduced in V+ 11.1.

11.1 Summary of New Features

Major Additions

1. Support for the Adept 550, 1850, and 1850XP robots.
   1. Dual-vision support (supported in V+ 11.0, but V+ 11.1 provides improved configurability).
   2. Individual-axis control software option (described in Chapter 15). This option provides:

      Support for up to 15 mechanisms

      Continuous-turn (spin) axes with the JTS robot module

General System-Level Additions

1. Enhanced the trajectory generator to improve cycle times and the predictability of continuous-path motions (including new OVERLAP/NOOVERLAP instructions for

SCARA and PUMA robots). See "Configurable V+ Trajectory Cycle Rates" on page 137.

3. Increased the number of servo channels that a single 68040 can service from 8 to 18. Increased the number of servo channels that a single 68030 can service from 8 to 9.
4. Enhanced the AdeptVision NGC tool to improve its robustness and execution speed.
5. Introduced the XZ robot module.
6. Manual Control Pendant (MCP) servicing is now enabled even if no robot is configured.
7. Changed EXY robot module to require only the "Kinematics" option license.

General Programming Language Additions

Detailed information on these changes is presented later in this chapter.

1. Added wildcards to DIRECTORY, LISTL, LISTR, and LISTS commands.
8. Changed the FCOPY command to assign the original creation date to copied files, not the current date.
9. Added switches to the LOAD command to dynamically squeeze programs, and to set them to read-only.

11.2 Changes to Monitor Commands

New Commands

ESTOP Monitor Command and Program Instruction

Syntax `ESTOP`

Arguments None

Details Immediately asserts the backplane emergency-stop signal (provided that a later model SIO module is installed). Immediately de-asserts High Power Enable (HPE). Then proceeds with normal power-down sequence.

Altered Commands

DIRECTORY

Also see page 103 for the changes in V+ 11.0.

The syntax for the DIRECTORY monitor command has been enhanced. The old syntax was:

```
DIRECTORY select
```

where `select` indicated if protected programs were to be suppressed or if only non-executable programs were to be displayed. The new syntax is:

```
DIRECTORY /x wildcard_spec
```

where /x is an optional switch that is followed by an optional wild card specification. The possible switch values are:

/Sto suppress protected programs
/?to display only non-executable programs
/Mto display only modified programs.

For any program name that is displayed, if the copy in memory has been modified since last being loaded or stored, a “M” is displayed before the program name.

The DIRECTORY command now supports wildcards using either the “?” or “*” character. Both wildcards operate identically, and can match 0, 1 or multiple characters.

DISABLE POWER

DISABLE POWER now requests that the robot perform a controlled deceleration and power-down sequence. This sequence consists of:

1. Decelerating all robots according to the user-specified parameters.

10. Turning on the brakes.

11. Waiting for the user-specified brake-delay interval.

12. Turning off the amplifiers and power.

13. Asserting the backplane Emergency Stop signal and de-asserting the High Power Enable (HPE) signal.

Note that DISABLE POWER may take an arbitrarily long time due to long deceleration times and long brake turn-on delays. (A new ESTOP command and program instruction has been introduced for situations when an immediate shutdown is desired. See Chapter page 132.)

FCOPY

The file creation date and time are now preserved, along with the standard file attributes, when a file is copied. The only attribute that is affected is the “archived” bit which is set to “not archived”. (See page 103 for the changes in V+ 11.0.)

FORMAT

(Also see page 104 for the changes in V+ 11.0.)

Floppy disk density is no longer checked at format time. This change is required to support the use of floppy drives that do not provide a disk-density signal. The error *Invalid disk format* format is no longer generated if a user attempts to format a disk in an invalid manner.

If a user attempts to format a low-density disk with the high-density format switch (i.e., “/J”, which is the default), the error *Bad block in disk header* (-523) is generated during the format process.

CAUTION: If a user attempts to format a high-density disk using one of the lower-density format switches (not "/J"), the format will proceed but may report a number of bad blocks detected at the end of the format process. Regardless of whether or not bad blocks are reported, such a disk is not reliable and should not be used for data storage.

LISTR/LISTS/LISTL

Wildcards are now accepted by the LISTR/LISTS/LISTL monitor commands. Note that for these commands only, wildcards must be specified by a "?" character. (That is, unlike the DIRECTORY command, "*" cannot be used as a wildcard character.) Multiple wildcards can be specified within each argument and each wildcard can match 0, 1, or multiple characters. For array variables, the [] characters must be explicitly specified, although wildcards can be used to match array indices.

LOAD

(Also see page 104 for the changes in V+ 11.0.)

Two new optional switches have been added to the LOAD command: /S and /R.

The new syntax is:

```
LOAD /Q/S/R filename
```

/S squeezes programs as they are loaded into memory in much the same way that the SQUEEZE program operates on program files. All in-line comments and full-line comments are deleted with the exception of full-line comments that begin with the character sequence ";*".

/R forces all of the loaded programs to be in read-only mode (except when other considerations dictate that a more secure mode should be utilized).

CAUTION: When a file is loaded with the /S switch, /R should also be asserted to prevent people from mistakenly editing the squeezed version of a file and then saving back their changes (and possibly overwriting the unsqueezed version).

NOTE: When a file is loaded in read-only mode, only the first program in the file is listed on the monitor (if /Q was not specified).

MDIRECTORY

The syntax for the MDIRECTORY monitor command has been changed. The new syntax is:

```
MDIRECTORY /M module_name
```

where /M is an optional switch and module_name is an optional module name. If /M is specified, only modified modules or modified programs within a module will be listed.

For any module or program name that is displayed, if the copy in memory has been modified since last being loaded or stored, a "M" is displayed before the program or module name.

SEE Editor Inserts Global Module Automatically

When the SEE editor creates a new program, it automatically inserts the program into the module named "global". This is a useful feature for grouping programs created on-line. (The MODULE command can be used to move a program from one module to another.)

11.3 Changes to V+ Programming Keywords

[For details about V+ programming keywords, refer to the *V+ Language Reference Guide*.]

11.4 Changes to Error Messages

[For details about V+ error messages, refer to the *V+ Language Reference Guide*.]

11.5 Changes to AdeptVision

Altered Keywords

VCORRELATE Program Instruction

```
VCORRELATE (cam, mode, dmode, max_depth, accept, give_up)
    data[i], act_depth = tplnum, ibr
```

Several important enhancements have been implemented that improve the speed of the Normalized Grayscale Correlation (NGC) tool.

One of the most important enhancements is the skipping of rows and/or columns when correlating at the most-reduced level of hierarchy. Not performing correlation matches at every pixel location results in a much faster correlation tool. However, certain templates such as the ones with low contrast or with skinny features do not permit skipping. VTRAIN.MODEL has been modified to now analyze each template during training and to determine a default skip pattern and a default depth of hierarchy. The determination criteria places higher priority on robustness than speed, resulting in a more conservative default depth and skip pattern. Being conservative means a slower tool, but with less variation in execution time and less chance of not finding the object.

The default values can be overridden by specifying the desired depth and skip pattern using input parameters "max_depth" and "mode" respectively. However, not using the recommended depth and skip pattern may result in mismatches or increased variability of execution times.

The previous unused input parameter "mode" is now used to specify skip pattern for VCORRELATE. Its definition is as follows:

0: default, use the mode determined by the vision system
1: non-skipping mode
2: skip rows only
3: skip columns only
4: skip both rows and columns

The input parameter "max_depth" specifies the depth of hierarchical search, as defined as below:

-1: default, use the maximum depth determined by the vision system
0: non-hierarchical search
1-4:depth of hierarchical search

VTRAIN.MODEL Program Instruction

```
VTRAIN.MODEL (cam, plan) $model_name, $text, ibr
```

The "plan" definition has been modified, but is backwards compatible.

VTRAIN.MODEL now analyzes a template and determines the default depth for hierarchical search and skip patterns for each level of hierarchy. The new information is stored in the template (template format has been changed to accommodate the additional information, see Incompatibility Summary).

Since template analysis is now done for hierarchical training, the input parameter "plan" is used to specify the mode of training as follows:

0: default, create a hierarchical grayscale template
1: (was for binary correlation - no longer used)
2: create a non-hierarchical grayscale template.

11.6 Changes Affecting Adept Robot Users

The Adept 550, 1850, and 1850XP robots are supported in V+ 11.1.

Changes to Trajectory Generation Algorithm

The V+ trajectory generation algorithm that determines how one motion transitions to another motion during Continuous Path mode has been changed. This modification affects all aspects of the motion transition: the speed of the transition, the acceleration of the transition, and the path that is followed during the transition. These changes improve the uniformity of corner rounding and allow cycle times to be better optimized.

Compared with V+ 11.0, the new algorithm provides:

- The path going from A to B to C is now similar to going from C to B to A.
- Whenever possible, the corner rounding radius will be increased when motion speed is increased.
- The radius of the corner rounding is more consistent, especially at high speeds.

The effect of these improvements is that the joint accelerations generated during the transition region can be greater than before, and can at times exceed the limits for percent acceleration and percent deceleration specified for the two motions.

"AS" Device Module now on V+ System Disk (ID = 1, 6, 7)

A copy of the "AS" (Adept SCARA) device-module file for Adept robots is now included in the \SYSTEM\ directory of the V+ 11.1 system disk. The 11.1 version of DM_UTIL is required to be able to select an Adept robot. Note that the functionality of DM_UTIL is now provided by CONFIG_C.

Manual Control Pendant Changes

See page 181.

11.7 Changes Affecting AdeptMotion Users

Configurable V+ Trajectory Cycle Rates

The rate of V+ trajectory evaluation is now configurable. The trajectory frequencies supported are 62.5 Hz, 125 Hz, 250 Hz, and 500 Hz. The frequency is specified in the "TRAJ_RATE" statement in the SYSTEM section of the configuration data on the V+ boot disk. (CONFIG_C 11.1 edit C or later is required to add the "TRAJ_RATE" statement to the configuration data, or to modify an existing statement.)

This option requires the Enhanced Trajectory Control license.

The following changes have been implemented in connection with this change:

Predicted Belt Position Returned by DEVICE and BELT Functions

As before, the predicted belt position returned by the DEVICE and the BELT functions reflects the anticipated position of the belt two trajectory cycles in the future. Formerly, this was fixed at 32 msec into the future. Now, the number of milliseconds into the future is two times the configured trajectory cycle time. The belt speeds returned by the DEVICE and BELT functions continue to be in the units mm/sec and counts/16 msec, respectively.

Limits on "Minimum Motion Times"

Changed the limits on the "minimum motion times" for joint interpolated and straight-line motions. These variables are set via the SPEC program and formerly had a minimum limit of 16 msec. These settings can now be reduced to be greater than or equal to the configured trajectory cycle time. As a convenience, if the values are set to be less than the configurated trajectory cycle time, the trajectory cycle time will be used as the minimum motion time. Specifically, if these values are set to 0, the corresponding type of motion, when very short or very fast, will be executed at the fastest possible rate.

The default values for the "minimum motion times" for joint and straight-line motions have been set to 0 in all robot modules.

ALTER Program Instruction

As before, the ALTER program instruction can send position and orientation change information to the trajectory generator once per trajectory cycle. Formerly, this was fixed at once per 16 msec. Now, if a faster trajectory cycle is configured, higher rates of updating can be achieved, but still only one transaction per trajectory cycle is permitted. Note, that

if ALTER is executed in the "accumulate" mode, a faster trajectory cycle rate will increase the rate of accumulation and cause the robot to move more quickly. To synchronize execution of the ALTER instruction with the trajectory generator, the new STATE(12) function should be used (see below).

STATE Real-valued Function

The STATE real-valued function has been enhanced as follows:

STATE(12) returns a flag that is set nonzero when an ALTER program instruction is executed for the currently selected robot, and cleared after the trajectory generator processes the posted ALTER data. This flag can be used to coordinate the execution of ALTER instructions with the processing of the data by the trajectory generator.

STATE(13) returns the trajectory generator execution rate in Hertz. That is, if the trajectory generator is executed once each major V+ cycle, a value of 62.5 would be returned by this function.

STATE(14) returns the servo code execution rate in Hertz. That is, if the servos are executed each 1 msec, this function would return a value of 1000 (1kHz).

Continuous-Turn Axes

For a description of the changes to the Joints (JTS) module, see [the SPIN instruction in the *V+ Language Reference Guide*].

NOT.CALIBRATED Parameter Range Changed

The range of the NOT.CALIBRATED parameter is now from –1 to 32767.

> **NOTE:** Bits for undefined robots now default to off. For example, on a single-robot system, this parameter now has values of 0 (calibrated) and 1 (not calibrated).

Default Task Priorities

Default task priorities have been changed so the trajectory generator task has high priority for all time slices. Also, the priorities of all other system tasks have been reduced so that the trajectory generator has the highest priority among these tasks. See the "System/User Task Priority Tables" on page 143.

New Kinematic Device Module: "X/Z Stacker Robot" (XZ, ID = 23)

This robot module controls a mechanism with two degrees of freedom—a linear joint (X) followed by a joint that provides vertical motion (Z). The XZ robot module can operate with either a rotary Z axis or a linear Z axis. In the linear mode, joint 2 moves directly up and down. In the rotary mode, joint 2 rotates about a horizontal axis, and the robot's tool is assumed to be always maintained in a downward direction by a simple pivot and gravity arrangement. Consequently, this robot produces motions that are equivalent to an X/Z Cartesian robot, as shown in Figure 11-1. .

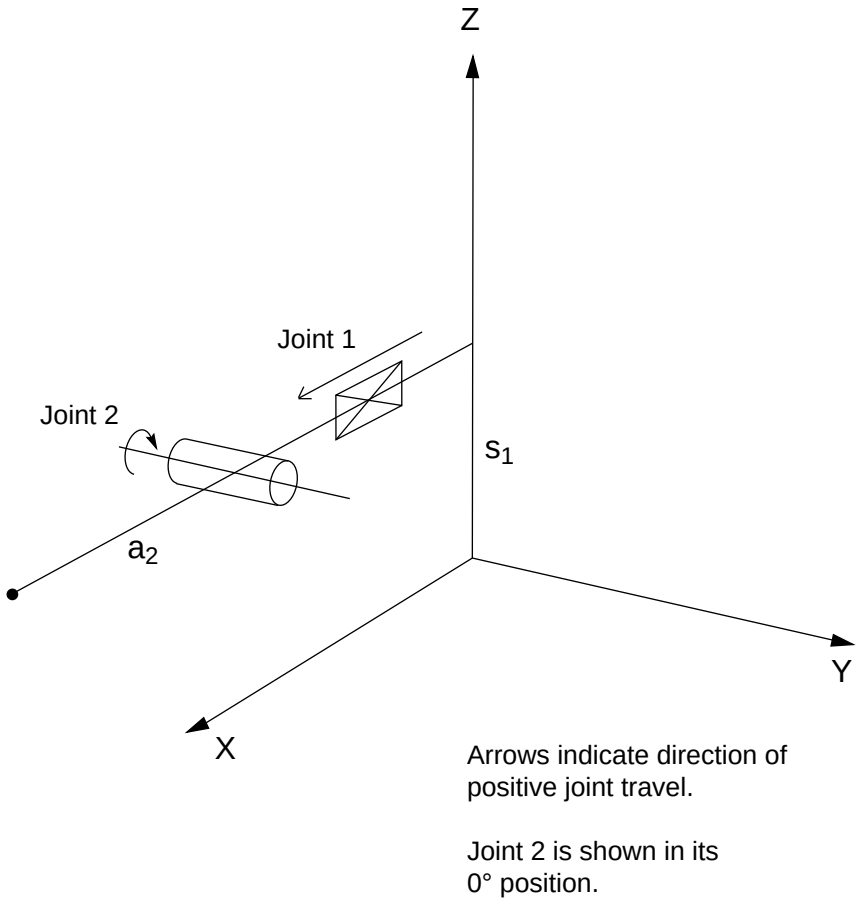

Figure 11-1. . Link Definitions and Dimensions for X / Z Robot (with rotary joint 2)

This module is available only with V+ 11.1 (or later). The module is supplied in the \SYSTEM\ directory of the V+ System Disk and can be installed using the CONFIG_C utility. The optional "Kinematics" software license is required.

Joint 1 is a linear axis that moves in the world X direction. Joint 2 is either (a) a linear axis that moves in the world Z direction, or (b) a revolute axis that rotates about an axis that is parallel to the world Y axis. This module supports a split-axis mode (user-option) for both joint 1 and joint 2 (total of 4 motors). Independent of the positions of joints 1 and 2, the orientation of the tool mounting flange always points down (assuming a NULL BASE and TOOL). That is, the positive Z axis of the tool mounting flange always points in the world -Z direction.

The selection of the type of Z axis is controlled by robot option bit 4 (counting from 1, mask ^H8). If this bit is set using the SPEC utility, the Z axis is implemented with a linear joint, otherwise the Z axis is implemented with a rotary axis. If a linear Z axis is configured, the two link dimensions accessible via SPEC are ignored.

Changes to Enhanced XYZ/Theta Module (EXY, ID = 18)

The Enhanced XYZ module now checks only for the Kinematic Modules license. Previously, it checked for both the Kinematic Modules license and the Enhanced Kinematic Modules license.

(Also see page 123 for changes in V+ 11.0.)

Changes to Trajectory Generation Algorithm

See page 136.

Servo Changes Affecting Compatibility From 11.0 to 11.1

Several servo tuning parameters have been redefined between V+ 11.0 and 11.1 in order to decouple them from the servo rate. This will make it easier for users to compare the effects and benefits of the alternate servo rates (1 kHz vs. 500 Hz).

In almost all cases, SPEC will automatically detect the old values and convert them when loading an old SPEC data file. A conversion formula is used by SPEC when loading old SPEC data files, as shown in Tables 11-1 through 11-3. You can use these formulas to verify that the data has been successfully converted.

Table 11-1. AdeptMotion Users Upgrading From V+ 11.0 to 11.1 (all systems)

Parameter	Conversion Formula
Pole	new_pole = (1/T)*ln(old_pole) 1000 Hz: T = 0.001 500 Hz: T = 0.002 (ln() is Natural Logarithm)
Zero	new_zero = (1/T)*ln(old_pole) 1000 Hz: T = 0.001 500 Hz: T = 0.002 (ln() is Natural Logarithm)

The following table applies only if you are using the optional 500 Hz servo rate:

Table 11-2. AdeptMotion Users Upgrading From V+ 11.0 to 11.1 (500 Hz systems only)

Parameter	Conversion Formula
Velocity Feed-Forward	1000 Hz: unchanged 500 Hz: new = old*2
Acceleration Feed-Forward	1000 Hz: unchanged 500 Hz: new = old*4
Integral Gain	1000 Hz: unchanged 500 Hz: new = old/2
Max.Integ step size	1000 Hz: unchanged 500 Hz: new = old/2

Table 11-2. AdeptMotion Users Upgrading From V+ 11.0 to 11.1 (500 Hz systems only)

Parameter	Conversion Formula
Duty-cycle filter	1000 Hz: unchanged 500 Hz: new = old+1
DAC output filter	1000 Hz: unchanged 500 Hz: new = old+1

Servo Changes Affecting Compatibility From 10.x to 11.1

DC Gain and Max Integrator (Imax) values were redefined in V+ 11.0 to reduce the interaction between some of the tuning parameters. This change only affects users who load SPEC data files created using V+ 10.x.

Table 11-3. AdeptMotion Users Upgrading From V+ 10.x to 11.0 or 11.1

Parameter	Conversion Formula
DC Gain	DC = old_Proportional _Gain * (1-z)/1-p) (Affects 1000 Hz and 500 Hz)
Max Integ.	New = old*Int.Gain - or - Max DAC Val (whichever is less) (Affects 1000 Hz and 500 Hz)

NOTE: The "Calibration Speed" parameter was redefined in V+ 11.0 from units of counts/second to counts/millisecond. At the same time, the DATA item number for this parameter was changed.

When loading SPEC data files created with V+ 10.x, SPEC recognizes the old DATA item and automatically converts the old value to the new definition and initializes the new DATA item correctly.

Integrator Value Now Backed Up

Formerly, the integrator value was cleared (zeroed) whenever the robot power was disabled.

With the servo in V+ 11.1, the integrator state is memorized under certain conditions and restored the next time power is enabled. Specifically:

1. After a power-down due to an error or emergency (ESTOP, latched servo error, envelope error, drive fault, motor stalled, duty cycle exceeded, zero index error, quadrature error, etc.), the integrator state is cleared (zeroed).

   Note that ESTOP (external or V+ keyword) does not directly clear the integrator. However, if the robot is moving when ESTOP is triggered, ESTOP will normally trigger an internal, hidden latched envelope-error.

   The integrator value is also zeroed when the controller power is shut down.

1. After a normal, controlled, power-down the integrator state is maintained.

Currently, gravity-loaded axes tend to "sag" momentarily each time power is enabled, while the integrator ramps up to overcome gravity. With this new feature, such axes will continue to sag slightly the first time power is enabled, but not on any subsequent non-emergency power-up/ power-down cycles. This feature should be transparent to most users.

Increased Number of Servo Joints per CPU Boards

The number of servo channels possible per CPU board has been increased to:

9 for the 030 (nominally for 2 VMIs, or 1 VJI, and 1 VFI [force] board), and
18 for the 040 (nominally for 4 VMIs, or 1 VJI + 2 VMIs, and 2 VFI [force] boards).

See Chapter 12 for additional information.

11.8 Changes to Adept Utility Programs

[For details about utility programs, refer to *Instructions for Adept Utility Programs*.]

11.9 Programming Notes

Clarification of WAIT.EVENT Operation

Interrupts must only be sent on levels 1 or 2 by 3rd-party boards. Sending an interrupt on other levels will cause unpredictable system behavior.

If an unexpected interrupt vector is received on interrupt level 1 or 2, the system drops to the debug window with the message:

```
*[Fatal] UnitTrap* at aaaaa, V = vector M:0
```

The same vector cannot be used for different interrupt levels. For example, if "INT.EVENT 200, 1" is issued in task 1 and "INT.EVENT 200, 2" is then issued in task 2, a "*Device not ready*" (-508) error is returned to task 2.

In order to free up a vector that has been assigned by a task that did not complete normally, a KILL command is required.

Internally, a V^+ task will go into a wait state for one of four reasons:

1. Someone stops it (e.g. ABORT).
2. Another higher priority task preempts it.
3. The task goes to "sleep" for some time interval.
4. The task is waiting for an event to occur.

A task can get out of Case 4 only by having its event flag set. A task might wait for many things: I/O, robot motion, etc. If an error occurs while a task is waiting, the task will hang until the event flag is set.

Many different situations can cause the event flag to be set. Because of this, the algorithm for checking for something to be complete should be as follows:

1. Clear the event flag.

5. Check if the desired operation is complete. If so, exit the loop.

6. Wait for the event flag to be set.

7. Loop to Step 1.

Whenever a different task wants to signal that it is complete, it must do the following:

1. Set some global variable to indicate that it is complete.

8. Set the event flag for the target task.

The order is critical for both these sequences to make sure that the system does not miss a completion, or detect extraneous completions.

> **NOTE:** WAIT.EVENT is the most efficient wait mechanism for a task, and is much preferred to polling at some fixed time interval.

Change to VME Memory Map

A 512-byte section of short address space has been changed from "Reserved for Adept" to "Reserved for Users". This change has been made to permit the use of 3rd-party boards that require an address in the upper part of short address space.

The user address space is $FC00 - $FDFF (512 bytes).

System/User Task Priority Tables

The following tables show the default task priorities for V+ 11.1. For an explanation of these changes, see "Default Task Priorities" on page 138.

These tables replace Tables 1-2 and 1-3 in Version 11.0, Rev. A of the *V+ Language User's Guide*

Table 11-4. System Task Priorities

	Slice Number															
System Task	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Trajectory generator	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Terminal and graphics driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58
Monitor task	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56
Network server (DDCMP)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54
Kermit driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52
Teach pendant driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
Disk driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	48
FLO driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46

Table 11-4. System Task Priorities (Continued)

	Slice Number															
System Task	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Serial line driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	44
PIPES driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0
Vision com-munications task	14	14	14	14	14	14	14	14	14	14	14	14	14	0	0	0
Vision analysis task	13	13	13	13	13	13	13	13	13	13	13	13	13	0	0	0
Servo background task	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0

Table 11-5. User Task Priorities

	Slice Number															
Task #	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
0	20	20	20	20	20	20	20	20	20	10	10	10	10	0	0	0
1	19	19	21	21	19	19	21	21	19	09	11	11	9	00	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0
4	15	15	15	15	15	15	15	15	15	05	05	05	05	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0
7 - 27	0	0	0	0	0	0	0	0	0	0	0	0	0	05	0	0

Multiple-Processor Systems 12

Up to four processor modules can be installed in an Adept MV controller. They can be any mix of 030 and 040 modules. In order to correctly use multiple processors you need to consider the following:

- Configuration of the processor boards
- Assignment of processor workloads

The information in this chapter is intended to be a fairly comprehensive reference for users configuring multiple-processor systems. In most cases, your controller will have been pre-configured at the factory with sufficient processors for your application. Also, the default software configuration is designed so that most users will not need to change the configuration.

You do not need to read this chapter if your controller has one only processor (one 030 or one 040).

If you are using AdeptMotion VME, and have more than one processor, you may find the detailed background information in section Chapter 12.1 useful.

If you are using AdeptVision VME but not AdeptMotion, read only section Chapter 12.2.

If you are installing additional processors, read Section Chapter 12.3.

If after using your system, you find the default assignment of processor workloads does not suit your application, read section Chapter 12.4.

If you have bought the optional "V+ Extensions" license, and intend to use the "Multiple V+ Systems" feature, read Chapter 13. This is an advanced feature that is not required for most applications. (You can use the other features of V+ Extensions without using the Multiple V+ Systems feature).

12.1 Processor/Memory Requirements for Motion Systems

The following are general guidelines for determining the required number of processors and their memory sizes for a given application:

Servo Processing Requirement

For standard servo code executing at a 1kHz update rate, a 68030 processor has sufficient execution power to support a maximum of 8 channels. That is, when 8 axes are being servoed by a 68030, no other processing tasks (e.g., V+ user tasks, trajectory generation, vision) should be assigned to that processor.

In general, servo processing requirements scale relatively linearly with the number of axes and the servo update rate. That is, 8 axes take approximately twice as long to service as 4 axes. Also, if the servos execute every 1ms, they use twice the processor power as servos executing at a 2 ms update rate.

CAUTION: The servo update rate affects all mechanisms controlled by the system. If you are using an Adept supplied robot, you should not change the servo rate.

A 68040 processor can be assigned 8 axes at 1 kHz and still have approximately 50 percent of its time available for other tasks. In general, a 68040 can execute software more than twice as fast as a 68030.

Number of Servos Allocated per Processor Board

In Version 11.0, only 8 servo channels can be configured per board for both 68030 and 68040 processors. In Version 11.1, 9 servo channels can be configured per 68030 processor and 18 channels per 68040 processor.

When associating servo processes with a VMI (VME Motion Interface) board, all channels of the VMI must be serviced by the same processor board. In addition, when a VMI is assigned to a processor board, it allocates 4 of the available servo processes per board even if less than 4 axes are being servoed. For example, if you are controlling a 6-axis robot with two VMI boards, all four channels of the first VMI board must be assigned to a single processor as a group. Likewise all four channels of the second VMI must be assigned to a single processor (although it need not be the same processor as the first 4 axes). If the two VMIs are assigned to the same processor, 8 servo processes on that board would be occupied even though only 6 channels are being used. In this situation, the processor computational load would only correspond to that for 6 axes, but no additional VMIs could be controlled by this processor.

When associating servo processes with a VJI (VME Joint Interface) board, all channels of the VJI must be serviced by the same processor board. In addition, when a VJI is assigned to a processor board, it allocates 8 of the available servo processes per board even if less than 8 axes are being servoed. For example, if you are controlling a 4-axis robot with two VJI boards, all eight channels of the first VJI board must be assigned to a single processor as a group. Likewise all eight channels of the second VJI must be assigned to a single processor (although it need not be the same processor as the first 8 axes). If the two VJIs are assigned to the same processor, 16 servo processes on that board would be occupied even though only 4 channels are being used. In this situation, the processor computational load would only correspond to that for 4 axes, but no additional VJIs could be controlled by this processor.

Trajectory Generation and MOVE Instructions

Servoing, vision, and (in some cases) V^+ user tasks can be configured to operate on any processor board. However, high-level motion control (i.e., trajectory generation, kinematic solution program execution, and V^+ motion instructions) can be executed only on processor #1. Therefore, as more axes are added to the system, the high-level motion control computational load on processor #1 increases, even if the servo processing is moved off to other processors.

For any given application, the processing power required to execute the high-level motion control is a function of which kinematic modules are used, and must be evaluated on a case-by-case basis.

Peripheral Drivers

As with trajectory generation, the drivers for disk I/O, manual control pendant I/O, graphics I/O, and global serial-line I/O execute only on processor #1. Thus, there is an impact on processor #1 whenever an auxiliary processor accesses one of these devices. However, communications between a processor board and its local serial lines, digital I/O, and analog I/O, are processed on the processor on which the V+ instruction is executed.

Conveyor Belt Encoders

A maximum of one encoder device module can be installed (requires a V+ Extensions License.) The Encoder Device module supports up to 6 encoders (default is 2). Thus, a maximum of 6 conveyor belt encoders can be interfaced to a controller. Each belt encoder requires one servo channel, although it adds a negligible amount of computational load. These encoders are physically connected via a Motion Interface board (VMI or VJI).

Force Sensors

The AdeptForce VME option allows up to three force sensors per controller. Each sensor requires one Force Interface Board (VFI). One or two VFIs can be assigned to each processor board. Each of these force sensors requires one element of the servo axis allocation.

The force sensor loads the processor computationally only when a force-sensing operation is taking place, and the load is somewhat less than a single servoed axis.

12.2 Processor/Memory Requirements for Vision Systems

Standard AdeptVision

The minimum processor/memory requirement for an AdeptVision system with one vision board is one processor with 4 MB of memory. Adding memory in a single-CPU configuration will not affect vision performance. Adding an auxiliary processor (and assigning the vision processing to that CPU) could significantly increase vision performance.

Dual AdeptVision

When a system contains two VIS boards, two processors must be present to execute two copies of the vision system software. However, there are no restrictions on which processor can execute V+ vision instructions. For example, in a two-processor/two-VIS system, either or both processors can issue V+ vision instructions for either vision system. However, in a dual-processor/dual-vision system with AIM VisionWare, a separate copy of AIM VisionWare must be executed on each processor, thus requiring a copy of V+ on each processor.

12.3 Configuration of the Processor Boards

When installing multiple processors, the following physical configuration options must be considered:

- Processor board locations
- Processor board addressing
- System controller functions

Processor Board Locations

In each controller, the first slot available for processor boards must be occupied by an 030 or 040 processor. This processor must be addressed as board 1 and it must have the system controller functions enabled (see below). This processor is considered the system processor.

All other processors may occupy any other available slot (slot 2 must be occupied by the SIO module, all the other slots are board independent).

Slot Ordering of Processor Boards

In general, the fastest processor with the greatest amount of memory should be configured as processor #1. The auxiliary processors should be ordered (i.e., numbered) first by speed and then by memory size.

Processor Board Addressing

The system processor must reside in slot 1 and be addressed as board 1. Each of the auxiliary processors must be addressed uniquely from 2 to 4. It does not matter which slot an auxiliary processor is in—auxiliary processor 2 can be in slot 6, auxiliary processor 3 in slot 5, etc. See the chapters on 030 and 040 system processors in the *Adept MV Controller User's Guide* for details on setting the board address.

System Controller Functions

On the 030 board, jumper JP1 (SCON) designates a processor as the VME system processor. The system processor controls functions such as interrupt processing and bus arbitration. This function must be enabled in system processor #1 and disabled in all auxiliary processors. Similarly, jumper JP3 (SCLK) must be enabled on the system processor and disabled on all other processors. See the chapter on system processors in the *Adept MV Controller User's Guide* for details on setting the SCON and SCLK jumpers.

On the 040 board, jumper J1 controls both controller and system clock functions. It should be in for processor 1 and out for all other processors.

In systems shipped from Adept, the processors will be correctly configured and you will not have to make any changes unless you exchange processors (for example, replacing an 030 system processor with an 040 processor and making the 030 an auxiliary processor).

12.4 Assignment of Processor Workloads

There are several system tasks, such as trajectory generation and peripheral drivers, that must run on processor 1 and cannot be reassigned.

The following system tasks can be assigned to different processors:

- Vision Processing

Each vision system in the controller can be assigned to a specific processor.

- Servo processing

The servo task for each VMI board can be assigned to a specific processor.

- A copy of the V+ command processor.

Each processor can run an individual copy of the V+ command processor. See Chapter 13 for more details on multiple copies of V+. This is an advanced feature that requires the V+ Extensions license.

Assigning Workloads with CONFIG_C

The assignment of workloads to the different processors is designed to be automatic in most cases. The user may examine or override the defaults using the CONFIG_C configuration utility. The default configuration implements the following processor workload configurations:

- If only one processor is installed, all tasks run on that processor.
- If a second processor is present, the vision task, and the servo tasks for the first two VMI boards are automatically assigned to it, otherwise to processor 1.
- If a third processor is present, the servo tasks for the third and fourth VMI boards are assigned to it, otherwise to processor 1.

  Note that after two VMI boards are assigned to an 68030 processor, subsequent VMI or VJI assignments fail. (This is due to the 9-channel limit.) Similarly, after one VJI is assigned to an 68030, subsequent VMI or VJI assignments fail.

- If a fourth processor is present, the servo tasks for the fifth and sixth VMI boards are assigned to it, otherwise to processor 1.
- If the V+ Extensions license is installed, a copy of the V+ command processor is also available on each installed processor. In most cases, the copies of V+ on the auxiliary processors will be idle, that is they will not be executing any user tasks. When idle, V+ uses less the one percent of the processor time. If you want to execute tasks or commands on the secondary V+ Systems, see Chapter 13.

Multiple V+ Systems 13

13.1 Overview

This chapter applies only to the special case of running multiple V+ systems (multiple processors might or might not run multiple V+ systems). This is an advanced feature that most users will not require.

> **NOTE:** You can skip this entire chapter if you do not plan to use this feature.

You can use multiple processors without using multiple V+ systems. For example, if you need more power than a single processor can provide, you might configure three processors as follows: Processor 1 (the system processor) would run V+ (operating system and language), Processor 2 would run the servo code, and Processor 3 would run the vision code (see Chapter 12).

When multiple processors are installed, there is a default allocation of the system software, which the user can customize using the configuration utility program CONFIG_C.

For applications demanding extremely intensive V+ processing, it is possible to run a copy of V+ on every processor. This option requires the V+ Extensions license, and is described in this chapter.

Requirements

You must purchase and install the V+ Extensions software license, and use the CONFIG_C utility program to configure your system appropriately. (You do not need V+ Extensions for multiple processors if the additional processors are being used only for vision and/or servo processing.)

Each V+ system must run on its own processor, therefore you must have at least one processor for every V+ system that you intend to run.

The A-Series graphics option is required.

Monitor Commands and Multiple V+ Systems

If more than one processor is running a copy of V+ and the system switch MONITORS is enabled, multiple monitor windows can be displayed. The first monitor window is the normal monitor window for the system processor (labeled “Monitor”), The monitor windows for the other V+ systems are labeled “Monitor_2”, “Monitor_3”, etc. Each of these processors runs its own independent V+ system, and can perform all of the V+ functions with the exceptions described below.

The default, each time the controller is turned on, is that the auxiliary monitor windows ("monitor_2", etc.) are hidden and disabled. To enable them, type the command ENABLE MONITORS (see next subsection).

Using Autostart With Multiple-V+ systems

For V+ processor 1, autostart is the same as on single-V+ systems, and performs these commands:

```
LOAD/Q auto
COMM auto
```

For V+ processors 2, 3, and 4, autostart performs the following commands:

```
LOAD/Q auto0n
COMM auto0n
```

where "n" is the V+ system number, from 2 to 4.

Note that when using autostart to execute programs on systems 2, 3, or 4, you do not have to have the MONITORS system switch enabled (on processor 1), unless you want access to the V+ command line ("." prompt) for these systems.

The autostart function is enabled (for all processors) using DIP switch 1 (ON enables autostart) on the front of the SIO module. See the *V+ Operating System User's Guide* for more details.

Multiple V+ Systems—Accessing the Command Prompt

If you are not using autostart, you must enable MONITORS, and use the "Adept" pulldown menu to select the Monitor window for the system you want to command. You can then enter V+ commands (such as LOAD and EXECUTE) at the V+ command "." prompt. See the *V+ Language User's Guide* for a description of the MONITORS system switch.

13.2 Inter-System Communications

V+ application programs running on the same processor communicate in the normal way, using global V+ variables. (V+ 11.0 and 11.1 can execute up to 7 tasks simultaneously on each processor, or up to 28 tasks if the optional "V+ Extensions" software license is installed.)

When multiple V+ systems are running, each operates on its own processor, and functions independently. Programs and global variables for one V+ system are not accessible to the other V+ systems.

Application programs running on different V+ systems can communicate via an 8 KB reserved section of shared memory on each board. This memory area is used only for communication between V+ application programs, and is not used for any other purpose.

This memory can be accessed by the six IOPUT_ instructions (IOPUTB, IOPUTD, IOPUTF, IOPUTL, IOPUTS, and IOPUTW), the five IOGET_ real-valued functions (IOGETB, IOGETD, IOGETF, IOGETL, and IOGETW), and the string function $IOGETS. See the *V+ Language Reference Guide* for more details.

The real-valued function IOTAS can be used to interlock access to this memory.

Each of the above keywords has a "type" parameter. Type 0 (zero), the default, is used to access memory on other Adept V+ processors.

Shared Data

The IOGET_, $IOGETS, and IOPUT_ keywords allow the following to be written and read:

- Single bytes
- 16-bit words
- 32-bit longwords
- 32-bit single-precision floating-point values
- 64-bit double-precision floating-point values
- Strings up to 128 bytes

An address parameter indicates the position within the application shared-area to which the value is to be written, or from which the value is to be read. Acceptable address values are 0 to hexadecimal 1FFF (decimal 8191).

Any Adept system processor can access the shared memory areas of all the Adept system processors (including its own area). The IOGET_, $IOGETS, IOPUT_ and IOTAS keywords have an optional parameter to specify the processor number. The default value for the processor parameter is 0, which is the local processor (that is, the processor on which the instruction is executing). A nonzero value for the processor parameter causes that processor to be accessed. (Note that a processor can access itself as either processor 0 or by its real processor number.)

For example, the instruction:

```
IOPUTS ^HFF, 0, 3 = "Hello"
```

will write five ASCII bytes to the shared memory area on processor 3 at the address ^HFF.

Adept MV controllers support up to four processors, numbered 1 to 4. The processor number is established by the board-address switches on the processor module. The V+ monitor window indicates the number of the processor with which it is associated: the monitor window for processor 1 is simply entitled "Monitor", the window for processor 2 is entitled "Monitor_2", and so on.

WARNING: V+ does not enforce any memory protection schemes for use of the application shared-memory area. It is the programmer's responsibility to keep track of memory usage. If you are using application or utility programs (for example, Adept AIM VisionWare or AIM MotionWare) you should read the documentation provided with that software to check that there is no conflict with your usage of the shared area. AIM users should note that Adept plans to assign application shared-memory starting from the top (address hexadecimal 1FFF) and working down. Therefore, users should start at the bottom (address 0) and work up.

If you read a value from a location that has not been previously written to, you will get an invalid value; *you will not get an error message*. The system will provide a value based upon the default memory contents and the manner in which the memory is being read. (Every byte of the application shared-area is initialized to zero when V+ is initialized.)

The memory addresses are based on single-byte (8-bit) memory locations. For example, if you write a 32-bit (4-byte) value to an address, the value will occupy four address spaces (the address that you specify, and the next three addresses).

If you read a value from a location using a format different than the format that was used to write to that location, you will also get an invalid value; *you will not get an error message*. The system will provide a value based upon the default memory contents (For example, if you write using IOPUTF and read using IOPUTL, the value read will be invalid.)

IOTAS and Data Integrity

Some IOPUT_ and IOGET_ operations involve multiple hardware read or write cycles. For example, all 64-bit operations will involve at least two 32-bit data transfers (three transfers if the operation crosses more than one 32-bit boundary). If a 16-bit or 32-bit operation crosses a 32-bit boundary, it will involve two transfers.

Operations that must cross a 32-bit boundary can be interlocked using the IOTAS( ) function. The syntax and an example are given in the *V+ Language Reference Guide* for 11.0. The IOTAS function performs a hardware-level "read-modify write" (RMW) cycle on the VMEbus to make a "Test And Set" operation indivisible in a multiprocessing environment. If multiple processors all access the same byte by using IOTAS, the byte can serve as an interlock between the processors.

WARNING: Depending on the application, there is a possibility that a V+ program running on one processor may update a shared-memory area while a program on another processor is reading it. In this case, data that is read across a 32-bit boundary may be invalid. If the data is being used for safety-critical operations, including robot motions, the programmer must use the IOTAS function to prevent such conflicts.

Efficiency Considerations

You can put your shared data on any processor. However, it is most efficient to put the data on the processor that will use it most often, or that is performing the most time-critical operations. (It takes slightly longer to access data on another processor than to access data on the local processor.) If you wish, you can put some of your data on one processor, and other data on a different processor. You must be careful to keep track of which data items are stored in which location.

32-bit and 64-bit operations operate slightly faster if the address is an exact multiple of four. 16-bit operations operate slightly faster if the address is an exact multiple of two.

Digital I/O

The digital I/O image, including input (1001-1512), output (1-512), and soft signals (2000-2512) is managed by processor 1. These signals are shared by all processors. The soft signals may be used to pass control information between processors.

13.3 Restrictions With Multiple Processors

There are several V+ operations that may be performed only from Processor #1. In general, robot control and system configuration changes must be performed from Processor #1. Processors other than #1 always start up with the stand-alone control module, with no belts or kinematic modules loaded. In addition, the following commands/instructions may be executed only on Processor #1:

- ENABLE/DISABLE of POWER
- ENABLE/DISABLE of ROBOT
- INSTALL

If attempted on another processor, they will return the error:

```
-666    *Must use Monitor #1*
```

S-Curve Trajectory Generation 14

This chapter describes the characteristics of the trajectory profiles in V+ 11.0 and later, and how these trajectories are affected by motion instructions and commands. For brevity, in the following sections, the word "acceleration" refers to both the acceleration and the deceleration phases of a motion.

14.1 Changes in V+ 11.0

SPEED Program Instruction

Unlike previous V+ versions, modifying the maximum speed in V+ 11.0 no longer has an affect on the maximum desired acceleration for a motion. Formerly, when the desired speed was increased, the desired acceleration was also automatically increased. At times, this was convenient, since it allowed a single parameter to be used to increase the overall performance of the robot. However, at other times, this coupling made optimizing the performance of the robot very difficult. As described later in the "SCALE.ACCEL" section, the acceleration and speed settings can now be independent; however, in V+ 11.0 and later they are coupled by default.

SPEED Monitor Command

In earlier versions of V+ the SPEED monitor command and the SPEED program instruction had the same effect on the robot's trajectory. In V+ 11.0 (and later) however, the effect of the monitor SPEED is quite different from the effect of the SPEED program instruction.

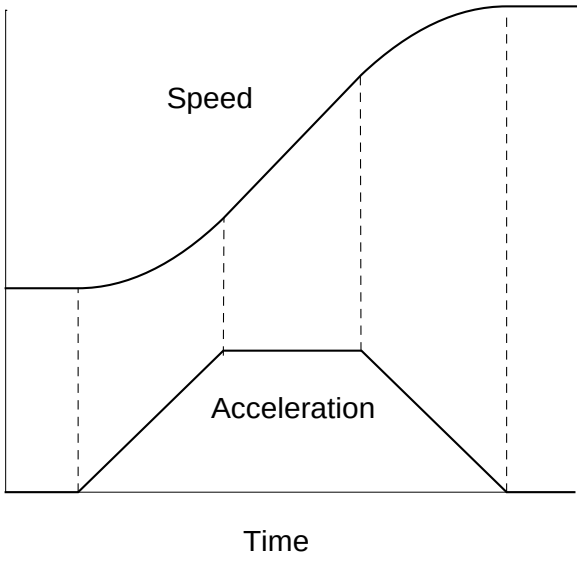

Figure 14-1. . S-Curve Generation

14.2 S-Curve Parameters

While there are many different motion profiles that can be characterized as "S-curves", in V^+ an S-curve is a trajectory that has a trapezoidal acceleration profile, as shown in Figure 14-1. . (In earlier versions of V^+, the acceleration profile was a square wave.)

The benefit of a trapezoidal acceleration profile is that the rate of change of acceleration (the "jerk") can be controlled. (By comparison, the magnitude of the jerk for a square-wave acceleration profile is always infinite.) For many mechanisms, controlling the jerk is significant because high jerk values can cause the mechanical structure of the robot to vibrate. Minimizing structural vibrations is especially important at the end of a motion, since such oscillations can adversely affect the settling time of the robot.

For a general trapezoidal profile, there are four acceleration values that can be specified:

1. The ramp up to maximum acceleration
1. The ramp down from maximum acceleration
2. The ramp up to maximum deceleration
3. The ramp down to zero acceleration.

In V^+, each of these four acceleration values can be individually specified, and a set of the four values defines a specific acceleration "profile". For each robot, there can be as many as nine different "profiles". Profile 0 is always defined to be a square-wave acceleration curve with all four ramp times set to zero. Profiles 1 through 8 are defined by the robot manufacturer and are a function of the mechanical design of the manipulator and the applications for which the robot was designed. For instance, the manufacturer might define a general-purpose profile that has all of the ramp times set equal to a nominal value

for the mechanism. This profile could be used whenever smooth performance throughout the motion was more important than minimum cycle time. In instances where cycle time is more important, a profile with high jerk values during the acceleration and low jerk values during the deceleration might be more appropriate.

Robot programmers may use the ACCEL instruction to select from any available S-curve profiles that may have been predefined for your robot. Consult your Robot User Guide to see which parameters are available for your robot.

The default profile is Profile 1. (The default may be changed permanently using the SPEC utility program, or overridden using the ACCEL instruction.) If any profile is selected that is not defined, including Profile 1, then Profile 0 is used instead. Profile 0 is "linear acceleration", the same profile as used on V+ version 10 and earlier. Thus, if no S-curve profiles have been defined for your robot, linear acceleration will automatically be used instead.

> **NOTE:** The S-curve parameters can be changed only by the robot manufacturer (using the SPEC program, and a unique password for that robot). If you are building your own robot, controlled by AdeptMotion VME, then you are the "manufacturer" and have full access to define the S-curve parameters without a password.

For a given motion, the duration of the motion and the characteristics of the acceleration profile are functions of several parameters. These parameters are controlled by a number of V^+ instructions and commands. In the following sections, the effects of each of these instructions and commands are described. In these descriptions, no distinction is made between interpolating in joint coordinates versus interpolating in a Cartesian coordinate system since, from the standpoint of trajectory profiles, these different coordinate systems can be treated in exactly the same manner.

14.3 Keyword Changes

ACCEL Program Instruction

The ACCEL program instruction defines the profile, maximum acceleration, and maximum deceleration to be used in subsequent motions. The profile is specified as one of the nine built-in V^+ profiles. The maximum acceleration and deceleration are specified as percentages of the 100% values defined for the robot.

Normally, the robot manufacturer sets the 100% acceleration and deceleration values to rates that can be achieved with typical payloads and robot link inertias. However, because the actual attainable accelerations vary greatly as a function of the end effector, payload, and the initial and final locations of a motion, accelerations greater than 100% may be permitted for your robot. The limits for the maximum values are defined by the robot manufacturer and vary from one type of robot to the next. If you specify a higher acceleration than is permitted, the limit established by the robot manufacturer is utilized.

You can use the functions ACCEL(3) and ACCEL(4) to determine the maximum allowable acceleration and deceleration settings.

For a given motion, the maximum attainable acceleration may actually be less than what you have requested. This occurs when a profile with a nonzero acceleration ramp time is used and there is insufficient time to ramp up to the maximum acceleration. That is, for a given jerk, a specific time must elapse before the acceleration can be changed from a zero value to the specified maximum value. If the maximum acceleration cannot be achieved, the trapezoidal profile will be reduced to a triangular shape. There are two circumstances when this will occur:

4. The motion is too short. In this case, the change in position is achieved before the maximum acceleration can be achieved
5. The maximum motion speed is too low. In this case, the maximum speed is achieved before the maximum acceleration.

In both of these situations, raising the maximum acceleration and deceleration values does not affect the time for the motion.

Hint: If you increase the maximum acceleration and deceleration values but the motion time does not change, try the following: increase the program speed; switch to an acceleration profile that allows faster acceleration ramp times; or switch to acceleration profile 0, which specifies a square-wave acceleration profile.

Note: This type of acceleration limiting cannot occur with acceleration profile 0, since a square-wave acceleration instantaneously changes acceleration values without ramping.

SPEED Program Instruction

The SPEED program instruction defines the maximum speed for the next or subsequent motions. The maximum speed is either specified as a percentage of the 100% values defined for the robot, or in units of distance per second. For the purposes of this discussion, we can ignore the latter type of specification since, this is internally equivalent to a percentage specification.

As with the accelerations, the robot manufacturer normally sets the 100% speed values to rates that can be achieved with typical payloads and robot link inertias. Also, speeds greater than 100% are typically allowed to permit shorter cycle times in situations where the payload or robot link inertias are reduced. If you specify a higher speed than is allowed, the limit established by the robot manufacturer will be utilized.

You can use the SPEED(8) function to determine the maximum allowable percentage program speed setting.

For a given motion, the maximum attainable speed may actually be less than what you have requested. This occurs when a trajectory is acceleration limited. In this situation, the robot is continuously accelerating and then continuously decelerating at the maximum rates allowed, but the specified speed cannot be achieved before the required change in position is completed. When this occurs, further increasing the maximum speed specification will not have an affect upon the time for that motion.

Hint: If you increase the maximum speed and the motion time does not change, try increasing the motion acceleration parameters as described in the previous section.

Note: This type of acceleration limiting can occur with any type of acceleration profile including the square-wave profile.

SPEED Monitor Command

The SPEED monitor command instantaneously alters the robot speed when a robot is moving under user program control. As with the SPEED program instruction, the SPEED monitor command takes an argument that is interpreted as a percentage. However, the effect of the monitor SPEED is quite different from the effect of program SPEED.

As previously described, when the program SPEED is altered, acceleration is unaffected, and vice versa. During a continuous-path motion, when either the program speed or acceleration is changed independently, the path of the robot may be altered when the robot is transitioning from one motion to the next. For example, let's examine the case where the robot starts at point A, moves to point B, and then turns right to move to a point C (the line B-C is perpendicular to A-B). In continuous path mode, since the robot only has finite acceleration, the robot will not travel directly through the point B. Instead, it will follow a curved path that is tangent to the lines A-B and B-C. The curvature of the path through the transition region is a function of the desired robot speed along A-B and B-C, and its maximum acceleration through the transition region. In general, if any of these speeds or the acceleration are independently altered, the curvature of the transition path will be modified.

Since the SPEED monitor command is primarily provided as a debugging aid to allow motions to be previewed at low speed, it is undesirable for this command to alter the path of the robot. Consequently, unlike the SPEED program instruction, the SPEED monitor command modifies both the robot speed and acceleration in such a way that the path of the robot is unaffected.

Also, because the monitor SPEED command is not intended as a speed tuning mechanism and also due to safety considerations, this command can only be used to slow down the motions specified by the user program. Consequently, monitor SPEED values over 100% are not permitted.

The effects of this command can be summarized as follows:

- Takes effect immediately, even during a program controlled motion (subject to certain limitations that restrict the rate at which the path speed can be altered).
- Alters both the motion speed and acceleration.
- Does not affect the path of the robot.
- Can only slow down the program-specified speed, not speed it up.
- Does not affect DELAY instructions so that critical time delays are not altered.
- Does affect any specified motion DURATIONs so as to not affect the path of the robot.

SCALE.ACCEL System Switch

In general, it is undesirable to have changes in the maximum program speed affect the maximum acceleration values. However, there is one situation where coupling between speed and acceleration can be quite convenient.

When programming an application, it is not unusual for a single value for the maximum acceleration to be used throughout the application. In this case, the tuning for individual motions largely consists of selecting an appropriate speed for each operation. If the maximum acceleration is selected so as to optimize high-speed motions and if an acceleration profile is used that has very fast acceleration ramps, a problem with slow-speed motions arises. With these trajectory parameters, during a slow motion, the robot will be quickly accelerated up to speed, will move slowly, and then will be quickly decelerated to a stop. In the extreme case where a square-wave acceleration profile is used with a very slow motion, at the start and end of the motion, the robot will be subjected to a very short acceleration impulse equal in magnitude to the maximum acceleration value. This impulse can cause an unacceptable vibration of the robot.

To address this behavior, V+ conditionally scales down the specified maximum acceleration and deceleration values when the specified program speed is below 100%. (When the program speed is at or above 100%, the accelerations and the program speed are not coupled.) If this coupling is not desired, the coupling can be disabled with the SCALE.ACCEL system switch.

Individual Axis Control 15

The following changes have been made in V+ Version 11.1 to support independent axis control:

- Changed the maximum number of mechanisms from 3 to 15.

  A "mechanism" can range from a complex multi-axis robot device, to a single axis operating independently. A typical system may have one or more multi-axis robots and several independent axes.

  The actual maximum number of multi-axis robot devices will be limited by the kinematic complexity of the devices. Typically up to 2 complex multi-axis mechanisms can be configured, depending on the processing power of your controller.

  The previous limit of 24 axes total per controller still applies.

- Added the ability to control continous-turn axes. (See the SPIN instruction [in the *V+ Language Reference Guide*].)
- Increased the maximum value of the parameter "NOT.CALIBRATED" from 7 to 32,767 (^H7FFF). This parameter is a bit mask, with a bit for each mechanism.
- The STATE(2) real-valued function has been enhanced.
- Added a new error message that more explicitly indicates the source of the error when a program attempts to move a "joints" robot along a straight-line path. See Error –635. Currently, only the JTS robot will generate this error message.

15.1 Manual Control Pendant Changes

The following changes to the Manual Control Pendant (MCP) ID display are to support manual control of up to 15 mechanisms.

The Status display has been changed. Formerly, the fourth soft button selected the ID display for robots one and two, and the fifth soft button selected the ID display for robot three. Now, the fourth button selects the robot ID display. Once inside the robot ID menu, the ID of the first robot is displayed. Pressing "+" or "MORE" displays the ID for the next robot. Pressing "–" displays the ID for the previous robot. DONE terminates the display mode.

When F3 is used to select the next robot and the robot number is greater than 3, the robot/device LED blinks. That is, for robot 1, this LED is off. For robot 2, this LED is solid on. For robot 3 and beyond, this LED blinks.

When one of the manual control modes (TOOL, WORLD, etc.) is selected, the normal background display of the program execution status is superceded by a display that indicates which robot is being manually controlled. The following information is displayed: the first 40 characters of the robot's startup message, the number of the robot, and the range of joints being controlled. When manual control mode is terminated, the MCP reverts to displaying the standard program execution information.

When the MCP is plugged into the controller, the background display is refreshed. Formerly, the background display would only be redrawn when the execution status of user task 0 was altered. This typically left the MCP LCD display blank after the MCP was plugged into a running system. This new refresh mode only affects the background display and does not change the situation when any other display mode is in effect.

When arm power is being enabled, the arm power LED on the MCP blinks and the STATUS command now reports “Enabling power”.

Index

W

X

Z

Adept User's Manual Comment Form

We have provided this form to allow you to make comments about this manual, to point out any mistakes you may find, or to offer suggestions about information you want to see added to the manual. We review and revise user's manuals on a regular basis, and we will give serious consideration to any comments or feedback you send us. Thank you for your input.

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