DENSO ROBOT

Vertical articulated

V*-D/-E SERIES

Horizontal articulated

H*-D/-E SERIES

Cartesian coordinate

XYC-4D SERIES

Vision device

μVision-21 SERIES

PROGRAMMER'S MANUAL I
PROGRAM DESIGN AND COMMANDS

(Ver. 1.95)

Preface

Thank you for purchasing this high-speed, high-accuracy assembly robot.

Before operating your robot, read this manual carefully to safely get the maximum benefit from your robot in your assembling operations.

Robot series and/or models covered by this manual

- Vertical articulated robot	V*-D/-E series
- Horizontal articulated robot	H*-D/-E series
- Cartesian coordinate robot	XYC-4D series
- Vision devaicec	μVision-21 series

Robot controller version (Note)

- Applicable to up to Ver. 1.9 of the RC5 type controller.

Note: The robot controller version is indicated in the main software ver. column of the controller setting table affixed on the controller. It can also be confirmed from the teaching pendant by reading the ROM version column displayed by “basic screen” - “F6 setting” - “F6 maintenance” - “F2 version”.

Important

To ensure operator safety, be sure to read the precautions and instructions in "SAFETY PRECAUTIONS," pages 1 through 9.

How the documentation set is organized

The documentation set consists of the following books. If you are unfamiliar with this robot and option(s), please read all books and understand them fully before operating your robot and option(s).

GENERAL INFORMATION ABOUT ROBOT

Provides the packing list of the robot and outlines of the robot system, robot unit, and robot controller.

INSTALLATION & MAINTENANCE GUIDE

Provides instructions for installing the robot components and customizing your robot, and maintenance & inspection procedures.

BEGINNER'S GUIDE

Introduces you to the DENSO robot. Taking an equipment setup example, this book guides you through running your robot with the teach pendant, making a program in WINCAPSII, and running your robot automatically.

SETTING-UP MANUAL

Describes how to set-up or teach your robot with the teach pendant, operating panel, or mini-pendant.

WINCAPSII GUIDE

Provides instructions on how to use the teaching system WINCAPSII which runs on the PC connected to the robot controller for developing and managing programs.

PROGRAMMER'S MANUAL (I), (II) - this book -

Describes the PAC programming language, program development, and command specifications in PAC.

RC5 CONTROLLER
INTERFACE MANUAL

Describes the RC5 controller, interfacing with external devices, system- and user-input/output signals, and I/O circuits.

ERROR CODE TABLES

List error codes that will appear on the teach pendant, operating panel, or PC screen if an error occurs in the robot series or WINCAPSII. These tables provide detailed description and recovery ways.

OPTIONS MANUAL

Describes the specifications, installation, and use of optional devices.

How this book is organized

This book is just one part of the documentation set. This book consists of SAFETY PRECAUTIONS and chapters one through five.

SAFETY PRECAUTIONS

Defines safety terms, safety related symbols and provides precautions that should be observed. Be sure to read this section before operating your robot.

Commands Listed in Alphabetical Order

Commands Listed According to Functions

PART 1 PROGRAM DESIGN

Chapter 1 Sample Program

This chapter utilizes a simple application example to provide usage of each command.

Chapter 2 Program Flow

This chapter provides an explanation on the rules, which are required for creating a program, for the operation of programs in the PAC language.

Chapter 3 Robot Motion

This chapter provides an explanation of various motions of the robot. The robot motion varies according to the reference position and the decision method for reach destination position.

Chapter 4 Speed, Acceleration and Deceleration Designation

This chapter provides an explanation of the meanings and settings for speed, acceleration, and deceleration.

Chapter 5 Vision Control

This chapter provides explanations of terms related to vision that are required in creating a program.

PART 2 COMMAND REFERENCE

Chapter 6 Guide to Command Reference

This chapter provides command descriptions and a command list for the PAC robot.
Use the command list to quickly search for information concerning each command.

Chapter 7 PAC Language Configuration Elements

This chapter provides an explanation of the element rules (identifier, variable, constant, operator, expression, and command) which construct the PAC language.

Chapter 8 PAC Language Syntax

This chapter provides an explanation on the rules of syntax when you describe a program in the PAC language.

Chapters 9 to 21

These chapters provide an explanation of each command in the PAC robot language. Commands are classified by function.

To quickly find an explanation of a particular command, use the command list in CHAPTER 1.

Chapter 22 Appendices

Character Code Table

Figures of the Shoulder, Elbow, and Wrist

Environment Setting Values

Using Condition Parameters

Reserved Word List

Conventional Language Command Correspondence Table (VS)

Version Correspondence Table

Setting Parameter Table

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SAFETY PRECAUTIONS

Be sure to observe all of the following safety precautions.

Strict observance of these warning and caution indications are a MUST for preventing accidents, which could result in bodily injury and substantial property damage. Make sure you fully understand all definitions of these terms and related symbols given below, before you proceed to the text itself.

⚠ **WARNING**	Alerts you to those conditions, which could result in serious bodily injury or death if the instructions are not followed correctly.
⚠ **CAUTION**	Alerts you to those conditions, which could result in minor bodily injury or substantial property damage if the instructions are not followed correctly.

Terminology and Definitions

Maximum space: Refers to the volume of space encompassing the maximum designed movements of all robot parts including the end-effector, workpiece and attachments. (Quoted from the RIA* Committee Draft.)

Restricted space: Refers to the portion of the maximum space to which a robot is restricted by limiting devices (i.e., mechanical stops). The maximum distance that the robot, end-effector, and workpiece can travel after the limiting device is actuated defines the boundaries of the restricted space of the robot. (Quoted from the RIA Committee Draft.)

Motion space: Refers to the portion of the restricted space to which a robot is restricted by software motion limits. The maximum distance that the robot, end-effector, and workpiece can travel after the software motion limits are set defines the boundaries of the motion space of the robot. (The "motion space" is Denso-proprietary terminology.)

Operating space: Refers to the portion of the restricted space (or motion space in Denso) that is actually used by the robot while performing its task program. (Quoted from the RIA Committee Draft.)

Task program: Refers to a set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. (Quoted from the RIA Committee Draft.)

(*RIA: Robotic Industries Association)

1. Introduction

This section provides safety precautions to be observed during installation, teaching, inspection, adjustment, and maintenance of the robot.

2. Installation Precautions

2.1 Insuring the proper installation environment

2.1.1 For standard type

The standard type has not been designed to withstand explosions, dust-proof, nor is it splash-proof. Therefore, it should not be installed in any environment where:

(1) there are flammable gases or liquids,

(2) there are any shavings from metal processing or other conductive material flying about,

(3) there are any acidic, alkaline or other corrosive gases,

(4) there is cutting or grinding oil mist,

(5) it may likely be submerged in fluid,

(6) there is sulfuric cutting or grinding oil mist, or

(7) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.

2.1.2 For dust-proof, splash-proof type

The dust-proof, splash-proof type is an IP54-equivalent dust-proof and splash-proof structure, but it has not been designed to withstand explosions. (The wrist of the VM-D-W and VS-E-W is an IP65-equivalent dust-proof and splash-proof structure.)

Note that the robot controller is not a dust- or splash-proof structure. Therefore, when using the robot controller in an environment exposed to mist, put it in an optional protective box.

The dust-proof, splash-proof type should not be installed in any environment where:

(1) there are any flammable gases or liquids,

(2) there are any acidic, alkaline or other corrosive gases,

(3) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,

(4) it may likely be submerged in fluid,

(5) there are any grinding or machining chips or shavings,

(6) any machining oil other than DENSO authorized oil is in use, or

Note: DENSO authorized oil: Yushiron Oil No. 4C (non-soluble)

(7) there is sulfuric cutting or grinding oil mist.

2.2 Service space

The robot and peripheral equipment should be installed so that sufficient service space is maintained for safe teaching, maintenance, and inspection.

2.3 Control devices outside the robot's restricted space

The robot controller, teach pendant, and operating panel should be installed outside the robot's restricted space and in a place where you can observe all of the robot’s movements when operating the robot controller, teach pendant, or operating panel.

2.4 Positioning of gauges

Pressure gauges, oil pressure gauges and other gauges should be installed in an easy-to-check location.

2.5 Protection of electrical wiring and hydraulic/pneumatic piping

If there is any possibility of the electrical wiring or hydraulic/pneumatic piping being damaged, protect them with a cover or similar item.

2.6 Positioning of emergency stop switches

Emergency stop switches should be provided in a position where they can be reached easily should it be necessary to stop the robot immediately.

(1) The emergency stop switches should be red.

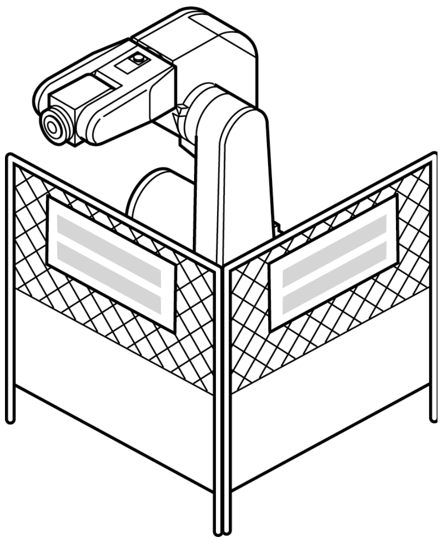
(2) Emergency stop switches should be designed so that they will not be released after pressed, automatically or mistakenly by any other person.

(3) Emergency stop switches should be separate from the power switch.

2.7 Positioning of operating status indicators

Operating status indicators should be positioned in such a way where workers can easily see whether the robot is on temporary halt or on an emergency or abnormal stop.

2.8 Setting-up the safety fence or enclosure



A safety fence or enclosure should be set up so that no one can easily enter the robot's restricted space. If it is impossible, utilize other protectors as described in Section 2.9.

(1) The fence or enclosure should be constructed so that it cannot be easily moved or removed.

(2) The fence or enclosure should be constructed so that it cannot be easily damaged or deformed through external force.

(3) Establish the exit/entrance to the fence or enclosure. Construct the fence or enclosure so that no one can easily get past it by climbing over the fence or enclosure.

(4) The fence or enclosure should be constructed to ensure that it is not possible for hands or any other parts of the body to get through it.

(5) Take any one of the following protections for the entrance/ exit of the fence or enclosure:

1) Place a door, rope or chain across the entrance/exit of the fence or enclosure, and fit it with an interlock that ensures the emergency stop device operates automatically if it is opened or removed.

2) Post a warning notice at the entrance/exit of the fence or enclosure stating "In operation--Entry forbidden" or "Work in progress--Do not operate" and ensure that workers follow these instructions at all times.

When making a test run, before setting up the fence or enclosure, place an overseer in a position outside the robot’s restricted space and one in which he/she can see all of the robot’s movements. The overseer should prevent workers from entering the robot's restricted space and be devoted solely to that task.

2.9 Positioning of rope or chain

If it is not possible to set up the safety fence or enclosure described in Section 2.8, hang a rope or chain around the perimeter of the robot’s restricted space to ensure that no one can enter the restricted space.

(1) Ensure the support posts cannot be moved easily.

(2) Ensure that the rope or chain’s color or material can easily be discerned from the surrounds.

(3) Post a warning notice in a position where it is easy to see stating "In operation--Entry forbidden" or "Work in progress --Do not operate" and ensure that workers follow these instructions at all times.

(4) Set the exit/entrance, and follow the instructions given in Section 2.8, (3) through (5).

2.10 Setting the robot's motion space

The area required for the robot to work is called the robot's operating space.

If the robot’s motion space is greater than the operating space, it is recommended that you set a smaller motion space to prevent the robot from interfering or disrupting other equipment.

Refer to the "INSTALLATION & MAINTENANCE GUIDE" Chapter 4.

2.11 No robot modification allowed

Never modify the robot unit, robot controller, teach pendant or other devices.

2.12 Cleaning of tools

If your robot uses welding guns, paint spray nozzles, or other end-effectors requiring cleaning, it is recommended that the cleaning process be carried out automatically.

2.13 Lighting

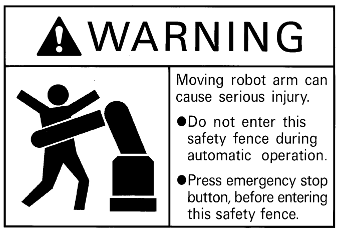
Sufficient illumination should be assured for safe robot operation.

2.14 Protection from objects thrown by the end-effector

If there is any risk of workers being injured in the event that the object being held by the end-effector is dropped or thrown by the end-effector, consider the size, weight, temperature and chemical nature of the object and take appropriate safeguards to ensure safety.

2.15 Affixing the warning label

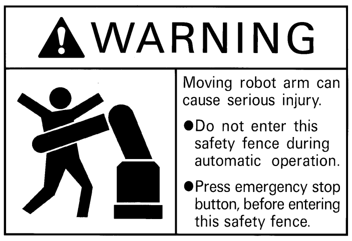
Place the warning label packaged with the robot on the exit/entrance of the safety fence or in a position where it is easy to see.


WARNING
Moving robot arm can cause serious injury.
●Do not enter this safety fence during automatic operation.
●Press emergency stop button, before entering this safety fence.

3. Precautions while robot is running

⚠ **Warning**

Touching the robot while it is in operation can lead to serious injury. Please ensure the following conditions are maintained and that the cautions listed from Section 3.1 onwards are followed when any work is being performed.


WARNING
Moving robot arm can cause serious injury.
●Do not enter this safety fence during automatic operation.
●Press emergency stop button, before entering this safety fence.

1) Do not enter the robot's restricted space when the robot is in operation or when the motor power is on.
2) As a precaution against malfunction, ensure that an emergency stop device is activated to cut the power to the robot motor upon entry into the robot's restricted space.
3) When it is necessary to enter the robot's restricted space to perform teaching or maintenance work while the robot is running, ensure that the steps described in Section 3.3 "Ensuring safety of workers performing jobs within the robot's restricted space" are taken.

3.1 Creation of working regulations and assuring worker adherence

When entering the robot’s restricted space to perform teaching or maintenance inspections, set "working regulations" for the following items and ensure workers adhere to them.

(1) Operating procedures required to run the robot.

(2) Robot speed when performing teaching.

(3) Signaling methods to be used when more than one worker is to perform work.

(4) Steps that must be taken by the worker in the event of a malfunction, according to the contents of the malfunction.

(5) The necessary steps for checking release and safety of the malfunction status, in order to restart the robot after robot movement has been stopped due to activation of the emergency stop device

(6) Apart from the above, any steps below necessary to prevent danger from unexpected robot movement or malfunction of the robot.

1) Display of the control panel (See Section 3.2 on the following page)
2) Assuring the safety of workers performing jobs within the robot's restricted space (See Section 3.3 on the following page)
3) Maintaining worker position and stance

   Position and stance that enables the worker to confirm normal robot operation and to take immediate refuge if a malfunction occurs.

4) Implementation of measures for noise prevention
5) Signaling methods for workers of related equipment
6) Types of malfunctions and how to distinguish them

Please ensure "working regulations" are appropriate to the robot type, the place of installation and to the content of the work.

Be sure to consult the opinions of related workers, engineers at the equipment manufacturer and that of a labor safety consultant when creating these "working regulations".

3.2 Display of operation panel

To prevent anyone other than the worker from accessing the start switch or the changeover switch by accident during operation, display something to indicate it is in operation on the operating panel or teach pendant. Take any other steps as appropriate, such as locking the cover.

3.3 Ensuring safety of workers performing jobs within the robot's restricted space

When performing jobs within the robot’s restricted space, take any of the following steps to ensure that robot operation can be stopped immediately upon a malfunction.

(1) Ensure an overseer is placed in a position outside the robot’s restricted space and one in which he/she can see all robot movements, and that he/she is devoted solely to that task.

① An emergency stop device should be activated immediately upon a malfunction.

② Do not permit anyone other than the worker engaged for that job to enter the robot’s restricted space.

(2) Ensure a worker within the robot's restricted space carries the portable emergency stop switch so he/she can press it (the robot stop button on the teach pendant) immediately if it should be necessary to do so.

3.4 Inspections before commencing work such as teaching

Before starting work such as teaching, inspect the following items, carry out any repairs immediately upon detection of a malfunction and perform any other necessary measures.

(1) Check for any damage to the sheath or cover of the external wiring or to the external devices.

(2) Check that the robot is functioning normally or not (any unusual noise or vibration during operation).

(3) Check the functioning of the emergency stop device.

(4) Check there is no leakage of air or oil from any pipes.

(5) Check there are no obstructive objects in or near the robot’s restricted space.

3.5 Release of residual air pressure

Before disassembling or replacing pneumatic parts, first release any residual air pressure in the drive cylinder.

3.6 Precautions for test runs

Whenever possible, have the worker stay outside of the robot's restricted space when performing test runs.

3.7 Precautions for automatic operation

(1) At start-up

Before the robot is to be started up, first check the following items as well as setting the signals to be used and perform signaling practice with all related workers.

1) Check that there is no one inside the robot’s restricted space.

2) Check that the teach pendant and tools are in their designated places.

3) Check that no lamps indicating a malfunction on the robot or related equipment are lit.

(2) Check that the display lamp indicating automatic operation is lit during automatic operation.

(3) Steps to be taken when a malfunction occurs

Should a malfunction occur with the robot or related equipment and it is necessary to enter the robot's restricted space to perform emergency maintenance, stop the robot’s operation by activating the emergency stop device. Take any necessary steps such as placing a display on the starter switch to indicate work is in progress to prevent anyone from accessing the robot.

3.8 Precautions in repairs

(1) Do not perform repairs outside of the designated range.

(2) Under no circumstances should the interlock mechanism be removed.

(3) When opening the robot controller's cover for battery replacement or any other reasons, always turn the robot controller power off and disconnect the power cable.

(4) Use only spare tools authorized by DENSO.

4. Daily and periodical inspections

(1) Be sure to perform daily and periodical inspections. Before starting jobs, always check that there is no problem with the robot and related equipment. If any problems are found, take any necessary measures to correct them.

(2) When carrying out periodical inspections or any repairs, maintain records and keep them for at least 3 years.

5. Management of floppy disks

(1) Carefully handle and store the "Initial settings" floppy disks packaged with the robot, which store special data exclusively prepared for your robot.

(2) After finishing teaching or making any changes, always save the programs and data onto floppy disks.

Making back-ups will help you recover if data stored in the robot controller is lost due to the expired life of the back-up battery.

(3) Write the names of each of the floppy disks used for storing task programs to prevent incorrect disks from loading into the robot controller.

(4) Store the floppy disks where they will not be exposed to dust, humidity and magnetic field, which could corrupt the disks or data stored on them.

CONTENTS

Commands Listed in Alphabetical Order

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
#					
#define	Replaces a designated constant or macro name in the program with a designated character string.	⊙	⊙	⊙	20-1
#error	Forcibly generates a compiling error if the #error command is executed.	⊙	⊙	⊙	20-3
#include	Fetches the preprocessor program.	⊙	⊙	⊙	20-4
#pragma optimize	Designates optimization to be executed for each program.	⊙	⊙	⊙	20-5
#undef	Makes a symbol constant defined with #define or macro definition invalid.	⊙	⊙	⊙	20-2
A					
ABS	Obtains the absolute value of an expression value.	⊙	⊙	⊙	15-1
ACCEL	Designates internal acceleration and internal deceleration.	⊙	⊙		12-47
ACOS	Obtains an arc cosine.	⊙	⊙	⊙	15-12
APPROACH	Executes the absolute movement designated in the tool coordinate system.	○	○		12-1
AREA	Declares the area where an interference check is performed.	○	○		9-2
AREAPOS	Returns the center position and direction of a rectangular parallelepiped with the position type for an area where an interference check is performed.	⊙	⊙		15-46
AREASIZE	Returns the size (each side length) of a rectangular parallelepiped which defines the interference check area with the vector type.	⊙	⊙		15-47
ARRIVE	Defines the motion ratio relative to the programmed full travel distance to the target point in order to make the current program stand by to execute the next step until the robot reaches the defined motion ratio.	⊙	V1.2		12-32
ASC	Converts to a character code.	⊙	⊙	⊙	15-50
ASIN	Obtains an arc sine.	⊙	⊙	⊙	15-13
ATN	Obtains an arc tangent.	⊙	⊙	⊙	15-14
ATN2	Obtains the arc tangent of expression 1 divided by expression 2.	⊙	⊙	⊙	15-15
AVEC	Extracts an approach vector.	⊙	⊙		15-24
B					
BIN$	Converts the value of an expression to a binary character string.	⊙	⊙	⊙	15-51
BLOB	Executes labeling.	⊙	⊙	⊙	21-67
BLOBCOPY	Copies an object label number.	⊙	⊙	⊙	21-74
BLOBLABEL	Obtains the label number for designated coordinates.	⊙	⊙	⊙	21-72
BLOBMEASURE	Executes feature measurement of the object label number.	⊙	⊙	⊙	21-70
BUZZER	Sounds a buzzer.	⊙	⊙		13-22

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
C					
CALL	Calls a program and executes it.	⊙	⊙	⊙	11-4
CAMIN	Stores an image from the camera in the image memory (process screen).	⊙	⊙	⊙	21-3
CAMLEVEL	Sets the camera image input level.	⊙	⊙	⊙	21-6
CAMMODE	Sets the function used to store a camera image.	⊙	⊙	⊙	21-4
change_bCap	Edits a caption for a specified button.	V1.5	V1.5		13-32
change_pCap	Edits a caption for a specified page.	V1.5	V1.5		13-33
CHANGETOOL	Changes the tool coordinate system.	⊙	⊙		12-62
CHANGEWORK	Changes the user coordinate system.	⊙	⊙		12-63
CHR$	Converts an ASCII code to a character.	⊙	⊙	⊙	15-52
CLEARLOG	Initializes recording of the servo control log.	⊙	⊙		19-5
com_discom	Releases the RS-232C port from binary transmission.	V1.5	V1.5		13-18
com_encom	Enables the RS-232C port only for binary transmission.	V1.5	V1.5		13-17
com_state	Gets the status of RS-232C or Ethernet port.	V1.5	V1.5		13-19
COS	Obtains a cosine.	⊙	⊙	⊙	15-16
CREATESEM	Creates a semaphore.	⊙	⊙		14-7
CURACC	Gets the current internal composite acceleration of joints included in a currently held arm group.	⊙	⊙		12-51
CURDEC	Gets the current internal composite deceleration of joints included in a currently held arm group.	⊙	⊙		12-53
CUREXJ	Gets the current angle of an extended-joint into a floating-point variable.	V1.5	V1.6		12-27
CURFIG	Obtains the current value of the robot figure.	⊙	⊙		12-35
CURJACC	Gets the current internal acceleration of individual joints included in a currently held arm group.	⊙	⊙		12-52
CURJDEC	Gets the current internal deceleration of individual joints included in a currently held arm group.	⊙	⊙		12-54
CUREXTACC	Obtains the current external acceleration value.	V1.4	V1.4		12-57
CUREXTDEC	Obtains the current external deceleration value.	V1.4	V1.4		12-58
CUREXTSPD	Obtains the current external speed value.	V1.4	V1.4		12-59
CURJNT	Obtains the current angle of the robot using type J.	○	○		12-24
CURJSPD	Gets the current internal speed of individual joints included in a currently held arm group.	⊙	⊙		12-55
CURPOS	Obtains the current position in the tool coordinate system using type P.	○	○		12-25
CURSPD	Gets the current internal composite speed of joints included in a currently held arm group.	⊙	⊙		12-56
CURTOOL	Obtains the currently designated TOOL number.	V1.4	V1.4		12-64
CURTRN	Obtains the current position in the tool coordinate system using type T.	⊙	⊙		12-26
CURWORK	Obtains the currently designated WORK number.	V1.4	V1.4		12-65
D					
DATE$	Obtains the current date.	⊙	⊙		17-1
DECEL	Specifies the internal composite deceleration of joints involved in a currently held arm group.	⊙	⊙		12-49
DEF FN	Declares a user-defined function.	⊙	⊙	⊙	9-4

4-axis	6-axis	Vision device	
⦿	⦿	⦿	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
DEFDBL	Declares a double precision real type variable. The range of double precision real type variables is from -1.79769313486231D + 308 to 1.79769313486231D + 308.	⦿	⦿	⦿	9-10
DEFEND	Defends a task.	⦿	⦿		14-4
DEFINT	Declares an integer type variable. The range of the integer is from -2147483648 to 2147483647.	⦿	⦿	⦿	9-8
DEFIO	Declares an I/O variable corresponding to the input/output port.	⦿	⦿	⦿	9-16
DEFJNT	Declares a joint type variable.	○	○		9-14
DEFPOS	Declares a position type variable.	○	○		9-13
DEFSNG	Declares a single precision real type variable. The range of single precision real variables is from -3.402823E+38 to 3.402823E+38.	⦿	⦿	⦿	9-9
DEFSTR	Declares a character string type variable. You can enter 247 characters or less as a character string.	⦿	⦿	⦿	9-11
DEFTRN	Declares a homogeneous transformation type variable.	⦿	⦿		9-15
DEFVEC	Declares a vector type variable.	⦿	⦿		9-12
DEGRAD	Converts the unit to a radian.	⦿	⦿	⦿	15-19
DELAY	Suspends program processing for a designated period time.	⦿	⦿	⦿	12-60
DELETESEM	Deletes a semaphore.	⦿	⦿		14-10
DEPART	Executes the relative motion in the tool coordinate system.	○	○		12-4
DESTEXJ	Gets the target position of an extended-joint invoked by the current motion command into a floating-point variable. If the robot is on halt, this command will get the current position (commanded value).	V1.5	V1.6		12-31
DESTJNT	Obtains the current movement instruction destination position using type J. The current position (instruction value) is obtained when the robot stops.	○	○		12-28
DESTPOS	Obtains the current movement instruction destination position with type P. When the robot stops, the current value (instruction value) is obtained.	○	○		12-29
DESTTRN	Obtains the current movement instruction destination position with type T. When the robot stops, the current position (instruction value) is obtained.	⦿	⦿		12-30
DIM	Declares an array.	⦿	⦿	⦿	9-17
disp_page	Displays a specified page of a TP operation screen.	V1.5	V1.5		13-34
DIST	Returns the distance between two points.	○	○		15-35
DO-LOOP	Executes a decision iteration (repetition).	⦿	⦿	⦿	11-9
DRAW	Executes the relative movement designated in the work coordinate system.	⦿	⦿		12-7
DRIVE	Executes the relative motion of each axis.	⦿	⦿		12-9
DRIVEA	Executes the absolute motion of each axis.	⦿	⦿		12-11
E					
END	Declares the motion end by a program.	⦿	⦿	⦿	11-1
ERL	Obtains the line number where an error occurred.	⦿	⦿		18-1

4-axis	6-axis	Vision device	
⦿	⦿	⦿	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
ERR	Obtains an error number that occurred.	⦿	⦿		18-2
ERRMSG$	Sets an error message.	⦿	⦿	⦿	18-3
EXIT DO	Forcibly exits from DO-LOOP.	⦿	⦿	⦿	11-11
EXIT FOR	Forcibly exits from FOR-NEXT.	⦿	⦿	⦿	11-14
EXP	Obtains an exponential function with a natural logarithm taken as a base.	⦿	⦿	⦿	15-2
F					
FALSE	Sets a value of false (0) to a Boolean value.	⦿	⦿	⦿	16-4
FIG	Extracts a figure.	○	○		15-36
FIGAPRL	Calculates figures at an approach position and a standard position available to move in CP motion.	○	○		12-37
FIGAPRP	Calculates an approach position where the PTP motion is available, and a reference position figure.	○	○		12-39
FLUSH	Clears the input buffer.	⦿	⦿	⦿	13-12
FLUSHSEM	Releases tasks from waiting for a semaphore.	⦿	⦿		14-11
FOR-NEXT	Repeatedly executes a series of instructions between FOR-NEXT sections.	⦿	⦿	⦿	11-12
G					
GETENV	Obtains the environment setting values of the system.	⦿	⦿	⦿	19-1
GetSrvData	Gets the internal servo data of robot joints.	V1.5	V1.5		12-69
GetJntData	Gets the internal servo data of a specified joint.	V1.5	V1.5		12-70
GIVEARM	Releases robot control priority.	⦿	⦿		14-19
GIVESEM	Releases a task from waiting for a semaphore.	⦿	⦿		14-12
GIVEVIS	Releases visual process priority.	⦿	⦿		14-21
GOHOME	Moves to the position (home position) defined by the HOME statement.	⦿	⦿		12-13
GOSUB	Calls a subroutine.	⦿	⦿	⦿	11-6
GOTO	Unconditionally branches a program.	⦿	⦿	⦿	11-21
H					
HALT	Stops executing a program.	⦿	⦿		12-41
HEX$	Obtains a value converted from a decimal to a hexadecimal number as a character string.	⦿	⦿	⦿	15-56
HOLD	Holds program processing for a time.	⦿	⦿		12-40
HOME	Declares arbitrary coordinates as a home position.	○	○		9-5
I					
IF-END IF	Conditionally decides a conditional expression between IF-END IF.	⦿	⦿	⦿	11-17
IF-THEN-ELSE	Executes a conditional decision of a logical expression.	⦿	⦿	⦿	11-18
IN	Reads data from the I/O port designated by an I/O variable.	⦿	⦿	⦿	13-1
INIT	Turns on motors, carrier out CAL, and sets the speed according to the preset supervisor task parameters.	V1.7	V1.7		12-68
INPUT	Obtains data from the RS232C or Ethernet port.	⦿	⦿	⦿	13-8
inputb	Inputs a single byte of data from the RS-232C or Ethernet port.	V1.5	V1.5		13-14
INT	Obtains the maximum integer value possible from a designated value.	⦿	⦿	⦿	15-3

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
INTERRUPT ON/OFF	Interrupts a robot motion.	⊙	⊙		12-42
IOBLOCK ON/OFF	Concurrently executes a non-motion instruction such as an I/O or calculation instruction during execution of a motion instruction.	⊙	⊙		13-3
J					
J2P	Transforms joint type data to position type data.	○	○		15-28
J2T	Transforms joint type data to homogeneous transformation type data.	○	○		15-29
JACCEL	Specifies the internal acceleration and deceleration of individual joints included in a currently held arm group.	⊙	⊙		12-48
JDECEL	Specifies the internal deceleration ratio of individual joints included in a currently held arm group.	⊙	⊙		12-50
JOINT	Extracts an angle from joint type coordinates.	○	○		15-37
JSPEED	Specifies the internal speed of individual joints included in a currently held arm group.	⊙	⊙		12-46
K					
KILL	Forcibly terminates a task.	⊙	⊙		14-2
L					
LEFT$	Extracts the left part of a character string.	⊙	⊙	⊙	15-57
LEN	Obtains the length of a character string in bytes.	⊙	⊙	⊙	15-58
LET	Assigns a value to a variable.	○	○	○	10-1
LETA	Assigns a value to an approach vector of the homogeneous transformation type.		⊙		10-2
LETENV	Sets the environment setting values of the system.	⊙	⊙	⊙	19-2
LETF	Assigns a value to a figure component of the position type or homogenous transformation type.	⊙	⊙		10-5
LETJ	Assigns a value to a designated link angle of the joint type.	⊙	⊙		10-6
LETO	Assigns a value to an orientation vector of the homogeneous transformation type.	⊙	⊙		10-3
LETP	Assigns a value to a position vector of the position type or homogenous transformation type.	⊙	⊙		10-4
LETR	Assigns a value to three rotation components of the position type.		⊙		10-7
LETRX	Assigns a value to the X axis rotation component of the position type.		⊙		10-8
LETRY	Assigns a value to the Y axis rotation component of the position type.		⊙		10-9
LETRZ	Assigns a value to the Z axis rotation component of the position type.		⊙		10-10
LETT	Assigns a value to the T axis component of the position type.	⊙			10-11
LETX	Assigns a value to the X axis component of the Vector type/ Position type/ Homogenous transformation type.	⊙	⊙		10-12
LETY	Assigns a value to the Y axis component of the Vector type/ Position type/ Homogenous transformation type.	⊙	⊙		10-13
LETZ	Assigns a value to the Z axis component of the vector type/ position type/ homogeneous transformation type.	⊙	⊙		10-14

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
LINEINPUT	Reads data to a delimiter through the RS232C or Ethernet port and assigns it to a character string type variable.	⊙	⊙	⊙	13-9
linputb	Inputs multiple bytes of data from the RS-232C or Ethernet port.	V1.5	V1.5		13-16
LOG	Obtains a natural logarithm.	⊙	⊙	⊙	15-4
LOG10	Obtains a common logarithm.	⊙	⊙	⊙	15-5
lprintb	Outputs multiple bytes of data to the RS-232C or Ethernet port.	V1.5	V1.5		13-15
M					
MAGNITUDE	Obtains the vector size.	⊙	⊙		15-27
MAX	Extracts the maximum value.	⊙	⊙	⊙	15-7
MID$	Extracts a character string for the designated number of characters from a character string.	⊙	⊙	⊙	15-59
MIN	Extracts the minimum value.	⊙	⊙	⊙	15-8
MOVE	Moves to the designated coordinate.	○	○		12-14
MPS	Converts an expression of speed.	⊙	⊙		15-22
N					
ndTC	Sets the TC time.	⊙	V1.2		4-23
ndTS	Sets the TS time and slow speed.	⊙	V1.2		4-23
O					
OFF	Sets an OFF (0) value.	⊙	⊙	⊙	16-1
ON	Sets an ON (1) value.	⊙	⊙	⊙	16-2
ON ERROR GOTO	Interrupts when an error occurs.	⊙	⊙		18-4
ON-GOSUB	Calls a corresponding subroutine to the value of an expression.	⊙	⊙	⊙	11-7
ON-GOTO	Executes an unconditional branch due to the value of an expression.	⊙	⊙	⊙	11-22
ORD	Converts to a character code.	⊙	⊙	⊙	15-60
OUT	Outputs data to the I/O port designated by an I/O variable.	⊙	⊙	⊙	13-2
OVEC	Extracts an orient vector.	⊙	⊙		15-25
P					
P2J	Transforms position type data to joint type data.	○	○		15-30
P2T	Transforms position type data to homogeneous transformation type data.	○	○		15-31
PI	Sets a π value.	⊙	⊙	⊙	16-3
POSCLR	Forcibly restores the current position of a joint to 0 mm or 0 degree.	V1.5	V1.6		12-34
POSRX	Extracts the X-axis rotation component.		⊙		15-41
POSRY	Extracts the Y-axis rotation component.		⊙		15-42
POSRZ	Extracts the Z-axis rotation component.		⊙		15-43
POST	Extracts the T-axis rotation component.	⊙			15-44
POSX	Extracts the X-component.	○	○		15-38
POSY	Extracts the Y-component.	○	○		15-39
POSZ	Extracts the Z-component.	○	○		15-40
POW	Obtains an exponent.	⊙	⊙	⊙	15-6
PRINT	Outputs data from the RS232C or Ethernet port.	⊙	⊙	⊙	13-10

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
printb	Outputs a single byte of data to the RS-232C or Ethernet port.	V1.5	V1.5		13-13
PRINTDBG	Outputs data to the debug window.	⊙	⊙		13-21
PRINTLBL	Sets a label (caption) for a user definition button.	⊙	⊙		13-23
PRINTMSG	Displays a message with a caption and icon on the color LCD of the teach pendant.	⊙	⊙		13-20
PROGRAM	Declares a program name.	⊙	⊙	⊙	9-1
PVEC	Extracts a position vector.	○	○		15-26
R					
RAD	Converts a value set in radians to degrees.	⊙	⊙	⊙	15-20
RADDEG	Converts the unit to degrees.	⊙	⊙	⊙	15-21
REM	Describes a comment.	⊙	⊙	⊙	11-23
REPEAT-UNTIL	Executes a tail decision iteration.	⊙	⊙	⊙	11-15
RESET	Sets an I/O port to OFF.	⊙	⊙	⊙	13-7
RESETAREA	Initializes an interference check.	⊙	⊙		12-67
RESUME	Returns from an interruption process routine.	⊙	⊙		18-5
RETURN	Returns from a subroutine.	⊙	⊙	⊙	11-8
RIGHT$	Extracts the right part of a character string.	⊙	⊙	⊙	15-61
RND	Generates random numbers from 0 to 1.	⊙	⊙	⊙	15-9
ROTATE	Executes a rotation movement around the designated axis.	○	○		12-19
ROTATEH	Executes rotary motion by taking an approach vector as an axis.	⊙	⊙		12-22
RUN	Concurrently runs another program.	⊙	⊙		14-1
RVEC	Extracts a figure.		⊙		15-45
S					
SEC	Converts a value expressed in seconds to milliseconds.	⊙	⊙	⊙	15-23
SELECT CASE	Executes a plural condition decision.	⊙	⊙	⊙	11-19
SET	Sets an I/O port to ON.	⊙	⊙	⊙	13-5
set_button	Sets button parameters.	V1.5	V1.5		13-27
set_page	Sets page parameters.	V1.5	V1.5		13-30
SETAREA	Selects the area where an interference check is performed.	⊙	⊙		12-66
SGN	Checks a sign.	⊙	⊙	⊙	15-10
SHCIRCLE	Searches for a circle.	⊙	⊙	⊙	21-90
SHCLRMODEL	Deletes a registered model.	⊙	⊙	⊙	21-80
SHCOPYMODEL	Copies a registered model.	⊙	⊙	⊙	21-79
SHCORNER	Searches for a corner.	⊙	⊙	⊙	21-87
SHDEFCIRCLE	Sets the condition for searching a circle.	⊙	⊙	⊙	21-89
SHDEFCORNER	Sets the conditions for a corner search.	⊙	⊙	⊙	21-86
SHDEFMODEL	Registers the search model.	⊙	⊙	⊙	21-76
SHDISPMODEL	Displays a registered model on the screen.	⊙	⊙	⊙	21-81
SHMODEL	Searches for a model.	⊙	⊙	⊙	21-82
SHREFMODEL	Refers to registered model data.	⊙	⊙	⊙	21-78
SIN	Obtains a sine.	⊙	⊙	⊙	15-17
SPEED	Specifies the internal composite speed of joints included in a currently held arm group.	⊙	⊙		12-44
SPRINTF$	Converts an expression to a designated format and returns it as a character string.	⊙	⊙	⊙	15-53

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
SQR	Obtains the square root.	⊙	⊙	⊙	15-11
STARTLOG	Starts recording of the servo control log.	⊙	⊙		19-4
ST_aspACLD	Changes the internal load condition values. There are the mass of payload, noted in grams (g), and the payload center of gravity, noted in millimeters (mm), for the load condition values. Designate both of them. (See Note1.)	V1.9	V1.9		12-71
ST_aspChange	Selects the internal mode for proper control setting of motion optimization.	V1.9	V1.9		12-72
STATUS	Obtains the program status.	⊙	⊙		14-5
ST_OffSrvLock	Releases servo lock for the specified axis.	V1.9			12-83
ST_OnSrvLock	Servo-locks a specified axis.	V1.9			12-82
STOP	Ends program execution.	⊙	⊙	⊙	11-2
STOPEND	This statement stops a continuously executed program or stops a program with a cycle option after a cycle. When a cycle of a program that includes this statement is started, the motion will not be affected even if this statement is executed.	⊙	⊙		11-3
STOPLOG	Stops servo control log recording.	⊙	⊙		19-6
STR$	Converts a value to a character string.	⊙	⊙	⊙	15-63
ST_ResetCompControl	Disables the compliance control function.		V1.9		12-87
ST_ResetCompEralw	Initializes the allowable deviation values of the position and the posture of the tool end under the compliance control.		V1.9		12-100
ST_ResetCompJLimit	Initializes the current limit under the compliance control.		V1.9		12-96
ST_ResetCompRate	Initializes the compliance rates.		V1.9		12-92
ST_ResetCompVMode	Disables the velocity control mode under the compliance control.		V1.9		12-98
ST_ResetCurLmt	Resets the motor current limit of the specified axis.	V1.9	V1.9		12-79
ST_ResetDampRate	Initializes the damping rates under the compliance control.		V1.9		12-102
ST_ResetEralw	Resets the allowable deviation value of the specified axis to the initial value.	V1.9	V1.9		12-81
ST_ResetFrcAssist	Initializes the force assistance (special compliance control function statement).		V1.9		12-94
ST_ResetFrcLimit	Initializes the force limiting rates.		V1.9		12-90
ST_ResetGravity	Disables the balance setting between the limited motor torque and gravity torque, which is made with ST_SetGravity.	V1.9	V1.9		12-74
ST_ResetGrvOffset	Disables the gravity offset function.	V1.9	V1.9		12-76
ST_ResetZBalance	Disables the gravity compensation function.	V1.9			12-104
STRPOS	Obtains the position of a character string.	⊙	⊙	⊙	15-62
ST_SetCompControl	Enables the compliance function.		V1.9		12-84
ST_SetCompEralw	Sets the allowable deviation values of the position and the posture of the tool tip under the compliance control.		V1.9		12-99
ST_SetCompFControl	Enables the compliance control function.		V1.9		12-86
ST_SetCompJLimit	Sets the current limit under the compliance control.		V1.9		12-95
ST_SetCompRate	Sets the compliance rates under the compliance control.		V1.9		12-91
ST_SetCompVMode	Sets the velocity control mode under the compliance control.		V1.9		12-97

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
ST_SetCurLmt	Sets the limit of motor current to be applied to the specified axis.	V1.9	V1.9		12-77
ST_SetDampRate	Sets the damping rates under the compliance control.		V1.9		12-101
ST_SetEralw	Modifies the allowable deviation of the specified axis.	V1.9	V1.9		12-80
ST_SetFrcAssist	Sets the force assistance under the compliance control.		V1.9		12-93
ST_SetFrcCoord	Selects a force limiting coordinate system.		V1.9		12-88
ST_SetFrcLimit	Sets the force limiting rates.		V1.9		12-89
ST_SetGravity	Compensates for the static load (gravity torque) applied to each joint and attains balance with gravity torque.	V1.9	V1.9		12-73
ST_SetGrvOffset	Compensates the torque of each joint programmed with ST_SetGravity for gravity torque.	V1.9	V1.9		12-75
ST_SetZBalance	Sets the gravity compensation value of the Z and T axes (exclusively designed for 4-axis robots).	V1.9			12-103
SUSPEND	Suspends a task.	⊙	⊙		14-3
T					
T2J	Transforms homogeneous transformation type data to joint type data.	⊙	⊙		15-32
T2P	Transforms homogeneous transformation type data to position type data.	⊙	⊙		15-33
TAKEARM	Gets an arm group. Upon execution of this statement, the programmed speed, acceleration and deceleration will be set to 100. If the gotten arm group includes any robot joint, this statement restores the tool coordinates and work coordinates to the origin.	⊙	⊙		14-14
TAKESEM	Obtains a semaphore with a designated semaphore ID.	⊙	⊙		14-13
TAKEVIS	Obtains visual process priority.	⊙	⊙		14-20
TAN	Obtains a tangent.	⊙	⊙	⊙	15-18
TIME$	Obtains the current time.	⊙	⊙		17-2
TIMER	Obtains the elapsed time.	⊙	⊙		17-3
TINV	Calculates an inverse matrix of homogeneous transformation type data.	⊙	⊙		15-34
TOOL	Declares a tool coordinate system.	○	○		9-6
TOOLPOS	Returns a tool coordinate system as the position type.	⊙	⊙		15-48
TRUE	Sets a value of true (1) to a Boolean value.	⊙	⊙	⊙	16-5
V					
VAL	Converts a character string to a numeric value.	⊙	⊙	⊙	15-64
VER$	Obtains the version of each module.	⊙	⊙	⊙	19-3
VISBINA	Binarizes the screen.	⊙	⊙	⊙	21-47
VISBINAR	Displays a binarized screen.	⊙	⊙	⊙	21-49
VISBRIGHT	Designates a drawing brightness value.	⊙	⊙	⊙	21-26
VISCAMOUT	Displays an image from the camera on the monitor.	⊙	⊙	⊙	21-7
VISCIRCLE	Draws a circle on the screen.	⊙	⊙	⊙	21-33
VISCLS	Fill (cleens) a designated screen, set in a mode with a designated brightness.	⊙	⊙	⊙	21-27
VISCOPY	Copies the screen.	⊙	⊙	⊙	21-54
VISCROSS	Draws a cross symbol on the screen.	⊙	⊙	⊙	21-36

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
VISDEFCHAR	Designates the size of characters and the display method.	⊙	⊙	⊙	21-39
VISDEFTABLE	Reads images on the camera and sets the look-up table data for image output.	⊙	⊙	⊙	21-11
VISEDGE	Measures the edge in a window.	⊙	⊙	⊙	21-60
VISELLIPSE	Draws an ellipse on the screen.	⊙	⊙	⊙	21-34
VISFILTER	Executes filtering on the screen.	⊙	⊙	⊙	21-50
VISGETNUM	Obtains an image process result from the storage memory.	⊙	⊙	⊙	21-93
VISGETP	Obtains designated coordinate brightness from the storage memory (processing screen).	⊙	⊙	⊙	21-42
VISGETSTR	Obtains code recognition result.	⊙	⊙	⊙	21-94
VISHIST	Obtains the histogram (brightness distribution) of the screen.	⊙	⊙	⊙	21-43
VISLEVEL	Obtains a binarization level based on the histogram result.	⊙	⊙	⊙	21-45
VISLINE	Draws a line on the screen.	⊙	⊙	⊙	21-30
VISLOC	Designates the display position of characters.	⊙	⊙	⊙	21-37
VISMASK	Executes calculations between images.	⊙	⊙	⊙	21-52
VISMEASURE	Measures features in the window (area, center of gravity, main axis angle).	⊙	⊙	⊙	21-55
VISOVERLAY	Displays draw screen information on the monitor.	⊙	⊙	⊙	21-9
VISPLNOUT	Displays an image in the storage memory on the monitor.	⊙	⊙	⊙	21-8
VISPOSX	Obtains an image process result (Coordinate X) from the storage memory.	⊙	⊙	⊙	21-95
VISPOSY	Obtains an image process result (Coordinate Y) from the storage memory.	⊙	⊙	⊙	21-96
VISPRINT	Displays characters and figures on the screen.	⊙	⊙	⊙	21-40
VISPROJ	Measures the projected data in the window.	⊙	⊙	⊙	21-58
VISPTP	Draws a line connecting two points on the screen.	⊙	⊙	⊙	21-31
VISPUTP	Draws a point on the screen.	⊙	⊙	⊙	21-29
VISREADQR	Reads the QR code.	⊙	⊙	⊙	21-64
VISRECT	Draws a rectangle on the screen.	⊙	⊙	⊙	21-32
VISREFCAL	Obtains calibration data (Vision-robot coordinate transformation).	⊙	⊙	⊙	21-98
VISREFHIST	Reads histogram results.	⊙	⊙	⊙	21-44
VISREFTABLE	Refers to data on the look-up table.	⊙	⊙	⊙	21-13
VISSCREEN	Designates a drawing screen.	⊙	⊙	⊙	21-24
VISSECT	Draws a sector on the screen.	⊙	⊙	⊙	21-35
VISSTATUS	Monitors the process result of each instruction.	⊙	⊙	⊙	21-97
VISWORKPLN	Designates the storage memory (process screen) to process.	⊙	⊙	⊙	21-41
W					
WAIT	Stops program processing based on a condition.	⊙	⊙		12-61
WHILE-WEND	Executes a head decision iteration.	⊙	⊙	⊙	11-16
WINDCLR	Deletes set window information.	⊙	⊙	⊙	21-19
WINDCOPY	Copies window data.	⊙	⊙	⊙	21-20
WINDDISP	Draws a designated window.	⊙	⊙	⊙	21-23
WINDMAKE	Designates an area for image processing.	⊙	⊙	⊙	21-14
WINDREF	Obtains window information.	⊙	⊙	⊙	21-22

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Commands	Functions	4-axis	6-axis	Vision device	Refer to:
WORK	Declares a user coordinate system.	○	○		9-7
WORKPOS	Returns the user coordinate system as the position type.	⊙	⊙		15-49
WRITE	Outputs data from the RS232C or Ethernet port.	⊙	⊙	⊙	13-11

Commands Listed According to Functions

4-axis	6-axis	Vision device	
⦿	⦿	⦿	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
Declaration Statements						
Program Name	PROGRAM	Declares a program name.	⦿	⦿	⦿	9-1
Interference Area Coordinates	AREA	Declares the area where an interference check is performed.	○	○		9-2
User Function	DEF FN	Declares a user-defined function.	⦿	⦿	⦿	9-4
Home Coordinates	HOME	Declares arbitrary coordinates as a home position.	○	○		9-5
Tool Coordinates	TOOL	Declares a tool coordinate system.	○	○		9-6
Work Coordinates	WORK	Declares a user coordinate system.	○	○		9-7
Local Variable Integer	DEFINT	Declares an integer type variable. The range of the integer is from -2147483648 to 2147483647.	⦿	⦿	⦿	9-8
Floating-point	DEFSNG	Declares a single precision real type variable. The range of single precision real variables is from -3.402823E+38 to 3.402823E+38.	⦿	⦿	⦿	9-9
Double-precision	DEFDBL	Declares a double precision real type variable. The range of double precision real type variables is from -1.79769313486231D + 308 to 1.79769313486231D + 308.	⦿	⦿	⦿	9-10
String	DEFSTR	Declares a character string type variable. You can enter 247 characters or less as a character string.	⦿	⦿	⦿	9-11
Vector	DEFVEC	Declares a vector type variable.	⦿	⦿		9-12
Position	DEFPOS	Declares a position type variable.	○	○		9-13
Joint	DEFJNT	Declares a joint type variable.	○	○		9-14
Homogeneous transform matrix	DEFTRN	Declares a homogeneous transformation type variable.	⦿	⦿		9-15
I/O	DEFIO	Declares an I/O variable corresponding to the input/output port.	⦿	⦿	⦿	9-16
Array	DIM	Declares an array.	⦿	⦿	⦿	9-17
Assignment Statements						
Variables	LET	Assigns a value to a variable.	○	○	○	10-1
Vector	LETA	Assigns a value to an approach vector of the homogeneous transformation type.		⦿		10-2

4-axis	6-axis	Vision device	
⦿	⦿	⦿	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
	LETO	Assigns a value to an orientation vector of the homogeneous transformation type.	⦿	⦿		10-3
	LETP	Assigns a value to a position vector of the position type or homogenous transformation type.	⦿	⦿		10-4
Figure	LETF	Assigns a value to a figure component of the position type or homogenous transformation type.	⦿	⦿		10-5
Link Angle	LETJ	Assigns a value to a designated link angle of the joint type.	⦿	⦿		10-6
Posture	LETR	Assigns a value to three rotation components of the position type.		⦿		10-7
Rotation Component	LETRX	Assigns a value to the X axis rotation component of the position type.		⦿		10-8
	LETRY	Assigns a value to the Y axis rotation component of the position type.		⦿		10-9
	LETRZ	Assigns a value to the Z axis rotation component of the position type.		⦿		10-10
	LETT	Assigns a value to the T axis component of the position type.	⦿			10-11
Axis Component	LETX	Assigns a value to the X axis component of the Vector type/ Position type/ Homogenous transformation type.	⦿	⦿		10-12
	LETY	Assigns a value to the Y axis component of the Vector type/ Position type/ Homogenous transformation type.	⦿	⦿		10-13
	LETZ	Assigns a value to the Z axis component of the vector type/ position type/ homogeneous transformation type.	⦿	⦿		10-14
Flow Control Statements						
Program Stop	END	Declares the motion end by a program.	⦿	⦿	⦿	11-1
	STOP	Ends program execution.	⦿	⦿	⦿	11-2
	STOPEND	This statement stops a continuously executed program or stops a program with a cycle option after a cycle. When a cycle of a program that includes this statement is started, the motion will not be affected even if this statement is executed.	⦿	⦿		11-3

4-axis	6-axis	Vision device	
⦿	⦿	⦿	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
Call	CALL	Calls a program and executes it.	⦿	⦿	⦿	11-4
	GOSUB	Calls a subroutine.	⦿	⦿	⦿	11-6
	ON-GOSUB	Calls a corresponding subroutine to the value of an expression.	⦿	⦿	⦿	11-7
	RETURN	Returns from a subroutine.	⦿	⦿	⦿	11-8
Repeat	DO-LOOP	Executes a decision iteration (repetition).	⦿	⦿	⦿	11-9
	EXIT DO	Forcibly exits from DO-LOOP.	⦿	⦿	⦿	11-11
	FOR-NEXT	Repeatedly executes a series of instructions between FOR-NEXT sections.	⦿	⦿	⦿	11-12
	EXIT FOR	Forcibly exits from FOR-NEXT.	⦿	⦿	⦿	11-14
	REPEAT-UNTIL	Executes a tail decision iteration.	⦿	⦿	⦿	11-15
	WHILE-WEND	Executes a head decision iteration.	⦿	⦿	⦿	11-16
Conditional Branch	IF-END IF	Conditionally decides a conditional expression between IF-END IF.	⦿	⦿	⦿	11-17
	IF-THEN-ELSE	Executes a conditional decision of a logical expression.	⦿	⦿	⦿	11-18
	SELECT CASE	Executes a plural condition decision.	⦿	⦿	⦿	11-19
Unconditional Branch	GOTO	Unconditionally branches a program.	⦿	⦿	⦿	11-21
	ON-GOTO	Executes an unconditional branch due to the value of an expression.	⦿	⦿	⦿	11-22
Comment	REM	Describes a comment.	⦿	⦿	⦿	11-23
Robot Control Statements						
Motion Control	APPROACH	Executes the absolute movement designated in the tool coordinate system.	○	○		12-1
	DEPART	Executes the relative motion in the tool coordinate system.	○	○		12-4
	DRAW	Executes the relative movement designated in the work coordinate system.	⦿	⦿		12-7
	DRIVE	Executes the relative motion of each axis.	⦿	⦿		12-9
	DRIVEA	Executes the absolute motion of each axis.	⦿	⦿		12-11
	GOHOME	Moves to the position (home position) defined by the HOME statement.	⦿	⦿		12-13
	MOVE	Moves to the designated coordinate.	○	○		12-14
	ROTATE	Executes a rotation movement around the designated axis.	○	○		12-19

4-axis	6-axis	Vision device	
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○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
	ROTATEH	Executes rotary motion by taking an approach vector as an axis.	⦿	⦿		12-22
	CURJNT	Obtains the current angle of the robot using type J.	○	○		12-24
	CURPOS	Obtains the current position in the tool coordinate system using type P.	○	○		12-25
	CURTRN	Obtains the current position in the tool coordinate system using type T.	⦿	⦿		12-26
	CUREXJ	Gets the current angle of an extended-joint into a floating-point variable.	V1.5	V1.6		12-27
	DESTJNT	Obtains the current movement instruction destination position using type J. The current position (instruction value) is obtained when the robot stops.	○	○		12-28
	DESTPOS	Obtains the current movement instruction destination position with type P. When the robot stops, the current value (instruction value) is obtained.	○	○		12-29
	DESTTRN	Obtains the current movement instruction destination position with type T. When the robot stops, the current position (instruction value) is obtained.	⦿	⦿		12-30
	DESTEXJ	Gets the target position of an extended-joint invoked by the current motion command into a floating-point variable. If the robot is on halt, this command will get the current position (commanded value).	V1.5	V1.6		12-31
	ARRIVE	Defines the motion ratio relative to the programmed full travel distance to the target point in order to make the current program stand by to execute the next step until the robot reaches the defined motion ratio.	⦿	V1.2		12-32
	POSCLR	Forcibly restores the current position of a joint to 0 mm or 0 degree.	V1.5	V1.6		12-34
Figure Control	CURFIG	Obtains the current value of the robot figure.	⦿	⦿		12-35
	FIGAPRL	Calculates figures at an approach position and a standard position available to move in CP motion.	○	○		12-37

4-axis	6-axis	Vision device	
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○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
	FIGAPRP	Calculates an approach position where the PTP motion is available, and a reference position figure.	○	○		12-39
Stop Control	HOLD	Holds program processing for a time.	⊙	⊙		12-40
	HALT	Stops executing a program.	⊙	⊙		12-41
	INTERRUPT ON/OFF	Interrupts a robot motion.	⊙	⊙		12-42
Speed Control	SPEED	Specifies the internal composite speed of joints included in a currently held arm group.	⊙	⊙		12-44
	JSPEED	Specifies the internal speed of individual joints included in a currently held arm group.	⊙	⊙		12-46
	ACCEL	Designates internal acceleration and internal deceleration.	⊙	⊙		12-47
	JACCEL	Specifies the internal acceleration and deceleration of individual joints included in a currently held arm group.	⊙	⊙		12-48
	DECEL	Specifies the internal composite deceleration of joints involved in a currently held arm group.	⊙	⊙		12-49
	JDECEL	Specifies the internal deceleration ratio of individual joints included in a currently held arm group.	⊙	⊙		12-50
	CURACC	Gets the current internal composite acceleration of joints included in a currently held arm group.	⊙	⊙		12-51
	CURJACC	Gets the current internal acceleration of individual joints included in a currently held arm group.	⊙	⊙		12-52
	CURDEC	Gets the current internal composite deceleration of joints included in a currently held arm group.	⊙	⊙		12-53
	CURJDEC	Gets the current internal deceleration of individual joints included in a currently held arm group.	⊙	⊙		12-54
	CURJSPD	Gets the current internal speed of individual joints included in a currently held arm group.	⊙	⊙		12-55
	CURSPD	Gets the current internal composite speed of joints included in a currently held arm group.	⊙	⊙		12-56
	CUREXTACC	Obtains the current external acceleration value.	V1.4	V1.4		12-57

4-axis	6-axis	Vision device	
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⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
	CUREXTDEC	Obtains the current external deceleration value.	V1.4	V1.4		12-58
	CUREXTSPD	Obtains the current external speed value.	V1.4	V1.4		12-59
Time Control	DELAY	Suspends program processing for a designated period time.	⦿	⦿	⦿	12-60
	WAIT	Stops program processing based on a condition.	⦿	⦿		12-61
Coordinate Transformation	CHANGETOOL	Changes the tool coordinate system.	⦿	⦿		12-62
	CHANGEWORK	Changes the user coordinate system.	⦿	⦿		12-63
	CURTOOL	Obtains the currently designated TOOL number.	V1.4	V1.4		12-64
	CURWORK	Obtains the currently designated WORK number.	V1.4	V1.4		12-65
Interference Check	SETAREA	Selects the area where an interference check is performed.	⦿	⦿		12-66
	RESETAREA	Initializes an interference check.	⦿	⦿		12-67
Supervisor Task	INIT	Turns on motors, carrier out CAL, and sets the speed according to the preset supervisor task parameters.	V1.7	V1.7		12-68
Internal Servo Data	GetSrvData	Gets the internal servo data of robot joints.	V1.5	V1.5		12-69
	GetJntData	Gets the internal servo data of a specified joint.	V1.5	V1.5		12-70
Particular Control	ST_aspACLD	Changes the internal load condition values. There are the mass of payload, noted in grams (g), and the payload center of gravity, noted in millimeters (mm), for the load condition values. Designate both of them. (See Note1.)	V1.9	V1.9		12-71
	ST_aspChange	Selects the internal mode for proper control setting of motion optimization.	V1.9	V1.9		12-72
	ST_SetGravity	Compensates for the static load (gravity torque) applied to each joint and attains balance with gravity torque.	V1.9	V1.9		12-73
	ST_ResetGravity	Disables the balance setting between the limited motor torque and gravity torque, which is made with ST_SetGravity.	V1.9	V1.9		12-74
	ST_SetGrvOffset	Compensates the torque of each joint programmed with ST_SetGravity for gravity torque.	V1.9	V1.9		12-75
	ST_ResetGrvOffset	Disables the gravity offset function.	V1.9	V1.9		12-76

4-axis	6-axis	Vision device	
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⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
	ST_SetCurLmt	Sets the limit of motor current to be applied to the specified axis.	V1.9	V1.9		12-77
	ST_ResetCurLmt	Resets the motor current limit of the specified axis.	V1.9	V1.9		12-79
	ST_SetEralw	Modifies the allowable deviation of the specified axis.	V1.9	V1.9		12-80
	ST_ResetEralw	Resets the allowable deviation value of the specified axis to the initial value.	V1.9	V1.9		12-81
	ST_OnSrvLock	Servo-locks a specified axis.	V1.9			12-82
	ST_OffSrvLock	Releases servo lock for the specified axis.	V1.9			12-83
	ST_SetCompControl	Enables the compliance function.		V1.9		12-84
	ST_SetCompFControl	Enables the compliance control function.		V1.9		12-86
	ST_ResetCompControl	Disables the compliance control function.		V1.9		12-87
	ST_SetFrcCoord	Selects a force limiting coordinate system.		V1.9		12-88
	ST_SetFrcLimit	Sets the force limiting rates.		V1.9		12-89
	ST_ResetFrcLimit	Initializes the force limiting rates.		V1.9		12-90
	ST_SetCompRate	Sets the compliance rates under the compliance control.		V1.9		12-91
	ST_ResetCompRate	Initializes the compliance rates.		V1.9		12-92
	ST_SetFrcAssist	Sets the force assistance under the compliance control.		V1.9		12-93
	ST_ResetFrcAssist	Initializes the force assistance (special compliance control function statement).		V1.9		12-94
	ST_SetCompJLimit	Sets the current limit under the compliance control.		V1.9		12-95
	ST_ResetCompJLimit	Initializes the current limit under the compliance control.		V1.9		12-96
	ST_SetCompVMode	Sets the velocity control mode under the compliance control.		V1.9		12-97
	ST_ResetCompVMode	Disables the velocity control mode under the compliance control.		V1.9		12-98
	ST_SetCompEralw	Sets the allowable deviation values of the position and the posture of the tool tip under the compliance control.		V1.9		12-99
	ST_ResetCompEralw	Initializes the allowable deviation values of the position and the posture of the tool end under the compliance control.		V1.9		12-100
	ST_SetDampRate	Sets the damping rates under the compliance control.		V1.9		12-101
	ST_ResetDampRate	Initializes the damping rates under the compliance control.		V1.9		12-102

4-axis	6-axis	Vision device	
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○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions				Refer to:
			4-axis	6-axis	Vision device	
	ST_SetZBalance	Sets the gravity compensation value of the Z and T axes.	V1.9			12-103
	ST_ResetZBalance	Disables the gravity compensation function.	V1.9			12-104
Input/Output Control Statements						
I/O Port	IN	Reads data from the I/O port designated by an I/O variable.	⦿	⦿	⦿	13-1
	OUT	Outputs data to the I/O port designated by an I/O variable.	⦿	⦿	⦿	13-2
	IOBLOCK ON/OFF	Concurrently executes a non-motion instruction such as an I/O or calculation instruction during execution of a motion instruction.	⦿	⦿		13-3
	SET	Sets an I/O port to ON.	⦿	⦿	⦿	13-5
	RESET	Sets an I/O port to OFF.	⦿	⦿	⦿	13-7
Command for RS232C and Ethernet Port	INPUT	Obtains data from the RS232C or Ethernet port.	⦿	⦿	⦿	13-8
	LINEINPUT	Reads data to a delimiter through the RS232C or Ethernet port and assigns it to a character string type variable.	⦿	⦿	⦿	13-9
	PRINT	Outputs data from the RS232C or Ethernet port.	⦿	⦿	⦿	13-10
	WRITE	Outputs data from the RS232C or Ethernet port.	⦿	⦿	⦿	13-11
	FLUSH	Clears the input buffer.	⦿	⦿	⦿	13-12
Serial Binary Transmission Commands	printb	Outputs a single byte of data to the RS-232C or Ethernet port.	V1.5	V1.5		13-13
	inputb	Inputs a single byte of data from the RS-232C or Ethernet port.	V1.5	V1.5		13-14
	lprintb	Outputs multiple bytes of data to the RS-232C or Ethernet port.	V1.5	V1.5		13-15
	linputb	Inputs multiple bytes of data from the RS-232C or Ethernet port.	V1.5	V1.5		13-16
	com_encom	Enables the RS-232C port only for binary transmission.	V1.5	V1.5		13-17
	com_discom	Releases the RS-232C port from binary transmission.	V1.5	V1.5		13-18
	com_state	Gets the status of RS-232C or Ethernet port.	V1.5	V1.5		13-19
Pendant	PRINTMSG	Displays a message with a caption and icon on the color LCD of the teach pendant.	⦿	⦿		13-20
	PRINTDBG	Outputs data to the debug window.	⦿	⦿		13-21
	BUZZER	Sounds a buzzer.	⦿	⦿		13-22
	PRINTLBL	Sets a label (caption) for a user definition button.	⦿	⦿		13-23

4-axis	6-axis	Vision device	
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⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
Programming a TP operation screen	set_button	Sets button parameters.	V1.5	V1.5		13-27
	set_page	Sets page parameters.	V1.5	V1.5		13-30
	change_bCap	Edits a caption for a specified button.	V1.5	V1.5		13-32
	change_pCap	Edits a caption for a specified page.	V1.5	V1.5		13-33
	disp_page	Displays a specified page of a TP operation screen.	V1.5	V1.5		13-34
Multitasking Control Statements						
Task Control	RUN	Concurrently runs another program.	⊙	⊙		14-1
	KILL	Forcibly terminates a task.	⊙	⊙		14-2
	SUSPEND	Suspends a task.	⊙	⊙		14-3
	DEFEND	Defends a task.	⊙	⊙		14-4
	STATUS	Obtains the program status.	⊙	⊙		14-5
Semaphore	CREATESEM	Creates a semaphore.	⊙	⊙		14-7
	DELETESEM	Deletes a semaphore.	⊙	⊙		14-10
	FLUSHSEM	Releases tasks from waiting for a semaphore.	⊙	⊙		14-11
	GIVESEM	Releases a task from waiting for a semaphore.	⊙	⊙		14-12
	TAKESEM	Obtains a semaphore with a designated semaphore ID.	⊙	⊙		14-13
Arm Semaphore	TAKEARM	Gets an arm group. Upon execution of this statement, the programmed speed, acceleration and deceleration will be set to 100. If the gotten arm group includes any robot joint, this statement restores the tool coordinates and work coordinates to the origin.	⊙	⊙		14-14
	GIVEARM	Releases robot control priority.	⊙	⊙		14-19
	TAKEVIS	Obtains visual process priority.	⊙	⊙		14-20
	GIVEVIS	Releases visual process priority.	⊙	⊙		14-21
Functions						
Arithmetic Function	ABS	Obtains the absolute value of an expression value.	⊙	⊙	⊙	15-1
	EXP	Obtains an exponential function with a natural logarithm taken as a base.	⊙	⊙	⊙	15-2
	INT	Obtains the maximum integer value possible from a designated value.	⊙	⊙	⊙	15-3
	LOG	Obtains a natural logarithm.	⊙	⊙	⊙	15-4
	LOG10	Obtains a common logarithm.	⊙	⊙	⊙	15-5
	POW	Obtains an exponent.	⊙	⊙	⊙	15-6
	MAX	Extracts the maximum value.	⊙	⊙	⊙	15-7
	MIN	Extracts the minimum value.	⊙	⊙	⊙	15-8

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
	RND	Generates random numbers from 0 to 1.	⊙	⊙	⊙	15-9
	SGN	Checks a sign.	⊙	⊙	⊙	15-10
	SQR	Obtains the square root.	⊙	⊙	⊙	15-11
Trigonometric Function	ACOS	Obtains an arc cosine.	⊙	⊙	⊙	15-12
	ASIN	Obtains an arc sine.	⊙	⊙	⊙	15-13
	ATN	Obtains an arc tangent.	⊙	⊙	⊙	15-14
	ATN2	Obtains the arc tangent of expression 1 divided by expression 2.	⊙	⊙	⊙	15-15
	COS	Obtains a cosine.	⊙	⊙	⊙	15-16
	SIN	Obtains a sine.	⊙	⊙	⊙	15-17
	TAN	Obtains a tangent.	⊙	⊙	⊙	15-18
Angle Conversion	DEGRAD	Converts the unit to a radian.	⊙	⊙	⊙	15-19
	RAD	Converts a value set in radians to degrees.	⊙	⊙	⊙	15-20
	RADDEG	Converts the unit to degrees.	⊙	⊙	⊙	15-21
Speed Conversion	MPS	Converts an expression of speed.	⊙	⊙		15-22
Time Function	SEC	Converts a value expressed in seconds to milliseconds.	⊙	⊙	⊙	15-23
Vector	AVEC	Extracts an approach vector.	⊙	⊙		15-24
	OVEC	Extracts an orient vector.	⊙	⊙		15-25
	PVEC	Extracts a position vector.	○	○		15-26
	MAGNITUDE	Obtains the vector size.	⊙	⊙		15-27
Pose Data Type Transformation	J2P	Transforms joint type data to position type data.	○	○		15-28
	J2T	Transforms joint type data to homogeneous transformation type data.	○	○		15-29
	P2J	Transforms position type data to joint type data.	○	○		15-30
	P2T	Transforms position type data to homogeneous transformation type data.	○	○		15-31
	T2J	Transforms homogeneous transformation type data to joint type data.	⊙	⊙		15-32
	T2P	Transforms homogeneous transformation type data to position type data.	⊙	⊙		15-33
	TINV	Calculates an inverse matrix of homogeneous transformation type data.	⊙	⊙		15-34
Distance Extraction	DIST	Returns the distance between two points.	○	○		15-35
Figure Component	FIG	Extracts a figure.	○	○		15-36
Angle Component	JOINT	Extracts an angle from joint type coordinates.	○	○		15-37
Axis Component	POSX	Extracts the X-component.	○	○		15-38
	POSY	Extracts the Y-component.	○	○		15-39
	POSZ	Extracts the Z-component.	○	○		15-40

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
Rotation Component	POSRX	Extracts the X-axis rotation component.		⊙		15-41
	POSRY	Extracts the Y-axis rotation component.		⊙		15-42
	POSRZ	Extracts the Z-axis rotation component.		⊙		15-43
	POST	Extracts the T-axis rotation component.	⊙			15-44
Figure Component	RVEC	Extracts a figure.		⊙		15-45
Position Function	AREAPOS	Returns the center position and direction of a rectangular parallelepiped with the position type for an area where an interference check is performed.	⊙	⊙		15-46
	AREASIZE	Returns the size (each side length) of a rectangular parallelepiped which defines the interference check area with the vector type.	⊙	⊙		15-47
	TOOLPOS	Returns a tool coordinate system as the position type.	⊙	⊙		15-48
	WORKPOS	Returns the user coordinate system as the position type.	⊙	⊙		15-49
Character String Function	ASC	Converts to a character code.	⊙	⊙	⊙	15-50
	BIN$	Converts the value of an expression to a binary character string.	⊙	⊙	⊙	15-51
	CHR$	Converts an ASCII code to a character.	⊙	⊙	⊙	15-52
	SPRINTF$	Converts an expression to a designated format and returns it as a character string.	⊙	⊙	⊙	15-53
	HEX$	Obtains a value converted from a decimal to a hexadecimal number as a character string.	⊙	⊙	⊙	15-56
	LEFT$	Extracts the left part of a character string.	⊙	⊙	⊙	15-57
	LEN	Obtains the length of a character string in bytes.	⊙	⊙	⊙	15-58
	MID$	Extracts a character string for the designated number of characters from a character string.	⊙	⊙	⊙	15-59
	ORD	Converts to a character code.	⊙	⊙	⊙	15-60
	RIGHT$	Extracts the right part of a character string.	⊙	⊙	⊙	15-61
	STRPOS	Obtains the position of a character string.	⊙	⊙	⊙	15-62
	STR$	Converts a value to a character string.	⊙	⊙	⊙	15-63
	VAL	Converts a character string to a numeric value.	⊙	⊙	⊙	15-64

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
Constants						
Built-in Constants	OFF	Sets an OFF (0) value.	⊙	⊙	⊙	16-1
	ON	Sets an ON (1) value.	⊙	⊙	⊙	16-2
	PI	Sets a π value.	⊙	⊙	⊙	16-3
	FALSE	Sets a value of false (0) to a Boolean value.	⊙	⊙	⊙	16-4
	TRUE	Sets a value of true (1) to a Boolean value.	⊙	⊙	⊙	16-5
Time/Date Control						
Time/Date	DATE$	Obtains the current date.	⊙	⊙		17-1
	TIME$	Obtains the current time.	⊙	⊙		17-2
	TIMER	Obtains the elapsed time.	⊙	⊙		17-3
Error Controls						
Error Information	ERL	Obtains the line number where an error occurred.	⊙	⊙		18-1
	ERR	Obtains an error number that occurred.	⊙	⊙		18-2
	ERRMSG$	Sets an error message.	⊙	⊙	⊙	18-3
Error Interruption	ON ERROR GOTO	Interrupts when an error occurs.	⊙	⊙		18-4
	RESUME	Returns from an interruption process routine.	⊙	⊙		18-5
System Information						
System	GETENV	Obtains the environment setting values of the system.	⊙	⊙	⊙	19-1
	LETENV	Sets the environment setting values of the system.	⊙	⊙	⊙	19-2
	VER$	Obtains the version of each module.	⊙	⊙	⊙	19-3
Log	STARTLOG	Starts recording of the servo control log.	⊙	⊙		19-4
	CLEARLOG	Initializes recording of the servo control log.	⊙	⊙		19-5
	STOPLOG	Stops servo control log recording.	⊙	⊙		19-6
Preprocessor						
Symbol Constants · Macro Definitions	#define	Replaces a designated constant or macro name in the program with a designated character string.	⊙	⊙	⊙	20-1
	#undef	Makes a symbol constant defined with #define or macro definition invalid.	⊙	⊙	⊙	20-2
	#error	Forcibly generates a compiling error if the #error command is executed.	⊙	⊙	⊙	20-3
File Fetch	#include	Fetches the preprocessor program.	⊙	⊙	⊙	20-4
Optimization	#pragma optimize	Designates optimization to be executed for each program.	⊙	⊙	⊙	20-5

4-axis	6-axis	Vision device	
⦿	⦿	⦿	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⦿	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
Vision Control (Option)						
Image Input and Output	CAMIN	Stores an image from the camera in the image memory (process screen).	⦿	⦿	⦿	21-3
	CAMMODE	Sets the function used to store a camera image.	⦿	⦿	⦿	21-4
	CAMLEVEL	Sets the camera image input level.	⦿	⦿	⦿	21-6
	VISCAMOUT	Displays an image from the camera on the monitor.	⦿	⦿	⦿	21-7
	VISPLNOUT	Displays an image in the storage memory on the monitor.	⦿	⦿	⦿	21-8
	VISOVERLAY	Displays draw screen information on the monitor.	⦿	⦿	⦿	21-9
	VISDEFTABLE	Reads images on the camera and sets the look-up table data for image output.	⦿	⦿	⦿	21-11
	VISREFTABLE	Refers to data on the look-up table.	⦿	⦿	⦿	21-13
Window Setting	WINDMAKE	Designates an area for image processing.	⦿	⦿	⦿	21-14
	WINDCLR	Deletes set window information.	⦿	⦿	⦿	21-19
	WINDCOPY	Copies window data.	⦿	⦿	⦿	21-20
	WINDREF	Obtains window information.	⦿	⦿	⦿	21-22
	WINDDISP	Draws a designated window.	⦿	⦿	⦿	21-23
Draw	VISSCREEN	Designates a drawing screen.	⦿	⦿	⦿	21-24
	VISBRIGHT	Designates a drawing brightness value.	⦿	⦿	⦿	21-26
	VISCLS	Fill (cleens) a designated screen, set in a mode with a designated brightness.	⦿	⦿	⦿	21-27
	VISPUTP	Draws a point on the screen.	⦿	⦿	⦿	21-29
	VISLINE	Draws a line on the screen.	⦿	⦿	⦿	21-30
	VISPTP	Draws a line connecting two points on the screen.	⦿	⦿	⦿	21-31
	VISRECT	Draws a rectangle on the screen.	⦿	⦿	⦿	21-32
	VISCIRCLE	Draws a circle on the screen.	⦿	⦿	⦿	21-33
	VISELLIPSE	Draws an ellipse on the screen.	⦿	⦿	⦿	21-34
	VISSECT	Draws a sector on the screen.	⦿	⦿	⦿	21-35
	VISCROSS	Draws a cross symbol on the screen.	⦿	⦿	⦿	21-36
	VISLOC	Designates the display position of characters.	⦿	⦿	⦿	21-37
	VISDEFCHAR	Designates the size of characters and the display method.	⦿	⦿	⦿	21-39
	VISPRINT	Displays characters and figures on the screen.	⦿	⦿	⦿	21-40

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
Vision Processing	VISWORKPLN	Designates the storage memory (process screen) to process.	⊙	⊙	⊙	21-41
	VISGETP	Obtains designated coordinate brightness from the storage memory (processing screen).	⊙	⊙	⊙	21-42
	VISHIST	Obtains the histogram (brightness distribution) of the screen.	⊙	⊙	⊙	21-43
	VISREFHIST	Reads histogram results.	⊙	⊙	⊙	21-44
	VISLEVEL	Obtains a binarization level based on the histogram result.	⊙	⊙	⊙	21-45
	VISBINA	Binarizes the screen.	⊙	⊙	⊙	21-47
	VISBINAR	Displays a binarized screen.	⊙	⊙	⊙	21-49
	VISFILTER	Executes filtering on the screen.	⊙	⊙	⊙	21-50
	VISMASK	Executes calculations between images.	⊙	⊙	⊙	21-52
	VISCOPY	Copies the screen.	⊙	⊙	⊙	21-54
	VISMEASURE	Measures features in the window (area, center of gravity, main axis angle).	⊙	⊙	⊙	21-55
	VISPROJ	Measures the projected data in the window.	⊙	⊙	⊙	21-58
	VISEDGE	Measures the edge in a window.	⊙	⊙	⊙	21-60
Code Recognition	VISREADQR	Reads the QR code.	⊙	⊙	⊙	21-64
Labeling	BLOB	Executes labeling.	⊙	⊙	⊙	21-67
	BLOBMEASURE	Executes feature measurement of the object label number.	⊙	⊙	⊙	21-70
	BLOBLABEL	Obtains the label number for designated coordinates.	⊙	⊙	⊙	21-72
	BLOBCOPY	Copies an object label number.	⊙	⊙	⊙	21-74
Search Function	SHDEFMODEL	Registers the search model.	⊙	⊙	⊙	21-76
	SHREFMODEL	Refers to registered model data.	⊙	⊙	⊙	21-78
	SHCOPYMODEL	Copies a registered model.	⊙	⊙	⊙	21-79
	SHCLRMODEL	Deletes a registered model.	⊙	⊙	⊙	21-80
	SHDISPMODEL	Displays a registered model on the screen.	⊙	⊙	⊙	21-81
	SHMODEL	Searches for a model.	⊙	⊙	⊙	21-82
	SHDEFCORNER	Sets the conditions for a corner search.	⊙	⊙	⊙	21-86
	SHCORNER	Searches for a corner.	⊙	⊙	⊙	21-87
	SHDEFCIRCLE	Sets the condition for searching a circle.	⊙	⊙	⊙	21-89
	SHCIRCLE	Searches for a circle.	⊙	⊙	⊙	21-90
Obtaining Results	VISGETNUM	Obtains an image process result from the storage memory.	⊙	⊙	⊙	21-93
	VISGETSTR	Obtains code recognition result.	⊙	⊙	⊙	21-94

4-axis	6-axis	Vision device	
⊙	⊙	⊙	Available with all series of robots and vision device.
○	○	○	Available with all series of robots. The command specifications differ between the 4-axis, 6-axis robot, and vision device.
⊙	V1.2		Available with the 4-axis robots and the 6-axis robots of Version 1.2 or later.

Classified by functions	Commands	Functions	4-axis	6-axis	Vision device	Refer to:
	VISPOSX	Obtains an image process result (Coordinate X) from the storage memory.	⊙	⊙	⊙	21-95
	VISPOSY	Obtains an image process result (Coordinate Y) from the storage memory.	⊙	⊙	⊙	21-96
	VISSTATUS	Monitors the process result of each instruction.	⊙	⊙	⊙	21-97
	VISREFCAL	Obtains calibration data (Vision-robot coordinate transformation).	⊙	⊙	⊙	21-98

PART 1

PROGRAM DESIGN

Chapter 1

Sample Program

This chapter utilizes a simple application example to provide usage of each command.

1.1 Model Case Application

This section describes a sample program by using an application as a model case as shown in Fig. 1-1.

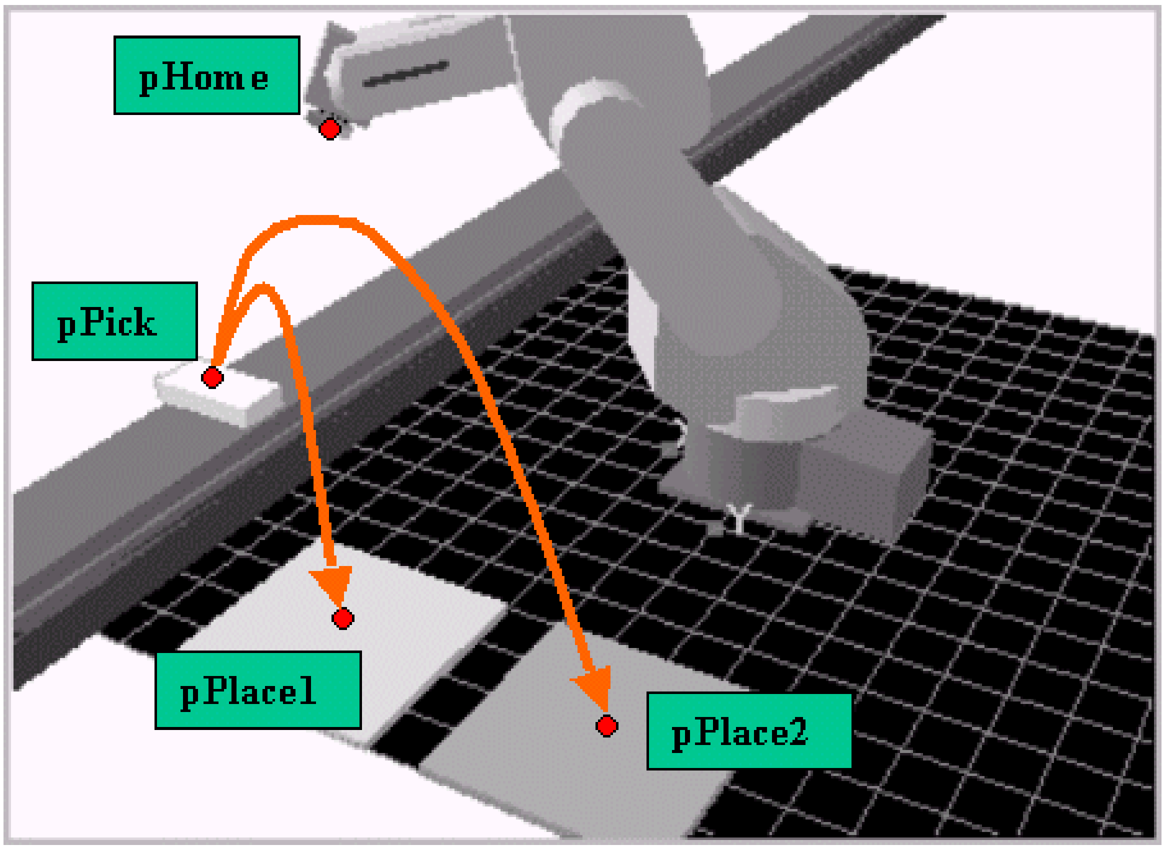


Fig. 1-1 Model Case Application

In this model case, the robot reads the QR code on the object placed at pPick. The robot determines to which of pPlace1 and pPlace2 it will carry the object depending on the QR code. It then picks and carries the object to each pre-determined position and places it. pHome is the home position, or the reference point position.

Note: **Refer to Part 2, “Flow of Personal Computer Teaching System Operation” in the BEGINNER'S GUIDE for instructions on how to create a program.**
The chapter provides an operation procedure explanation on how to create a program by using the same model case application.

1.2 Program Flow

Fig. 1-2 shows the program flow of the model case.

```
        * * * * Macro Definition * * * * *
#define pHome         10   'Home position
#define pPick1        11   'Part chuck position
#define pPlace1       12   'Part A unchuck position
#define pPlace2       13   'Part B & C unchuck
                           'position
#define ioParts       34   'Part supply signal
#define ioPartsAck    104  'Synchronization signal
                           'of part supply signal
#define  ioChuck      106  'If ON, chucks. If OFF,
                           'unchucks.
#define  ioUnChuck    107  'If ON, unchucks. If
                           'OFF, chucks.
#define iPartsld      0    'Part number
#define iCountA       1    'Number of A parts
#define iCountBC      2    'Number of B and C parts
#define ioComplete    105  'Motion finish signal
#define ioCompleteAck 35   'Synchronization signal
                           'of motion finish
                           'signal
#define ioErrQR       108  'QR read error
#define ioErrQRAck    36   'Check QR read error.
```

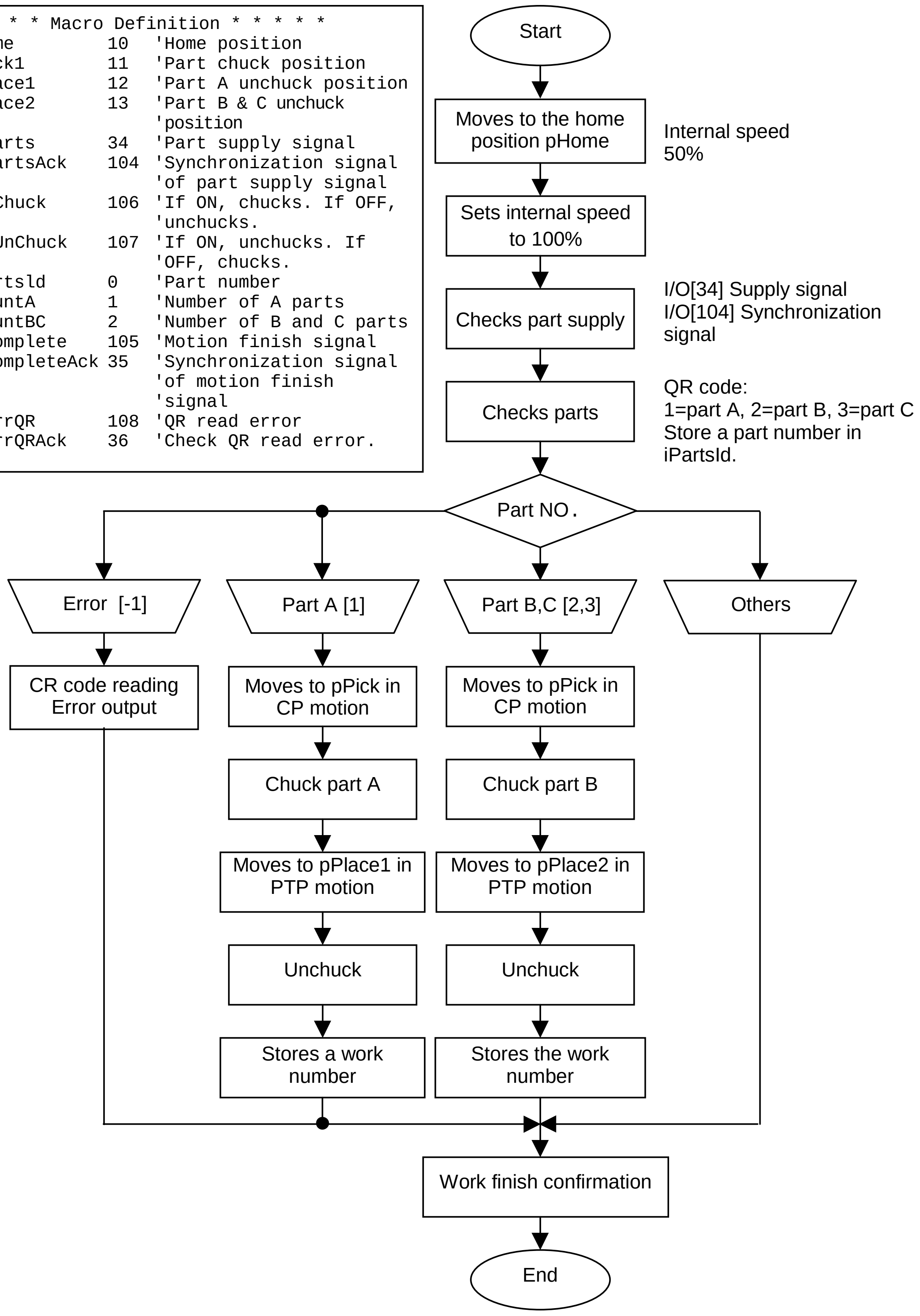

Start
Moves to the home position pHome
Internal speed 50%
Sets internal speed to 100%
Checks part supply
I/O[34] Supply signal
I/O[104] Synchronization signal
Checks parts
QR code:
1=part A, 2=part B, 3=part C
Store a part number in iPartsId.
Part NO.
Error [-1]
Part A [1]
Part B,C [2,3]
Others
CR code reading Error output
Moves to pPick in CP motion
Moves to pPick in CP motion
Chuck part A
Chuck part B
Moves to pPlace1 in PTP motion
Moves to pPlace2 in PTP motion
Unchuck
Unchuck
Stores a work number
Stores the work number
Work finish confirmation
End

Fig. 1-2 Model Case Program Flow

1.3 Program List

Below is a program list for the model case.
There are 4 programs: “PRO1,” “PRO2,” “dioSetAndWait,” and “dioWaitAndSet.”
“PRO1” is the main program.
“PRO2” is the subprogram related to QR code reading.
“dioSetAndWait” and “dioWaitAndSet” are subprograms to operate the I/Os used to check part supply. These two programs are stored in the PAC program manager program bank.

Program coding list “PRO1”

```
'!TITLE “Pick & Place”
#INCLUDE  “dio_tab.h”                                'Reads a DIO macro definition file.
#INCLUDE  “var_tab.h”                                'Reads a variable macro definition file.
#DEFINE   appLen     100                             'Defines an approach length.
            appLen and 100 are functionally equivalent.

PROGRAM pro1 Declares a program name. See p. 9-1.

   TAKEARM Statement required to run the             'Obtains an arm semaphore.
           robot. See p. 14-13.
   MOVE P, P[pHome], S=50                            'Moves to the home position at 50% of
             Equivalent to macro P[10] or P10. See p. 20-1.   'internal speed in PTP motion.

   SPEED 100                                         'Sets the internal speed to 100%.
   CALL dioWaitAndSet(ioParts, ioPartsAck)           'Checks part supply.
        Invokes a program. See pp. 2-1 and 2-3.

   CALL pro2                                         'Reads the QR code.
   SELECT CASE I[iPartsId] Statement that conditionally executes a statement block
                  Macro    depending on I[○○] and passes control. See p. 11-19.
     CASE -1 If I[○○] is -1, the following will be executed.   'Countermeasure for QR code reading
                                                     'failures.
       CALL dioSetAndWait(ioErrQR, ioErrQRAck)       'Outputs an error.
     CASE 1
       GOSUB *PlacePartsA                            'Processes part A.
        Calls a subroutine. See p. 2-2.

     CASE 2, 3
       GOSUB *PlacePartsBC                           'Processes parts B and C.
   END SELECT
   CALL dioSetAndWait(ioComplete,ioCompleteAck)      'Outputs the motion finish signal.
   GIVEARM Releases the arm semaphore                'Releases the arm semaphore.
           declared with TAKEARM.
END
```

Continued on the following page.

Program coding list “PRO1”(Continued)

```
' ===== Chucking a part =====
*ChuckItem: *Specifies a label with OO:. Will be called later by CALL*ChuckItem.
    RESET IO[ioUnChuck] Equivalent to IO[106].
            Macro
      Turns IO off. See p. 13-7.
    SET IO[ioChuck] Equivalent to IO[106].
             Macro
      Turns IO on. See p.13-5.

    RETURN Statement that structures a subroutine with *ChuckItem.


 ' ===== Unchuck parts =====
 *UnchuckItem: Label
    RESET IO[ioChuck]
    SET IO[ioUnChuck]
    RETURN Statement

 ' ===== Part A processing =====
 *PlacePartsA: Label name (declares a subroutine)
    APPROACH P, P[pPick], appLen                        'Moves to a position 100mm away from the
    Moves the arm  Equivalent to  Equivalent to macro 100 defined   'chuck point in CP motion.
    to a point right  macro P[11].  in the 4th line. Defining this way
    above P[pPick1].                makes it possible to modify the
                                    approach length by changing one
                                    value.
    MOVE L, P[pPick], S=80                              'Moves to a chuck point at 80% of internal
      Statement. See p. 12-14.                          'speed in CP motion.

    GOSUB *ChuckItem                                    'Chucks a part.
    DEPART L, appLen                                    'Moves to a position 100 mm away from the
    Statement.  Equivalent to macro 100 defined in the 4th line.   'current position.
    See p. 12-4. Defining this way makes it possible to modify the
                 approach length by changing one value.

    APPROACH P, P[pPlace1], appLen                      'Moves to a position 100 mm away from the
    Moves the arm to a point right  Equivalent to macro 100   'unchuck position in CP motion.
    above P[pPick1].                defined in the 4th line.
                                    Defining this way makes it
                                    possible to modify the
                                    approach length by changing
                                    one value.
    MOVE L, P[pPlace1], S=50                            'Moves to the unchuck point at 50% of
      Statement. See p. 12-14.                          'internal speed in CP motion.

    GOSUB *UnchuckItem                                  'Unchucks the part.
    DEPART L, appLen                                    'Moves to a point 100 mm away from the current
    Statement.  Equivalent to macro 100 defined in the 4th line.   'position in CP motion.
    See p. 12-4. Defining this way makes it possible to modify the
                 approach length by changing one value.


    I[iCountA] = I[iCountA] + 1                         'Counts the number of parts A.
         Increases I[iCountA] by one.
 RETURN
```

Continued on the following page.

Program coding list “PRO1”(Continued)

```
' ===== Parts B and C processing =====
*PlacePartsBC: Label name (declares a subroutine)
   APPROACH P, P[pPick], appLen                   'Moves to a position 100mm away from the
                                                  'chuck point in CP motion.
```
Moves the arm to a point right above P[pPick1].

Equivalent to macro 100 defined in the 4th line. Defining this way makes it possible to modify the approach length by changing one value.

```
   MOVE L, P[pPick], S=90                         'Moves to a chuck point at 90% of internal
                                                  'speed in CP motion.
   GOSUB *ChuckItem                               'Chucks a part.
   DEPART L, appLen                               'Moves to a position 100 mm away from the
                                                  'current position.
```
Statement. See p. 12-4.

Equivalent to macro 100 defined in the 4th line. Defining this way makes it possible to modify the approach length by changing one value.

```
   APPROACH P, P[pPlace2], appLen                 'Moves to a position 100 mm away from the
                                                  'unchuck position in CP motion.
```
Moves the arm to a point right above P[pPick1]. See p. 12-1.

Equivalent to macro 100 defined in the 4th line. Defining this way makes it possible to modify the approach length by changing one value.

```
   MOVE L, P[pPlace2], S=80                       'Moves to the unchuck point at 80% of
                                                  'internal speed in CP motion.
```
Statement. See p. 12-14.

```
   GOSUB *UnchuckItem                             'Unchucks the part.
   DEPART L, appLen                               'Moves to a point 100 mm away from the current
                                                  'position in CP motion.
```
Statement. See p. 12-4.

Equivalent to macro 100 defined in the 4th line. Defining this way makes it possible to modify the approach length by changing one value.

```
   I[iCountBC] = I[iCountBC] + 1                  'Counts the number of parts B and C.
RETURN
```

Continued on the following page.

Program coding list “PRO2”

```
'!TITLE “Reading QR code”
#INCLUDE  “var_tab.h”                     'Reads the variable macro definition file.

'Store a parts number in [iPartsId].
PROGRAM pro2
   DIM len1 AS INTEGER
               Makes local variable declaration "lenl" usable as a local integer variable.

   TAKEVIS Declares control on vision device. Required to use     'Obtains the visual semaphore.
           vision device.
   VISSCREEN 1,0,1                        'Designates draw screen 0 to the draw
   See p. 21-24.                          'destination.

   VISCLS 0                               'Clears draw screen 0.
   See p. 21-27.

   VISOVERLAY 1                           'Displays draw screen 0.
   See p. 21-9.

   CAMIN  1,0,0                           'Retrieves the image on the camera to
   See p. 21-3.                           'process screen 0.

   VISPLNOUT  0,1                         'Displays process screen 0.
   See p. 21-8.

   VISREADQR  1,WINDREF(1, 2),WINDREF     'Reads the QR code.
   See p. 21-64.
    (1, 3),0,0,1

   WINDDISP  1                            'Displays the window.
   See p. 21-23.

   VISLOC  10  , 10                       'Designates the position to display.
   See p. 21-37.

   IF VISSTATUS(0) = 0 THEN               'When the measuring result is OK.
     len1 = VISGETNUM(0, 0)               'Obtains the number of measured characters.
     VISPRINT  VISGETSTR(1, len1)         'Displays the measurement result.
     I[iPartsId] = VAL(VISGETSTR(1, len1))   'Stores the part number.

   ELSE
     VISPRINT  “Cannot recognize a code.”  'Displays an error.
     I[iPartsId] = -1                     'Store –1 when an error occurs.

   ENDIF
  Branches conditionally. See p. 11-17.
   GIVEVIS  Releases control on vision device.   'Releases the visual semaphore.

END
```

Note: Process window 1, for reading the QR code, is assumed to have been defined already.

Program coding list "WAIT → SET" (Library)

```
'!TITLE “WAIT    SET”
PROGRAM dioWaitAndSet(waitIndex%, ackIndex%)
                            Declares with argument.  See p. 9-1.
   RESET IO[ackIndex]  Statement. See p. 13-7.            'Synchronization signal OFF

   WAIT IO[waitIndex] = ON Statement that waits for IO☐   'Waits for synchronization signal ON.
                           coming on. See p. 12-53.

   SET IO[ackIndex]  See p. 13-5.                         'Synchronization signal ON

END
```

Program coding list "SET → WAIT" (Library)

```
'!TITLE “SET    WAIT”
PROGRAM dioSetAndWait(ackIndex%, waitIndex%)
                            Declares with argument.  See p. 9-1.

   SET IO[ackIndex]  See p. 13-5.                         'Synchronization signal ON

   WAIT IO[waitIndex] = ON Statement that waits for IO☐   'Waits for synchronization signal ON.
                           coming on. See p. 12-53.
   RESET IO[ackIndex]  Statement See p. 13-7.             'Synchronization signal OFF

END
```

Chapter 2

Program Flow

This chapter provides an explanation of the flow regulation required for creating programs using the PAC language.

2.1 Calling a Program and Subroutine

A section of a program that repeats a specific motion can be put out of the program and called if required.
The method of putting this section in the same program is called a subroutine.
If this section is independently put in a separate file as another program and that program is called, this is referred to as calling a program.
A subroutine must be included in the same file as the calling program.
The program of an independent separate file can be called from various programs and commonly used.
If a series of work is organized as a unit of a subroutine or another program the same contents do not have to be described repeatedly. This is effective for correcting descriptions, reducing the creation time and otherwise improving the ease of reading programs.

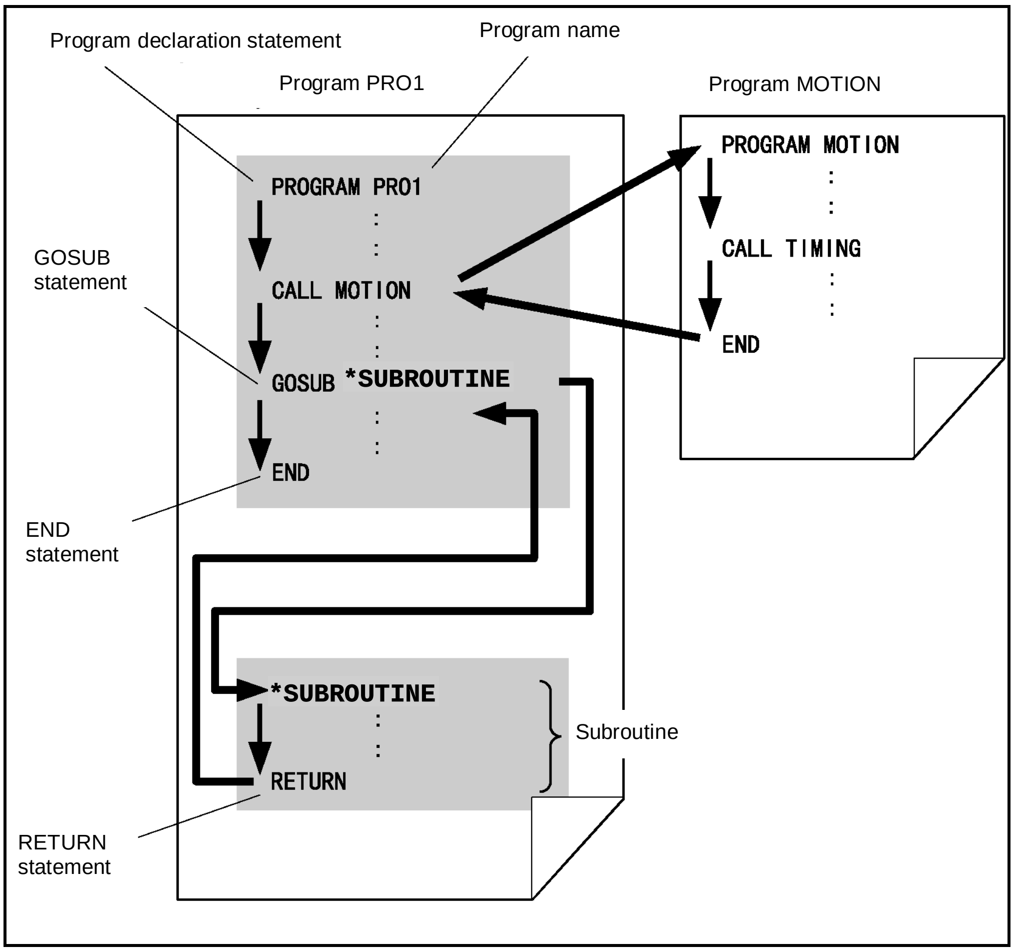


Fig. 2-1 Difference Between Calling a Program and Calling a Subroutine

2.1.1 Calling a Subroutine

To use the same program at different positions in one program describe the process as a subroutine. The subroutine can be used by calling it from the different positions.
The subroutine must be described in the same file as the calling program.
If a subroutine is called using a GOSUB statement, control moves to the subroutine. If control executes a RETURN statement on the last line of the subroutine, it returns to the next line of the program that called the subroutine.
A subroutine can be called from another subroutine.
Because the subroutine is in the same file as the calling program, local variables are common. Therefore, variables do not have to be transferred when the subroutine is called. However, it cannot be called from other files and it cannot be directly started from the pendant or an external device either.

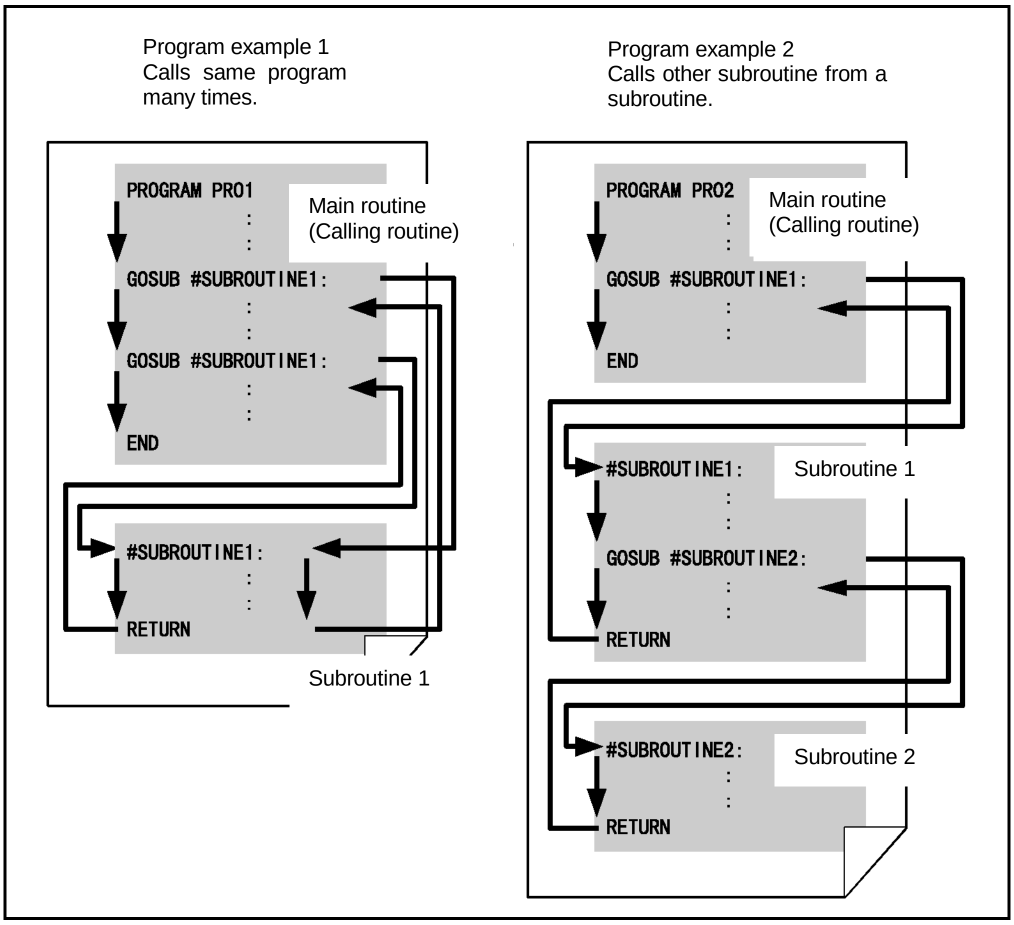


Fig. 2-2 Calling a Subroutine

2.1.2 Calling a Program

If a program is created separately from the one that is mainly executed, the program can be used by calling it like a subroutine.
When the program is called, designate the program name using a CALL statement.
When a CALL statement calls a program, control moves to the program that is called. If control executes an END statement on the last line of the called program, control returns to the next line in the calling program.
The called program can also call another program. However, the called program cannot call the calling program.
Since one program can call multiple programs, efficiency can be raised by creating a universal program.
Only global variables can be commonly used in the calling program. Pass local variables as arguments if required since they are not commonly used. Refer to "8.16 Calling with a Value and with Reference".

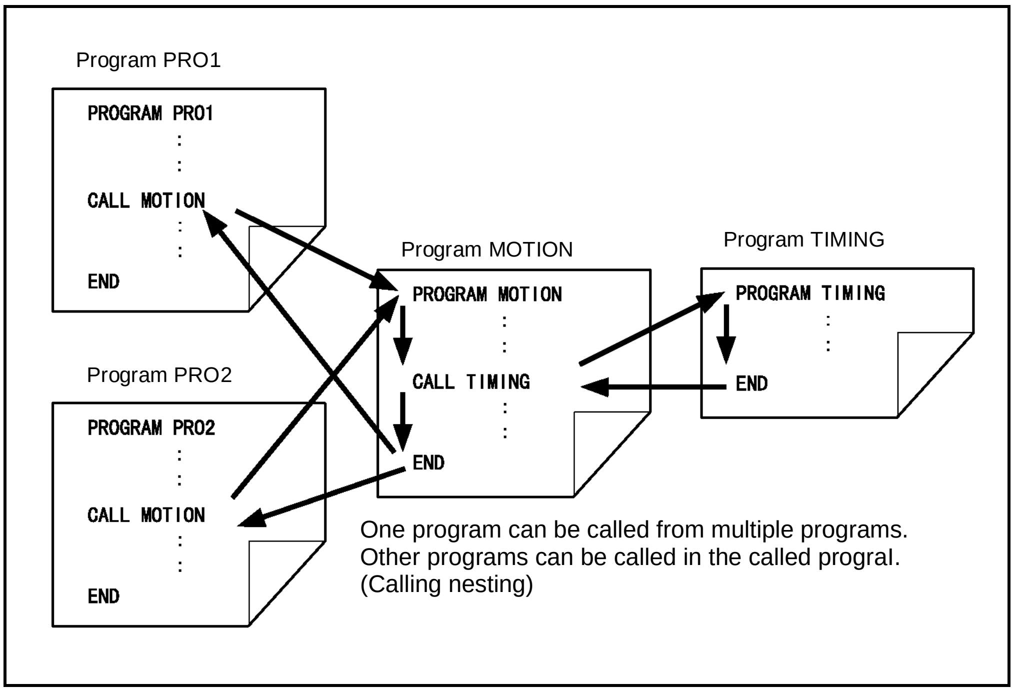


Fig. 2-3 Program Calling Diagram

2.1.3 Program Recursive Call

When a program is called, the calling program itself can be designated as a program name using a CALL statement. This is referred to as a recursive call.

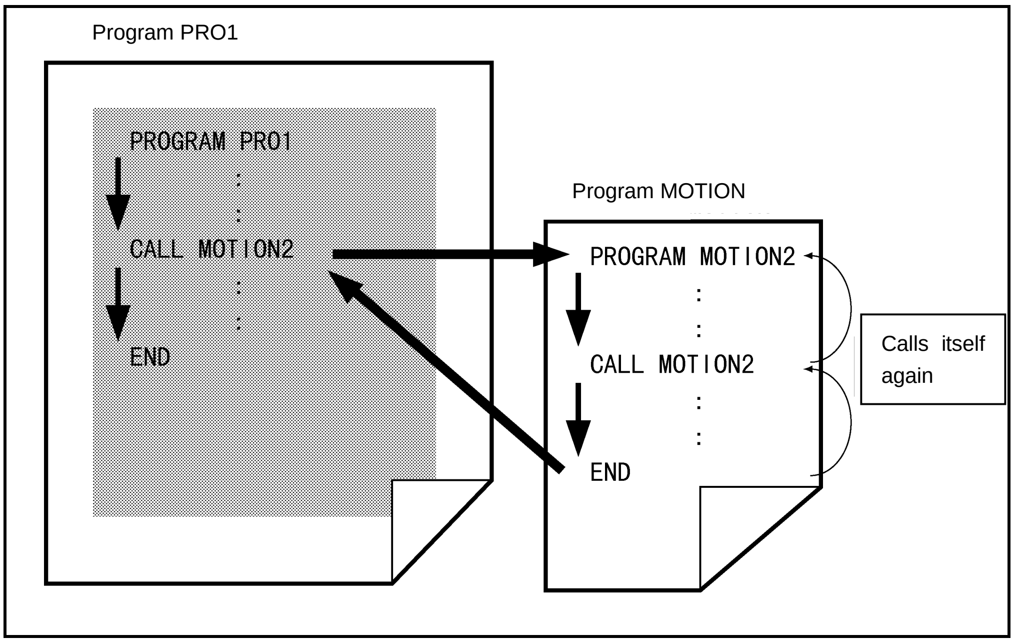


Fig. 2-4 Program Recursive Calling Diagram

Note: The variables in a PAC program are stored in the static memory of each program; therefore, pay attention to has to use variables when a recursive call is used. If the initial value is set using a local variable the value returns to its initial value every time the program is called.

2.2 Running a Program

The following 3 methods are available for running a program.

- Start using teach pendant operation.
- Start using the operating panel.
- Start by using I/O from an external device.

As explained below, there are limitations to running a program depending on the running method.
For the method by which the started program calls another program, refer to “2.1 Calling a Program and Subroutine”.

2.2.1 Running from the Teach Pendant

To run a program from the teach pendant, use teach check mode or internal automatic mode.
The programs that can be started are limited to programs that do not include any arguments. A program with any type of program name can be started.

2.2.2 Running from the Operating Panel

Use internal automatic mode to run a program from the operating panel.
The programs that can be started are limited to ones with a name that conforms to the “PRO< number >” format.

Note (1): The mode cannot be changed to teach check mode from the operating panel.
Note (2): A program with a program name format of “PRO< number >” cannot include arguments.

2.2.3 Running from an External Device

In external automatic mode, a program can be run with input from external I/O.
The programs that can be started are limited to the ones with a program name in the “PRO< number >” format.
The programs that can be started from an external device is limited to programs PR00 to PR032767 in standard mode and PR00 to PR0127 in compatible mode.

Note: A program with a program name format of “PRO< number >” cannot include arguments.

2.3 Multitasking

A PAC language program can concurrently execute progress management of multiple programs. Each program forms its own motion process and this is called a task.
Concurrent progress management of multiple programs means that there are multiple tasks present. This is called multitasking.

2.3.1 Priority

To run a task using the RUN command, designate a priority. As a result all tasks have their own priority.
The VS series robot checks task priority at fixed time intervals during program execution, and changes tasks so that the tasks in the waiting status with the highest priority are executed.
As a result the program is executed in sequence of the highest priority. If tasks have the same priority, the robot controls the tasks so that the task execution order alternates at each fixed time interval. Since the alternating task execution requires such a short time to be controlled it appears as if multiple programs are executed concurrently.

2.3.2 Communication among Tasks

When the robot is controlled in multitasking operation, tasks sometimes need to be synchronized or exclusively controlled so those tasks do not operate at the same time. In any case, communication among tasks is required since the tasks must exchange signals.
For communication among tasks semaphores are generally used but I/O can also be used with the VS series robots.

2.3.2.1 Semaphore

Up to 32 semaphores can be created as required. Prior to using semaphores, if a semaphore is created using a CREATESEM command the semaphore ID can be obtained. This semaphore ID can be used to designate a specific semaphore.
In either synchronization control or exclusive control, a task waiting for a command from another task will execute a TAKESEM command and then wait for the task to send a command to execute using a GIVESEM command. If the task sending a command is ready, it executes a GIVESEM command and allows the task, which is waiting for a semaphore, to execute the process.
One GIVESEM command is valid only for a task that is waiting for one semaphore.
When multiple tasks are waiting for a semaphore with the same semaphore ID, one of two queuing (execution waiting) systems can be selected for processing (first-come order or priority order starting from a specific task). Use the CREATESEM command to designate the queuing system.

The following two programs “MOTION1” and “TIMING” are examples of synchronization control that use semaphores.
If the program “TIMING1” is run the program “MOTION1” starts concurrently. The timing of the “MOTION1” is created by the “TIMING1” with a semaphore to execute the MOVE command.

```
                                PROGRAM TIMING1
                                      I1 = CREATESEM (1)
                                      TAKESEM I1
PROGRAM MOTION1    ◄───────────────── RUN MOTION1
      TAKEARM                         I[1]=0
      SPEED 100                       DO WHILE I[1]<10
      RUN TIMING                         DELAY 5000
      TAKESEM I1◄─────────────────────   GIVESEM I1
      MOVE P, P1                      LOOP
      MOVE P, P2                      DELETESEM I1
END                             END
```

Fig. 2-5 Example of Synchronization Control Using Semaphore

2.3.2.2 I/O

The robot can communicate among tasks by using I/O.
The following two programs “MOTION2” and “TIMING2” are examples of synchronization control that use I/O. The motion is the same as “Example of synchronization control using semaphore” explained in “3.3.2.1 semaphore."
If communication among tasks is executed using I/O then only the first come order Queuing method can be used.

If the program “TIMING2” is run, the timing of the “MOTION2” is created by the “TIMING2” according to the status of IO [118] to execute the MOVE command. This operation repeats itself until the “TIMING2” loop ends.

```
                                PROGRAM TIMING2
PROGRAM MOTION2    ◄───────────────── RUN MOTION2
      TALEARM                         I[1]=0
      SPEED 100                       DO WHILE I[1]<10
      WAIT IO[118]  ◄───────────────     SET IO[118]
      MOVE P, P1                         DELAY 500
      MOVE P, P2                         RESET IO[118]
END                                   DELAY 5000
                                      LOOP
                                END
```

Fig. 2-6 Example of Synchronization Control Using I/O

2.4 Serial Communication

2.4.1 Circuit Number

The table below lists the relationship between the circuit numbers and channel numbers assigned in the robot controller.

Circuit and Channel Number Assignment

Circuit number	Channel number	Used as:
0	ch1	Teach pendant port
1	ch2	Universal port
2	ch3	(Reserved)
3	ch4	(Reserved)
4 to 7 (NOTE1)	ch5 to ch8	Ethernet server ports
8 to 15 (NOTE1)	ch9 to ch16	Ethernet client ports (**NOTE2**)

NOTE1: Version 1.9 or later
NOTE2: When using the Ethernet client port, you need to open or close a port using com_encom or com_discom statement explained in Section 7.2, "Serial Binary Transmission."
NOTE3: For setting the Client or Server of the Robot Controller, refer to “SETTING-UP MANUAL, Section 5.7”.

2.4.2 Communication Command

In PAC language, the following four commands are used for communication through the RS232C or Ethernet interface. The command format is the same for both the RS232C and Ethernet. For commands, refer to Section 13.2.

PRINT statement (Output)
WRITE statement (Output)
INPUT statement (Input)
LINEINPUT statement (Line input)

The PRINT and WRITE statements differ in their output form. Character-strings outputted in the form of WRITE statement can be correctly inputted using the INPUT statement.

2.4.3 Clearing the Communication Buffer

The FLUSH statement clears the RS232C and Ethernet communication buffers.
Be sure to clear those buffers before starting communication.

FLUSH statement : Refer to Section 13.2, “ FLUSH”

2.4.4 Sample Application

In this section, a practical program sample is illustrated as a simple application that uses serial communication. Refer to this sample for practical application.
In this sample application the robot controller counts the number of motions and transmits the data for these motions at fixed intervals. On the personal computer side, the data for the number of motions sent from the robot controller is received. The program in the robot controller is described using the PAC language. Visual Basic is used for an example of the personal computer.
If the programs shown in "2.4.4.1 Robot Controller Program" and "2.4.4.2 Personal Computer Program" are prepared in the robot controller and in the personal computer respectively and then run, the number of robot motions will be transmitted through the RS232C circuit and received by the personal computer.

2.4.4.1 Robot Controller Program

Figs. 2-7 and 2-8 show examples of programs in the robot controller. These two programs execute multitasking operation.
The program "PRO1" first initializes the counter and the coordinates and then concurrently runs the "PRO2". In the "PRO1" the robot executes the reciprocal motion between "P2" and "P1." During this operation the "PRO2" sends the number of robot motions stored in variable I[1] every 2 seconds (2000 milliseconds) through the RS232C port (ch2).

```
'!TITLE ”Robot motion”
PROGRAM PRO1
       I1=0                            ' Clears the count.
       P1=(370,400,750,-90,90,0,5)     ' Sets the coordinate.
       P2=(510,400,750,-90,90,0,5)     ' Sets the coordinate.
       RUN PRO2                        ' Concurrently runs task.
       TAKEARM                         ' Obtains robot control
                                       ' priority.
       DO
         MOVE P,P2                     ' Moves to point P2.
         DELAY 1000                    ' Waits 1 second.
         MOVE P, P1                    ' Moves to point P1.
         I1=I1+1                       ' Counts the number
                                       ' of movements.
       LOOP                            ' Executes loop.
END
```

Fig. 2-7 Program "PRO1" "Robot Motion" of the Robot Controller

```
'!TITLE ”Sending”
PROGRAM PRO2
   DO
        PRINT #2,I1
        DELAY 2000
   LOOP
END
```

Fig. 2-8 Program “PRO2” “Sending” of the Robot Controller

2.4.4.2 Personal Computer Program

A program in the personal computer is shown below.
The beginning section of the program list defines a program module for communication. The last section of the program has programs for receiving data by the use of each module.

Note: This program is described using Visual Basic made by Microsoft Corporation and using the communication control made by Bunka Orient Co., Ltd. Therefore, run the program on the personal computer where Visual Basic and PDQComm are installed.

```
'   Module defining statement
'
'   Communication port and communication speed setting
'   PortNo%     :  Designates communication port    1 or 2
'   ComInitString$:  Sets communication speed etc. “9600,N,8,1”
'
Private Sub CommOpen(PortNo%,ComInitString$)
        '----------------------------------------
        ' Communication speed setting
        '----------------------------------------
        PDQComm1.CommPort = PortNo%
        PDQComm1.Settings= ComInitString$      '“9600,N,8,1”
        '----------------------------------------
        ' Without handshake
        ' Input timeout value setting (in millimeters)
        ' Receiving buffer size setting
        ' Sending buffer size setting
        '----------------------------------------
        PDQComm1.Handshaking = 0
        PDQComm1.InTimeout = 50
        PDQComm1.InBufferSize = 2048
        PDQComm1.OutBufferSize = 2048

        '----------------------------------------
        ' Open a port.
        '----------------------------------------
```

Continued on the following page.

```
        PDQComm1.PortOpen = True
End Sub



'
' Closes the communication port.
'
'
Private Sub CommClose()
        '----------------------------------------
        ' Closes a port.
        '----------------------------------------
        PDQComm1.PortOpen = False
End Sub

'
' Encloses the character string designated to the communication port
' in double Quotations.  The system then adds a carriage return to
' the end of the line and sends this.
' SendText$:    character string to send
'
Private Sub CommWrite(SendText$)
        '----------------------------------------
        ' When character string and control code ich (CR+LF) are sent.
        '----------------------------------------
        PDQComm1.Output = Chr(&H22) &SendText$ & Chr(&H22) & Chr(13)
        & Chr(10)

        '----------------------------------------
        ' Waits until the output buffer becomes vacant.
        '----------------------------------------
        Do
                DoEvents
        Loop Until PDQComm1.OutBufferCount = 0
End Sub

'
' Obtains the character string received from the communication port
' until the carriage return appears, and then returns the character
' string.
'
Private Function CommRead()

        '----------------------------------------
        ' Data reading process
        '----------------------------------------
        InString$ =""
        Do While 1
                DoEvents
```

Continued on the following page.

```
              '---------------------------------------
              'Reading received data.
              '---------------------------------------
              If PDQComm1.InBufferCount > 0 Then
                      InString$ = InString$ +PDQComm1.Input
                      If InStr(1, InString$,vbCr,
vbBinaryCompare) <> 0 Then Exit Do
              End If
       Loop
       CommRead = InString$

End Function

Using sample
Private Sub mnuCh1_Click()
       ' Uses port 1 and sets the baud rate to 19200.
       CommOpen 1,”19200,N,8,1”
       ' Receives moving count number from the controller.
       ReadBuf$ = CommRead
       ' Closes the used port.
       CommClose
End Sub
```

Fig. 2-9 Program on the Personal Computer Side

2.4.5 Serial Binary Transmission (Version 1.5 or later)

In Version 1.4 or earlier, the robot controller can transmit only ASCII codes via the RS-232C ports. In Version 1.5 or later, it may support byte-controlled binary data transmissions, increasing the types of connectable communications devices.

In Version 1.743 or later, Ethernet ports are also available in serial binary transmission as well as RS-232C ports.

2.4.5.1 Using Serial Binary Transmission

Connect the robot controller to external equipment with an RS-232C or Ethernet interface cable and use the following commands:

■ **Data input/output commands**

(1)	`printb`	Output a single byte of data.
(2)	`inputb`	Input a single byte of data.
(3)	`lprintb`	Output multiple bytes of data.
(4)	`linputb`	Input multiple bytes of data.
(5)	`com_encom`	Enable COM port.
(6)	`com_discom`	Disable COM port.
(7)	`com_state`	Get COM or Ethernet port status.

NOTE: The `com_encom`, `com_discom`, and `com_state` are functionally extended for supporting Ethernet, but their conventional functions and syntaxes are not changed.

■ **Transmission system**

(1)	Transmission method	:	RS-232C
(2)	Transmission port	:	Controller RS-232C port, μVision board RS-232C port
(3)	Pin array	:	Same as conventional
(4)	Transmission status	:	

Controller RS-232C port	Variable, same as the previous controllers
μVision board RS-232C port	Transmission speed : 9600bps Bit length : 8 Parity bit : None Stop bit : 1 Flow control : None

2.5 Library

The program library is used to collect all-purpose programs like parts and use them accordingly. In the PAC language, since other programs can be called from a program, programs can be developed more efficiently using the programs in the library or by registering a created program to the library.

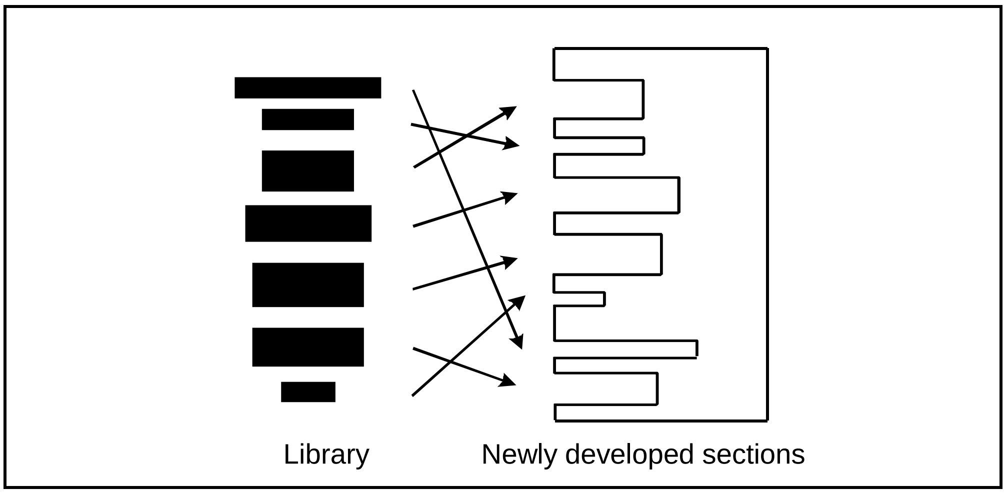


Fig. 2-10 Image of Program Development Using the Library

2.5.1 Program Bank

The PAC manager of WINCAPSII provides a program bank for using the library. The program bank is a tool used to register a program as a library, or to add registered programs to a project.
For operation of the program bank, refer to "5.6.2 Program Bank" in Owner's Manual (WINCAPSII).

2.5.1.1 Program Library Classifications

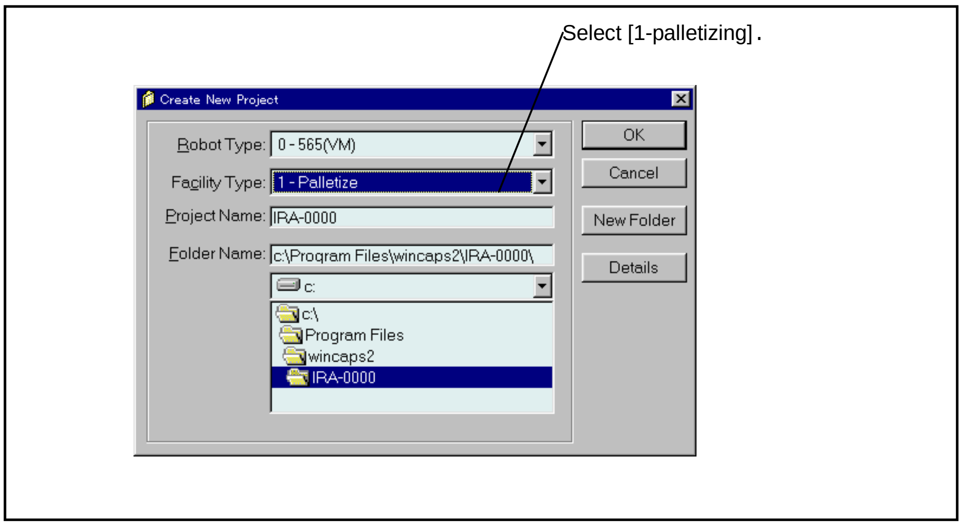
The standard program library is classified into the following 7 classes.

Table 2-2 Standard Program Library Class

	Class name	Description
1	Conventional language	Provides functions similar to conventional language commands.
2	Palletizing	Provides a palletizing function.
3	Tool operation	Provides tool operation related functions.
4	Input/output	Provides DIO and RS232C input/output related functions.
5	Arm motion	Provides arm motion related functions except for the above described.
6	Vision	Provides vision operation related functions.
7	Ver. 1.2 compatible	Provides the version 1.2 compatible library that can be used in Controller Software Version 1.2* or earlier. This library contains three programs--ndVcom, pltMove, and pltMove0. If in Version 1.2* or earlier any of those programs not in this library but in classes 1 to 6 above is used, a compilation error will result. Use libraries in classes 1 to 6 above except for those three programs.

2.5.2 Palletizing Library

There is no special instruction for palletizing in the PAC language. But palletizing operation can be realized using a program prepared as a library.
A library can be added for palletizing to a project by using the program bank. When the system executes "New system project," if [1-palletizing] is selected in the column [EQuipment type] of the dialog box [New project], a library program is automatically registered in the program project from the beginning of the library.


Select [1-palletizing] .

Create New Project

Robot Type: 0 - 565(VM)
Facility Type: 1 - Palletize
Project Name: IRA-0000
Folder Name: c:\Program Files\wincaps2\IRA-0000\

c:
c:\
Program Files
wincaps2
IRA-0000

Fig. 2-11 [New Project] Dialog Box

2.5.2.1 Palletizing

Palletizing is used to place parts on a pallet or pick them up in order from a pallet with partitions as shown in Fig. 2-12.
A library program for palletizing is created so that the robot executes palletizing operation only when the number of partitions and positions of the 4 corners are taught.
The palletizing program changes the pick-up position on the pallet every time the program is called.

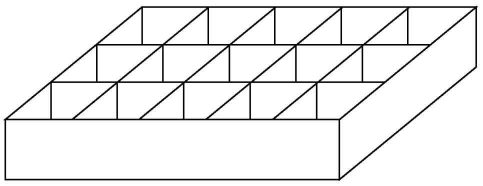


Fig. 2-12 Pallet with Partitions

[1] Palletizing Parameter

Figs. 2-13 to 2-15 and Table 2-3 show the required parameters for palletizing. The PAC language stores these parameters as the values of variables.

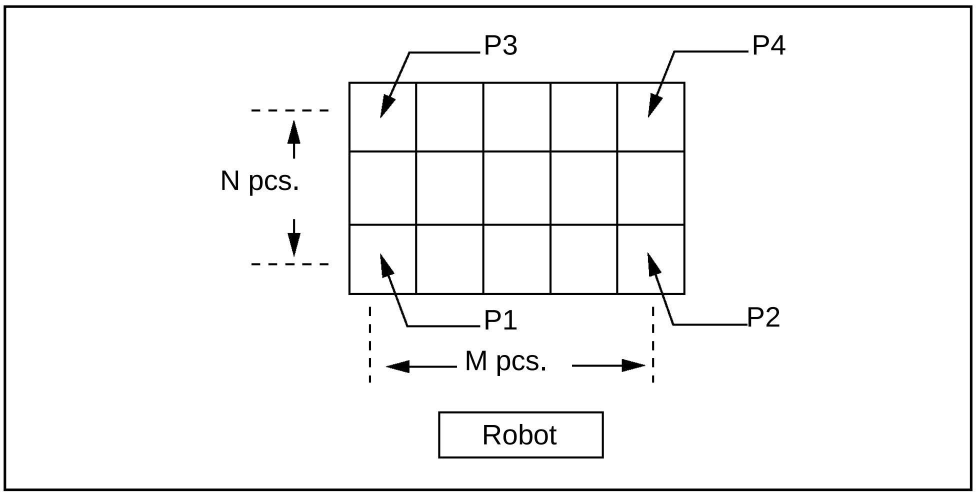


Fig. 2-13 Top View of Pallet

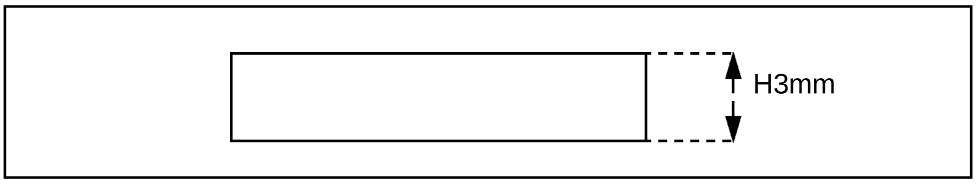


Fig. 2-14 Side View of Pallet

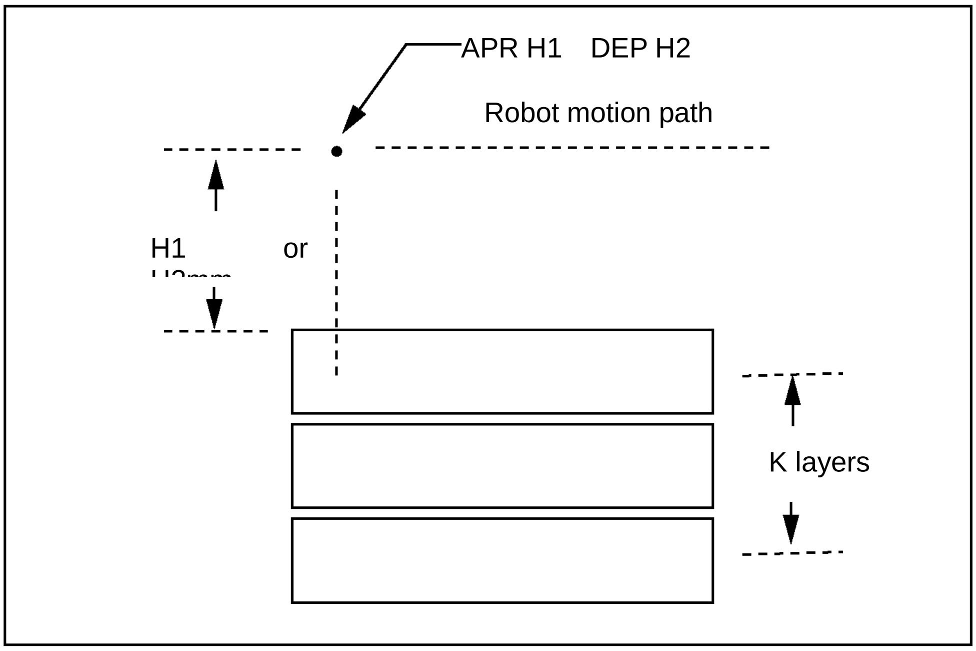


Fig. 2-15 Pallet Layer Drawings

Table 2-3 Parameters Required for Palletizing

Symbol	Name	Meaning	Unit
	Palletizing number	Palletizing index number	None (Integer)
N	Number of side partitions	Number of partitions in the direction from P1 to P3	Pc (Integer)
M	Number of lengthwise partitions	Number of partitions in the direction from P1 to P2	Pc (Integer)
K	Number of layers	Number of pallet layers	Pc (Integer)
H1	Approach length	Approach length when the robot gets access to a pallet.	mm (Single precision real)
H2	Depart length	Depart length when the robot leaves the pallet.	Mm (Single precision real)
H3	Pallet height	Height of one pallet layer	Mm (Single precision real)
	However, H1 and H2 must satisfy the following conditions. $H1 > [H3 \times (K-1)] + 5$ $H2 > [H3 \times (K-1)] + 5$		
P1 P2 P3 P4	The relative position of the 4 corner points on the pallet shown in Fig. 2-13 cannot be exchanged. The robot figure taught at position P1 is maintained at all points.		

N Number of side partitions
Shows the number of partitions in the pallet side direction.
Fig. 2-13 shows 3 partitions.

M Number of lengthwise partitions
Shows the number of partitions in the pallet lengthwise direction.
Fig. 2-14 shows 5 partitions.

K Number of layers
Shows the number of pallet layers.
Fig. 2-15 shows 3 layers.

H1 Approach length
Shows the approach length when the robot gets access to a pallet.
Every time the palletizing program is called, the same approach length is used.

H2 Depart length
Shows the depart length when the robot leaves a pallet.
Every time the palletizing program is called, the same depart length is used.

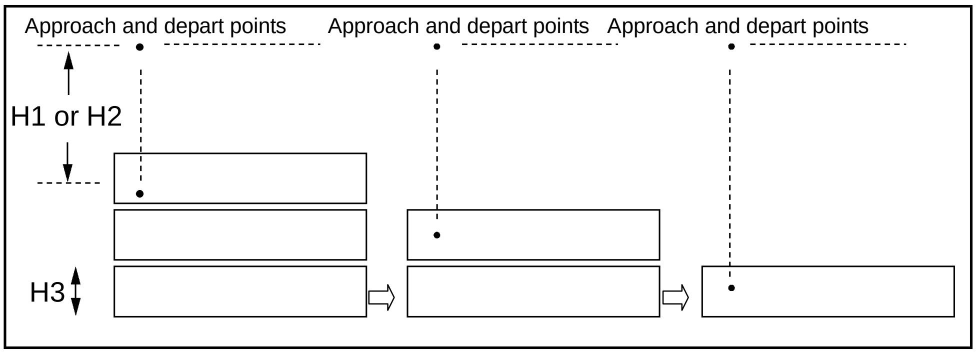
H3 Pallet height
Shows the 1 pallet layer height.
If the number of layers increases, enter a positive value.
If the number of layers decreases due to removal of pallets, enter a negative value.
If the number of layers does not change, enter 0.

Note: H1 and H2 must satisfy the following conditions.

H1 > {H3 × (K-1)} + 5

H2 > {H3×(K-1)} + 5

If these conditions are not satisfied, an error occurs during initialization. These are provided so that the robot does not collide with a pallet. They are used to set an approach point and a depart point that are 5 mm higher than the maximum number of layers. Even if the number of layers increases or decreases, the approach and depart points are the same as shown in Fig. 2-16.



Approach and depart points
Approach and depart points
Approach and depart points
H1 or H2
H3

Fig. 2-16 Change of Layer Number and the Approach and Depart Points.

Points P1, P2, P3, and P4 at the 4 corners of the pallet show the positions of parts. Fig. 2-17 shows each point and the respective execution sequence.

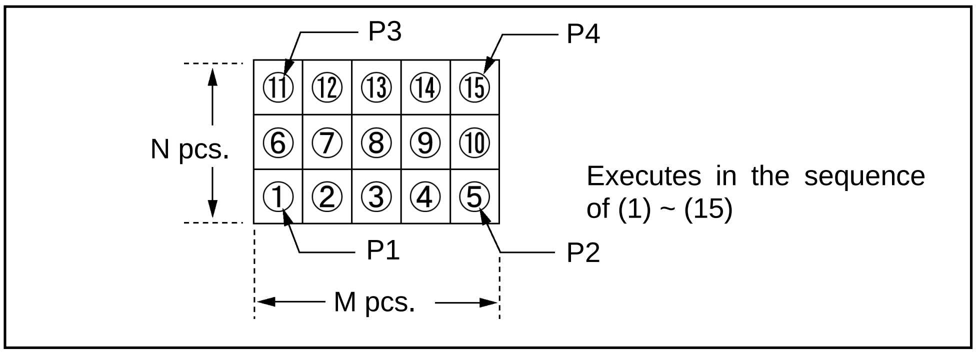


Fig. 2-17 Palletizing Sequence

[2] Parameter Value Setting

Set the parameter values such as the numbers of side and lengthwise partitions and the layers in palletizing by calling “pltInitialize” from the program library.

If you select [1-palletizing] in [Equipment type] in the [New project] dialog box when “New system project” is executed, the program “PRO2” titled “palletizing initialization template 1” is automatically registered in the library. Since this program is called “pltInitialize”, change the values of the arguments in the CALL statement to the proper ones before using.

```
'!TITLE ”palletizing  Initialization template 1”
#DEFINE pltIndex    0

PROGRAM PRO2
  CALL pltInitialize(pltIndex, 4,3,1,50,50,50,52,53,54,55)     'Initializes palletizing
                                                              'number 0.
END
```

Fig. 2-18 Library Program “Palletizing Initialization Template 1”

```
CALL pltInitialize(pltIndex, 3, 5, 3, 50, 50, 10, 52, 53, 54, 55) in parameter
description
  1st     Palletizing program No. (pltIndex)
  2nd     Number of side partitions (3)
  3rd     Number of lengthwise partitions (5)
  4th     Number of layers (3)
  5th     Approach length (50mm)
  6th     Depart length (50mm)
  7th     Pallet height (10mm)
  8th     P1 position (P52) ⎫
  9th     P2 position (P53) ⎬  Designate only a number for type P variable.
 10th     P3 position (P54) ⎭
 11th     P4 position (P55)
```

Fig. 2-19 Description of Parameter “pltInitialize”

The meaning of this parameter can be seen with the tool “Command builder” in the PAC manager of WINCAPSII.

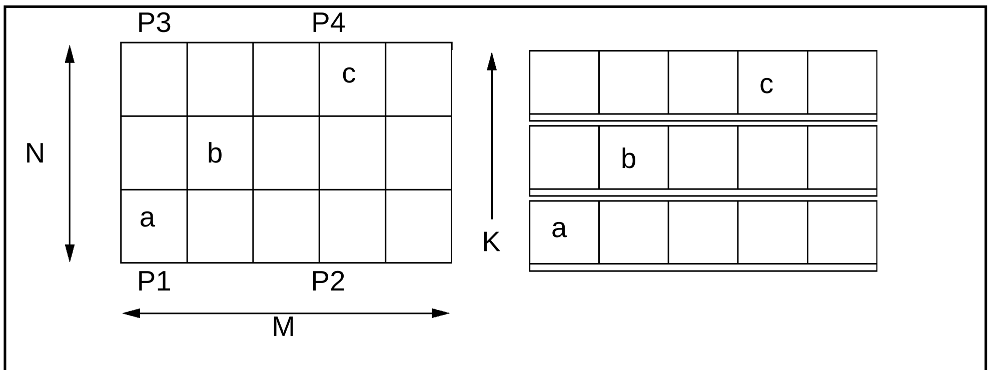
[3] Palletizing Counter

In palletizing the robot counts the number of partitions and stores the count values as variables.
There are 4 types of counters; side direction (N), lengthwise direction (M), height direction (K) and total (cnt).
These counters are defined in “pltKernl” which is the nucleus program for controlling palletizing operation.
The library program “pltMove” adds a value of 1 to the total counter every time one operation is finished and adjusts the values of the other counters.
The library program “pltDecCnt” subtracts 1 from the total counter value every time calling is made, and each counter value is adjusted by subtraction.
Up to 30 palletizing programs can be created as the initial setting.
Therefore, there are 31 sets of palletizing counters. To change the number of palletizing programs, refer to “2.5.2.2.1 Palletizing Program Customization.”

Count Rule

The palletizing counter adds a value of 1 to the total counter every time “pltMove” is executed and adjusts the values of the other counters. As a result of this the next pallet position is ensured.
If 1 is added to the total counter, the position of the lengthwise counter (M) moves to the next. If the lengthwise counter (M) reaches the end and it becomes the maximum value, then the side direction counter (N) moves to the next and the lengthwise counter (M) becomes its minimum value. If the position of the widthwise counter (N) reaches the end and becomes the maximum value, the position of the vertical direction counter (K) moves to the next and the widthwise counter (N) becomes the set minimum value.
If a palletizing program is stopped during processing and is then restarted, the robot moves to the next position because the value of the counter variable is counted up.
The contents of the palletizing counter are stored even if the power is turned off. If the system is not initialized after being rebooted, the robot proceeds with palletizing from the previous counter value.

**Note:	If an execution program is loaded after compiling, the values of variables are initialized.**



When N=3, m=5, and K=3,
Point a is N=1, m=1, K=1
Point b is N=2, m=2, K=2
Point c is N=3, m=4, K=3

Fig. 2-20 Relation between Palletizing Position and Counter

Counter Initialization

When pallets are replaced or all partitions are not used the counters need to be initialized.
In the initialization of the counters all palletizing counters are set to “1.”
All the palletizing counters can be initialized at once by using “pltResetAll” of the library program.
For example, if all counters of pallet number 1 are initialized, describe as follows.

```
    CALL   pltResetAll(1)
```

If each palletizing counter is independently initialized, use “pltLetN1,” “pltLetM1,” “pltLetK1” and “pltLetCnt.”
For example, if the N counter of pallet number 1 is initialized, describe as follows.

```
    CALL   pltLetN1(1, 1)
```

Note: **The variables are inifialized after compiling by loading the execution program.**

End Signal of Palletizing Program

The palletizing program sets a one layer finish flag or all layer finish flag if one layer or all layers are finished.
To obtain the one layer finish flag status, use the library program “pltGetPLT1END.” To obtain the all layer finish flag status, use the library program “pltGetPLTEND.”
To reset (0) the 1 layer finish flag, use the library program “pltResetPLT1END.”
To reset (0) the all layer finish flag, use the library program “pltResetPLTEND.”

2.5.2.2 Palletizing Program

A practical palletizing program varies in special situations depending on the application. However, the standard procedure for assembling the program by the use of the library is prepared in the program “PRO1” of the title “Palletizing Template 2.”
Use this “Palletizing Template 2” as a model and add the required items for the application to make full use of program development.
Fig. 3-21 shows the program “PRO1” of the title “Palletizing Template 2.”
This example is based on the following assumptions.

- The points of palletizing are P50-P55.
- In the prepared program, the robot moves to fixed position P50 and executes the palletizing program 0. Then it moves to assembling position P51 to unchuck. It checks the layer finish and if the finish signal is output, it changes the pallet accordingly. If there is no workpiece then it terminates the motion.

“Palletizing Template 2” with the program name “PRO1” and “Palletizing initialization template” with the program name “PRO2” are automatically registered if “Palletizing” is selected in the item “Equipment type” of the “New project” dialog box when a new project is created with WINCAPSII. Refer to p.2-14 “2.5.2 Palletizing library.”

```
' !TITLE "Palletizing Template 2"
' !AUTHOR "Denso Robot Engineering Dept.
#DEFINE pltIndex    0                ' Palletizing program No.
                                     ' Any numeric value from 0 to 30 is available for
selection. #DEFINE ChuckNG        40   ' Number of pick up inspections IO.
                                     ' Any numeric value is available for selection.
PROGRAM PRO1                         ' Change the name to the proper one.
  MOVE P, P50                        ' Moves to fixed position P50.
                                     ' Moves to palletized P50.
  IF IO[ChuckNG] = ON THEN           ' Pick up inspection for the previous time.
    CALL pltDecCnt(pltIndex)         ' Subtract 1 from the total counter.
  END IF
  CALL pltMove(pltIndex)             ' Executes palletizing number 0.
  MOVE P, P51                        ' Moves to assembling position P51.
                                     ' Moves to palletized P51.
  '<--- Insertion such as unchuck motion --->
  CALL pltGetPLT1END(pltIndex,0)     ' Obtains a finish signal for the 1st layer in I[0].
                                     ' The second argument "0" is an array number of "I"
                                     ' that is decided on the next line.
  IF I[0] THEN                       ' When this is ON (e.g. when <>0)
    '<--- Insertion of pallet change motion --->
    CALL pltResetPLT1END(pltIndex)   ' Clears the finish signal for the 1st layer.
  END IF
END
```

Fig. 2-21 Program Name “PRO1” and “Palletizing Template 2”

[1] Palletizing Program Customization

Q. How do you change a palletizing program to execute to 1?
A. Change the value of “pltIndex” in “PRO1” and “PRO2” to “1.”

Q. How do you change the menber of palletizing partitions to 5 for side and 3 for lengthwise?
A. Change “3” and “5” of the second and third parameters of “pltInitialize” to “5” and “3” respectively.
* CALL pltInitialize (pltIndex, 5, 3, 3, 50, 50, 10, 52, 53, 54, 55)

Q. How do you change the number of palletizing programs available?
A. Change “31” of “#DEFINE mcPaltMax 31” the in “pltKernel” program to any number you like and the number of palletizing programs can be set.

Q. How do you set a palletizing dodge point?
A. If you add a dodge point of X = 10, Y = 10, Z = -10 to the approach direction, add a command to move a point with parallel deviation “(10, 10, -10) H” added to a point P[mcNextPos] in the file “paltmove1. pac”.
* MOVE P, P[mcNextPos] + (10, 10, -10)H 'Moves to the dodge point of 'X=10, Y=10, Z=-10.

Q. How do you obtain N1, M1 and K1?
A. Add the program libraries “pltGetK1”, “pltGetM1”, and “pltGetN1.”
* call pltGetK1(Index, iValue)
* call pltGetM1(Index, iValue)
* call pltGetN1(Index, iValue)
'Index . . . Palletizing program No.
'iValue. . . Number of type I variable to which K1, M1, and N1 values are returned.

```
Example) #define   pltIndex    0         'Palletizing program No.
                   Program Exmp
                   DefInt  Index, iValue
                   Index = pltIndex      'Inserts a palletizing program
        'number into Index register.
                   call pltGetK1(Index, iValue)      'Returns the value of
                                                     'K1 to the type I
                                                     'variable
                                                     'designated with
                                                     'iValue.
                   call pltGetM1(Index, iValue)      'Returns the value of
                                                     'M1 to the type I
                                                     'variable
                                                     'designated with
                                                     'iValue.
                   call pltGetN1(Index, iValue)      'Returns the value of
                                                     'N1 to the type I
                                                     'variable
                                                     'designated with
                                                     'iValue.
                   End
```

Q. How do you chAnge N1, M1 and K1?

A. Add the program libraries “pltLetK1”, “pltLetM1”, “pltLetN1”.

```
* call pltLetK1(Index, iValue)
* call pltLetM1(Index, iValue)
* call pltLetN1(Index, iValue)
         'Index . . . Palletizing program No.
         'iValue. . . Enter this value into K1, M1, and N1.

Example) #define   pltIndex    0          'Palletizing program No.

                   Program Exmp
                   DefInt  Index, iValue
                   Index  = pltIndex      'Inserts the palletizing
                                          'program number
                                          'into the Index register.
                   iValue = 10            'Enters values in K1, M1, and
                                          'N1.
                   call pltLetK1(Index, iValue)
                                          'Enters the value of iValue
                                          'into K1.
                   call pltLetM1(Index, iValue)
                                          'Enters the value of iValue
                                          'into M1.
                   call pltLetN1(Index, iValue)
                                          'Enters the value of iValue
                                          'into N1.
                   End
```

Q. How do you obtain the total counter?

A. Add the program library ”pltGetCnt.”

```
*call pltGetCnt(Index, iValue)
'Index ....Palletizing program No.
'iValue ...Number of type I variable to which the value
             of the total counter is returned.

Example) #define   pltIndex    0           'Palletizing program No.

                   Program Exmp
                   DefInt Index, iValue
                   Index = pltIndex        'Inserts the palletizing
                                           'program number into Index
                                           'register.
                   call pltGetCnt(Index, iValue)
                                           'Returns the value of the
                                           'total counter to the type
                                              'I variable specified with
                                              'iValue.
                   End
```

Q. How do you change the total counter?

A. Add the program library “pltIncCnt.”

```
* callpltLetCnt(Index, iValue)
        'Index . . . Palletizing program No.
        'iValue. . . This value is entered in the total counter.

Example) #define   pltIndex    0        'Palletizing program No.

                   Program Exmp
                   DefInt  Index, iValue
                   Index  = pltIndex    'Inserts the palletizing
                                        'program No.
                                        'into the Index register.
                   iValue = 0           'Enters a value into the
                                        'total counter.
                   call pltLetCnt(Index, iValue)
                                        'The value of iValue is
                                        'entered into the total
                                        'counter.
                   End
```

Q. With what timing does the total counter count?

A. It counts up when “pltKernel (Index, -15, mcNextPos, ndErr)” is executed.
Therefore, if the program library “pltGetNextPos,” “pltMove” and “pltMove0”
are executed, the total counter will count up.

```
* call  pltMove(Index)
* call  pltMove0
* call  pltGetNextPos(Index, NextPos)
        'Index . . . .      Palletizing program No.
        'NextPos . . .      Type P variable number where
                            the position of the next
                            position is entered.
```

Chapter 3

Robot Motion

There are various robot motions according to reference point settings or how to determine whether the robot reaches the destination position. This chapter provides an explanation of these robot motions.

3.1 Absolute Motion and Relative Motion

3.1.1 Absolute Motion

An absolute motion is a motion to move a taught position.
An absolute motion always moves to a taught position without being affected by the previous motion.
The commands to execute an absolute motion are as follows.

APPROACH, MOVE, GOHOME, DRIVEA

3.1.2 Relative Motion

A relative motion is a motion to move by a taught distance from the current position.
Since a relative motion sets its reference to the current position of the result of executing the previous motion command, the previous motion command affects the motion.
The commands to execute a relative motion are as follows.

DEPART, DRAW, DRIVE, ROTATE, ROTATEH

3.1.3 Absolute Motion and Relative Motion Examples

Here are two example programs to move the robot from the current position P1 to point P3 through point P2.

"MOVEMENT1" is expressed with an absolute motion.
"MOVEMENT2" is expressed with an absolute motion and a relative motion. If you execute them, both programs perform the same motion, as shown in Fig. 3-3.

```
PROGRAM MOVEMENT1
      TAKEARM
      MOVE L, P2
      MOVE L, P3
END
```

Fig. 3-1 Absolute Motion Example

```
PROGRAM MOVEMENT2
     TAKEARM
     MOVE L, P2
     DRAW L, V3     'V3 is the relative distance of P2 and P3.
END
```

Fig. 3-2 Relative Motion Example

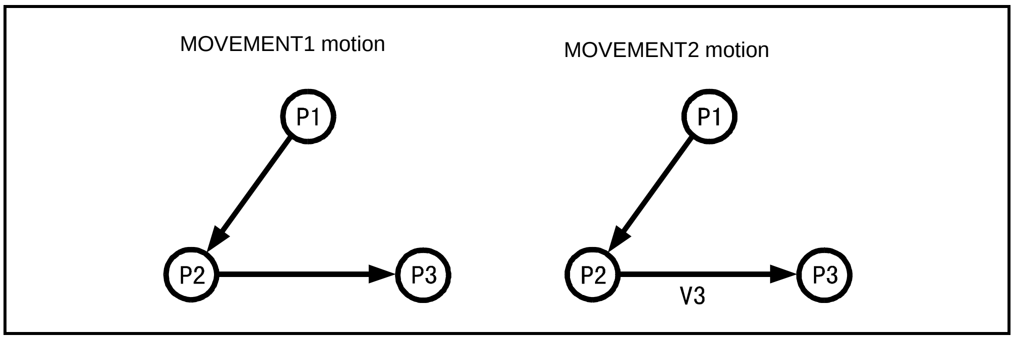


Fig. 3-3 Motion Examples of Two Programs

If you delete the first motion instruction “MOVE P, P1” from “MOVEMENT1” and “MOVEMENT2”, their motions change, as shown in Fig. 3-4.
With “MOVEMENT1,” the robot moves to point P3 with an absolute motion, however, ”MOVEMENT2” moves by V3 from the current position with a relative motion.

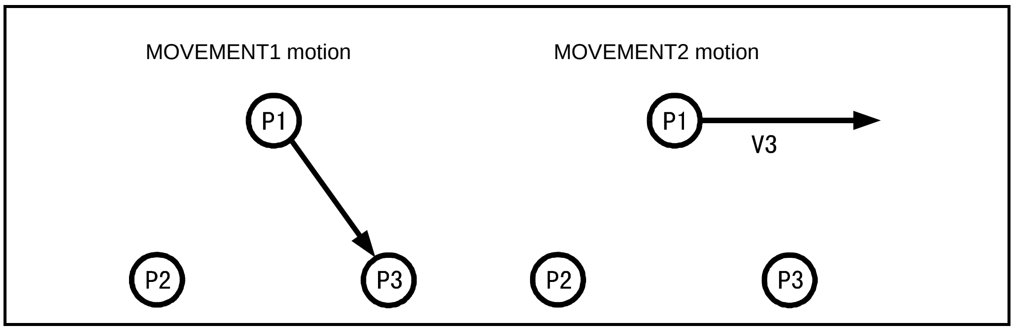


Fig. 3-4 Motion Examples of Two Programs (After deletion)

Note: A relative motion executes a movement to a designated relative distance from the current position. Therefore, if you execute a relative motion, right after you skip the motion instruction with the INTERRUPT ON/OFF instruction (refer to “12.3 INTERRUPT ON/OFF”), the position of motion finish may change depending on the timing of the ON interruption signal. To fix the motion finish position, use an absolute motion.

3.2 Confirming Reach Position

There are three methods of determining the first motion finish when the robot arm changes from one motion to another. They are called pass motion, end motion and encoder value check motion. The following explains each motion.

3.2.1 Pass Motion

A pass motion is a motion to pass the vicinity of a taught motion position or relative position.
If you designate the pass start displacement distance to “@P” or “@Numeric value (Numeric value > 0)” for all motion commands, you can execute a pass motion.

3.2.2 End Motion

Among motions to reach a taught motion position or relative position, an end motion is a motion to determine if the robot has reached the destination position when the command value of the servo system meets the destination position.
If you designate the pass start displacement distance to “@0” for all motion commands, you can execute an end motion.

3.2.3 Encoder Value Check Motion

Among motions to reach a taught motion position or relative position, an encoder value check motion is a motion to determine if the robot has reached the destination position when the encoder value entered within a designated pulse (initial value 20) from the destination position. You can change the designated pulse in the program for each axis.
If you designate the path pass displacement distance to “@E” for all motion commands, you can execute an encoder value check motion.

Note (1): **If the encoder value is outside the designated pulse from the destination position, the robot does not determine it has reach the destination position and does not proceed to the next motion. You should consider the deviation amount of the servo system when you decrease the designated pulse or when the load is large.**

Note (2): **In machine lock operation, all motions designated with “@E” are executed with motions of “@0”. Therefore, the program execution time displayed is less than that of the practical motion.**

Note (3): **If the reach position check method is described, the end motion “@0” is automatically set to the pass start displacement distance.**

3.2.4 Motion Examples of Pass, End and Encoder Value Check

These examples show three programs to move the robot from the current position P1 to point P3 through point P2. They are program examples of pass motion, end motion and encoder value confirmation motion, respectively.

```
PROGRAM PASS_MOVE
     TAKEARM
     MOVE P, @P P2
     MOVE P, @0 P3
END
```

Fig. 3-5 Pass Motion Program Example

```
PROGRAM END_MOVE
     TAKEARM
     MOVE L, @0 P2
     MOVE L, @0 P3
END
```

Fig. 3-6 End Motion Program Example

```
PROGRAM ENCODER_MOVE
     TAKEARM
     MOVE L, @E P2
     MOVE L, @0 P3
END
```

Fig. 3-7 Encoder Value Check Motion Program Example

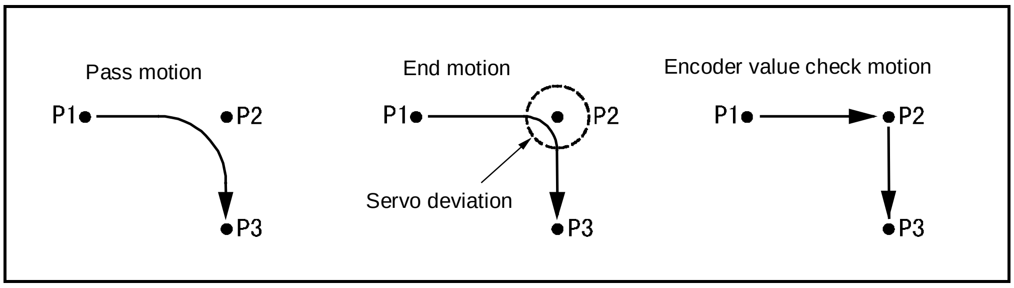


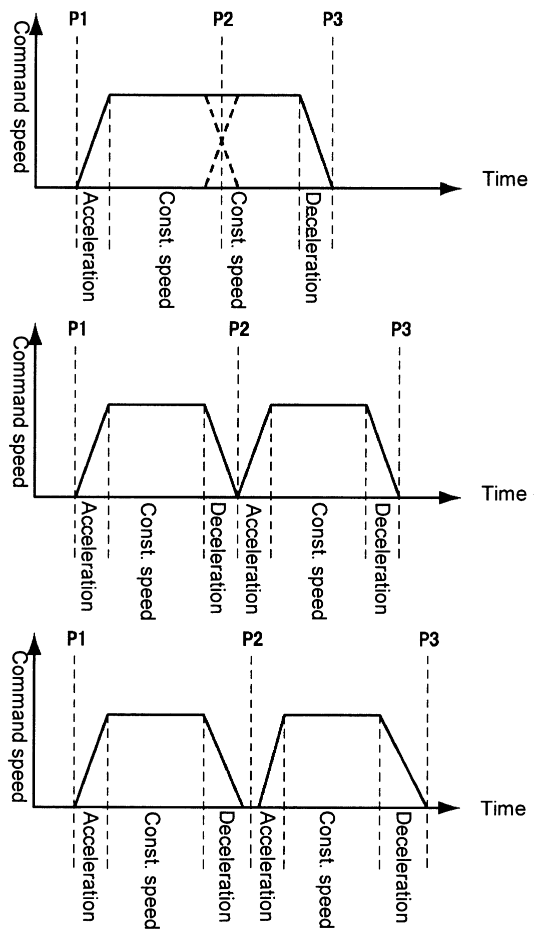
Fig. 3-8 Examples of Pass Motion, End Motion and Encoder Value Check Motion

3.2.5 Execution Time Difference among Pass Motion, End Motion and Encoder Value Check Motion

Among the three motions, the pass motion has the fastest execution time, followed by the end motion and finally the encoder check motion.

The pass motion starts the next acceleration motion during deceleration time before it reaches P2 as is shown in Fig. 3-9. Therefore, the execution time is shorter than the end motion, which executes deceleration and acceleration individually.

In the encoder value check motion, because the robot strictly checks reach of the destination position with the encoder value, it requires more time to eliminate servo deviation than the end motion does.



The pass motion is fastest because it overlaps deceleration and acceleration at P2.

The end motion executes deceleration and acceleration individually at P2.

The encoder value check motion takes longer time than the end motion, because it executes deceleration and position check at P2 and P3.

Fig. 3-9 Execution Time of Pass Motion, End Motion and Encoder Value Check Motion

3.2.6 If Pass Motion Does Not Execute

In the following cases, even if a pass motion is designated, the robot moves with end motion.

3.2.6.1 If Pass Motion Command Is at the End of the Main Program

The pass motion command to be executed at the end of the main program is executed as the end motion command. For example, in Fig. 3-10, the robot reaches the last position P3 with an end motion.

```
PROGRAM PRO10
    TAKEARM
    MOVE L, @P P1
    MOVE L, @P P2
    MOVE L, @P P3
END
```

Fig. 3-10 A Program Example of Pass Motion Command Present on the Last Line of the Main Program.

However, if you continuously run the main program, P3 becomes a pass motion as shown in Fig. 3-11.

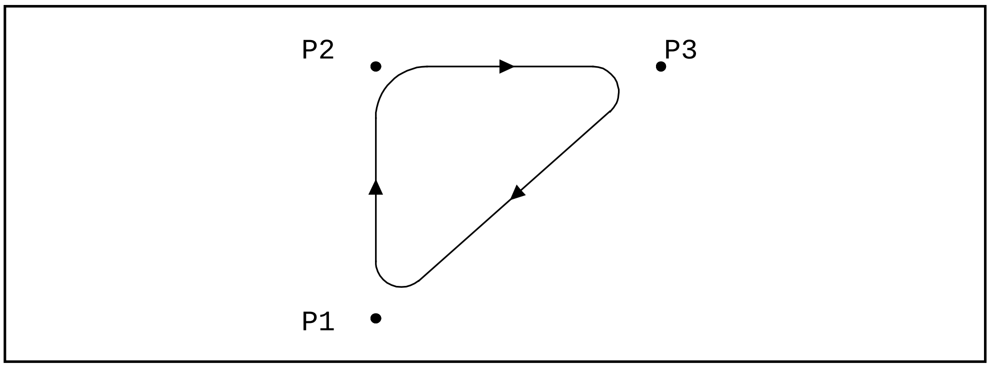


Fig. 3-11 Main Program is Continuously Running.

3.2.6.2 If GIVEARM Is Present after Pass Motion Command

If you execute GIVEARM (refer to p.14-17 " GIVEARM"), the robot waits until the motion completely stops. Therefore, if you execute GIVEARM just after the pass motion command, the robot does not execute the pass motion.

3.2.7 If Pass Motion Effect Reduces

3.2.7.1 If Non-Motion Command Is Present after Pass Motion

If a non-motion command is present between a pass motion command and the next motion command, the effects of reducing the execution time of the pass motion decrease. A non-motion command is one, which does not let the robot move.
Fig. 3-12 shows an example of when a non-motion command present between a pass motion command and the next motion command. For example, as shown in Fig. 3-13, the non-motion command is executed during deceleration time of the path motion command. Therefore, the effects of reducing the execution time of the pass motion decrease.

```
PROGRAM PRO13
   MOVE L, @P P2     ' Pass motion command
   SET IO1           ' Non motion command
   RESET I02         ' Non motion command
               :
   MOVE L, @0 P3     ' End motion command
END
```

Fig. 3-12 Example of Presence of Non-motion Command Between Pass Motion Command and the Next Motion Command

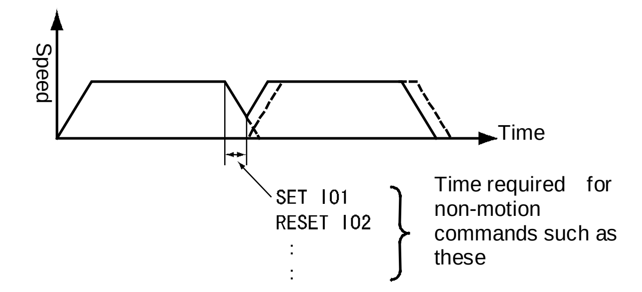


Fig. 3-13 Example of Less Effect of Reducing Pass Motion Execution Time

3.2.7.2 If Path after Pass Is Short

If the speed pattern becomes a triangle, due to a short path after pass, the pass start position delays so that pass motion ends after the path deceleration pass finishes. Therefore, if the path deceleration prior to the pass is small as shown in Fig. 3-14, the pass effect decreases.

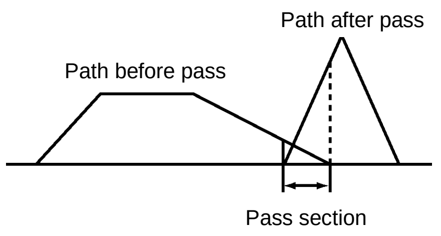


Fig. 3-14 Triangle Pattern Due to Short Path After Pass

3.2.8 If Acceleration Affects Pass Motion Path

The VS-D series robot automatically sets the square of speed divided by one hundred for acceleration and deceleration when you set speed.
If you use a SPEED command, in the same manner as above, acceleration and deceleration is set.
If the robot executes a pass motion by using the set automatic acceleration, its motion path is always constant. Fig. 3-15 shows an example when the speed is set to 60% and 80%.

⚠CAUTION: **When you set acceleration, be sure to check that there is no danger of collision due to the change of pass motion path.**

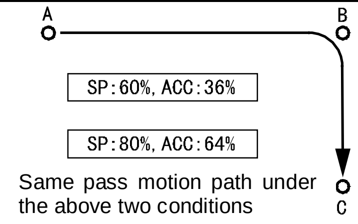


Fig. 3-15 Example of Automatic Acceleration Setting

If you set arbitrary acceleration, the motion path may change. Fig. 3-16 shows an example of 60% speed with 100% acceleration and 10% deceleration.

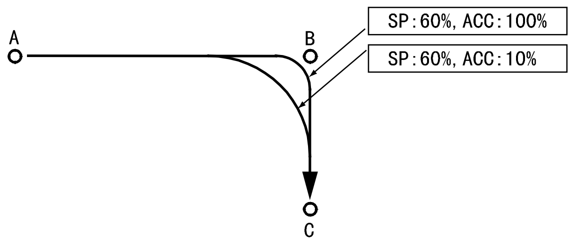


Fig. 3-16 Example of Arbitrary Acceleration Setting

⚠CAUTION: **If you execute an instantaneous stop during deceleration of the pass motion and restart the motion, the robot moves to the position of the next step command value. Therefore, exercise due care if speed, acceleration, and deceleration are occurring.**

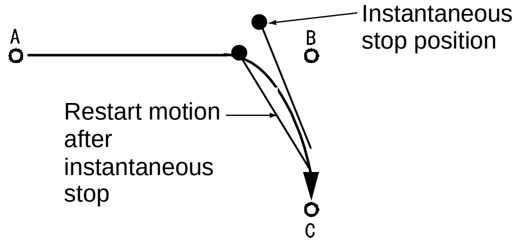

Instantaneous stop position
A
B
Restart motion after instantaneous stop
C

Fig. 3-17 Restart the Motion After the Instantaneous Stop

3.2.9 Pass Start Displacement

If you designate pass start displacement with “@P,” the next motion starts together at the start of deceleration of the motion, which is executed until that time. Therefore, the distance L between the path start position and passing point B changes depending on the speed and the acceleration.

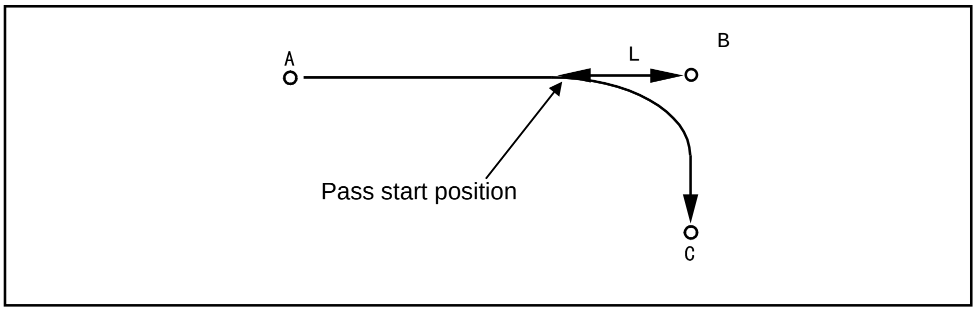
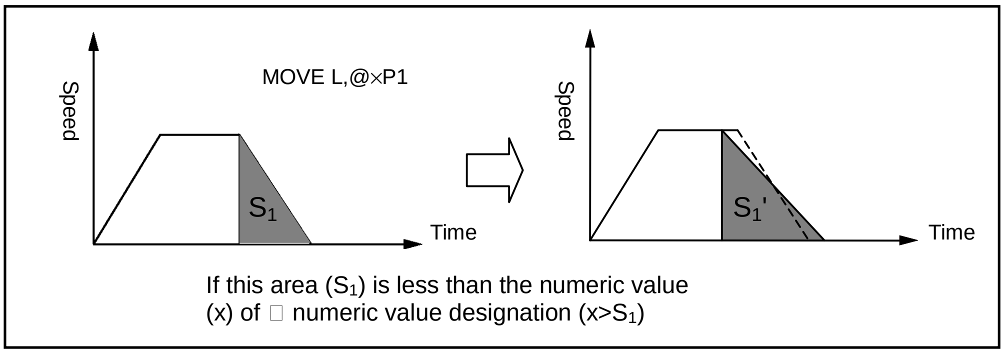


Fig. 3-18 Pass Start Position

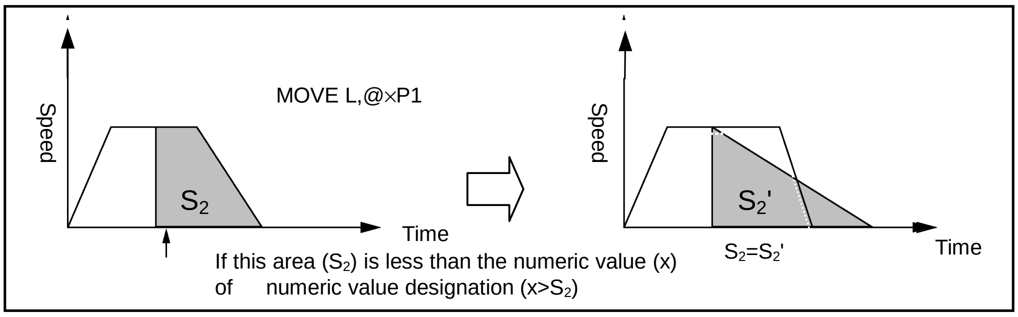
If you designate pass start displacement with “@ numeric value,” the pass motion starts from a position with a value = L (mm).
If the value designated with “@ numeric value” exceeds the deceleration movement distance, the deceleration start position is corrected as shown in Fig. 3-19.
Therefore, if designated with “@ numeric value,” the deceleration is reduced and the movement path may be longer.



If this area (S_1) is less than the numeric value (x) of □ numeric value designation ($x>S_1$)

Fig. 3-19 Deceleration Start Position

The value designated with “@ numeric value” exceeds half of the movement distance, the deceleration start position is fixed to half of the movement distance as shown in Fig. 3-20.



If this area (S_2) is less than the numeric value (x) of numeric value designation ($x>S_2$)

Fig. 3-20 If (@numeric value) Exceeds 1/2 of Movement Distance

Therefore, when X>S2, the pass motion never changes even if you change X. And when X>S2, the "Set path start displacement distance again" warning is displayed on the pendant.

If the deceleration start position changes, the acceleration time of the next path also changes. As shown in Fig. 3-21, the motion time may be longer compared with @P designation.

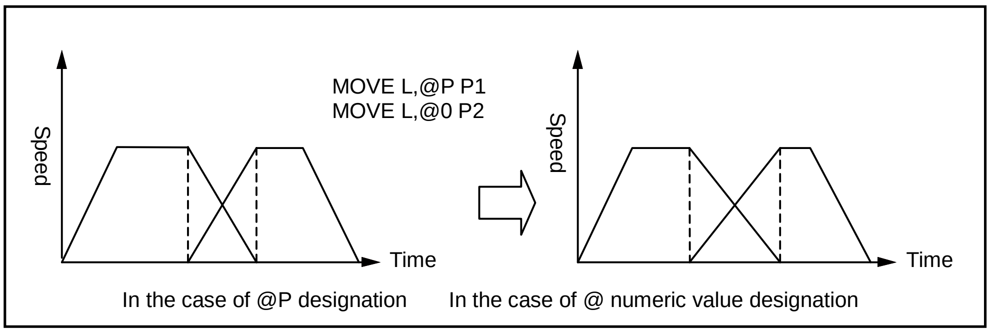


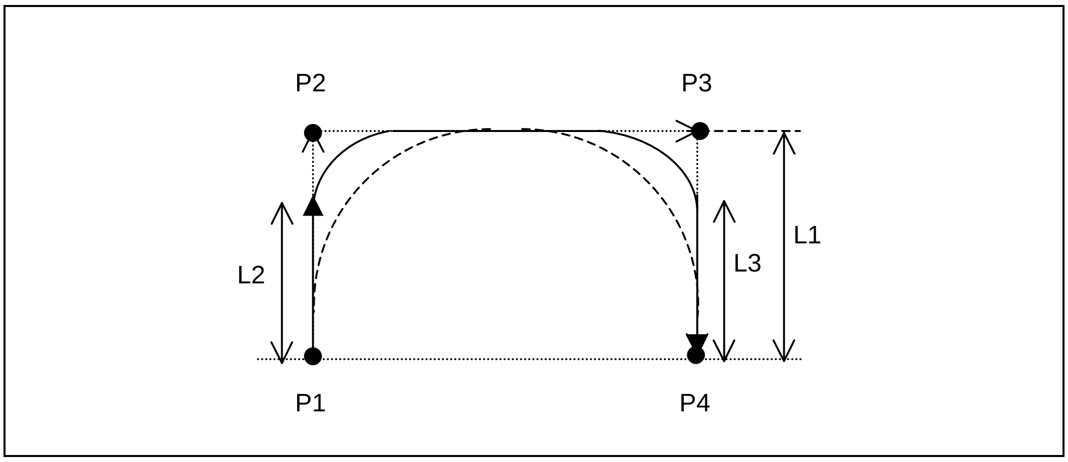
Fig. 3-21 Motion Time When the Deceleration Start Position Changes.

Note: In the following case, even if you designate with "@ numeric value," the pass motion starts from the position which is less than the position of numeric value = L (mm).

(1) If the speed pattern becomes a triangle because of its short curve.
Similar to "If path motion effect reduces" on page 4-7, the pass motion start position changes. Especially, if the robot executes the path motion, when the motion changes from low speed to high speed, the pass motion start position may easily change. During the pass motion, use a constant internal speed before and after the pass motion.

3.2.10 Arch Motion Control [Version 1.9 or later, only for 4-Axis Robot]

The arch motion control facilitates an effective pick-and-place motion.



The above figure shows a pick-and-place motion from source position P1 to destination position P4. The pick-and-place motion can be usually accomplished by setting route positions P2 and P3. In the motion, specifying a pass motion in the vicinity of positions P2 and P3 may save the motion time of the arm endpoint.

Unlike a usual pass motion, the new arch motion control allows the arm endpoint to move from anywhere on the Z axis towards the next position, enabling more efficient pick & place motion.

Further, it is easy to program the arch motion control. You need to define only the move distance of the Z axis from P3 to P4 (L1), the distance from P1 to the arch start position (L2), and the distance from P4 to the arch end position (L3).

Note that the arch motion does not support the position control so that the path of the arm endpoint may vary depending upon the actual robot speed. Be careful with interference with the surrounding facilities when the robot is in arch motion. Under the arch motion control, all robot operations are performed via point-to-point (PTP) moves.

PAC library for Arch Motion Control: ArchMove, SetArchParam

3.3 Interpolation Control

When the robot arm moves, there is not just one path. You can create various paths together with the operation of each axis. You can also control the robot so that it creates line or circle paths. An explanation of the control methods, according to the types of motion paths, is as follows.
Use the commands shown below to designate an interpolation method.

The commands to designate an interpolation method :
APPROACH, DEPART, DRAW, MOVE

3.3.1 PTP Control

PTP (Point to Point) can be defined as the movement from one point to another point. The path on which the robot moves depends on the robot posture and is not always a straight line.
Fig. 3-22 shows an example of motion by PTP control. If you designate "P" when you designate the interpolation method with the motion control command, the robot executes the PTP motion.
If you designate a Type P or Type T variable as the PTP motion destination position and also designate robot figure, the robot moves so that the robot becomes the designated robot figure. If you do not designate any robot figure, it will be the current robot figure.

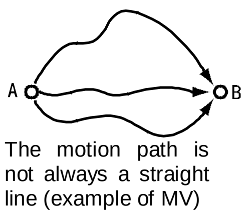

A
B
The motion path is not always a straight line (example of MV)

Fig. 3-22 PTP Control Motion

3.3.2 CP Control

CP control manages interpolation so that the path to reach the motion destination position will be a straight line.
Fig. 3-23 shows an example of CP control motion.
If you designate “L” for designation of the interpolation method with the motion control command, the robot executes the CP motion.

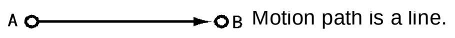


Fig. 3-23 CP Control Motion

- When CP control is executed, the robot cannot simply move the position of a different figure from the current figure. If you designate a different figure, an error of “607F robot figure mismatch” may occur. However, if the movement is available, the error may not occur.
- A figure similar to the current one is selected as the robot figure when CP control is executed. Therefore, even if you designate the robot figure with a Type P or Type T variable, the figure may not become the one designated. If the figure is different from the figure designated, a warning “601C change figure” may occur.
- If you execute the first motion command in a program with CP control the, motion may not be available depending on the robot position. PTP control is recommended for the first motion command in the program.

3.3.3 Arc Interpolation Control

Arc interpolation controls interpolation so that the path to reach the motion destination position will be an arc.
Fig. 3-24 shows an example of motion by arc interpolation control.
If you designate “C” for designation of the interpolation method with the motion control command, the robot executes an arc interpolation motion.

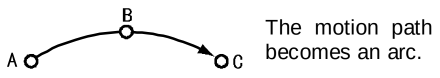


Fig. 3-24 Arc Interpolation Control Motion

- When arc interpolation control is executed, the robot cannot simply move to the position of a different figure from the current figure in the same manner as in CP control. If you designate a different figure, an error of “607F robot figure mismatch” may occur. However, if the movement is possible, the error may not occur.
- A figure similar to the current one is selected for the robot figure when arc interpolation control is executed. Therefore, even if you designate the robot figure with a Type P and Type T variable, the figure may not become the one designated. If the figure is different from the figure designated, a warning “601C change figure” may occur.
- If you execute the first motion command in a program with arc interpolation control, the motion may not be available depending on the robot position. PTP control is recommended for the first motion command in the program.

3.4 If Output Command Is Present after Motion Instruction

The current position of the robot normally experiences delay in moving to the position commanded by the robot controller, when the motion command is executed.
In the case of the end motion, the robot controller proceeds to the next command after the command position reaches the destination position of the motion command. Therefore, if there is an output command after the motion command, the output command may possibly be executed before the robot reaches the destination position.
There are the following methods to execute the next command after the robot reaches the destination position.

- Set wait time with a DELAY command (Fig. 3-25 shows a program example).
- Do not use an end motion. Use an encoder value check motion. Fig. 3-26 shows a program example.

Note: In the encoder value check motion, if the payload is heavy, the encoder value may not completely meet the destination position.

```
PROGRAM PRO13
       :
       :
    MOVE L, @0 P3     'End motion command
    DELAY 500         'Waits 0.5 seconds.
    SET IO1           'Sets I/O1 to ON.
    RESET IO2         'Sets I/O2 to OFF.
       :
       :
END
```

Fig. 3-25 Program Example to Set Wait Time Due to the DELAY Command

```
PROGRAM PRO13
        :
        :
    MOVE L, @E P3     'Encoder value check motion
    SET IO1           'command
    RESET IO2         'Sets I/O1 to ON.
        :             'Sets I/O2 to OFF.
        :
END
```

Fig. 3-26 Program Example using an Encoder Value Check Motion

3.5 Compliance Control Function

3.5.1 Overview

The compliance control function provides compliance for a robot by software. This function absorbs a position displacement in handling and prevents an excessive force applied to a robot or a work. This function is divided into two parts; setting compliance to individual joints (current limiting function) and compliance function to individual elements of the coordinate system at the tip of a robot (tip compliance control function).
The current limiting function is available for Ver 1.20 or later and the tip compliance control function is available for the vertical articulated robot Ver. 1.40 or later (VM-6070D not included).

Note: This function is explained by using PAC libraries in this section. In version 1.9 or later, the statement commands described on Section 12.10, "Particular Control" are also available.

3.5.2 Current limiting function for individual axes [V1.2 or later]

This function sets compliance for individual axes. Limiting the torque of motors for individual axes realizes compliance. You can specifically use this function to prevent an excessive force applied to a robot or a work, or to avoid a down due to over load or over current.

3.5.2.1 How to Use Current Limiting Function

You can use the library function and execute the current limiting libraries (SetCurLmt, ResetCurLmt) to enable or to disable this function. Make sure to provide the following setting. See the section for the PAC library for more information on the library.

(1) Tip Payload Specification (Required)
You should specify the exact mass of payload and payload center of gravity of the tip. You should set values corresponding to a hand and a work you use to the mass of payload [g], the payload center of gravity X6 [mm], the payload center of gravity Y6 [mm], and the payload center of gravity Z6 [mm]. If the mass changes during chucking or unchucking a work, you should use aspACLD to change the setting.
See the optimal load capacity setting function in the 4.7 "User Preferences" for more information.
Notes: If you fail to provide exact values, your robot may fall toward the direction of the gravity when you are setting the current limit.

(2) Gravity Offset Specification (Required)
You should enable the gravity offset specification. Otherwise, you will receive an error, "665a Current limiting specification is not available". To enable the gravity offset, you should use the pendant to set the enabling/disabling gravity offset setting to 1. To do so, follow the steps below:
1) On the initial screen of the pendant, press [F2 Arm]→[F6 Aux.]→[F7 Config.]. You will see the configuration parameter screen.
2) Press [F3 Jump] and specify 24. You will see the enabling/disabling gravity offset setting line.
3) Enter 1 to the enabling/disabling gravity offset setting and press OK.
When you set 1 to the enabling/disabling gravity offset setting, the gravity offset is always enabled after the calibration is completed.

Though you can also use SetGravity and ResetGravity to enable/disable the gravity offset, your robot may present a slight movement while switching between the enabled state and disabled state. We recommend that you use the configuration of the pendant to set the enabling/disabling gravity offset setting to 1 and call SetGravity once in your initialization program.

(3) Gravity Offset Compensation (If Applicable)
The difference between the setting of the mass of payload of the tip and the actual mass of payload may present an error in the gravity balance based on the gravity offset. When you set a smaller current limit to an axis where gravity applied, your robot may fall toward the direction of gravity. The gravity offset compensation function compares the torque at the stationary state of your robot and the gravity offset torque to compensate the error. When you set the current limit to 30% or less for an axis where gravity applied, always set the gravity offset compensation.
You should execute SetGrvOffset to have compensation value calculated when the robot is stopping. The value you will obtain is for the posture when SetGrvOffset is executed. You should execute SetGrvOffset again when the posture deviates largely from that when compensated.
Executing SetGrvOffset may generate a compensation value including an error when an external force such as a contact is applied to the robot. Run SetGrvOffset when the external forces (except for gravity) are not present.

(4) Allowable Deviation Specification (If Applicable)
If an external force is applied while current is limited, joint will rotate toward the direction of the force. This will increase the deviation of the angle of the joint and may cause an error, “612* J *Excessive Deviation”. If this is the case, you should use SetEralw to set the allowable deviation specification. The function checking deviation is provided for safety. You should not extend the range.

(5) Library Execution Procedure

■ When Current Limiting Enabled

1) Use the pendant to set the enabling/disabling gravity offset setting to 1 in the configuration.
2) Add the following statement to your initialization program.
CALL SetGravity
3) Enable the current limiting. Provide (statement) when necessary.
Wait until an action is completed.
(CALL SetGrvOffset) ‘Calculate the gravity offset compensation value
CALL SetCurLmt(n1, m1) ‘Set the current for n1 axis to m1 (%) of the rating
(CALL SetEralw(n2, m2)) ‘Set the current for n2 axis to m2 (%) of the rating

■ When Current Limiting Disabled
CALL ResetCurLmt(0) ‘Reset the current limits for all axes and initialize the allowable deviation
(CALL ResetGrvOffset) ‘Initialize the gravity offset compensation values

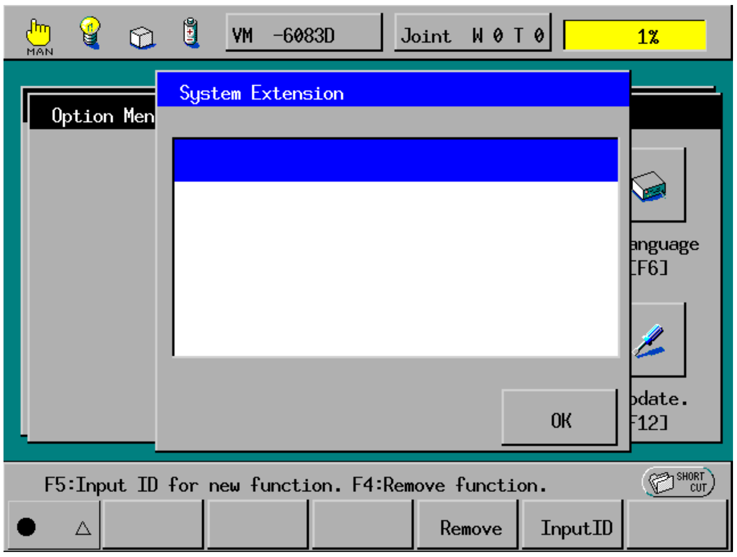
3.5.3 Tip Compliance Control Function [V1.4 or later]

This function sets compliance for the individual elements of the coordinate system at the tip of a robot. Controlling motor torque values for individual axes based on the force limit at the tip realizes the compliance of the tip. You can select a coordinate system from either the base, the tool or the work coordinate system. You can use this function to align your robot in a specified direction according to an external force or to have your robot push against an object to check a height.

3.5.3.1 Enabling the function

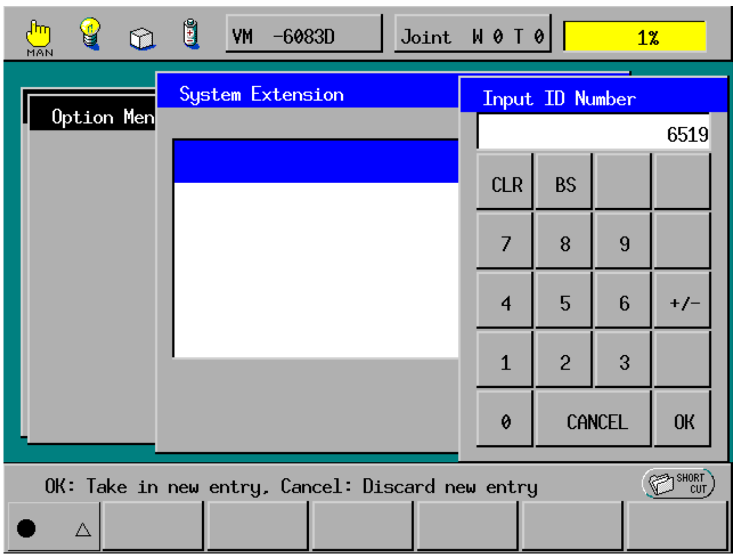
This function is an extended function. Thus, you should use the pendant to enable the compliance control function. Once you enable an extended function, the setting is maintained after you turn off the controller and you do not need to set again. To enable the compliance control function, follow the steps below.

(1) View the system extension screen of the pendant.
Operation flow: Main screen-[F6 Set]-[F7 Option]-[F8 Extend]



F5:Input ID for new function. F4:Remove function.

(2) Press [F5 Input ID] for adding a function. You will see the ID number screen.
(3) Enter the ID number. The ID number is 6519.



OK: Take in new entry, Cancel: Discard new entry

(4) Press OK, check a system message you will receive, and press OK again.

3.5.3.2 How to Use Tip Compliance Control Function

You can use the library function and execute the compliance control libraries (SetCompControl, ResetCompControl) to enable or disable this function. Make sure to provide the following setting. See the section for the PAC library for more information on the library.

(1) Tip Payload Specification (Required)
See 2-1 “How to Use Current Limiting Function”.

(2) Gravity Offset Specification (Required)
See 2-1 “How to Use Current Limiting Function”.

(3) Compliance Control Parameters (Required)
There are following five parameters.

1) Force Limiting Coordinate System Selecting Parameter
Select either the base, the tool or the work coordinate system for the force limiting coordinate system. Use the compliance control library (SetFrcCood) for specification.

2) Force Limiting Rate
Specify the rate of force limiting for the individual elements (translations along and rotations about X, Y, and Z axes) of the coordinate system specified at 1). Use the compliance control library (SetFrcLimit) for the specification. When you specify SetFrcLimit, 3) the compliance rate and 4) the damping rate will be the same.

3) Compliance Rate (If Applicable)
Specify the rate of compliance for the individual elements (translations along and rotations about X, Y, and Z axes) of the coordinate system specified at 1). Use the compliance control library (SetCompRate) for the specification. When you specify SetCompRate, 4) the damping rate will be the same.

4) Damping Rate (If Applicable)
Specify the rate of damping for the individual elements (translations along and rotations about X, Y, and Z axes) of the coordinate system specified at 1). Use the compliance control library (SetDampRate) for the specification. You seldom use this function except for the velocity control mode, which is a special tip compliance control function. Note that you should not specify values smaller than the compliance rates specified in SetFrcLimit and SetCompRate.

5) Allowable Position/Posture Deviation under Compliance Control (If Applicable)
Specify the allowable position/posture deviation for the individual elements (translations along and rotations about X, Y, and Z axes) of the coordinate system specified at 1). Use the compliance control library (SetCompEralw) for the specification. The initial value for the position deviation is 100 (mm) and the posture deviation is 30 (degree). The function checking deviation is provided for safety. You should not extend the range unnecessarily.

(4) Gravity Offset Compensation (If Applicable)
The gravity offset compensation function compares the torque at stationary state of your robot and the gravity offset torque to compensate the error when SetCompControl is specified. Executing SetCompControl may generate an error in the compensation value when an external force such as a contact is applied to the robot. Run SetCompControl while the external forces (except for gravity) are not present. Use SetGrvOffset and SetCompFControl and execute the libraries as described below when you enable the compliance control under external forces are applied to your robot.

(SetCompControl = SerGrvOffset + SetCompFControl)
While your robot is stationary without contacts (interference) with external objects, execute
CALL SetGrvOffset
Move your robot in contact (interference) with external objects
CALL CompFControl

(1) Library Execution Procedure

■ When Compliance Control Enabled

1) Use the pendant to set the enabling/disabling gravity offset setting to 1 in the configuration.
2) Add the following statement to your initialization program
```
CALL SetGravity
```
3) Enable the compliance control. Provide (statement) when necessary.
```
CALL SetFrcCoord(n)   'Set the force limiting coordinate system to n
CALL SetFrcLimit(fx, fy, fz, mx, my, mz)
        'Set the rate of force limiting to (fx, fy, fz, mx, my, mz) [%]
(CALL SetCompRate(cx, cy, cz, crx, cry, crz))
        'Set the rate of compliance to (cx, cy, cz, crx, cry, crz) [%]
(CALL SetDumpRate (dx, dy, dz, drx, dry, drz))
        'Set the rate of damping to (dx, dy, dz, drx, dry, drz) [%]
CALL SetCompControl 'Enable the compliance control
(CALL SetCompEralw (ex, ey, ez, erx, ery, erz))
        'Set the allowable position deviation to (ex, ey, ez) (mm), and set
        the allowable posture deviation to (erx, ery, erz) (degree).
(CALL SetEralw (n1, m1))
         'Set the allowable deviation for n1 axis to m1 (degree)
```

■ When Compliance Control Disabled. Provide (statement) when necessary.
```
CALL ResetCompControl        'Disable compliance control
CALL ResetCompEralw          'Initialize position deviation
(Call ResetEralw(0))         'Initialize angle deviation
```

3.5.3.3 How to Use Special Tip Compliance Control Function Library

You can use the special compliance control function library to make better use of the compliance control function. However, since this function directly change the robot control data, your robot may present an abnormal action depending on values you will specify. Set the allowable deviation to small values for adjusting. You can specify the following parameters for the special compliance control function library.

(1) Force Assistance under Compliance Control
Applying a force assistance in the direction of aligning will facilitate the profiling motion when your robot cannot profile due to friction or the like. You can use the compliance control function library (SetFrsAssis) to specify assistance values in individual directions. The initial values are 0 after turned on.

(2) Current Limiting Setting under Compliance Control
Under the compliance control condition, providing motors with torque according to the position deviations controls the force at the tip. Thus, the conventional control according to angular deviations for individual axes is not active (current limit = 0), and the robot motion may be oscillating. If this is the case, you can adjust the current limiting setting in stead of adjusting the force limiting rate under the compliance control condition to realize a smoother control. When you use the current limiting setting in stead of the force limiting setting to adjust the tip force limit in a specific direction, set the force limiting setting in that direction to 0 and adjust the current limiting setting of the angle rotating for the motion in the limiting direction. You can use the special tip compliance control function library (SetCompLimit) to set the current limit for the individual axes. The initial values are 0 after turned on.

(3) Parameters for Selecting How to Control Compliance
Control according to the velocity deviation in stead of the position deviation will increase the stability in contacting motion. You can use a special tip compliance control function library (SetCompVMode) to set the velocity control mode and use SetFrcLimit and SetDampRate to set the control direction.
(Example) Setting the velocity control mode in Z axis direction

```
CALL SerFrcCoord(0)
CALL SetCompVMode
CALL SetFrcLimit (100, 100, 0, 100, 100, 100)
CALL SetDampRate (100, 100, 100, 100, 100, 100)
CALL SetCompControl
```

3.5.3.4 Notes for Your Safety

(1) Error Detecting Functions
When the force is limited by the compliance function, a robot may move toward the force limiting direction due to an external force. Also a robot may move due to the component force in a force limiting direction of an external force applied in a direction other than the force limiting direction.
The following functions have been added to detect abnormality for the safety in adjusting a robot.

1) Position deviation under compliance control error (60F8)
This error occurs when the position deviation at the robot tool tip exceeds the limit. The initial values for allowable deviation are 100 (mm) for translation along and 30 (degree) about X, Y and Z axis. You can use SetCompEralw to change the allowable deviation. Since large allowable deviation may prevent detecting an error, do not set excessive limits.

2) Force limit reference error (60FB)
This error occurs when an excessive force is applied at the robot tool tip. This error occurs when you have a robot contact in the direction where you set a high force limiting rate. Make sure that the force limiting direction and the force limiting parameters are set properly when you receive this error.

3) Exceeded speed limiting reference under the compliance control (60FC)
A high speed motion is not available under the compliance control. This error occurs when the product of the internal speed and the external speed exceeds 50%. When this error occurs, you should reduce the internal speed setting.

4) PTP motion is not available under the compliance control (60FD)
The PTP motion (see 3.3.1 "PTP Control") is prohibited under the compliance control. This error occurs when you execute a PTP motion. You should change to the CP motion or execute a PTP motion after you disable the compliance control. Also, this error occurs when you start for continuing motion or restart in the resuming path mode.

5) Current position exceeds J* soft limit under the compliance control (66D*)
A robot may move to a position exceeding a soft limit due to an external force under the compliance control. Then, this error happens. Though a motor will not be turned off in the manual mode when a soft limit is exceeded, a motor will be turned off when this error occurs under the compliance control.

(2) For Adjusting Safely
A robot may fall in the direction of gravity due to an error in the parameter setting or moves toward an unexpected direction due to an external force under the compliance control.
To secure the safety for adjusting, do not set the excessive values for the allowable angle deviation and the allowable position deviation. Also use SetCompEralw to set smaller values than the initial values (10 [mm] for translation along and 5 [degree]) for rotation about X, Y and Z axes) for allowable deviations in directions other than the force limiting direction before adjusting.

(3) Adjusting Parameters for Compliance Control Functions
Adjust limited force under compliance control based on the force limiting rate. However the relation between the force limiting values and the force limiting rate varies depends on the posture and the direction of a robot. Adjust the force limiting parameters for each force limiting posture and direction.
A robot profiles in the direction of an external force when a joint torque due to the external force becomes larger than the static friction of a joint. On the other hand, the static friction is larger than a joint torque due to an external force, a robot stays in equilibrium.
A robot may move toward the force limiting direction (the direction of reference value) if the equilibrium between the friction and the limited force changes as the result of the friction change due to the posture alteration during robot operation under compliance control. Pay attention to the robot motion toward the force limiting direction when you operate a robot while controlling the compliance.

(4) Position Teaching
You can use the function for setting positing to variables to teach position of a robot. The position setting into variables is the current position reference of a robot. When you push a robot to move and set positions (direct teaching) under the compliance control, there are difference between the position reference and an actual position. Please follow the procedure below to teach positions under the compliance control.

1) Decide an I type variable for teaching number. We assume I10 here.
2) Prepare the following program.
When you use P type variable for teaching:
```
Program DirectTeach
      P(I10)=CURPOS
end
```
When you use J type variable for teaching:
```
Program DirectTeach
      J(I10)=CURJNT
end
```
3) Assign teaching position number to I10, move a robot to a teaching point, and execute DirectTeach.

(5) Setting Tool Coordinate and Work Coordinate

When you use SetFrcCoord to set the force limiting coordinate to the tool coordinate and execute compliance control, if you use Changetool to change the tool coordinate under the compliance control, the force limiting direction will not change. However the tool coordinate will change in terms of the robot motion. This will cause a discrepancy between the force limiting coordinate system and the motion coordinate system. This applies to the work coordinate as well as the tool coordinate.

If you set large values to X, Y, and Z of the tool coordinate to execute compliance control, the control sensitivity to the change of the robot posture will be high and a robot may present an oscillation resulting in a stop by error. If this is the case, you should use SetFrcLimit and SetCompRate to decrease the parameters gradually from 100.

(6) Continuing Function

The continuing motion is not available during the compliance control. If you turn off a motor and turn on the motor in a state ready for continuing motion, you will receive an error “66EF Compliance control is disabled”. If you start for continuing after a momentary stop, you will receive an error “66FD PTP motion is not available under the compliance control”.

(7) Recovery after Power Failure

The function for recovery after power failure is not available if the power to the controller is discontinued under the compliance control.

(8) Robot Motion Accuracy under Compliance Control

When a motion command is executed under the compliance control, the accuracy of the motion trajectory of a robot decreases. The position in the force limiting direction may present a large deviation. If you need an accurate motion, disable the compliance control function.

The stop accuracy of a robot decreases under the compliance control. If you execute an encoder value check motion (See “4.2.3 Encoder Value Check Motion”), a robot may stop for a longer period or you may receive an error “6651 Check command time over”. If you need accuracy for stop, disable the compliance control function.

Chapter 4

Speed, Acceleration and Deceleration Designation

The maximum rates of speed, acceleration and deceleration must be set.
This chapter provides explanations of the meanings and settings of speed, acceleration and deceleration.

4.1 External Speed and Internal Speed

There are external speed and internal speed for VS series robots.
The external speed is the speed set from the teach pendant or an external device prior to execution of a program.
The internal speed is the speed set with a command in a program.

4.2 Speed Designation

The product of external speed and internal speed determines the actual speed of robot motion.
For example, if the following conditions are set,
  external speed: 70%
  internal speed: 30%
the expression below is obtained.
  Actual speed = maximum speed $\times$ 0.7 $\times$ 0.3
The actual speed is 21% of the maximum speed.

If you change the internal speed using the SPEED command in a program, internal acceleration and internal deceleration are also set. The internal acceleration and internal deceleration the internal speed squared and divided by 100.
The JSPEED command changes the internal axis speed. If you change the internal axis speed, internal axis acceleration and internal axis deceleration also change. Internal axis acceleration and internal axis deceleration are the internal axis speed squared and divided by 100.

4.3 External Acceleration, External Deceleration, Internal Acceleration and Internal Deceleration

Acceleration and deceleration are both classified into external acceleration/ deceleration and internal acceleration/deceleration.
External acceleration and external deceleration are set with the teach pendant or an external device prior to execution of a program.
Internal acceleration and internal deceleration are set with a command in a program.

4.4 Setting Acceleration and Deceleration

The product of external acceleration and internal acceleration determines actual acceleration and deceleration.
For example, if the following conditions are set,
 external deceleration: 70%
 internal deceleration: 30%
the expression below is obtained.
 Actual deceleration = maximum deceleration $\times$ 0.7 $\times$ 0.3
The actual deceleration is 21% of the maximum deceleration.
The commands to set acceleration and deceleration are listed in Table 4-1.

Table 4-1 Setting Commands of Acceleration and Deceleration

Command	Function
SPEED	Internal speed setting
ACCEL	Internal acceleration setting
DECEL	Internal deceleration setting
JSPEED	Internal axis speed setting
JACCEL	Internal axis acceleration setting
JDECEL	Internal axis deceleration setting

4.5 Example of Setting Speed and Acceleration

The program shown in Fig. 4-1 does not set any internal speed.
If you execute this type of program at 80% external speed, the following results occur.

```
PROGRAM PRO1
TAKEARM
   MOVE P, P1
END

Actual speed = external speed x internal speed
             = 80% x 100%
             = 80%

Actual acceleration = external acceleration x internal
acceleration
                    = 64% x 100%
                    = 64%

Actual deceleration = external deceleration x internal
deceleration
                    = 64% x 100%
                    = 64%
```

Fig. 4-1 Example of Not Setting Internal Speed

The internal speed is set in the program in Fig. 4-2.
If you execute a similar program at 80% external speed, the following results occur.

```
PROGRAM PRO2
TAKEARM
   SPEED 50           'internal speed50%
   MOVE P, P1
END

Actual speed = external speed x internal speed
             = 80% x 50%
             = 40%

Actual acceleration = external acceleration x internal
acceleration
                    = 64% x 25%
                    = 16%

Actual deceleration = external deceleration x internal
deceleration
                    = 64% x 25%
                    = 16%
```

Fig. 4-2 Example of Setting Internal Speed

The program shown in Fig. 4-3 sets internal acceleration and deceleration.
If you execute this program at 80% external speed, the following results occur.

```
PROGRAM PRO1
TAKEARM
   ACCEL 50            ' Internal acceleration:  50%
   DECEL 25            ' Internal deceleration:  25%
   MOVE P, P1
END

Actual speed = Internal speed x internal speed
             = 80% x 100%
             = 80%

Actual acceleration = external acceleration x internal
acceleration
                    = 64% x 50%
                    = 32%

Actual deceleration = external deceleration x internal
deceleration
                    = 64% x 25%
                    = 16%
```

Fig. 4-3 Example of Settings for Internal Acceleration and Deceleration

Caution: **When you set acceleration and deceleration, check that there is no danger of collision due to pass changes.**
If you change the speed or acceleration using a motion option or with a command during a pass motion, be aware of the possibility of a collision.

4.6 Control Sets of Motion Optimization

This function is to set proper speed and acceleration according to the mass of payload and the posture of the robot. You can select a control set of motion optimization among 4 sets listed in Table 4-1.

Table 4-1 Control Sets of Motion Optimization

Control set	Setting condition	Description	
		PTP motion	CP motion
0	Mass of payload	Maximum acceleration	Maximum acceleration
1	Mass of payload and robot posture	Maximum speed, acceleration	Same as control set 0
2		Same as control set 0	Maximum speed, acceleration
3		Same as control set 1	Same as control set 2

4.6.1 Control Set 0

This control set is the default when you boot the controller. Set the maximum acceleration of PTP motion and CP motion according to the robot load condition value.
In VS-D series robots, the relation between the load condition and the minimum movement time in the case of control set 0 is shown in Figs. 4-4 to 4-9. For cycle time calculation in designing, refer to these figures.
For another series robots, refer to "Installation & Maintenance Guide ".

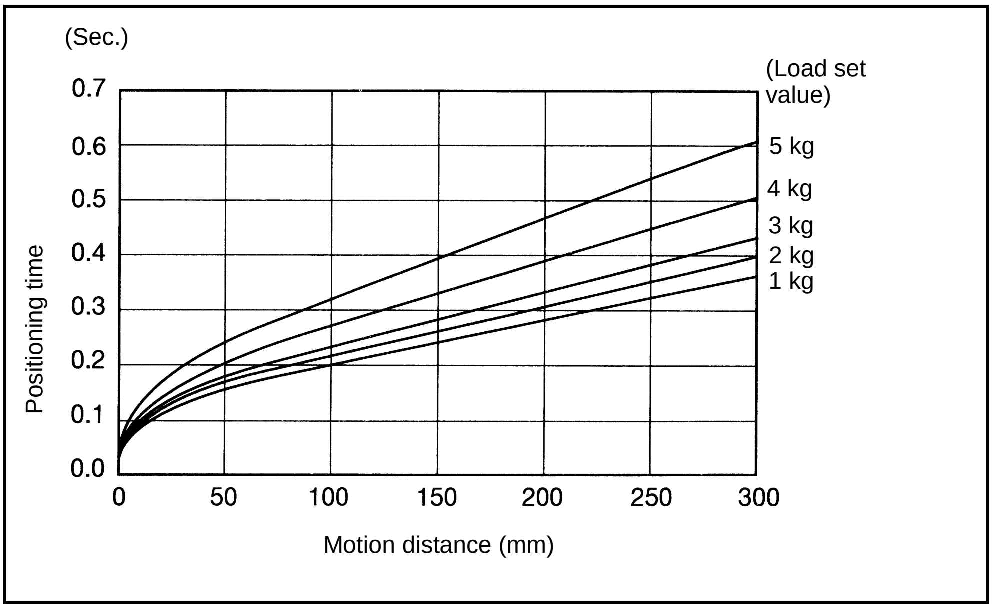


Fig. 4-4 CP Motion Positioning Time (VS-D)

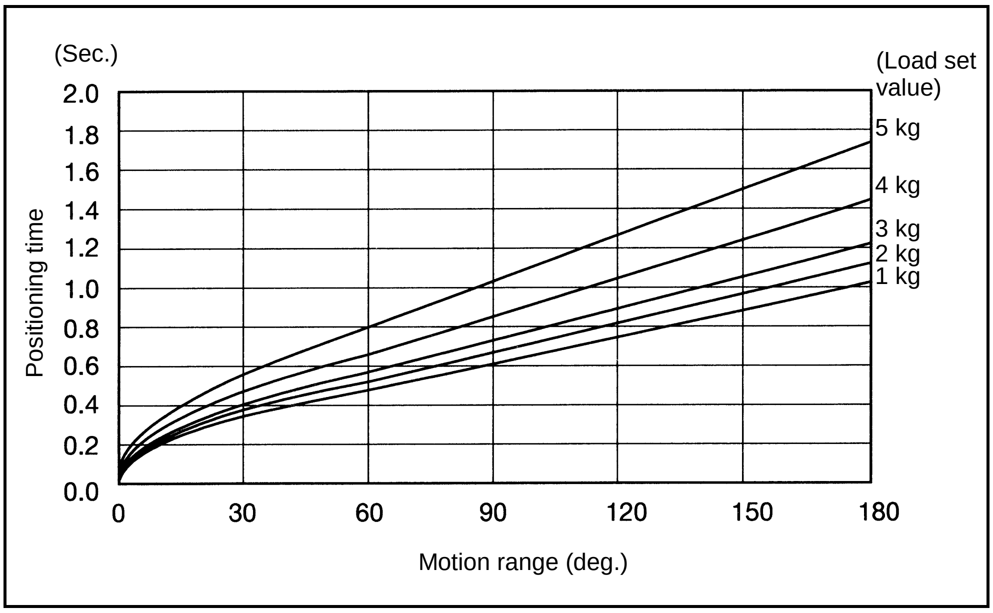


Fig. 4-5 1st- and 2nd-Axis Positioning Time in PTP Motion (VS-D)

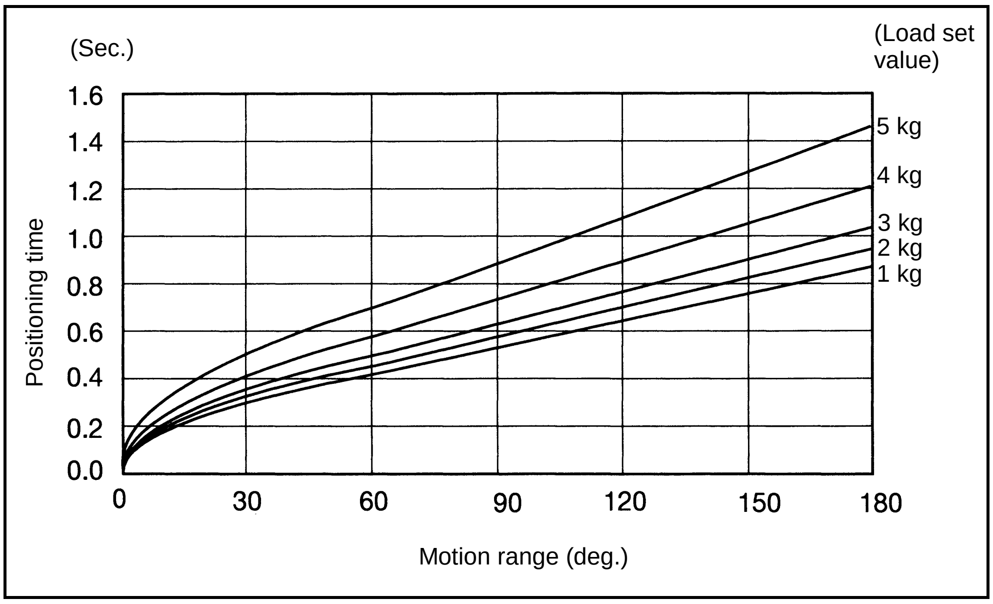


Fig. 4-6 3rd, 4th, and 5th-Axis Positioning Time in PTP Motion (VS-D)

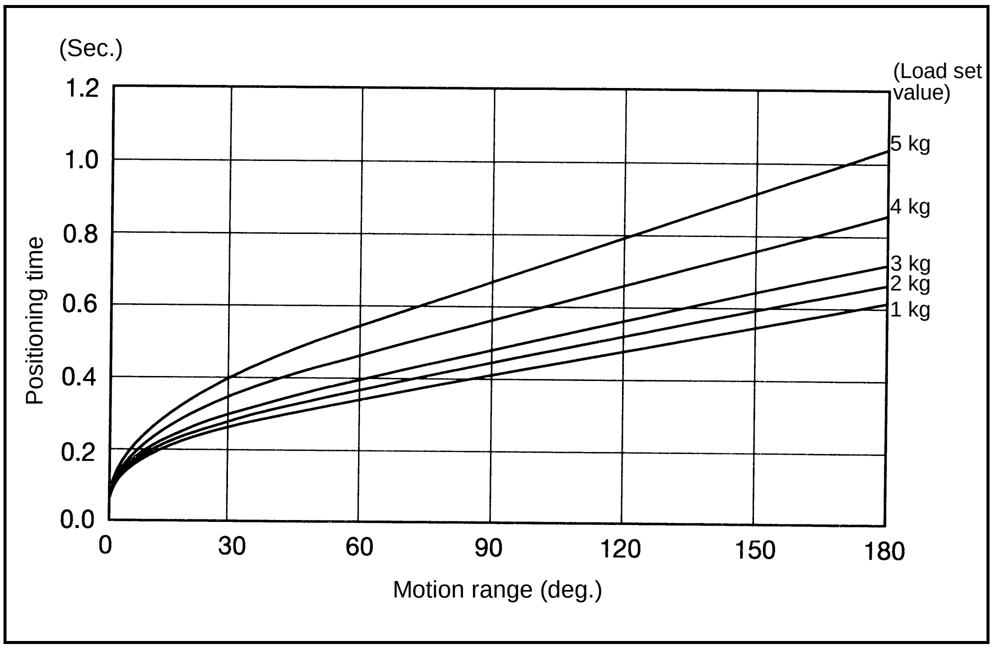


Fig. 4-7 6th-Axis Positioning Time in PTP Motion (VS-D)

4.6.2 Control Set 1

Set the maximum speed and acceleration for the 1st, 2nd and 3rd axes in PTP motion according to the load condition value of the robot and the robot figure in motion. For the 4th, 5th and 6th axes in PTP motion, and for CO motion, this is the same as that of control set 0.

4.6.2.1 Using Control Set 1

If you need to reduce the motion time in PTP motion, select control set 1.
Check the motion time for control set 1 in machine lock operation.

4.6.2.2 Precautions for Using Control Set 1

An overload error or excess deviation error may occur in motion. For the load factor, check the overload estimation value on the pendant. (Refer to the SETTING-UP MANUAL, Section 5.3, "Displaying anticipated overloads to the capacity of motors and brake resistance of the robot controller, [F2]—[F6]—[F10].") Or, check the load factor using the log function of WINCAPSII (refer to the WINCAPSII Guide, Section 10.4, "Actions Menu").

If an overload error occurs, adjust the motor load by setting appropriate values of the timer, internal speed, and acceleration.
If an excess deviation occurs, adjust the speed and acceleration.

Depending on the motion speed, the pass locus may change by approximately 20 mm. Therefore, because the pass motion near an obstacle may possibly interfere with the obstacle, execute the motion in control set 0.

4.6.3 Control Set 2

Set the maximum speed and acceleration in CP motion according to the load condition value of the robot and the robot figure in motion. This is the same as that of control set 0 in PTP motion.

4.6.3.1 Using Control Set 2

Use control set 2 in the following two cases.

- If you need to reduce the motion time in CP motion.
  Fig. 4-8 shows the relation between the load condition and the shortest moving time in control set 2. However, because the robot may possibly and automatically reduce the speed during motion, check the motion time in machine lock operation.

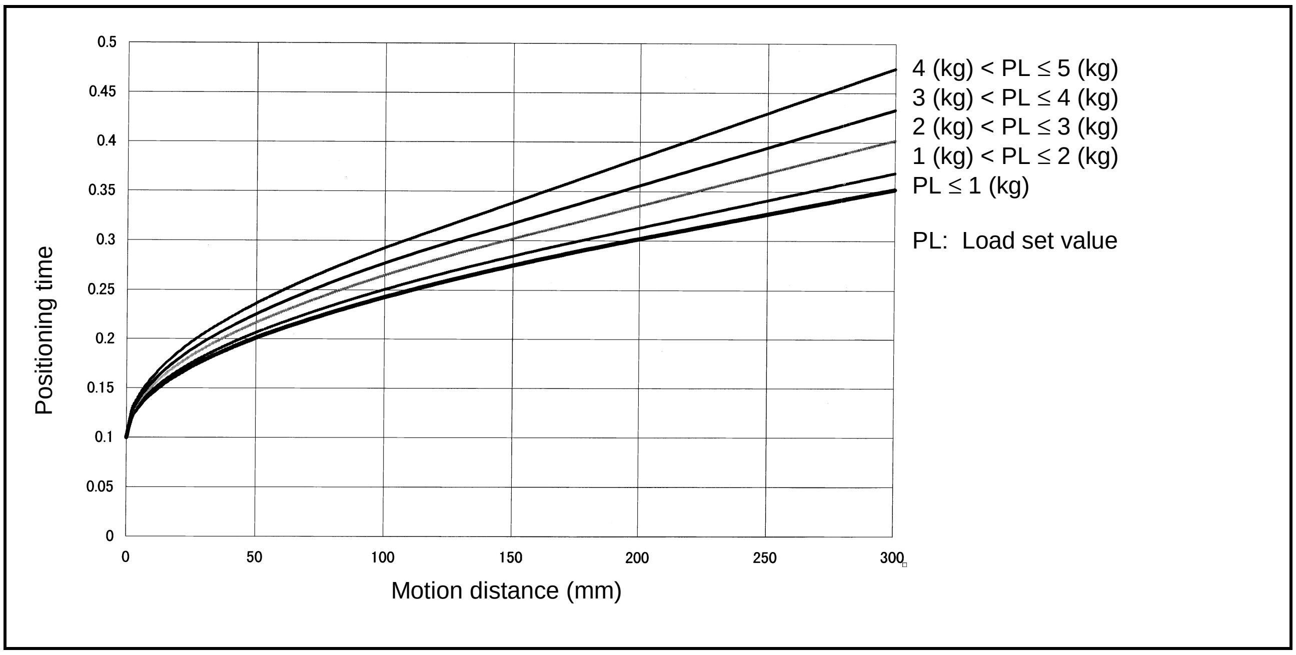


Fig. 5-8 Positioning Time in CP Motion (Shortest time) ; (VS-D)

- If you select control set 0 or 1, an error of command speed limit over (6081 to 6086) occurs in CP motion. In control set 0 or 1, if the path passes near a singular point (refer to the SETTING-UP MANUAL, Subsection 4.1.3, "[2] Boundaries of Robot Figures") or the vicinity of the motion range limit, an error of command speed limit over may occur, stopping the robot. In control set 2, however, the speed automatically falls within the command speed limit, allowing you to operate the robot without the above error.

4.6.3.2 Precautions for Using Control Set 2

- In this control set, an overload error may occur during the robot motion. When you adjust the speed, check the load rate using the log function of the load estimation value on the pendant. (Refer to the SETTING-UP MANUAL, Section 5.3, "Displaying anticipated overloads to the capacity of motors and brake resistance of the robot controller, [F2]—[F6]—[F10].") Or, check the load rate using the log function of WINCAPSII (refer to the WINCAPSII Guide, Chapter 10, "Outline of Log Manager"). If an overload error occurs, adjust the motor load by setting appropriate values of the timer or internal speed and acceleration.

- Depending on the motion speed, the path may possibly change by approximately 20 mm. Therefore, because in the pass motion near obstacles, the robot may interfere with them, execute control set 0.

- Because the speed may change in the constant speed movement section in CP motion, perform work that requires constant speed movement in control set 0 or 1.

- Errors of command acceleration limit over (6761 to 6766) and excessive deviation (6111 to 6116) may occur in CP motion. If such an error occurs, adjust the acceleration with internal speed and internal acceleration. A path shift of up to approximately 5 mm may also occur in high-speed motion. Therefore, use the robot by reducing the speed if there is an obstacle near the motion.

- If you stop the robot instantaneously during speed reduction near the vicinity of a singular point (refer to the SETTING-UP MANUAL, Subsection 4.1.3, "[2] Boundaries of Robot Figures"), the instantaneous stop time may extend. The instantaneous stop distance, however, remains unchanged.

4.6.4 Control Set 3

In this control set, the robot moves the same as in control set 1 in PTP motion and control set 2 in CP motion. Refer to "4.6.2 Control Set 1" and "4.6.3 Control Set 2" described above.

4.6.5 Using Conditions That You Must Set

If you determine the mass of payload (end-effector and workpiece) which is applied on the 6th axis of the robot, set the mass of payload and the center of gravity position. Set the mass of payload and the center of gravity position in the using condition of the pendant or WINCAPSII (refer to p.4-8.). You can change them even with a program in order to change the tool or workpiece. For changing them with a program, refer to "4.7.2 Setting Internal Load Condition Value (Mass of Payload and Center of Gravity Position) and Internal Mode."

4.6.6 Notes for Setting

There are external load condition values (mass of payload, center of gravity position) and an external mode that are set with the pendant and WINCAPSII and internal load condition values and an internal mode that are set in a program in load condition value (mass of payload and center of gravity position) and mode which are set with this function.

If you set the external load condition values and the external mode, the internal load condition values and the internal mode also have the same values.

The robot moves by setting the maximum speed and acceleration from the internal load condition and the internal mode.

You can check the current internal load condition values and the internal mode on the pendant (refer to "4.7 Control Set of Motion Optimization in User Preferences").

When you turn ON the main power of the controller, both the internal and external modes are set to "0." (Note: only Ver. 1.3* before. See Section 4.7.4.)

And the internal load condition values become the same as the external load condition values. Therefore, set the internal mode and the internal load condition values in a program according to your requirement.

The external load condition values before delivery are 7000 [g] of end load mass, and X6=0 [mm], Y6=80 [mm] and Z6=100 [mm] of the load center of gravity position.

Note (1): **Be sure to set the correct load condition values corresponding to the load. Improperly set data will cause overcurrent, excessive deviation, overload and other errors during robot operation, resulting in a robot failure. Additionally, when the robot stops on receiving a robot stop signal, the stop distance may extend and the robot may collide with peripheral devices.**

Note (2): **Set the correct robot installation condition. Set this with the pendant or WINCAPSII (refer to Part 1 "4.7.3 Setting robot installation condition").**

Improperly set data will cause overcurrent, excessive deviation, overload, and other errors during robot operation, resulting in a robot failure. Additionally, when the robot stops on receiving a robot stop signal, the stop distance may extend and the robot may collide with peripheral devices.

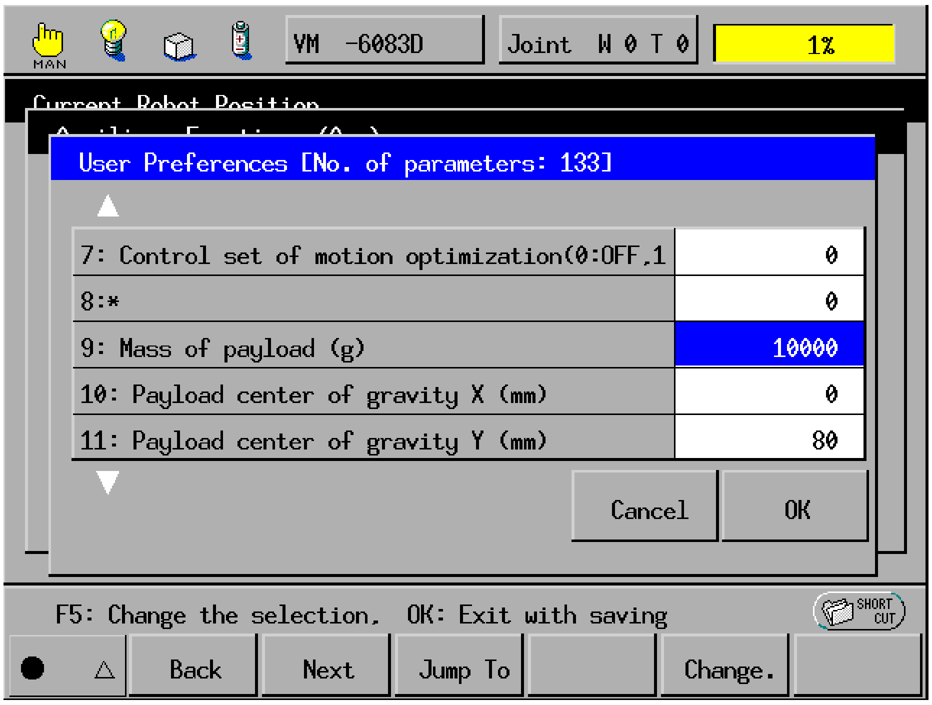
4.7 Setting the Master Control Parameters in User Preferences

4.7.1 Setting Master Control Parameters of the Mass of Payload, Center of Gravity, and Control Set of Motion Optimization

■ Setting with the Teach Pendant

Access: Top screen
└ [F2 Arm] ┐
└ [F6 Aux.] ┐
└ [F7 Config.]

If you use the teach pendant and follow the above procedure, the User Preferences window will appear where you can set master control parameters such as the control set of motion optimization and the mass of payload. Refer to the “SETTING-UP MANUAL, Section 2.9 ."



User Preferences [No. of parameters: 133]

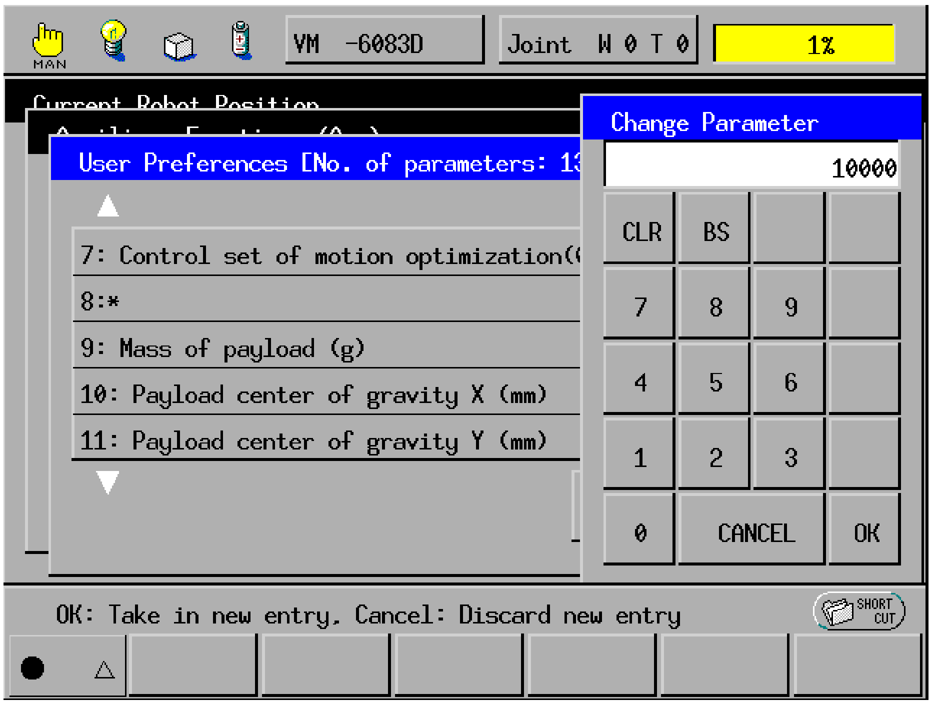
7: Control set of motion optimization(0:OFF,1	0
8:*	0
9: Mass of payload (g)	10000
10: Payload center of gravity X (mm)	0
11: Payload center of gravity Y (mm)	80

F5: Change the selection. OK: Exit with saving

Select the following items in this User Preferences window, then press [F5 Change.] to call up the numeric keypad where you can enter new values.

Setting item:
"Control set of motion optimization"
"Mass of load (g)"
"Payload center of gravity X (mm)"
"Payload center of gravity Y (mm)"
"Payload center of gravity Z (mm)" or “Inertia of payload (kgcm^2)”
(for 4-axes robot in Ver.1.9 or later)

The entry range of "Control set of motion optimization" is from 0 to 3. If you enter any value out of this range, the following error may appear: “Error 6003 Exceeded valid numeric value range.”
The entry range of "Mass of load" is specified in each robot model. If you enter any value out of this range, the following error will occur: “Error 60d2 End load set value exceeded permissible value”.
For "Payload center of gravity," enter a value that conforms to the following range. If the value is out of the following range, “Error 60d2 End load set value exceeded permissible value” will occur.

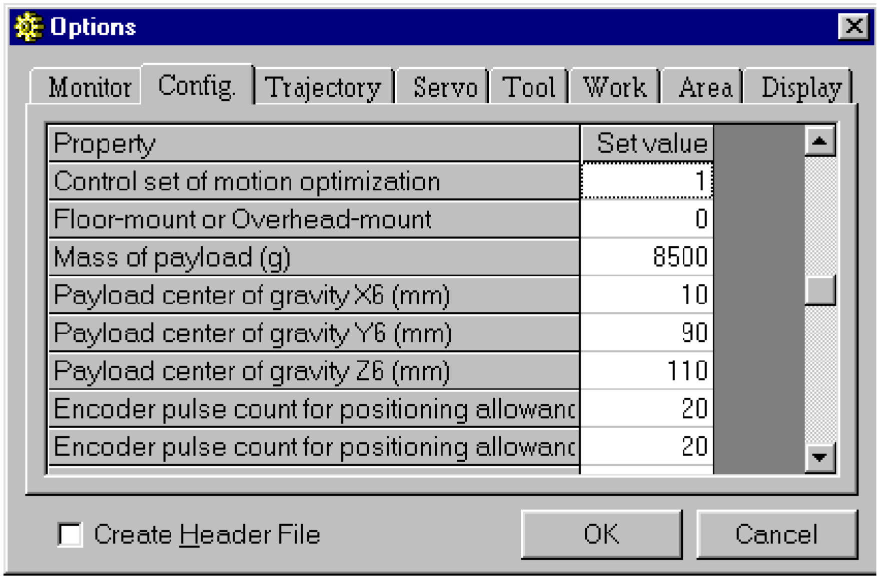

VM -6083D
Joint W 0 T 0
1%
Current Robot Position
User Preferences [No. of parameters: 13
7: Control set of motion optimization(
8:*
9: Mass of payload (g)
10: Payload center of gravity X (mm)
11: Payload center of gravity Y (mm)
Change Parameter
10000

OK: Take in new entry, Cancel: Discard new entry

■ Setting with WINCAPSII

This section explains the methods used to set the external load condition values (Mass of payload and center of gravity) and the external mode with the personal computer teaching system WINCAPSII. Refer to the " SETTING-UP MANUAL, Section 2.9 " and the "WINCAPSII Guide, 8.6.1.2 User Preferences."

Select Options from the Tools menu of Arm Manager and the Options window will appear.
Click on the User Preferences tab in the Options window to display the User Preferences window.

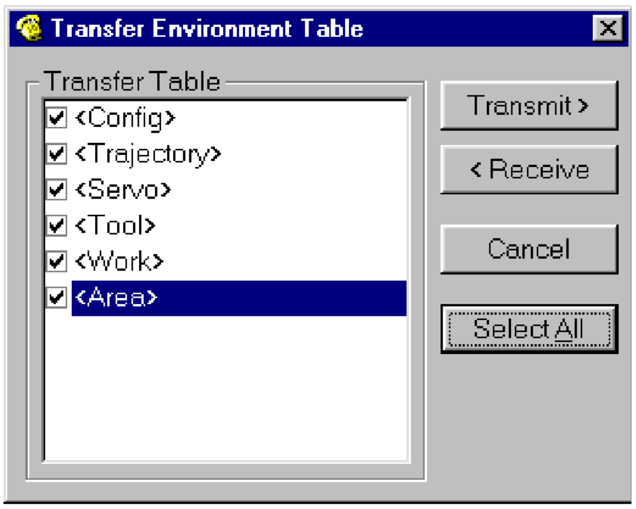


Property	Set value
Control set of motion optimization	1
Floor-mount or Overhead-mount	0
Mass of payload (g)	8500
Payload center of gravity X6 (mm)	10
Payload center of gravity Y6 (mm)	90
Payload center of gravity Z6 (mm)	110
Encoder pulse count for positioning allowanc	20
Encoder pulse count for positioning allowanc	20

If the set value boxes of the following items are double-clicked on this [User Preferences (No. of parameters:)] screen, the respective parameter values can be edited.

Setting item:
"Control set of motion optimization"
"Mass of payload (g)"
"Payload center of gravity X (mm)"
"Payload center of gravity Y (mm)"
"Payload center of gravity Z (mm)" or “Inertia of payload (kgcm^2)”
(for 4-axes robot in Ver.1.9 or later)

After each parameter value is set, transmit the data to the robot controller.
First, turn OFF the motor power with the MOTOR key on the teach pendant. Set Arm Manager to the connection status and click on **Transmit** of Arm Manager to display the Transfer Environment Table. Then, execute transmission.
For transmission, refer to the "WINCAPSII Guide, 8.2.5 Transfer Project" .



Note (1): Click on < Receive in the Transfer Environment Table to receive data from Arm Manager of the controller. The external load condition value and the external mode can be received in this case. However, the internal load condition values and the internal modes that are edited in a program cannot be transmitted to WINCAPSII).

Note (2): Enter the payload center of gravity in the TOOL0 coordinates (refer to Fig. 4-9). The unit is mm. The reference position of the TOOL0 coordinates is the 6th axis flange center. The reference position of the TOOL0 coordinates is the center of the 6th axis flange. For component Y, it is the direction from the flange center to a pinhole of ϕ6H7 (orientation vector direction). For component Z, it is the direction vertical to the flange surface through the flange center (approach vector direction). For component X, it is the X-axis direction (normal vector direction) in the right-hand coordinate system when the orientation vector is set to the Y axis and the approach vector is set to the Z axis (refer to Fig. 4-10).

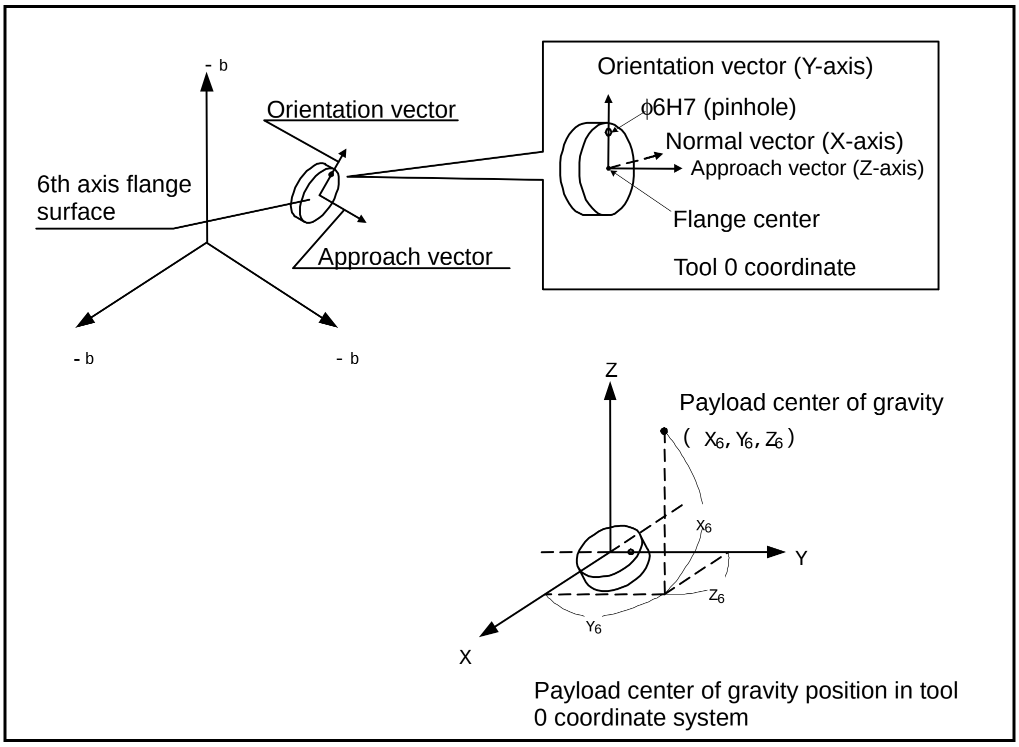


Fig. 4-9 Payload Center of Gravity

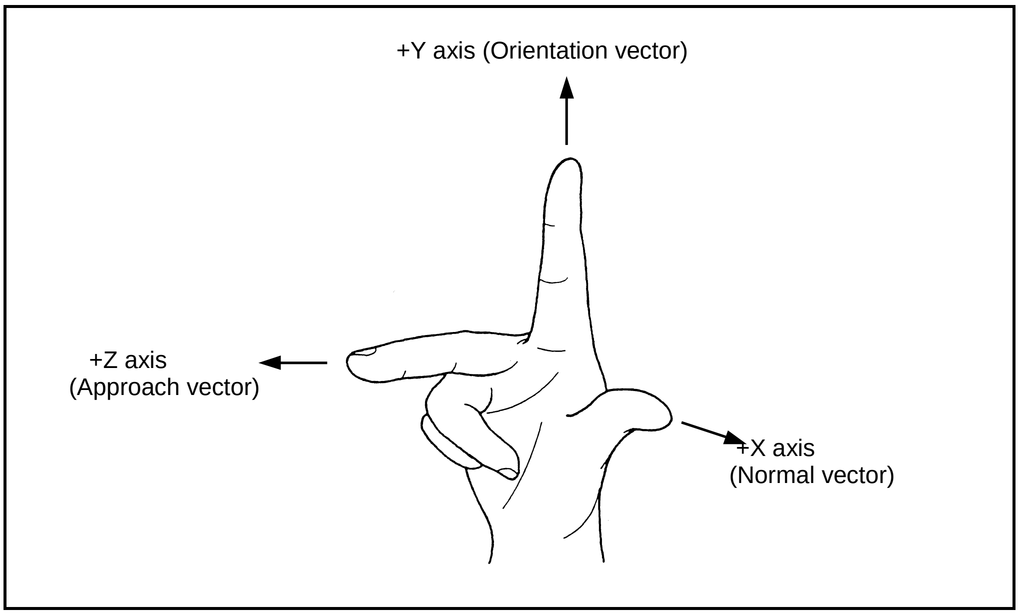


Fig. 4-10 Right-Hand Coordinate System

4.7.2 Setting Internal Load Condition Values (Mass of Payload and Center of Gravity) and Internal Mode

4.7.2.1 Setting Internal Load Condition Values

Set these values by executing the conventional language library aspACLD. For details, refer to "22.1 Conventional Language."

4.7.2.2 Setting Internal Mode

Set this mode by executing the conventional language library aspChange. For details, refer to “22.1.2 aspChange.”

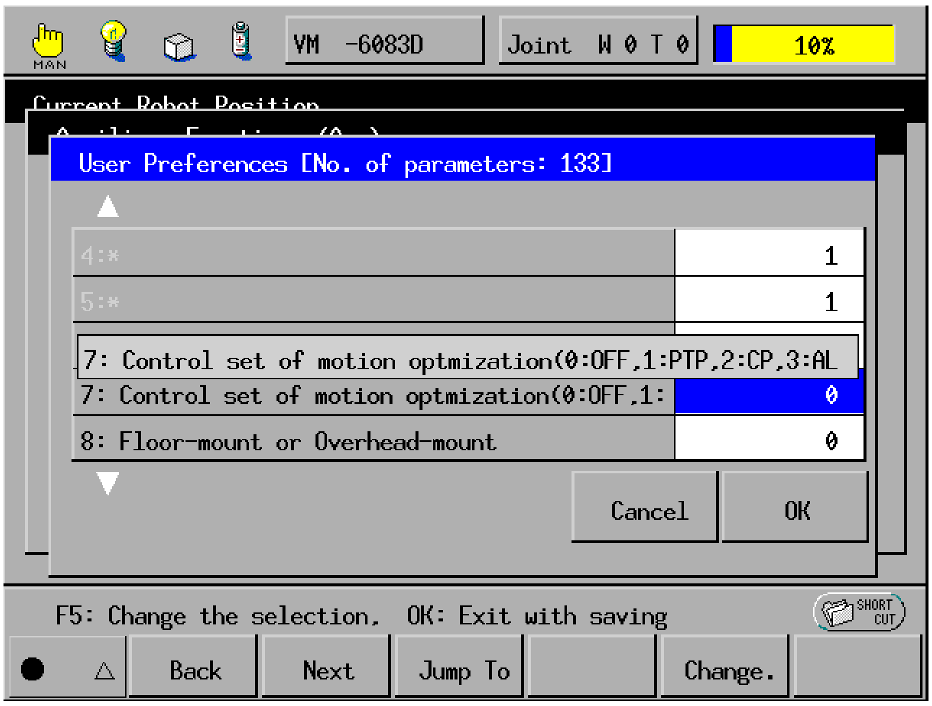
4.7.3 Setting Robot Installation Condition

This is a setting for floor installation use and for gantry use. Set “0” for floor installation and “1” for gantry use. Before shipping, it is set to “0” (floor installation). This setting must be changed if the robot is to be installed on the ceiling.

■ Setting with the Teach Pendant

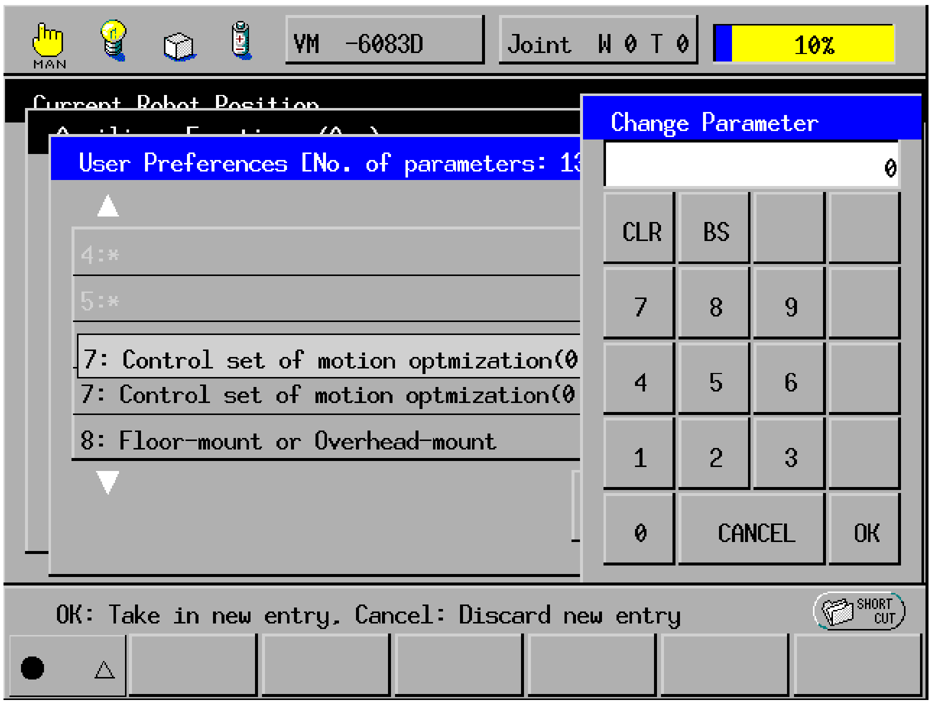
```
Operation flow:  Main screen
                 └[F2 Arm] ┐
                           └ [F6 Aux.] ┐
                                       └[F7 Config.]
```

If you use the teach pendant and follow the above procedure, the User Preferences window will appear where you can set master control parameters such as the control set of motion optimization and the mass of payload. Refer to the " SETTING-UP MANUAL, Section 2.10 “.



```
4:*                                                    1
5:*                                                    1
7: Control set of motion optmization(0:OFF,1:PTP,2:CP,3:AL
7: Control set of motion optmization(0:OFF,1:          0
8: Floor-mount or Overhead-mount                       0
F5: Change the selection.  OK: Exit with saving
```

Select the "Floor-mount or Overhead-mount" item in this User Preferences window, then press [F5 Change.] to call up the numeric keypad where you can enter new values.
Set “0” or “1”: otherwise, the following error occurs: 6003 Excess in effective value range.



4:*

5:*

7: Control set of motion optmization(0

7: Control set of motion optmization(0

8: Floor-mount or Overhead-mount

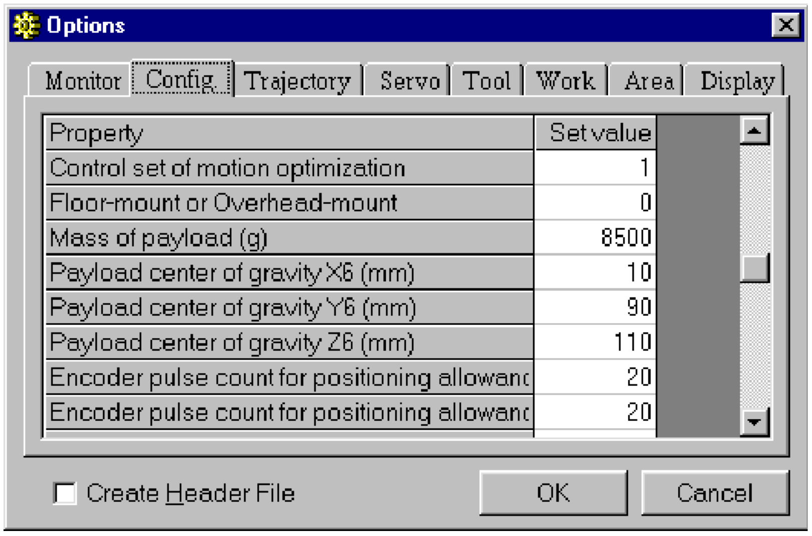
OK: Take in new entry, Cancel: Discard new entry

Note: Transmit the installation condition set using the teach pendant to WINCAPSII. For information on the transmission procedure, refer to Note (1) on page 4-18.

■ Setting with WINCAPSII

This section explains the setting method for floor installation and for gantry installation using the personal computer teaching system WINCAPSII. Refer to the " SETTING-UP MANUAL, Section 2.9 " and the "WINCAPSII Guide, 8.6.1.2 User Preferences."

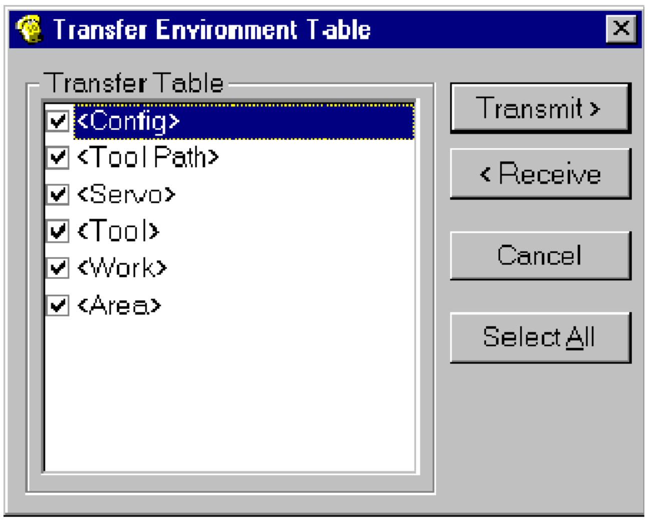
Select Options in the Tools menu of Arm Manager and the Options window will be displayed.
Click on the User Preferences tab on the Options window to display the User Preferences window.



Property	Set value
Control set of motion optimization	1
Floor-mount or Overhead-mount	0
Mass of payload (g)	8500
Payload center of gravity X6 (mm)	10
Payload center of gravity Y6 (mm)	90
Payload center of gravity Z6 (mm)	110
Encoder pulse count for positioning allowanc	20
Encoder pulse count for positioning allowanc	20

If the Set value box of [floor or gantry] on the [Using condition (parameter number:)] screen is double-clicked, the parameter value can be edited.

After the parameter values are set, transmit the data to the robot controller. First, turn OFF the motor power with the MOTOR key on the teach pendant. Set Arm Manager to the connection status and click on **Transmit** of Arm Manager to display the Transfer Environment Table. Then, execute transmission.
For transmission, refer to the "WINCAPSII Guide , 8.2.5 Transfer Project" .



Note (1):	**Click on < Receive in the Transfer Environment Table to receive data from Arm Manager of the controller. The external load condition value and the external mode can be received in this case. However, the internal load condition values and the internal mode which are edited in a program cannot be transmitted to WINCAPSII.**
Note (2):	**Enter the payload center of gravity in the Tool 0 coordinate system (See Fig. 4-9). The unit should be mm. The origin of the Tool 0 coordinate system coincides with the center of the 6 axis flange, the Y component directs from the center of the flange to the ϕ6H7 pin hole (the direction of the orientation vector), the Z component passes through the center of the flange and is aligned with the normal of the flange face (the direction of the approach vector), and the X component is the X axis of a right hand coordinate system where Y axis is the orientation vector and the Z axis is the approach vector (See Fig. 4-10).**

4.7.4 How to Set Optimal Load Capacity Initializing [V1.4 or later]

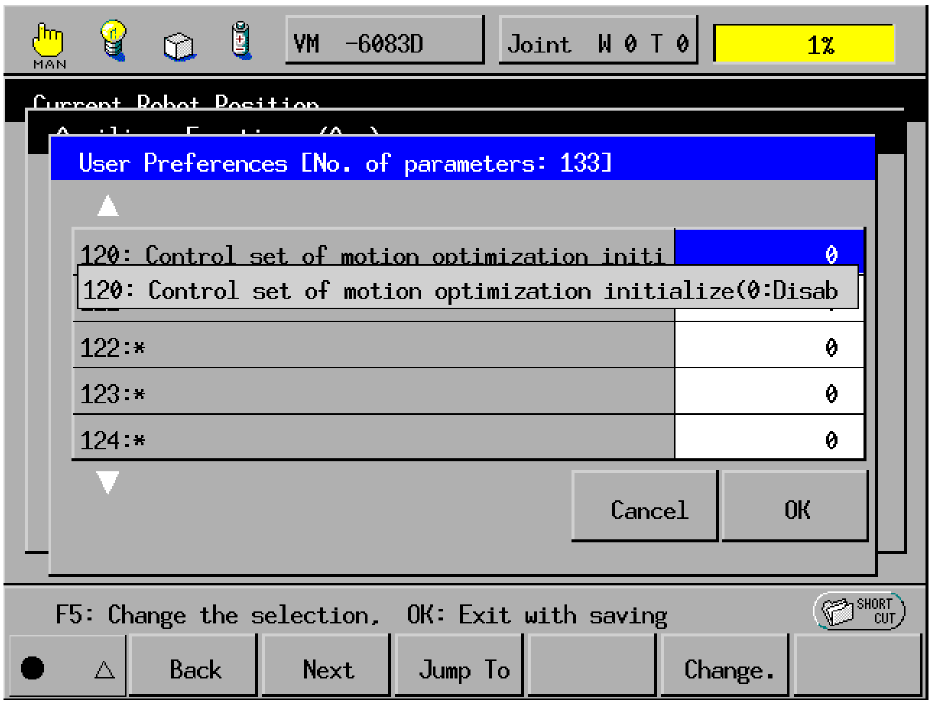
This section describes how to set the optimal load capacity initializing mode to the mode 0 or how to maintain the current setting after the controller is turned on.

Set Value	Description
0	Initializes the optimal load capacity setting mode to the mode 0 after the controller is turned on.
1	Does not initialize the optimal load capacity setting mode after the controller is turned on (maintains the current setting).

■ Setting with Teach Pendant

Operation flow: Main Screen-[F2 Arm] [F6 Aux.]-[F7 Config.]

The [User Preference (No. of Parameters:)] screen appears after you use the teach pendant to go through the operation flow above. On the screen, you will see the current internal load condition values and the internal mode.


VM -6083D
Joint W 0 T 0
1%
User Preferences [No. of parameters: 133]

```
120: Control set of motion optimization initi        0
120: Control set of motion optimization initialize(0:Disab
122:*                                                0
123:*                                                0
124:*                                                0
```

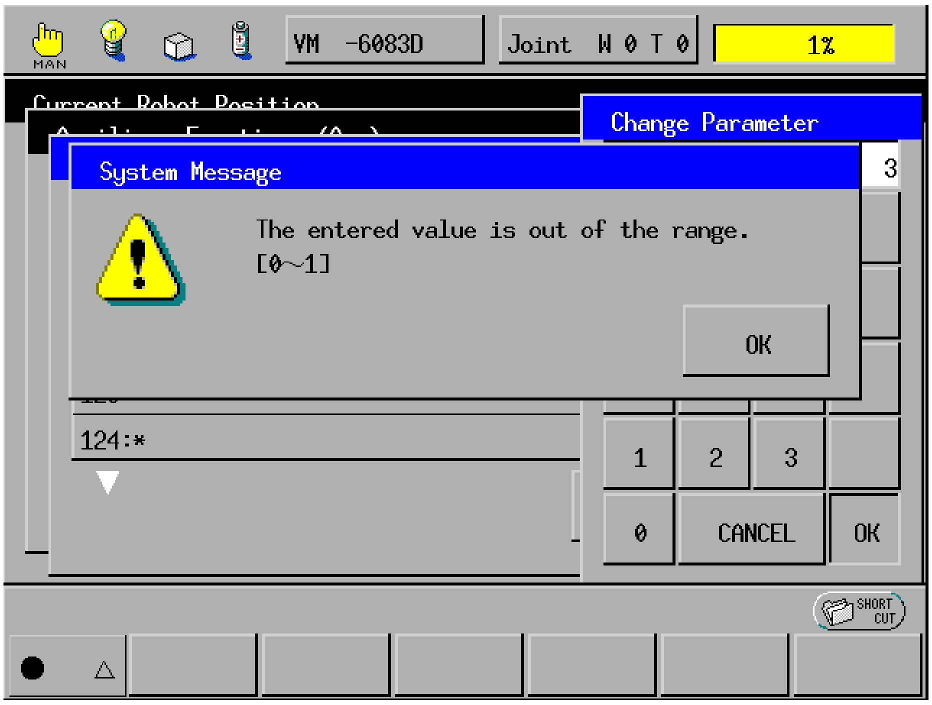
F5: Change the selection, OK: Exit with saving

On the [User Preference (No. of Parameters:)] screen, select [Set Optimal Load Capacity Initializing] and press [F5 Set change]. The [Parameter change] screen will appear and you will be able to change individual parameter values.

0: Disabled→ Initializes after the controller is turned on.

1: Enabled→ Does not initialize after the controller is turned on. (maintains the current values)

You can provide only 0 or 1 to set the optimal load capacity initializing, otherwise you will receive an error, "6003 Exceeding valid range".



System Message

The entered value is out of the range.
[0~1]

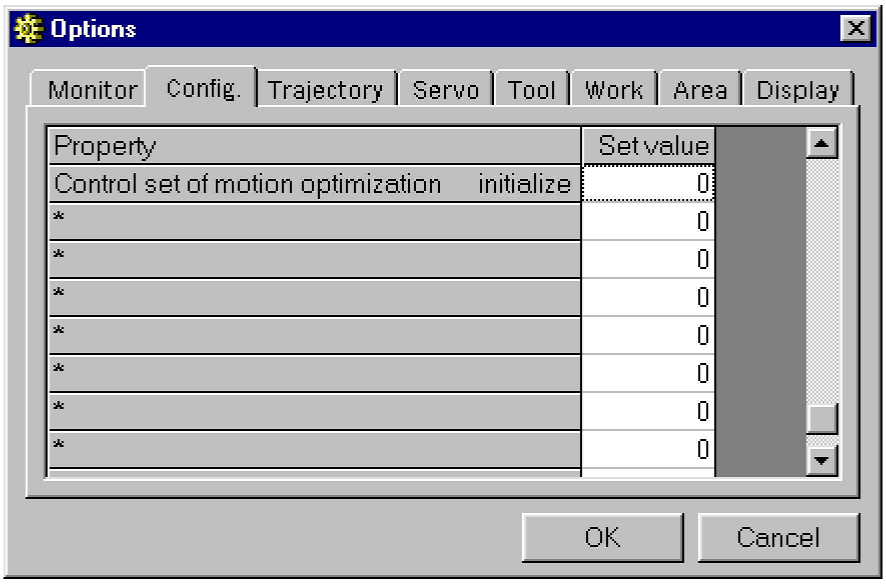
OK

Note: You should transfer the optimal load capacity initializing settings specified by the teach pendant to WINCAPSII. See 4.7.3 Setting with WINCAPS Note (2) for how to transfer the settings.

■ Setting with WINCAPS II

This section describes how to use the WINCAPS II, a PC-based teaching system, to set the optimal load capacity initializing.

Select [Set] from [Tools] menu of Arm Manager to view [Set] window.
Click [User Preference] tab of the [Set] window to see [User Preferences].



Property	Set value
Control set of motion optimization initialize	0
*	0
*	0
*	0
*	0
*	0
*	0
*	0

Double click a setting item for the optimal load capacity initializing to change the parameter values in this [User Preference (No. of Parameters:)] screen.

After you have finished parameter setting, you may transfer the data to the robot controller. First, use [MOTOR] on the teach pendant to turn off the motors. Make the Arm Manager connected, click [Transfer] to display [Transfer] dialog box, and execute the transfer.
See "8.2.5 Transfer" in "WINCAPS II Guide" for the transfer.

You can provide only 0 or 1 to set the optimal load capacity initializing, otherwise you will receive an error, "6003 Exceeding valid range".

Note: When you click [←Receive] in [Transfer] dialog box to receive data in the Arm manager of the controller. Changes made to the optimal load capacity initializing setting will not be transferred to WINCAPSII

.

4.8 Safety Features

4.8.1 ndTc (Statement) [V1.2 or later]

Function

Sets the TC time length.

Syntax

ndTc(<TClength>)

Explanation

This statement is functionally equivalent to the TC command of the conventional language.

The TC time length can be set within the range from 0 to 600 seconds. The factory default is 60 seconds.

The specification of 0 produces the same function as TC OFF of the conventional language.

Macro Definition

Requires a <pacman.h> file.

Related Terms

ndTs

4.8.2 ndTs (Statement) [V1.2 or later]

Function

Sets the TS time length and the slow speed.

Syntax

ndTs(<TSlength>,<Slowspeed>)

Explanation

This statement is functionally equivalent to the TS command of the conventional language.

The TS time length can be set within the range from 3 to 30 seconds. The factory default is 5 seconds.

The slow speed can be set within the range from 1 to 10%. The factory default is 10%.

Macro Definition

Requires a <pacman.h> file.

Related Terms

ndTc

Chapter 5

Vision Control

This chapter provides an explanation of vision related terms required for creating programs.

5.1 Vision Control

This section explains commands to use the μVision board, which is optionally built in the robot controller.
You should read this chapter when you create or enter a program using the vision device.

5.1.1 Terms of Vision Control

5.1.1.1 Pixel

The μVision board treats image element data as a group of dots. One dot is called pixel or image element.
The number of pixels handled by the μVision board can be expressed in pixels on two different screens. The process screen storage memory is 512 by 480 pixels and the draw only screen memory is 624 by 480 pixels.

5.1.1.2 Brightness

Each pixel of image data processed by the μVision board has a value to express lightness. This value is called brightness. The brightness value ranges from 0 to 255, in 256 levels. The nearer the value is to 0, the darker the image will be. Oppositely, the nearer the value is to 255, the brighter the image will be.

5.1.1.3 Window

Set a window as shown in Fig. 5-1 to display the μVision board vision processing range. With the window, the size is memorized for each window number inside the μVision board. There are two ways to edit the window. The first is with the vision manager and second is by the user program. Note that window information, which is edited by the user program, is lost if you turn OFF the power.

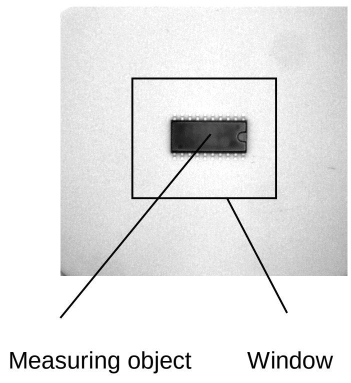


Fig. 5-1 Image Process Window

5.1.1.4 Area, Center of Gravity and Major Axis Angle

[1] Area

The board binarizes image data taken from the camera and counts each pixel of white (1) and black (0) in the designated range of the window area. The µVision board counts the area by real-time binarization without changing the brightness value of each pixel in the window. Therefore, you do not have to binarize image data beforehand.

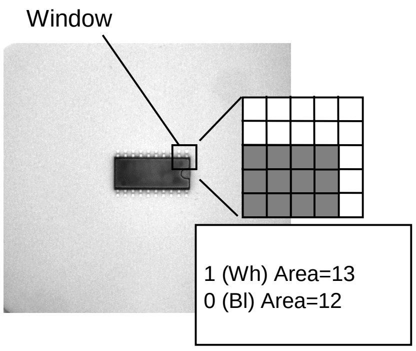


Fig. 5-2 Area

[2] Center of Gravity

Image data taken from the camera displays the object as a plane. The point where the object weight is balanced on the plane is called the center of gravity. The µVision board obtains the center of gravity from the pixels of white (1) and black (0) in the designated range of the window. The center of gravity is expressed with coordinate values of X and Y.

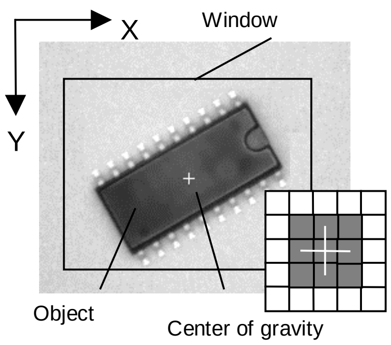


Fig. 5-3 Center of Gravity

[3] Major Axis Angle

Image data taken from the camera displays the object as a plane. When the object on this plane is rotated, the longitudinal direction axis, which is easy to rotate, is called the major axis of the main axis. The axis vertical to this is called the minor axis of the main axis.
The μVision board defines an angle (   ) from the horizontal axis (X axis) to the major axis of the main axis as the main angle. The main axis angle is obtained to an object in white (1) or black (0), in the designated range of the window after binarization of the image data.

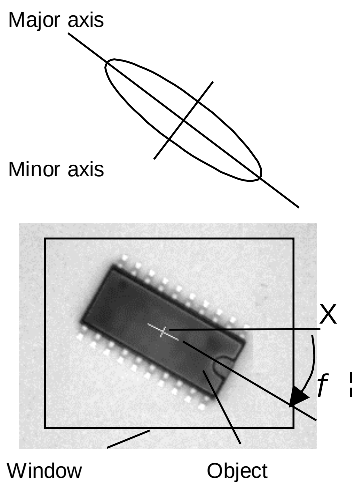


Fig. 5-4 Main Axis Angle

Note: The main axis angle cannot be specified for a square or circle.

5.1.1.5 Binarization

[1] Binarization

Image data taken in the µVision board from the camera has 256 levels of brightness for each pixel. Binarization rewrites each pixel's brightness to white (1) and black (0) with a threshold value as the boundary. This threshold value is called the binarization level. The µVision board designates binarization levels with two values, a lower binary limit and a upper binary limit. The levels for values between the lower binary limit and the upper binary limit are binarized to white (1) and other levels to black (0).

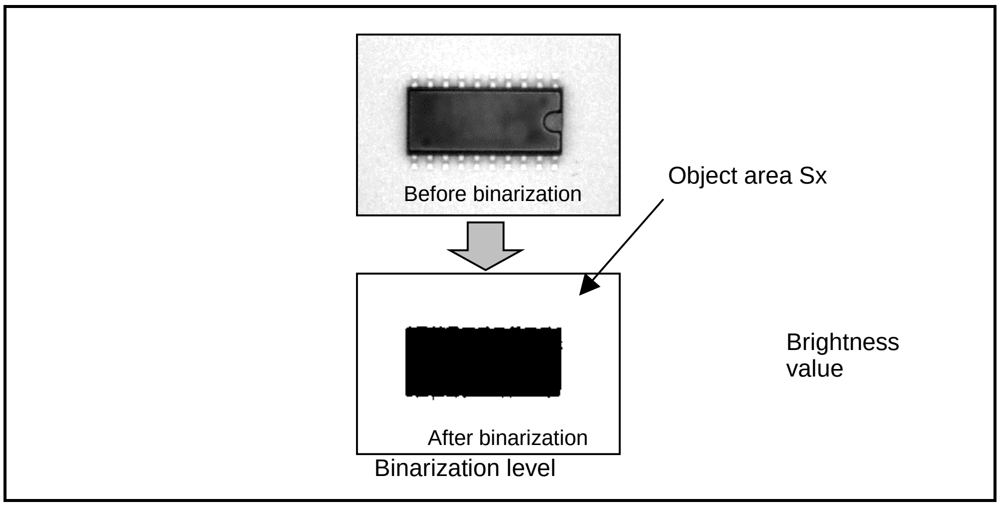
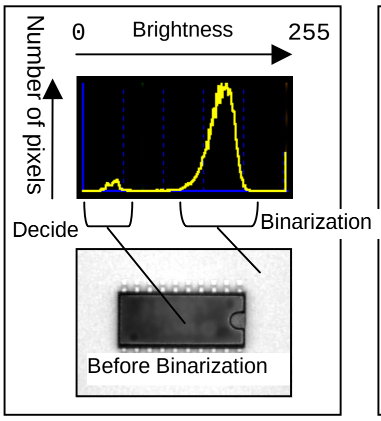


Fig. 5-5 Binarization

[2] Histogram

A histogram counts the occurrence frequency of brightness values in a designated range of a window of the image data taken from the camera. Drawing the histogram as a graph helps you easily understand the distribution of brightness values and you can therefore, easily determine the binarization level. The µVision board provides an automatic binarization level decision function. This function uses histograms to decide the binarization level. Fig. 5-6 is a histogram of image data before binarization. You can see 2 images separated into an object and a background. Fig. 5-7 shows the result of binarization with different binarization levels. By adjusting the lower binary limit and the upper binary limit, you can achieve different binarization results.



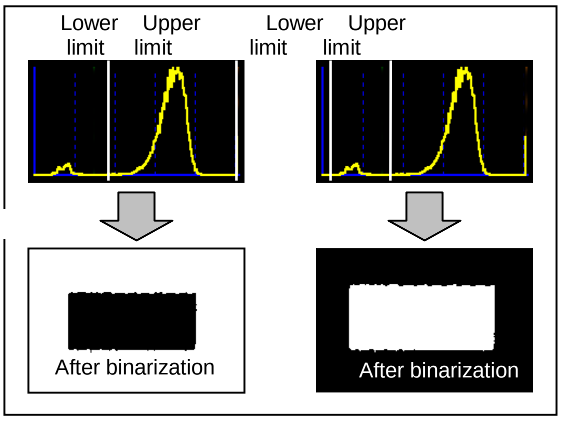


Fig. 5-6 Before Binarization Fig. 5-7 After Binarization

[3] Binarization Level Detection

Mode Method

If the histogram of an image forms a double-humped distribution, which has two peaks corresponding to the object shape and the background, the method used to set the binarizatioin level (t) to the valley section (t) which lies between the two humps is called a mode method.
Since the μVision board detects the peak and valley in the histogram in the direction from brightness value 0 to 255, as shown in Fig. 5-8, point t is regarded as the valley and the board sets it as the binarization level.

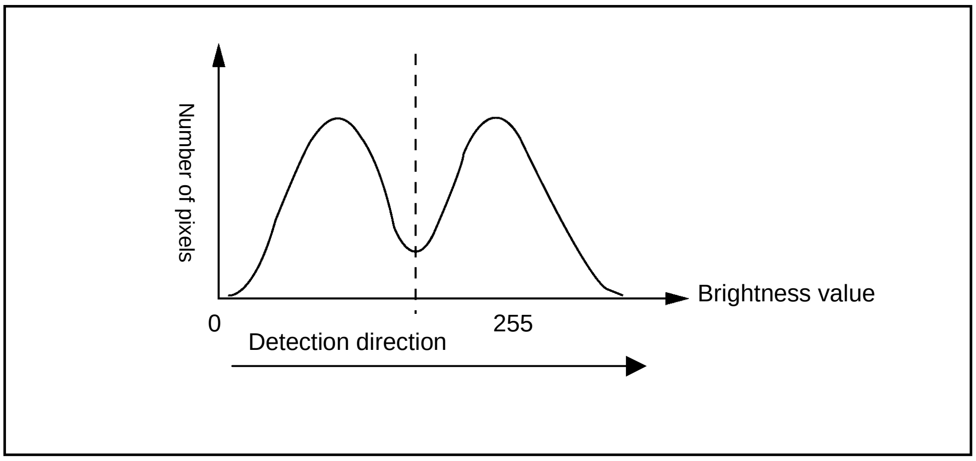


Fig. 5-8 Binarization Level Due to Mode Method

Discrimination Analysis Method

In an image histogram, you divide the brightness value into black and white sections with the binarization level K. The method of determining the binarization level K by using the statistical method to clearly divide the 2 sections is called the discrimination analysis method.
If a image does not have a double-humped distribution histogram, the mode method described above is inappropriate. You can determine the optimal threshold value with the discrimination analysis method instead.

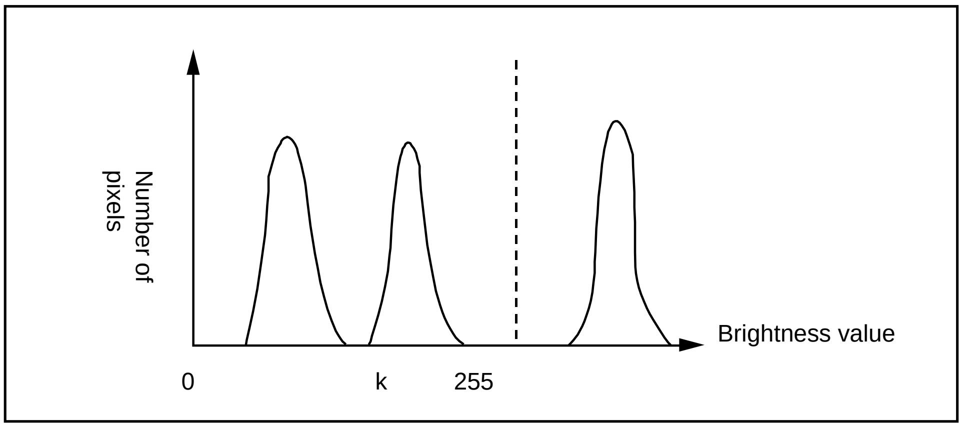


Fig. 5-9 Binarizatioin Level by Discrimination Analysis Method

P Tile Method

This method detects the binarization level where the object area coincides with Sx, by the use of a histogram when the object's white and black area is already known as Sx.

If the object is white, the area is obtained by adding pixels from a higher brightness value of the histogram. If the calculated result reaches Sx at the brightness level, the brightness value is set as the binarization level.

If the object is black, the area is obtained by adding pixels from a lower brightness value. The binarizatioin level is obtained in the same manner as the white area.

This method is effective when the object area is known beforehand.

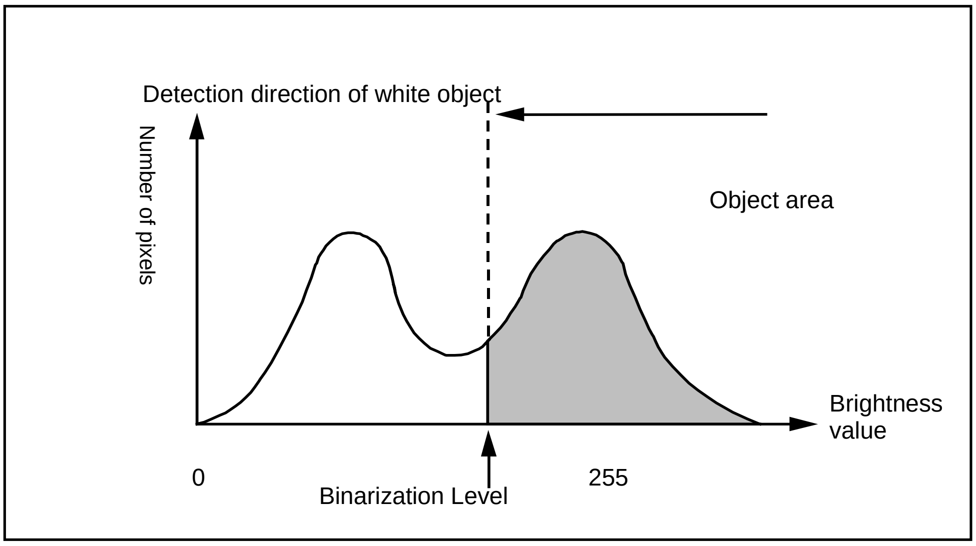
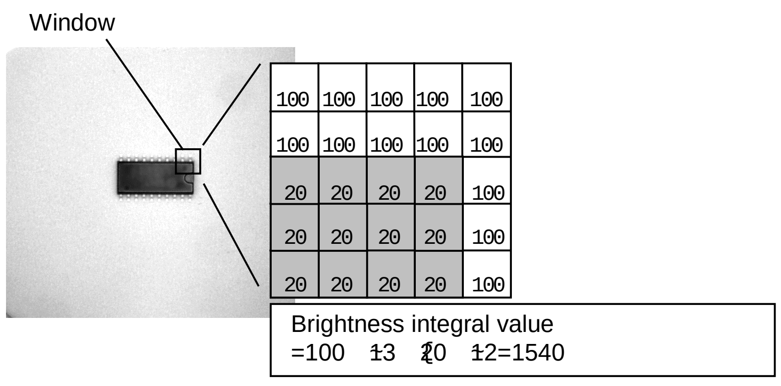


Fig. 5-10 Binarization Level Due to P Tile Method

5.1.1.6 Brightness Integral Value

The total of all pixel brightness values in the range designated with the window for the obtained image from the camera is called a brightness integral. The value of the total is called a brightness integral value.



100	100	100	100	100
100	100	100	100	100
20	20	20	20	100
20	20	20	20	100
20	20	20	20	100

Brightness integral value
=100 ×13 +20 ×12=1540

Fig. 5-11 Brightness Integral Value

5.1.1.7 Edge

A point that changes the object in a designated window from dark to light (black to white) or light to dark (white to black), namely, the brightness changing point, is called an edge.
The edge position that is detected by the μVision board is the brightness value of the area value that satisfies the designated level value. You can use an absolute value and a differential value to designate the level value. Use them appropriately, depending on the status of the object. For absolute designation, the system detects a level where the brightness value or area value passes the designated position. However, in differential value designation, positions are detected where the changed brightness value or area value is greater than the designated value.

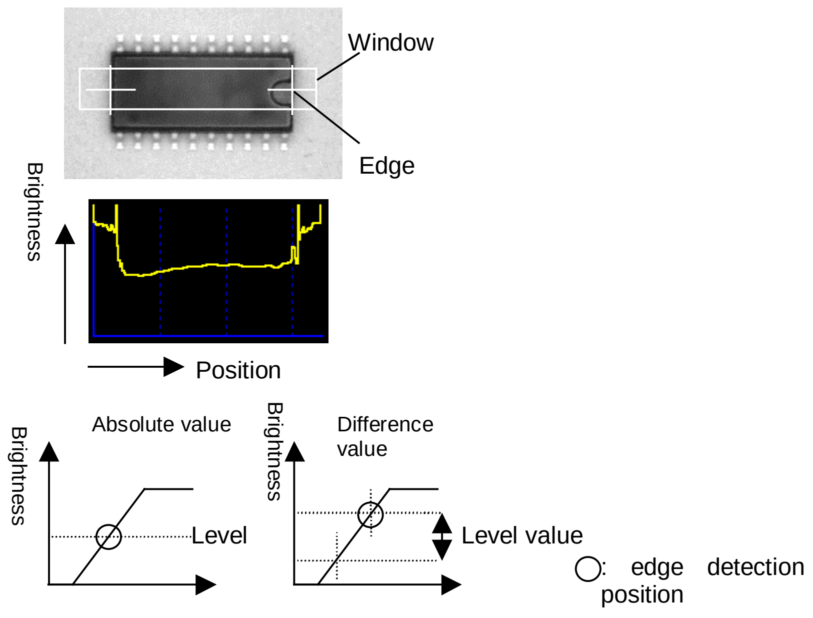


Fig. 5-12 Edge

5.1.1.8 Labeling

Labeling is a process to binarize the obtained image data from the camera and attach a sequence number to the link areas of white (1) or black (0) pixels.

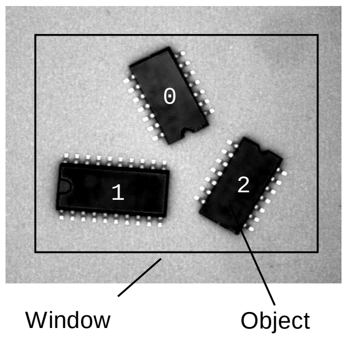


Fig. 5-13 Labeling

With labeling, you can separately and individually handle multiple objects present in the range designated with the window.
When labeling is executed, the μVision board can determine the area, center of gravity, main axis angle, filet shape, and periphery length as individual object features. The filet shape is a circumscribe polygon of the objects.

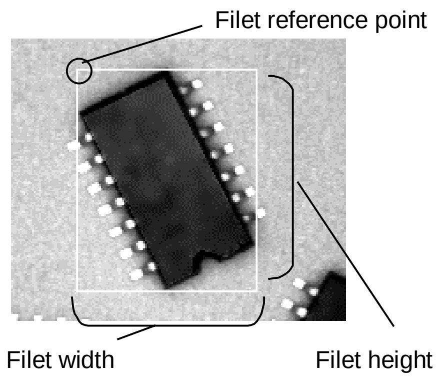


Fig. 5-14 Filet Shape

The periphery length is the sum of pixel counts, which form the outer shape of the object.

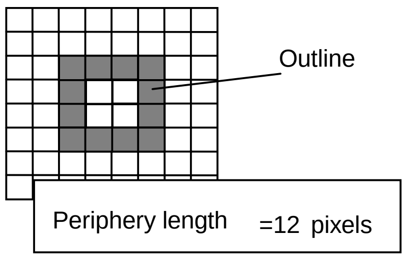


Fig. 5-15 Periphery Length

5.1.1.9 Search

Search moves the standard image data (search model) previously stored in the searching range (within the window range) of the measuring object image, and finds the matching position with the search model.

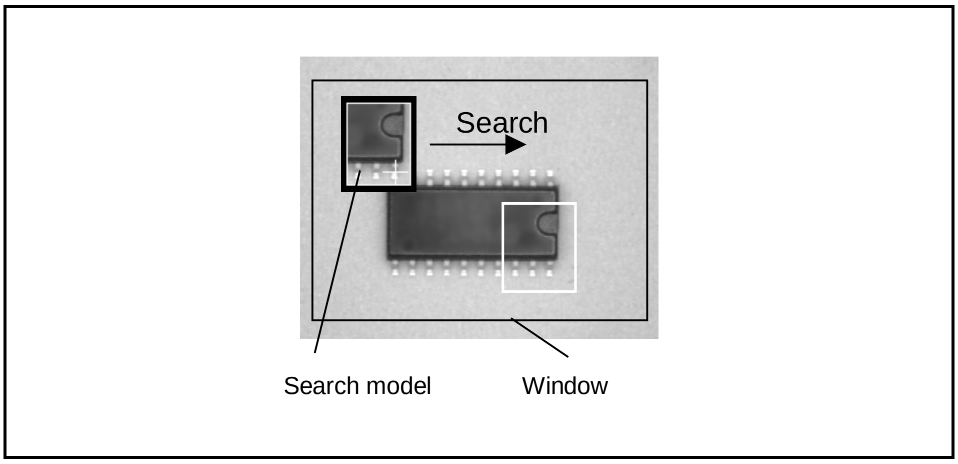


Fig. 5-16 Search

In the µVision board, standard image data is called a search model.
It is comprised of image data and the reference coordinates (OX, OY).

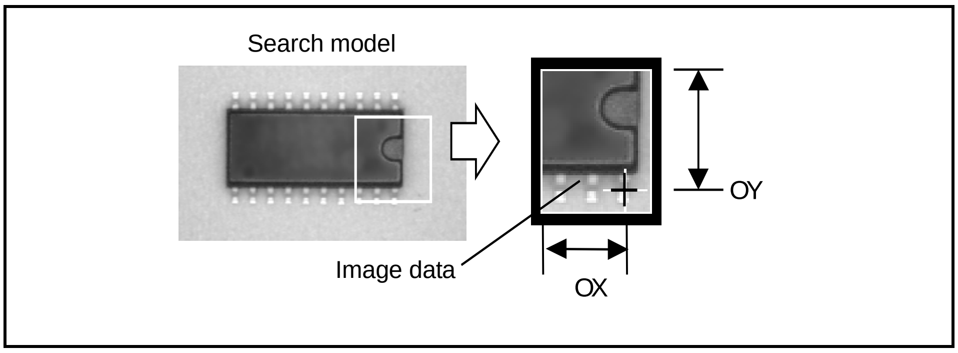


Fig. 5-17 Search Model

The value that an expressed degree of search model corresponds to the measuring object image is called a correspondence degree. If the correspondence value larger than the designated one is obtained, the system can obtain the coordinates of the correspondence position of the search model and the measuring object image. The detection accuracy of the coordinates is 1 (the minimum unit of the pixel). You can obtain results with an accuracy of less than 1 pixel using sub pixels. If you execute measurement with sub pixels, it takes longer time to measure than to measuring with pixels.

PART 2

COMMAND REFERENCE

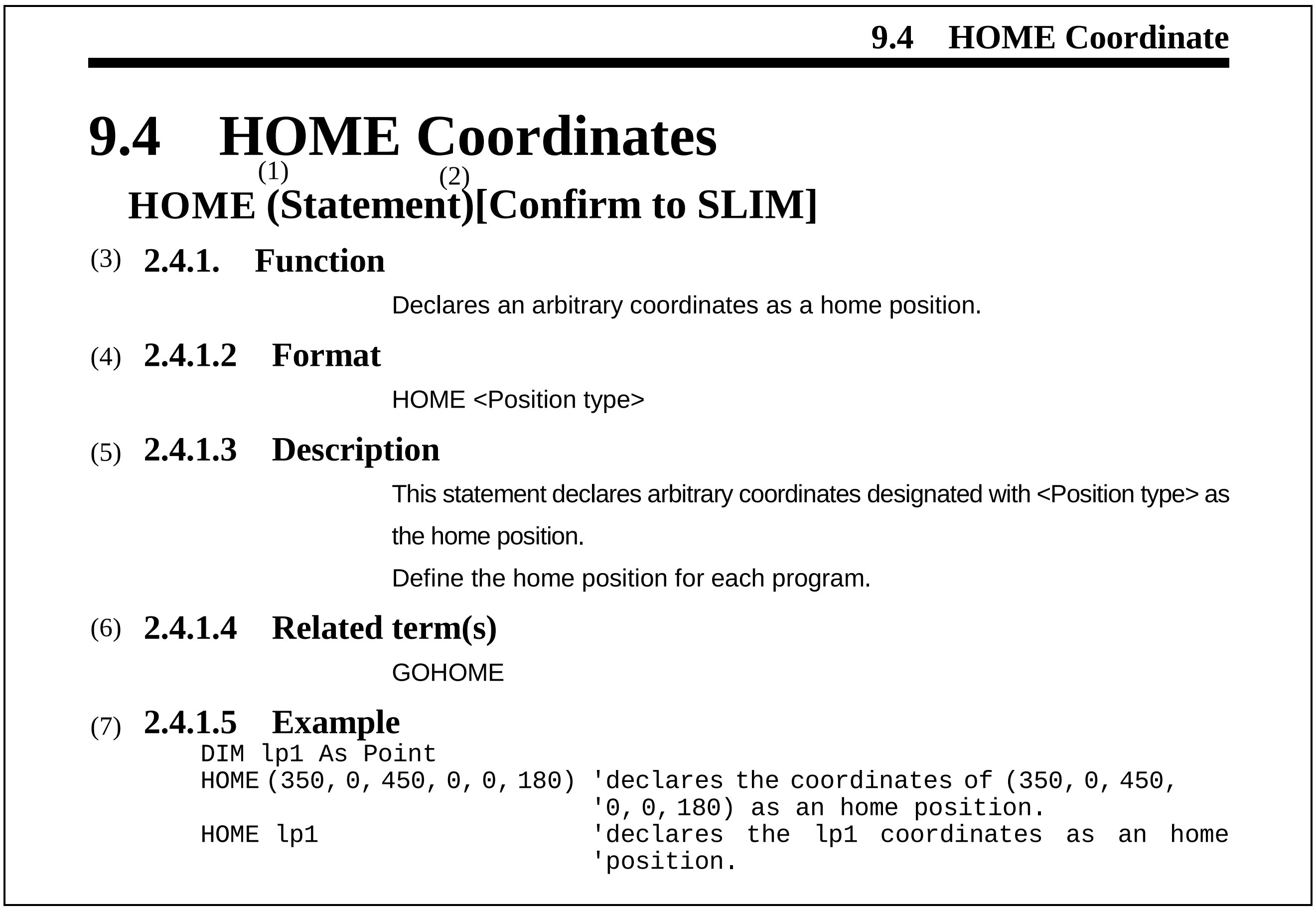
Chapter 6

Guide to Command Reference

This chapter provides command descriptions and a command list for the PAC robot.
Use the command list to quickly search for information concerning each command.

6.1 Description Format of Command Explanations

Chapter 9 and the following chapters provide descriptions of each PAC command. This section explains the description format of commands.



9.4 HOME Coordinate

9.4 HOME Coordinates

(1) (2)

HOME (Statement)[Confirm to SLIM]

(3) **2.4.1. Function**

Declares an arbitrary coordinates as a home position.

(4) **2.4.1.2 Format**

HOME <Position type>

(5) **2.4.1.3 Description**

This statement declares arbitrary coordinates designated with <Position type> as the home position.

Define the home position for each program.

(6) **2.4.1.4 Related term(s)**

GOHOME

(7) **2.4.1.5 Example**

```
DIM lp1 As Point
HOME (350, 0, 450, 0, 0, 180) 'declares the coordinates of (350, 0, 450,
                              '0, 0, 180) as an home position.
HOME lp1                      'declares  the  lp1  coordinates  as  an  home
                              'position.
```

Description format of command explanations

(1) Command name: describes the command name first.

(2) Command type: describes the command type (statement, function, system variable, built-in constant) after the command name. If the command conforms to the SLIM standard, [Conforms to SLIM] is added.

(3) Function: explains the function of the command.

(4) Format: describes the syntax of the description format. If the command includes an argument, the argument description is enclosed in "<" and ">." If there are plural arguments, a delimiter "," is used.

Elements which can be ignored are enclosed in square brackets ("[" and "]").

"[,<b>]" in "[" and "]" in the "[<a>[,<b>]]" format means that if <a> is ignored then "[,<b>]" must also be ignored.

If only one element is required in a set of elements, the set of elements is described within brackets "{" and "}", and each argument is separated by a delimiter "|".

(5) Explanation: describes how to use the command.

(6) Related terms: shows other related commands or explanations.

(7) Example: gives a description of how to use the command.

6.2 Command List

6.2.1 Commands Listed in Alphabetical Order

Refer to Commands Listed in Alphabetical Order that follows the Contents.

6.2.2 Commands Listed According to Functions

Refer to Commands Listed According to Functions that follows the Contents.

Chapter 7

PAC Language Configuration Elements

This chapter provides an explanation of the elements that configure the PAC language.

7.1 New Robot Language PAC

A programming language used to describe robot motion and work is called a robot language.
The robot language used for DENSO robots is called PAC (Programming language for Assembly Cell). PAC was newly developed to increase efficiency in the development and maintenance of robot control programs over conventional languages. The major features are described below.

- It is upwardly compatible with the industrial robot language SLIM that conforms to JIS.
- Easy to read because it is a structured programming language, and this also makes development and maintenance easy.
- Not only robot programs can be described but also vision device control is universal with PAC.
- Program processing is effective as a result of a multitasking function.
- As a result of an interruption process function, exceptional processing, such as when an error occurs, can be described efficiently.

7.2 Relation between PAC Robot Language and Conventional Languages

Conventionally there are many problems with robot languages such as incompatibility between different robots and manufacturers. JIS has enacted an industrial robot program language SLIM to standardize robot languages to help alleviate the burden of managing different languages for different robots.

SLIM was standardized (JIS B 8439) with the purpose of mainly describing assembly work, and data types and robot motion instructions particular to a certain robot are added based on BASIC language.

Therefore, one advantage of SLIM is that even persons accustomed to robot languages prior to SLIM can master the SLIM language with comparative ease.

The PAC robot language used for DENSO robots is based on the structured BASIC language, an upper compatible BASIC language. This gives PAC the advantages of SLIM while also providing various other features such as a structured language and a multitasking function. Since the specifications are the same as SLIM in regard to instructions special to robots, PAC is also upwardly compatible to the SLIM language. PAC can thus respond to high requirements by making use of the advantage of SLIM that even persons accustomed to robot languages prior to SLIM can master it with relative ease.

7.3 Language Element

The following elements are used to construct the PAC language.

- Identifier ...... the name to identify a construction element.
- Variable....... to temporarily store data.
- Constant...... data with a constant value.
- Operator...... a symbol to calculate two values.
- Expression .. a combination of construction elements used to obtain a value.
- Command.... an instruction built into the PAC language to execute processes.

There are only a few types of variables and constants.
This chapter provides an explanation of the construction elements and data types.
For information regarding commands refer to Part 2 “Command Reference.”

7.4 Name

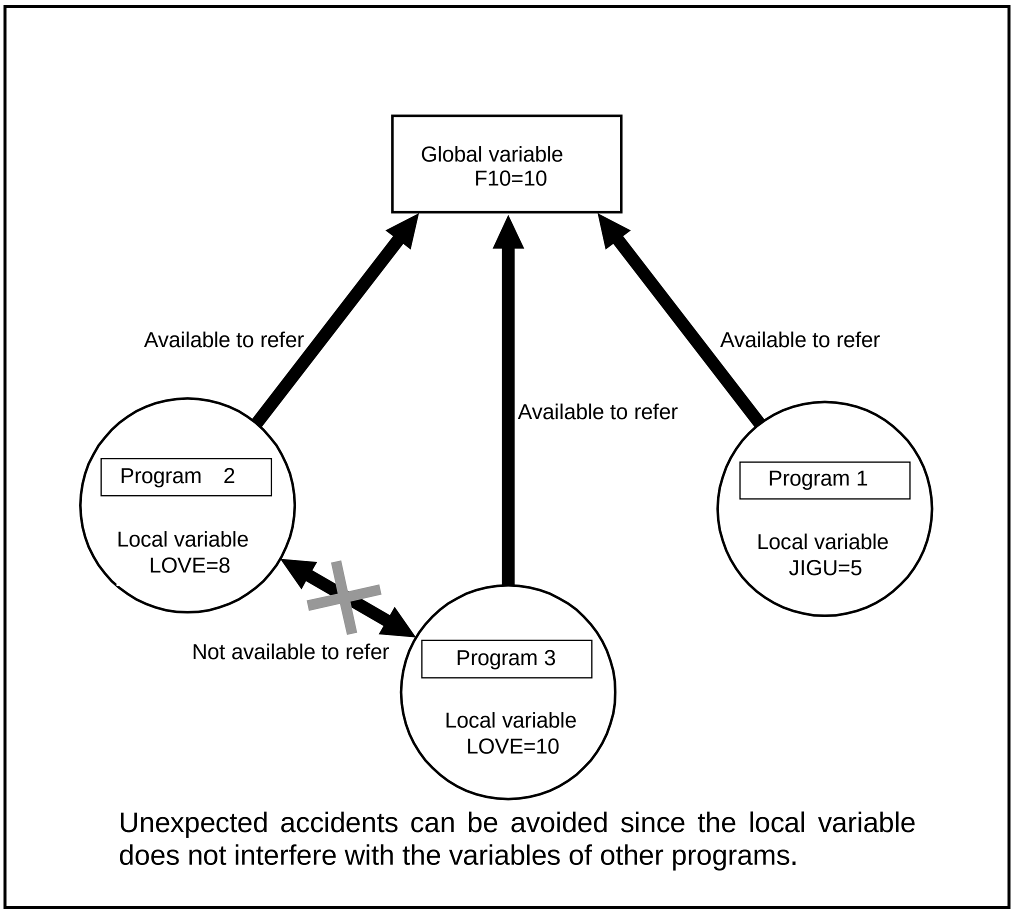
The PAC language has regulations for identifying various elements in a program. This chapter provides an explanation of these regulations. Names that express commands, variables, functions, labels and programs follow the conventions described below.

- A name must begin with a character (one-byte alphabet, no discrimination between uppercase and lowercase letters)or ruled symbol.
- Characters, numerals and underscores can be used for names.
- The first character of a name must be an alphabet letter.
- A period, slash, back slash, blank, colon, semicolon, single quote, double quotation, and asterisk cannot be used.
- Characters such as +, -, *, /, (,) that are used as operators cannot be used.
- To distinguish the name from other words, place a blank character between the name and the other words.
- The maximum number of characters that can be used for a name is 64.

7.5 Identifier

7.5.1 Variable

A variable is used to temporarily store data used in a program. There are global variables, local variables and system variables.
A global variable can be commonly used from any program (task).
A local variable is valid only in one program. Even if another program executed together also has a variable with the same name, it works only in the program it belongs to and does not affect the programs mutually.



Global Variable and Local Variable

[1] Global Variable

A global variable name is expressed with an alphabet letter (I, F, D, S, V, P, J, T, IO)that expresses the type with an integer expression added after the letter. Only an I/O variable has 2 letters (IO).
For example, F0001, F1, and F[1] all express the same single precision real type variable.
Since variable names are reserved by the system, they can be used without declaration. The following types can be used for global variables.

- Type I: integer type (range: -2147483648 ~ + 2147483647)
  Example) I0001, I1, I[1]
- Type F: single precision real type (-3.402823E + 38 ~ 3.402823E + 38)
  Example) F0001, F1, F[1]
- Type D: double precision real type
  (-1.79769313486231D + 308 ~1.79769313486231D + 308)
  Example) D0001, D1, D[1]
- Type S: character string type (Maximum 247 characters)
  Example) S0001, S1, S[1]
- Type V: vector type (X, Y, Z)
  Example) V0001, V1, V[1]
- Type P: position type (X, Y, Z, RX, RY, RZ, FIG) (6 axes)
  Example) P0001, P1, P[1]
- Type J: joint type (J1, J2, J3, J4, J5, J6) (6 axes)
  Example) J0001, J1, J[1]
- Type T: homogeneous transformation type
  (Px, Py, Pz, Ox, Oy, Oz, Ax, Ay, Az, FIG)
  Example) T0001, T1, T[1]
- Type IO: I/O type
  Example) IO0001, IO1, IO[1]

NOTE: Types V, P, J, and T are not available with vision equipment μVision-21.

Global Variable Indirect Reference

When a global variable is designated, the variable number is designated using an expression. This is called an indirect reference.
If an indirect reference is executed, the variable number enclosed in [ ] is expressed.

Example:

```
I1 = I[5*3]         'Assigns a value of I15 to I1.

F1 = F[I1]          'Assigns a type F variable with a value of I1 to F1.

D1 = D[I1+1]        'Assigns a type D variable with a value that is I1 plus 1 to D1.

S1 = S[I7]          'Assigns a type S variable with a value of I7 to S1.

V1 = V[I1]          'Assigns a type V variable with a value of I1 to V1.

MOVE L, P[I5]       'Moves to a position of type P variable with a value of I5.

J1 = J[I5*3]        'Assigns a type J variable with a value that is 3 times I5 to J1.

T1 = T[I1*3]        'Assigns a type T variable with a value that is 3 times I1 to T1.

SET  IO[I1*5]       'Sets a bit type port with a value that is 5 times I1 to ON.
```

[2] Local Variable

The following variable types can be used for local variables in the same manner as global variables.

- Type I: integer type (range: - 2147483648 ~ + 2147483647)
- Type F: single precision real type (-3.402823E + 38 ~ 3.402823E + 38)
- Type D: double precision real type
  (- 1.79769313486231D + 308 ~ 1.79769313486231D + 308)
- Type S: character string type (maximum 247 characters)
- Type V: vector type (X, Y, Z)
- Type P: position type (X, Y, Z, RX, RY, RZ, FIG) (6 axes)
- Type J: joint type (J1, J2, J3, J4, J5, J6) (6 axes)
- Type T: homogeneous transformation type
  (Px, Py, Pz, Ox, Oy, Oz, Ax, Ay, Az, FIG)
- Type IO: I/O type

Local variables can be used after type declaration is executed using type declaration commands.
Type declaration can also be executed using the type declaration characters for numeric value type and character string type local variables. For type declaration commands and type declaration characters, refer to "8.6 Declaration Statement."

Note (1): If a variable is used without type declaration, it functions as a single precision real type variable. However, if a variable without type declaration is used, it may cause a programming error. Therefore, type declaration should be executed if possible.

Note (2): In the default setting of the personal computer teaching system WINCAPSII, "Explicit type declaration is always required" is set. If this is set and type declaration is ignored, an error will occur when compiling is carried out. If there are no special considerations, use the system with this setting.

Note (3): If local variables other than the I/O type are referred to in the program, a certain value must be assigned to the local variable (initialization of variable) before referring to it. If a variable is referred to without this local variable initialization, an error will occur in execution. Variables can be initialized by describing an assignment statement for the variable in the program beforehand or by using DEFINT A = 1, for example, to describe it in the variable declaration section of the program for variables other than array variables.

Note (4): If you restart the program when a program having local variables is called using CALL and it is being executed or in the wait or hold status, the system should have two tasks : one is created by the first call and the other is created at restart. Although they are different tasks the same program cannot secure independence of the local variables and thus the robot may perform some unexpected or incorrect action. To avoid this, do not start the program independently when the program is called using the CALL command.

Note (5): Types V, P, J, and T are not available with vision equipment μVision-21.

[3] System Variable

A system variable is used to check the system status. Since the variable name uses words reserved by the system, the variable name does not have to be declared. The following are system variables.

CURJNT CURPOS CURTRN CURFIG CURACC CURDEC CURJDEC CURJSPD CURSPD DESTJNT DESTPOS DESTTRN DATE$ TIME$ TIMER ERL ERR

7.5.2 Function

A function is used to obtain the operation result of the designated value (argument) using the operation method determined beforehand. There are some functions which do not have arguments depending on the function type.
In the PAC language, there are a function for handling pose and vector data, a function for handling numeric value data, a function for handling character string data and a user defined function.
For function commands, refer to Chapter 15 “Command Reference”.

7.5.3 Label

A label expresses the statement position in a program. The destination position of a branch can be expressed with a label.
If the label is set using a meaningful name, the program will be easy to understand.

7.5.4 Program

A program can be designated using the program name and calling other programs from the program.
Declare a program name at the head of the program using the PROGRAM command.
For program names, refer to "8.2 Program Name and Declaration".

Program example: program call using a program name

Program on the program calling side

```
PROGRAM PRO1
    IF IO[138] = ON THEN
        CALL MOTION
    ELSE
        DELAY 200
    END IF
END
```

"MOTION" program on called side.

```
PROGRAM MOTION
    TAKEARM
    SPEED 100
    MOVE P, P1
    DELAY 200
    MOVE P, P2
END
```

7.6 Data Type

The following data types are handled in the PAC language; character string, numeric value, position, vector and I/O. These data types are described below.

7.6.1 Character String

Character string (String) type data is also referred to as type S data.
It can include a maximum of 247 characters.

7.6.2 Numeric Value

The following 3 types of data exist under numeric value type data.

Type I:	integer type (range: -2147483648 ~ + 2147483647)
Type F:	single precision real type (-3.402823E + 38 ~ 3.402823E + 38)
Type D:	double precision real type (-1.79769313486231D + 308 ~ 1.79769313486231D + 308)

7.6.3 Vector

Vector type data is also referred to as type V data.
It is comprised of three single precision real parameters of components X, Y and Z.

Type V:	vector type (X, Y, Z)

7.6.4 Pose

The following 3 types exist under pose type data.

Type P:	position type (X, Y, Z, RX, RY, RZ, FIG)
Type J:	joint type (J1, J2, J3, J4, J5, J6)
Type T:	homogeneous transformation type (Px, Py, Pz, Ox, Oy, Oz, Ax, Ay, Az, FIG)

7.6.5 I/O (ON/OFF)

I/O type data has an I/O port status (ON or OFF) as a value.

7.7 Data Type Conversion

Changing the data type among different data types is also possible.

7.7.1 Numeric Value

Numeric value data can be converted by following the rules below.

- If numeric value data is assigned to a different type numeric value variable, the numeric value is converted to meet the variable type.
- If an operation is executed with a different type numeric value, the operation is carried out so that the higher precision type is used.
- In a logical operation, numeric values are converted to integers and the operation is executed. The result becomes an integer.
- If a real type is converted to an integer, the result is rounded off to the maximum integer which does not exceed the result.
- If a double precision real type is assigned to a single precision real type, the result is rounded off to 7 significant digits.

7.7.2 Character and Numeric Value

The PAC language provides the following commands to convert characters, character strings, character codes, and numeric values.

Conversion Commands for Characters and Numeric Values

After conversion / Before conversion	Converted to character code	Converted to Character string	Converted to numeric value	Converted to binary notation character string	Converted to hexadecimal notation character string
Character code		CHR$	-	-	-
Character	ASC		VAL$	-	-
Numeric value	-	STR$		BIN$	HEX$

7.7.3 Pose Type Data

The type conversion of pose type data can be executed using the following functions. The tool and work coordinate systems when type conversion is executed are reflected in the pose type data.

Conversion Commands for Pose Type Data

After conversion / Before conversion	Converted to type P	Converted to type J	Converted to type
Type P		P2J	P2T
Type J	J2P		J2T
Type T	T2P	T2J	

```
Example:  J0 = P2J (P0)
          T0 = P2T (P0)
          P0 = J2P (J0)
          T0 = J2T (J0)
          P0 = T2P (T0)
          J0 = T2J (T0)
```

7.8 Constant

A constant is an expression with a fixed value.
Constants in the PAC language are classified into the following.

1 Numeric value data	Type I: integer type constant
	Type F: single precision real type constant
	Type D: double precision real type constant
2 Character string data	Type S: character string type constant (maximum of 247 characters)
3 Vector data	Type V: vector type constant (X,Y,Z)
4 Pose data	Type P: position type constant (X,Y,Z,RX,RY,RZ,FIG) (in case of 6 axes)
	Type J: joint type constant (J1,J2,J3,J4,J5,J6) (in case of 6 axes)
	Type T: homogeneous transformation type constant (Px,Py,Pz,Ox,Oy,Oz,Ax,Ay,Az,FIG) (Each element of type V, P, J, and T is single precision real.)

Constants of each type are explained as follows.

7.8.1 Numeric Value Constant

[1] Integer Type Constant

This constant is an integer from -2147483648 to +2147483647.
There are 3 kinds of notations for integer type constants: decimal, binary and hexadecimal.

Decimal Format

This is an integer type constant expressed using decimal numbers.
If you add an integer type postposition "%" to a real type within a range of –2147483648 to +2147483647, it is regarded as a constant integer type with the digits after the decimal point rounded down.

```
Example: 32767
         -125
         +10
         3256.21% → Since this is an integer type
                    postposition, it is regarded as 3256.
```

Binary Format

This is an integer type constant expressed using binary numbers.
This is expressed by an arrangement of 0s and 1s using "&B" at the head of the numeric value.
If the range for a numeric value of an integer type constant is expressed in the binary format, it is
&B0~&B11111111111111111111111111111111
(in the range of 32 bits).

```
Example: &B110
         &B0011
```

Hexadecimal Format

This is an integer type constant expressed using hexadecimal numbers.
This is expressed by an arrangement of 0 to F with “&H” at the head of the numeric value.
If the range for a numeric value of the integer type constant is expressed in the hexadecimal format, it is
&H0~&HFFFFFFFF (in the range of 32 bits).

```
Example: &H100
         &H3D5A
```

[2] Single Precision Real Type Constant

This is a constant of real type that has significant digit precision up to 7 digits.
The range of a value is -3.402823E + 38 ~ 3.402823E + 38.
The following 3 notation formats are available for a single precision real type constant.

- A number that has a single precision real type postposition “!” at the end
- Exponential format with the use of E
- Real of 7 digits or less without the above designation

```
Example: 1256.3
         35.78!
         -9.345E-06
```

[3] Double Precision Real Type Constant

This is a real type constant that has significant digit precision up to15 digits.
The range of a value is -1.79769313486231D + 308 ~ 1.79769313486231D + 308.
The following 3 notation formats are available for a double precision real type constant.

- A number that has a double precision real type postposition “#” at the end
- Exponential format with the use of D
- Real of more than 7 digits or less than 15 digits without the above designation

```
Example: 1256.325468
         35.78#
         -9.345D-06
```

Note: An error may occur due to the internal expression and significant digit number of single precision real type constants and double precision real type constants.
Example
F1=10.0025
D1=10.0025
In this case, it is internally expressed as 1.0002499580383...E+1, and if this is entered with the single precision real type, this becomes 10.00250 by rounding off the next digit of the significant digit number (8th digit).
If this is entered with the double precision real type, this becomes a value like 10.002499580383... by rounding off the next digit of the significant digit number (16th digit).

7.8.2 Character String Constant

The character string type constant is a constant used to express a character sting.
Express a character string by putting it in double quotations.
The length of a character string must be 247 characters or less.

```
Example: “PAC”
```

7.8.3 Vector Type Constant

A vector type constant is a constant with vector expression consisting of components X, Y and Z.
Each element of X, Y, and Z is expressed with single precision real.

```
Example: Vector type constant is assigned to vector type
         variable V1.
         V[1] = (1,0,0)
```

7.8.4 Pose Constant

[1] Position Type Constant

A position type constant is comprised of position (X, Y, Z), posture (RX, RY, RZ) and figure (FIG), and it has 7 single precision real parameters. The position X, Y, and Z are expressed in units of mm, the posture(RX, RY, RZ) in units of rotation angle (°) and the figure (FIG) using numbers from 0 to 31 (undefined is -1).

Note: If any value other than 0 to 31 is entered to FIG, the value you enter will be displayed but it will be internally handled as undefined (-1).

The posture shows the rotation angle of the X-, Y- and Z-axes, and each right hand direction is taken as forward rotation. The range is limited to -180° ~ +180°. Since the posture depends on the rotation sequence of axes, the rotation sequence is regulated only from the X-, Y- and Z-axes.

```
Example: Position  type  constant  is  assigned  to  position
type     variable P1.
         P[1] = (100,200,300,10,20,30,0)
         ‘X=100,Y=200,Z=300,RX=10,RY=20,RZ=30,FIG=0
```

The element component of a position type variable can be ignored in the aniddle of programming. If it is ignored, “0” is designated to Y, Z, RX, RY, RZ and “-1 (undefined)” to FIG. You cannot ignore the component X.

```
For example,
       P[0] = (100,200,300)
and
       P[0] = (100,200,300,0,0,0,-1)
have the same meaning.
```

[2] Joint Type Constant

A joint type constant is constructed of each axis value from the 1st to 6th. Each axis value is expressed using single type real. The unit is degrees.

```
Example: Joint type  constant is assigned to axis type
         variable J1.
         J[0] = (10,20,30,40,50,60) '1~6 axes:
         10°,20°,30°,40°,50°,60°
```

The element component of a joint type variable can be ignored in the middle of programming. If it is ignored, “0” is designated. You cannot ignore the J1 component.

```
For example,
         J[0] = (10,20)
and
         J[0] = (10,20,0,0,0,0)
have the same meaning.
```

[3] Homogeneous Transformation Type Constant

A homogeneous transformation type constant is a pose constant that is expressed with 3 vectors of position, orient and approach, and with figure.
The 3 vectors are expressed with 3 single precision real type parameters respectively. Therefore, the homogeneous transformation type constant should be expressed with 10 single precision real type parameters.
The unit for the 3 elements of a position vector is mm.

Note: The orient vector and the approach vector are both unit vectors with a size of 1 and must vertically intersect each other. If a vector is designated that does not satisfy the above conditions and it is in turn used with the motion command, the system takes priority over the approach vector and executes motion after automatically crossing the orient vector.

```
Example: Assigns homogeneous transformation type constant
         to homogeneous transformation type variable T1.
         T[1] = (10,20,30,1,0,0,0,1,0,4)
```

7.9 Expression and Operator

An expression is used to return a value. There are expressions that have an independent value and expressions that are comprised of multiple elements linked via operators. All data type values in the PAC language are expressed with expressions.
If the operators described in the following sections are used, the operation in the expression can be executed.

7.9.1 Assignment Operator

Use the assignment operator [=] in the assignment statement to assign variables. A value the on right side of the assignment operator is assigned to the left side.
In the assignment statement, use the following commands according to the data type.

LET, LETA, LETF, LETJ, LETO, LETP, LETR, LETRX, LETRY, LETRZ, LETX, LETY, LETZ

Since a command can be ignored only for the LET command used to assign a numeric value variable, the following two expressions have the same meaning.

```
Example: LET I1 = 5          'Assigns 5 to I1.
         I1 = 5              'Assigns 5 to I1.
```

7.9.2 Arithmetic Operator

Use the operators listed in Table 1-3 in arithmetic operations.
An operation is executed with the priority shown in the table.

Table 1-3 Arithmetic Operators

Arithmetic operator	Operation description	Operation priority
^	Exponential (Exponentiation)Operation	High
-	Negative sign	↑
*, /	Multiplication, division	↕
MOD	Remainder	↓
+, -	Addition, subtraction	Low

Note (1): An error occurs in execution if division by 0 is executed.
Note (2): If a digit overflow occurs in addition or multiplication of integers, the overflow figures are ignored. Note that an error does not occur.
Example: I1 = 2147483647 + 1 '2147483647 is the maximum allowable value of integer type variable.
If the above expression is executed, the result is -2147483648.
-2147483648 is the minimum allowable value of integer type variables.

Note (3):	**An error occurs if a digit overflow occurs in addition or multiplication of real or if an attempt is made to assign a value that cannot be recorded with an integer type variable from the real type variable.**
Note (4):	**In subtraction among integers, the result is rounded off to the maximum integer which does not exceed the result.**
Note (5):	**The sign of an integer remainder is decided as given in below Table .**

Arithmetic Operators

Divisor / Dividend	**+**	**0**	**-**
+	+	Error	+
0	0	Error	0
-	-	Error	+

7.9.3 Relational Operator

A relational operator is used to compare two numeric values. The result is obtained with a Boolean value (True "1" and False "0"), and is used in a conditional expression in the flow control statement for example.

Relational Operators

Relational operator	**Operation description**
=	Equal to
=.	Nearly equal (Approximation comparison)
<>	Not equal to
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to

Remark:	**For comparison precision of the approximation comparison operator (=.), you can set with "Approximation comparison precision" of the program table in [Project Set] of [File] in [PAC manager].**

7.9.4 Logical Operator

The logical operator executes bit operations.
An operation is executed after values other than integer type are converted to integer type.

Note: If a value out of the permissible range is designated for integer type, an error occurs in execution.

Logical Operators

Logical operator	Operation description
NOT	Negation
AND	Logical product
OR	Logical addition
XOR	Exclusive logical addition

```
Example: Bit operation
         I1 = &B1100  XOR  &B0101
         The result of this example is &B1001.
```

NOTE: `NOT` operator

The `NOT` operator is one of the logical bit operators, so it cannot negate any evaluation result of an expression such as I1=I2. (Refer to the PROGRAMMER'S MANUAL, Subsection 7.9.4.)

The following sample cannot negate the evaluation result:

```
     if NOT (I1=I2) then…
```

If the result of I1=I2 is Truth, the NOT operator cannot make it False.

To negate the evaluation result, write as follows:

```
     if (I1=I2) = FALSE then…
```

7.9.5 Character String Operator

A character string can be linked with a character string operator “+”.

```
Example: A$ = “ABC” + “DEF”  'A$ becomes “ABCDEF”.
```

7.9.6 Vector Operation

In a vector operation, use the operators shown in below Table .
An operation is carried out according to the priority shown in the table.

Vector Operators

Vector operator	Operation description	Operation priority
., *, x	Inner product, scalar, outer product	High
+, -	Addition, subtraction	Low

```
Example1:Calculation of inner product of V1 and V2.
         F1 = V1 . V2

Example2:Calculation of twice of V1.
         V2 = V1 * 2

Example3:Calculation of outer product V1 and V2.
         V3 = V1 x V2
```

Note: Since the sign of the outer product operator is the letter “x,” be sure to add a blank character before and after the sign.

7.9.7 Position Operation

This is the operation executed for position type data.
Only “+” can be used for operation of parallel motion and rotation deviation.

Example1: Calculation of point P1 which is (dx, dy, dz) away from the reference point P0 deviation in the robot coordinate system.
P1 = P0 + (dx, dy, dz) or P1 = P0 + (dx, dy, dz, 0, 0, 0)

Example2: Calculation of point P2 which is (df, dg, dh) away from the current position in the tool coordinate system.
P2 = * + (df, dg, dh)H or P2 = * + (df, dg, dh, 0, 0, 0)H

Example3: Calculation of point P3 which is obtained so that the figure at the reference point is rotated by Rx (degree) around X axis, by Ry (degree) around Y axis and Rz (degree) around Z axis in the robot coordinate system.
P3=P0 + (0, 0, 0, Rx, Ry, Rz)

Example4: Calculation of point P4 which is (df, dg, dh) away from the current position in the tool coordinate system, and is rotated by Rx (degree) around the normal vector, by Ry (degree) around the orient vector, and Rz (degree) around the approach vector.
P4=* + (df, dg, dh, Rx, Ry, Rz)H

Note: A position type variable cannot be used for deviation.

7.9.8 Joint Operation

This is the operation executed for joint type data.
Only “+” can be used for operations of parallel deviation.

```
Example: Calculation of point J1 which is (d1, d2, d3, d4,
         d5,  d6)  away  from  the  reference  point  J0
         deviation in the robot coordinate system.
         J1 = J0 + (d1, d2, d3, d4, d5, d6)
```

Note : A joint type variable cannot be used for deviation.

7.9.9 Homogeneous Transformation Array Operation

This is the operation executed for homogeneous transformation arrays.
For the product of a homogeneous transformation array, use the operator [*].

```
Example: Calculate T3 with product of T1 and T2.
         T3 = T1 * T2
Where, the figure T3 is set to that of T2.
```

7.9.10 Operator Precedence (Version 1.5 or later)

In Ver. 1.5, one program line may contain arithmetic operators, logical operators, and relational operators together.

The precedence of those operators is shown below.

Operators	Operations	Precedence
`^`	Index (Exponent)	High
`-`	Negation	↑
`*, /, ., x`	Multiplication, division, inner product, outer product	
`MOD`	Modulo arithmetic	
`+, -`	Addition, subtraction	
`NOT`	Logical negation	
`AND`	Logical multiplication	
`OR`	Logical addition	
`XOR`	Exclusive logical addition	↓
`=, =., <>, <, >, <=, >=`	Relational operators	Low

When more than one operator occurs at the same level of precedence, the Main Software resolves the expression by proceeding from left to right.

The parentheses ( ) allow you to override operator precedence; that is, operations enclosed with parentheses are first carried out.

Example of operator precedence

1. $\texttt{if } \underbrace{\underbrace{\texttt{IO128 = } \underbrace{\texttt{ON and IO129}}_{(1)}}_{(2)} \texttt{ = OFF}}_{(3)} \texttt{ then}$

2. $\texttt{if } \underbrace{\underbrace{\texttt{(IO128 = ON)}}_{(1)} \texttt{ and } \underbrace{\texttt{(IO129 = OFF)}}_{(2)}}_{(3)} \texttt{ then}$

In the above examples, the operation order is (1) through (3).

7.10 Units for the PAC Language

Below Table shows the units of expression for each physical value in the PAC language.

Units of Expression for Each Physical Value in the PAC Language

Physical value	Unit
Length	Millimeter (mm)
Angle	Degree (DEGREE)
Time	Millisecond (msec.)
Speed	% (Rate of the maximum speed)
Acceleration	% (Rate of the maximum acceleration)
Deceleration	% (Rate of the maximum deceleration)

Chapter 8

PAC Language Syntax

This chapter provides an explanation of the regulations for writing a program using the PAC language.

8.1 Statement and Line

A PAC language program is configured with multiple lines.
One statement can be described on an arbitrary line.
The length of a line may be up to 255 bytes.
A statement is the minimum unit to describe a process in the PAC language and it is comprised of one command.
A command is comprised of a command name and the information (parameter) given to the command.

8.2 Program Name and Declaration

Declare the items required for program execution such as the program name and variables prior to execution.
Especially if a program name is declared, it must be declared on the first valid line of the program. This statement is called a PROGRAM declaration statement.
The PROGRAM declaration statement can be ignored. If ignored the program file name is used as the program name. For example, if the program file name is PRO1.PAC, and another name is not designated with a PROGRAM declaration statement, the program name is set to PRO1.
If a PROGRAM declaration statement is ignored, an argument cannot be passed when a program is called. Moreover, it becomes hard to understand a program when edited. Do not ignore a PROGRAM declaration statement unless there is a special reason.
For calling a program, refer to "2.1 Calling a Program and Subroutine."

Note (1): **Programs that can be run by teach pendant operation are limited to ones without any arguments. And programs that can be called with an external device are limited to ones with a program name using the format "PRO <number>". Programs that cannot be run with the teach pendant or an external device can be called from other programs.**

Note (2): **When a program with a program name that uses the format "PRO<number>" is called, an argument cannot be passed.**

Note (3): **If "PRO" is set for the first 3 letters of a program name, be sure to add a number.**
Since <Number> is interpreted as numerals, it may be handled as PRO1 it may be handled as PRO1 even if it is described as PRO01 or PRO001.

8.3 Label

A label can be used to indicate a branch destination and the position of a statement in a program.
The following rules apply when using a label.

- A label name starts with an asterisk (*) .
- The second letter of a label name must be an arbitrary alphabet letter.
- Any combination of alphabet letters and numerals can be used for the third letter and the following letters in a label name.
- The last letter of a label name must be a colon (:) .
- A reserved word cannot be used as a label name.
- A label name to be referred to must be placed at the head of a line.
- An error occurs if the same label name to be referred to is duplicated.
- The range in which a label can be referred to is only in the program where the label is present.

```
PROGRAM WITH_LABEL
    IF IO138=1  THEN*ACTION:  ELSE  *NOACTION:
    *ACTION:        SPEED 100
                    MOVE P, P1
                    DELAY 200
                    MOVE P, P2
    *NOACTION:      DELAY 200
    END IF
END
```

Program Example Using Label

8.4 Character Set

The characters which can be used in the PAC language include alphabet letters, numerals, and symbols. For the alphabet letters, no distinction is made between upper case and lower case letters.
The symbols include the following in addition to arithmetic operators of (+, -, *, /).

- Comma (,)
  Used to separate each parameter.
- Semicolon (;)
  Used to separate each parameter in an argument of a command.
- Single quotation (')
  Used as a substitute for the REM command.
- Double quotation (")
  Used to designate character string data by placing these quotations at the head and end of an arbitrary character string.
- Asterisk (*)
  Used at the head of a label name.
  This indicates the current position of the interface coordinate system.
- Blank
  Always required at the head and end of an instruction name.

Note: You can include the Chinese character codes (Shift JIS) into the comment of the REM statements and string constants

8.5 Reserved Word

A word which has fixed usage for PAC language processing such as command names or operators are called a reserved word.
To use reserved words, special characters must be inserted (blank characters, ”, # and :) before and/or after each word, in order to identify them.
Reserved words in the PAC language are given in “ Reserved word list” in Appendix-5.
A reserved word cannot be used itself as a variable name or label, but a name which includes a reserved word can be used. For example, “HOME” is a reserved word, but you can use a name such as “HOME1” for a variable name or label.

8.6 Declaration Statement

Declare definitions in a declaration statement before using variables, constants, functions and so on that are required to have designated names or types in a program.
The following 3 broad types of statements fall under the declaration statement.

- Type declaration : declares the type of a variable on constant.
- Function/program declaration : declares a function or program.
- User coordinate system declaration : declares a user coordinate system.

8.6.1 Type Declaration

[1] Type Declaration Character (Postposition)

Fixed postpositions can be used to declare a variable type. Postpositions are as follows.

Type Declaration Characters (Postpositions)

Type	Postposition	Example
Integer type postposition	%	A%
Single precision real type postposition	!	A!
Double precision real type postposition	#	A#
Character string type postposition	$	A$

Note: The variable type in a program is handled as the type first declared. Even if a different type postposition from the declaration is used in the middle of a program, the type is not identified.
A, A%, A!, A#, and A$ are recognized as the same variables and are registered as the type first used. Therefore, an error will occur if a different type postposition from the one first used is used.

[2] Type Declaration Instruction

The following type declaration commands can be used to declare the variable type.

Type Declaration Instructions

Type	Command	Example
Integer type	DEFINT	DEFINT AA, AB
Single precision real type	DEFSNG	DEFSNG BA, BB
Double precision real type	DEFDBL	DEFDBL CA, CB
Character string type	DEFSTR	DEFSTR DA, DB
Vector type	DEFVEC	DEFVEC EA, EB
Position type	DEFPOS	DEFPOS FA, FB
Joint type	DEFJNT	DEFJNT GA, GB
Homogeneous transformation type	DEFTRN	DEFTRN HA, HB

In these commands a variable can be initialized together with type declaration. In a declaration statement using these commands, a postposition cannot be added to a variable name.

Example:

```
DEFINT AA = 1          'Assigns 1 to AA as an integer type.
DEFSNG BB (10)         'Sets BB to a single precision real
                       type 'of which number of elements is
                       10.
```

Bad example:

```
DEFINT AB%          'An error occurs because a
                    'postposition is used.
```

[3] Array Declaration

This is a declaration statement for an array. An array can be created for all types except for an I/O variable by adding a postposition to a variable name. However, an array cannot be initialized together with the declaration.
The subscript of an array must be 0 or more. The array can be up to 3 dimensions.
The upper limit of the total number of elements for an array is 32767.

Array Declaration

Type	Command	Example
Array declaration	DIM	DIM AA (10,10)

Example of array declaration:

```
DIM CC (3,3,3)  AS INTEGER'Sets CC to 3-dimensional array of an integer
                          'type.
```

The above example can be expressed as follows by the use of a DEFINT command.

```
DEFINT CC (3,3,3)         'Sets CC to 3-dimensional array of an integer
                          'type.
```

Note: Difference between DEF??? statement and DIM statement
A DIM statement can be used for more than just an array.
For example, instead of
DEFINT CC,
Express as follows.
DIM CC AS INTEGER
Since it cannot be initialized at the same time as the type declaration, a DIM statement is more universal than a DEF??? statement. For example, the following expression cannot be created using a DIM statement.
DEFINT CC = 1   'Declares CC as an integer type and sets the initial value to 1.
If it is not initialized together with the declaration, all types of arrays can be handled in the same manner. Therefore, using a DIM statement is recommended.

[4] I/O Variable Declaration

A variable name corresponds to a specific I/O port.

I/O Variable Declaration

Type	Command	Example
I/O variable declaration	DEFIO	DEFIO PORT = BYTE,104

8.6.2 Function/program Declaration

Commands used to declare a function or a program name are as follows.

Function/Program Declaration

Type	Command	Example
Function declaration	DEF FN	DEF FN AREA (R) = PI * R * R
Program declaration	PROGRAM	PROGRAM PRO1

8.6.3 User Coordinate System Declaration

Commands shown below are used to declare a user coordinate system.

User Coordinate System Declaration

Type	Command	Example
Interference area declaration	AREA	AREA 1, P0, V0, 15, 6
Tool coordinate system declaration	TOOL	TOOL 1, P0
Work coordinate system declaration	WORK	WORK 1, P0

8.7 Assignment Statement

An assignment statement sets a value for a variable of each type.
There are 4 assignment statements for numeric values; assignment statement, character string assignment statement, vector assignment statement and pose assignment statement.

Note: The LET command can be ignored in all assignment statements.

8.7.1 Numeric Value Assignment Statement

A numeric value assignment statement assigns a value to a numeric value variable.

```
Example:  LET I[1] = 10     'Assigns 10 to I[1].
          D[2] = 3.14       'Assigns 3.14 into D[2].
```

8.7.2 Character String Assignment Statement

A character string assignment statement assigns a character string type variable.

```
Example:  S[2] = "DENSO"    'Assigns "DENSO" to S[2].
          LET SS$ = S[2]    'Assigns a value of S[2] to SS$.
```

8.7.3 Vector Assignment Statement

A vector assignment statement assigns a vector type variable. The following 4 commands can be used.

Vector Assignment Statements

Type	Command	Example
Vector type assignment	LET	LET V[2] = (1,2,3)
X component assignment	LETX	LETX V[2] = F1
Y component assignment	LETY	LETY V[2] = F1
Z component assignment	LETZ	LETZ V[2] = F1

8.7.4 Pose Assignment Statement

There are 4 types of pose assignment statements: position assignment statement, joint assignment statement, homogeneous transformation assignment statement, and home position assignment statement.

[1] Position Assignment Statement

A position assignment statement assigns a position type variable. The following commands can be used.

Position Assignment Statements

Type	Command	Example
Position type assignment	LET	LET P[3] = (10, 10, 10, 0, 0, 0)
Position vector assignment	LETP	LETP P3 = V1
Rotation vector assignment	LETR	LETR P3 = V2
X component assignment	LETX	LETX P[3] = F1
Y component assignment	LETY	LETY P[3] = F1
Z component assignment	LETZ	LETZ P[3] = F1
RX component assignment	LETRX	LETRX P[3] = F1
RY component assignment	LETRY	LETRY P[3] = F1
RZ component assignment	LETRZ	LETRZ P[3] = F1
Figure component assignment	LETF	LETF P[3] = I1

[2] Joint Assignment Statement

A joint assignment statement assigns a joint type variable. The following commands can be used.

Joint Assignment Statements

Type	Command	Example
Joint type assignment	LET	LET J[4] = (1, 2, 3, 4, 5, 6) 6 axes
Axis component assignment	LETJ	LETJ 1, J[4] = F1

[3] Homogeneous Transformation Assignment Statement

A homogeneous transformation assignment statement assigns a value to a homogeneous transformation type variable. The following commands can be used.

Homogeneous Transformation Assignment Statements

Type	Command	Example
Homogeneous transformation assignment	LET	LET T[x]= (1, 2, 3, 4, 5, 6, 7, 8, 9, 4)
Position vector assignment	LETP	LETP T[x] = V1
Orientation vector assignment	LETO	LETO T[x] = V[1]
Approach vector assignment	LETA	LETA T[x] = V2
Figure component assignment	LETF	LETF T[x] = I1

[4] Home Position Assignment Statement

A home position assignment statement sets an arbitrary position as the home position.

Home Position Assignment Statements

Type	Command	Example
Home position assignment	HOME	HOME * or HOME CURPOS Sets the current position as the home position.

8.8 Flow Control Statement

Use a flow control statement to control the execution sequence of each statement in a program.
Use a label in a program control flow statement to indicate the position of it in a program.
The flow control can be roughly classified into 5 statements: unconditional branch, conditional branch, selection, repeat and calling defined process.

8.8.1 Unconditional Branch

Use this to transfer program execution to an arbitrary position. Describe a label for the statement you would like to execute next, after the GOTO command.

Example: GOTO *LABEL1

8.8.2 Conditional Branch

If an IF ~ THEN ~ ELSE statement or IF ~ ENDIF statement is used, a branch destination determines whether the designated condition is satisfied.
If the relational expression value described just after IF is true (TRUE (1)), the process after THEN is executed. Otherwise, the process after ELSE is executed.

8.8.3 Selection

Depending on the value of a designated expression, the process to be executed is selected. There are 3 commands.

In SELECT CASE statements, place an arithmetic expression after CASE on the SELECT line. The process is executed from the line of CASE that has a value satisfying this arithmetic expression to the next CASE line or the END SELECT line. If those CASE lines do not satisfy the expression, the process is executed from the line after CASE ELSE to the END SELECT line.

In ON ~ GOSUB statements place an arithmetic expression after ON. The process proceeds to a subroutine according to the value of the arithmetic expression.

In ON ~ GOTO statements place an arithmetic expression after ON. The process proceeds to a label name according to the value of the arithmetic expression.

8.8.4 Repeat

This controls repetition according to a designated condition. There are 4 commands for this.

In FOR ~ NEXT statements, place a repetition condition after the FOR line. The process from FOR to the corresponding NEXT line repeats until this condition is satisfied.

In DO ~ LOOP statements, place a relational expression after WHILE or UNTIL. While this is satisfied (in the case of WHILE) or until this is satisfied (in the case of UNTIL) , the process between the DO line and the Loop line repeats itself.

In WHILE ~ WEND statements, place a relational expression after WHILE. While this is satisfied, the process between the WHILE line and the WEND line repeats itself. This has the same function as DO WHILE ~ LOOP statements.

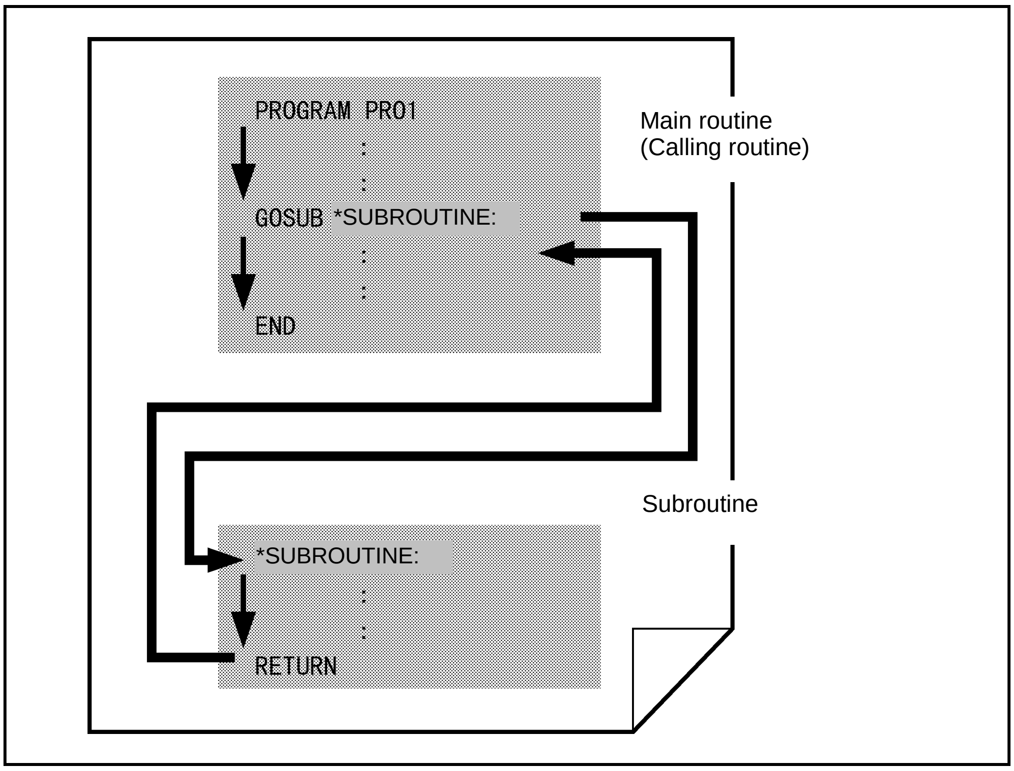
In REPEAT ~ UNTIL statements, place a relational expression after UNTIL. Until this is satisfied, the process between the REPEAT line and the UNTIL line repeats itself. This has the same function as DO ~ LOOP UNTIL statements.

8.8.5 Calling Defined Process

If a part of a program that repeats a particular motion is separated, the part can be called as it is required. This is referred to as a calling defined process.
For the calling defined process there are two kinds of calling; subroutine calling and program calling.

[1] Subroutine

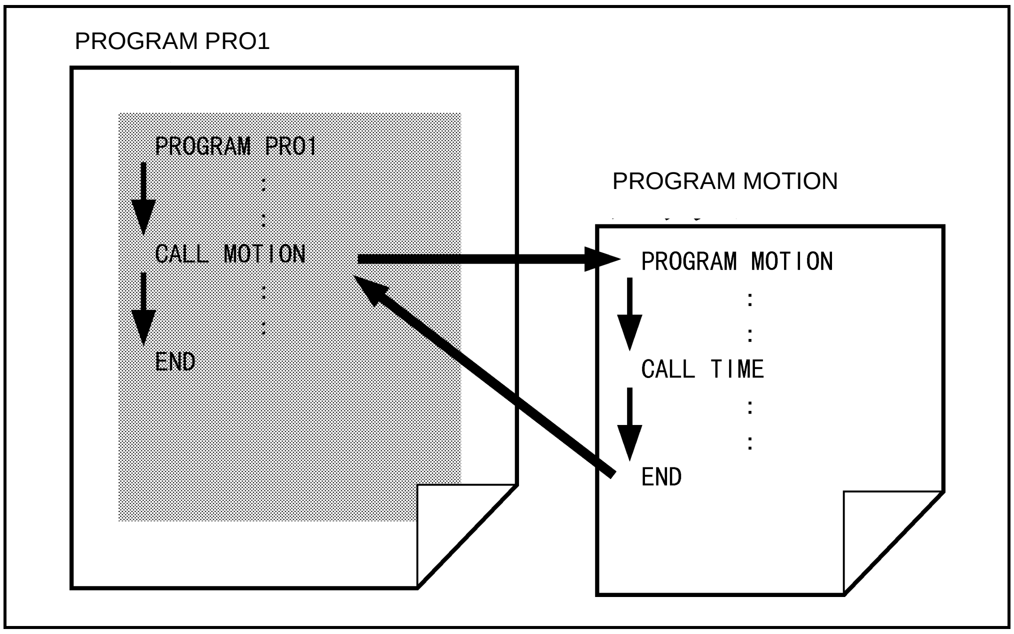
If a subroutine is called, designate a destination with a label in a GOSUB statement.
The subroutine must be written in the same file as the program to be called. The last line of the subroutine should have a RETURN statement. After a series of processes are performed, the RETURN statement is executed and control is returned to the next line in the program which called the subroutine.



Subroutine Calling Structure

[2] Program

If a program is called, designate the program name in a CALL statement and execute it. A recursive call can also be executed.
For details refer to “2.1 Calling a Program and Subroutine”.



Program Calling Structure

8.9 Robot Control Statement

Robot control statements can be roughly classified into a motion control statement, a figure control statement, a stop control statement, a speed control statement, a time control statement, and a coordinate transformation statement.

8.9.1 Motion Control Statement

A statement to control the robot motion is called a motion control statement. There are robot arm motion control statements, hand control statements and motor control statements.

[1] Robot Arm Control

There are four types of robot arm motion control statements; statements for type P, type J, type T and for data other than P/J/T.

Destination Pose: Type P, J, T Data

Motion Control Commands (The Destination Pose is Data of Type P, J and T.)

Type of motion	Command
General movement	MOVE
Approach movement	APPROACH
Depart movement	DEPART

Destination Pose: Oher Than Type P, J, T Data

Motion Control Commands (The Destination Pose is Other Than Type P, J and T.)

Type of motion	Command
Rotation movement	ROTATE
Approach direction rotation movement	ROTATEH
Translation movement	DRAW
Each axis relative motion	DRIVE
Each axis absolute motion	DRIVEA
Home position movement	GOHOME

8.9.2 Stop Control Statement

The stop control statement stops or ends program execution.

Stop Control Commands

Type of motion	Command	Remark
Execution temporal stop	HOLD	Stop after a step.
Execution stop	HALT	Instantaneously stops SUSPENDs own task.
Execution end	STOP	KILLs own task.
Motion abort	INTERRUPT	Instantaneously stops due to interruption.

8.9.3 Speed Control Statement

A speed control statement can be used to set the movement speed, as well as the acceleration and deceleration of the arm.

Speed Control Commands

Type of motion	Command
CP control speed designation	SPEED
PTP control speed designation	JSPEED
CP control acceleration deceleration	ACCEL
PTP control acceleration deceleration	JACCEL
CP control deceleration designation	DECEL
PTP control deceleration designation	JDECEL

8.9.4 Time Control Statement

A time control statement executes motion control of the robot according to the elapsed time.

Time Control Commands

Type of motion	Command
Designated time stop	DELAY
Conditional stop	WAIT

8.9.5 Coordinate Transformation Statement

A coordinate transformation statement changes the coordinate system.

Coordinate Transformation Commands

Type of motion	Command
Tool coordinate system change	CHANGETOOL
Work coordinate system change	CHANGEWORK
Enables interference check area	SETAREA
Disables interference check area	RESETAREA

8.10 Input/output Control Statement

There are 3 types of input/output control statements; DI/DO statement, RS232C control statement and pendant control statement.

8.10.1 DI/DO Control Statement

A DI/DO control statement controls I/O port input/output.

DI/DO Control Commands

Type of motion	Command
Data reading	IN
Data writing	OUT
I/O port ON	SET
I/O port OFF	RESET
Non-motion instruction concurrent processing	IOBLOCK

8.10.2 RS232C Control Statement

An RS232C control statement controls RS232C port input/output.

RS232C Control Commands

Type of motion	Command
Data printing	PRINT
Data reading	INPUT
Data writing	WRITE
Buffer clear	FLUSH

8.10.3 Pendant Control Statement

A pendant control statement sets pendant input and output.

Pendant Control Commands

Type of motion	Command
Debug screen output	PRINTDBG
Operation panel button definition	PRINTLBL
Message screen output	PRINTMSG
Sounds buzzer	BUZZER
TP Operation Screen definition	set_ button set_ page change_ bCap change_ pCap disp_ page

8.11 Multitasking Control Statement

Multitasking control statements include a task control statement and a semaphore control statement.

8.11.1 Task Control Statement

A task control statement controls tasks except for those which include a task control statement.

Task Control Commands

Type of motion	Command
Task creation and running	RUN
Task abort	SUSPEND
Task deletion	KILL
Task protection	DEFEND

8.11.2 Semaphore Control Statement

A semaphore control statement executes semaphore-related control.

Semaphore Control Commands

Type of motion	Command
Semaphore creation	CREATESEM
Semaphore deletion	DELETESEM
Semaphore release	GIVESEM
Semaphore obtaining	TAKESEM
Semaphore waiting task release	FLUSHSEM

8.11.3 Special Semaphore Control Statement

Special Semaphore Control Statements

Type of motion	Command
Arm semaphore release	GIVEARM
Arm semaphore obtaining	TAKEARM
Vision semaphore release	GIVEVIS
Vision semaphore obtaining	TAKEVIS

8.12 Time and Date Control

Time and data control statements obtain the current time and date, the elapsed time, and the control interruption due to time.

Time and Date Control Commands

Type of motion	Command
Obtains the current date	DATE$
Obtains the current time	TIME$
Obtains the elapsing time	TIMER

8.13 Error Control

An error control statement controls interruption due to an error.

Error Control Commands

Type of motion	**Command**
Error interruption definition	ON ERROR GOTO
Error code	ERR
Error line	ERL
Error recovery	RESUME

8.14 System Information

System information can be obtained using the following commands.

System Information Commands

Type of motion	Command
Obtains the system environment setting value	GETENV
System environment setting value assignment	LETENV
Obtains the ROM version information	VER$
Obtains the program status.	STATUS

8.15 Preprocessor

A preprocessor statement controls character string replacement or file fetch when a program is converted (compiled) into execution form.

Preprocessor Command

Type of motion	**Command**
Replacing a character string with a constant and macro name	#define
Canceling a #define statement	#undef
File fetch	#include
Pseudo-error occurrence	#error
Designates program optimization	#pragma optimize

8.16 Calling with a Value and with Reference

It may be desired to pass data to a program when another program is called from the current program. In this case the data can be passed by adding an argument list after by the program name to be called. “Calling with a value” directly passes a value while “calling with reference” passes variables using an argument passing method.
The commands to call a program are CALL and RUN. For the CALL command, both calling methods can be used, however, for the RUN command, only “calling with a value” can be used.
The type of argument passed to a program must match that of the argument described in the program to be called. Therefore, if a constant is passed, a type declaration character must be added. And in the program to be called, a type declaration character must be added to the argument name because the argument is declared as a local variable.

8.16.1 Calling with a Value

When constants are passed, expressions and character strings always use values. If a variable is enclosed in parenthesis, it is regarded as an expression. Thus, even a variable can be passed with a value.

Example: Method of calling a program PROGRAM SUB1 (AA#).

• If a variable is passed as a value	CALL SUB1 ((D1))
• If a constant is passed	CALL SUB1 (10#)
• If an expression is passed	CALL SUB1 (D1 + D2)

Note 1: When a variable is passed as a value, calling with a value of the entire array is impossible. If you write such a calling, it will be processed as "calling with reference."

Note 2: When an expression is passed, note the type of the result of the expression. It must be the same as the type of the argument of the program to be called.

8.16.2 Calling with Reference

A local variable can be passed as an argument.
To designate an entire array as an argument, put the array name in parentheses.

When the contents of a variable passed by calling with reference are changed in the program to be called, the change is valid even if the flow returns to the calling program.

Example 1: If you call the program PROGRAM SUB1 (AA#)

- If a local variable is passed 1 (When DD has been declared with DEFDBL)
  CALL SUB1 (DD#)
- If a local variable is passed 2 (When DA has been declared with DEFDBL)
  CALL SUB1 (DA)

Note: A value must be assigned to a local variable beforehand. In the following case, use a value to pass.
CALL SUB1 (D1)

Example 2: If the program PROGRAM SUB2 (BB% (10)) is called

- If the entire array is called (When AB% (10) has been declared with DIM)
  CALL SUB2 (AB% ())

8.17 Vision Control

8.17.1 Image Input/output

The commands below control camera images and image data in memory.

Image Input/Output Control Commands

Type of motion	Command
Stores camera images in memory	CAMIN
Camera image storage function setting	CAMMODE
Camera image input level setting	CAMLEVEL
Displays camera images on the monitor	VISCAMOUT
Displays memory images on the monitor	VISPLNOUT
Displays draw screen information on the monitor	VISOVERLAY
Look-up table data setting	VISDEFTABLE
Look-up table data reference	VISREFTABLE

8.17.2 Window Setting

The commands below are used to execute window (range for executing image processing) editing.

Window Setting Commands

Type of motion	Command
Window information setting	WINDMAKE
Window information clear	WINDCLR
Window information copy	WINDCOPY
Window information reference	WIMDREF
Window draw	WINDDISP

8.17.3 Draw

The commands below are used to control the draw motion in storage memory (processing screen) and overlay memory (draw only screen) .

Draw Commands

Type of motion	Command
Draw destination screen designation	VISSCREEN
Brightness designation in draw	VISBRIGHT
Screen deletion	VISCLS
Point draw	VISPUTP
Line draw by designating length and angle	VISLINE
Line draw by connecting 2 points	VISPTP
Rectangle draw	VISRECT
Circle draw	VISCIRCLE
Ellipse draw	VISELLIPSE
Sector draw	VISSECT
Cross symbol draw	VISCROSS
Character display position designation	VISLOC
Draw character setting	VISDEFCHAR
Character display	VISPRINT

8.17.4 Image Processing

The commands below are used to execute image data processing.

Image Processing Commands

Type of motion	Command
Process object screen designation	VISWORKPLN
Designated coordinate brightness obtaining	VISGETP
Histogram measurement	VISHIST
Histogram result reference	VISREFHIST
Binarization level calculation	VISLEVEL
Binarization process	VISBINA
Binarization display	VISBINAR
Filter process	VISFILTER
Operation between images	VISMASK
Screen copy	VISCOPY
Measurement of area, center of gravity, and main axis angle	VISMEASURE
Projection data measurement	VISPROJ
Edge measurement	VISEDGE

8.17.5 Code Recognition

The command below executes QR code reading.

Code Recognition Command

Type of motion	Command
QR code reading	VISREADQR

8.17.6 Labeling

The commands shown below are used to execute label processing.

Labeling Commands

Type of motion	Command
Labeling execution	BLOB
Feature measurement for label number	BLOBMEASURE
Label number obtaining	BLOBLABEL
Label image copy	BLOBCOPY

8.17.7 Search Function

The commands below are used to execute registration and search of image models.

Search Function Commands

Type of motion	Command
Search model registration	SHDEFMODEL
Registered model information obtaining	SHREFMODEL
Registered model copy	SHCOPYMODEL
Registered model deletion	SHCLRMODEL
Registered model display	SHDISPMODEL
Model search	SHMODEL
Corner search condition setting	SHDEFCORNER
Corner search	SHCORNER
Circle search condition setting	SHDEFCIRCLE
Circle search	SHCIRCLE

8.17.8 Result Obtaining

The commands below are used to obtain information related to the contents of results after image processing.

Result Obtaining Commands

Type of motion	Command
Image process result obtaining	VISGETNUM
Control recognition result obtaining	VISGETSTR
Image process result X coordinate obtaining	VISPOSX
Image process result Y coordinate obtaining	VISPOSY
Process result status obtaining	VISSTATUS

8.17.9 Vision Calibration

The command below is used to obtain calibration (vision-robot coordinate transformation) data.

Vision Calibration Command

Type of motion	Command
Coordinate transformation data obtaining	VISREFCAL

Chapter 9

Declaration Statements

When variables or functions are used in a program they must be defined with a declaration statement. The declaration statement commands explained in this chapter are used for this purpose.
However, system variables and built-in functions can be used directly in a program without declaration.

9.1 Program Name

PROGRAM (Statement)

Function

Declares a program name.

Format

PROGRAM <Program name> [(<Argument>[,<Argument>...])]

Explanation

This statement declares the character string designated in <Program name> as the program name.
Declare a program name on the first line of the program. If there is no program name declaration on the first line, the file name becomes the program name.
When the program name has a name in a PRO <Number> format, an argument cannot be used.
The first character of a program name must be an alphabetic letter. A maximum of 64 letters can be used for program name.
For <Argument>, the argument data sent from the calling side is applied. If a variable is sent as an argument using a CALL statement and the value of the variable specified with <Argument> in the PROGRAM statement is changed, the value of the variable specified in <Argument> on the calling side also changes.
The <Argument> type must be the same type as that in the CALL statement.
The type is expressed as follows using a postposition or AS expression.

```
    PROGRAM  SUB0 (aa%, bb!)
    PROGRAM  SUB0 (aa AS INTEGER, bb AS SINGLE)
```

If an array variable is used in <Argument>, enter the maximum value of the array subscript defined in the DIM statement as well as the number of subscripts.
A maximum of 32 <Argument>'s can be used.
Programs which can be started from the operating panel and external devices are only programs of PRO <number>.

Related Terms

CALL

Example

```
PROGRAM PRO1                    'Declares PRO1 as the program name.
PROGRAM SUB2 ( la, lb%, lc# )   'Declares SUB2 which includes arguments of la, lb%,
                                'and  lc# as a program.
PROGRAM SUB3 ( lb%( 12, 5 ) )   'Declares SUB3 as a program and receives arguments
                                'with a two-dimensional array of lb%.  In this example
                                'the array
                                'subscripts are 12 and 5.
PROGRAM SUB0 ( la%, lb! )
PROGRAM SUB0 ( la As Integer, lb As Single )
```

9.2 Interference Area Coordinates

AREA (Statement)

Function

Declares the area where an interference check is performed.

Format

AREA <Area number>, <Position>, <Vector>, <I/O number>, <Position type variable number for storing interference position> [,<Error output>]

Explanation

This statement declares an interference check area.
The number of areas that can be declared with <Area number> is 8, from 0 to 7.
<Position> is the center position and angle of an interference check area.
<Vector> designates the interference check area zone.
The side length of an area becomes twice each component of <Vector>.
Designate the I/O number, which is set when interference occurs in the interference check area, to <I/O number>. The status of I/O is maintained until RESETAREA is executed or the I/O is RESET.
In Version 1.8 or later, <I/O number> can be expressed in variable such as IO104 or IO[104]. Also in Version 1.8 or later, setting -1 to <I/O number> prohibits output to the I/O line.

<P variable number for interference position> is a position variable number in which you want to save the coordinates where area interference occurs. **In Version 1.8 or later, <P variable number for interference position> can be expressed in position variable such as P55 or P[55]. Also in Version 1.8 or later, setting -1 to <P variable number for interference position> prohibits assignment to the position variable.**
In Version 1.8 or later, <Error output> is any of the following numbers.

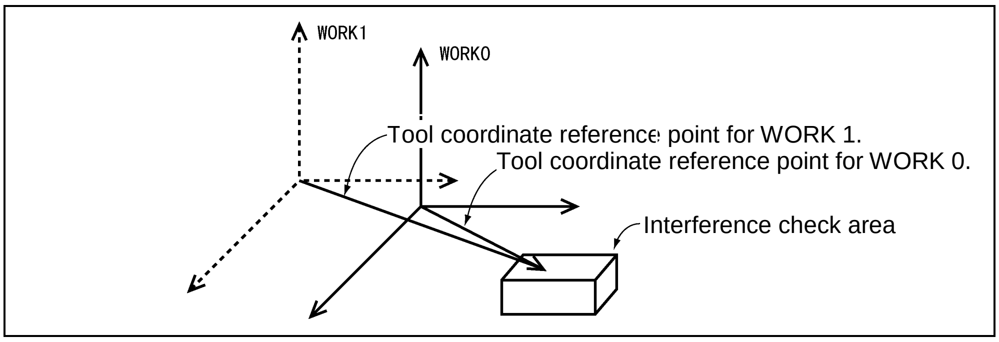
<Error output>	The system will detect it as an error when:	Error signal output
0	**The robot arm invades the defined area.**	**No**
1		**Yes**
2		**Yes (You may switch to Manual mode and operate the robot manually for recovery.)**
3	**The robot arm exits from the defined area.**	**No**
4		**Yes**
5		**Yes (You may switch to Manual mode and operate the robot manually for recovery.)**

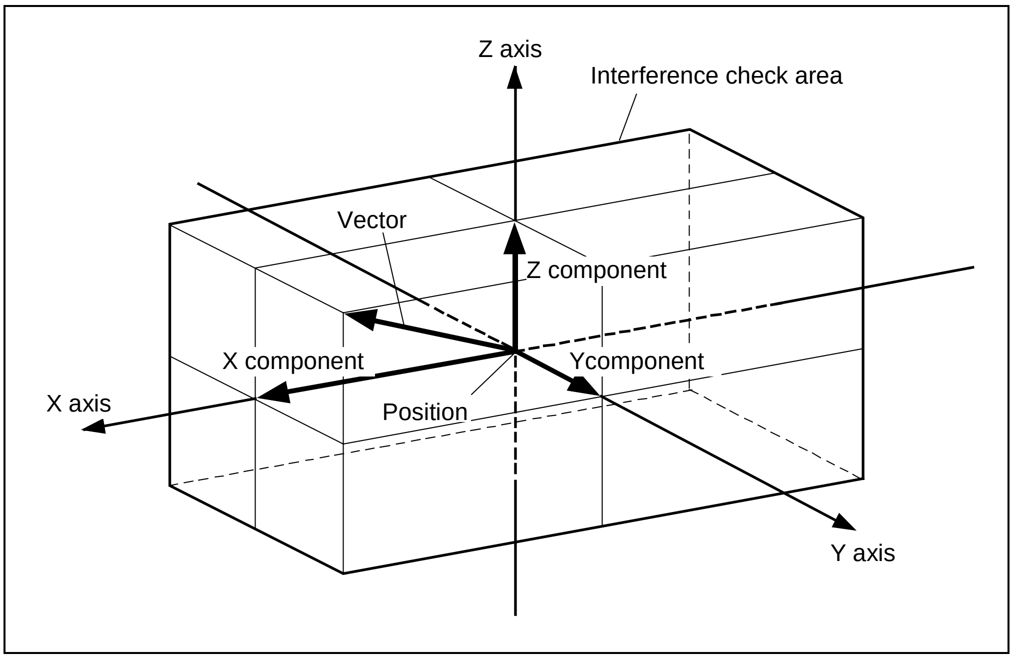
To check interference, the system compares the cube defined as an interference check area with the origin of the currently active tool coordinates. If the origin of the tool coordinates is inside the interference check area, then the system determines it as interference.
If area interface is detected and the I/O signal is set to active, then the system will get the origin of the current tool coordinates in the user coordinates into a position variable number specified by <P variable number for interference position>. Usually, the origin of the tool coordinates lies on the surface of the cube; however, if the origin lies inside the cube at execution of SETAREA, the system gets that position into <P variable number for interference position>.

The interference area can be set using either WINCAPSII or the teach pendant.

Notes

The center position of an area is always based on WORK0.
Even if the user coordinate system is changed, the position of the interference check area will not change.


WORK1
WORK0
Tool coordinate reference point for WORK 1.
Tool coordinate reference point for WORK 0.
Interference check area



Related Terms

SETAREA, RESETAREA, AREAPOS, AREASIZE

Example

```
6-/4-axis       AREA 2, P50, V10, 104, 55
                                  'Defines an area at number 2 specified by P50'and
                                  V10.
                SETAREA 2         'Makes area check of number 2 valid.
                RESETAREA 2       'Makes area check of number 2 invalid.

6-axis          AREA 2, P50+(100, 100, 0, 10, 0, 0), V10, 104, 55
                                  'Defines an area at number 2 specified by P50+
                                  '(100, 100, 0, 10, 0, 0) and V50.
                SETAREA 2         'Makes area check of number 2 valid.
                RESETAREA 2       'Makes area check of number 2 invalid.

4-axis          AREA 2, P50+(100, 100, 0, 10), V10, 104, 55
                                  'Defines an area at number 2 specified by P50+
                                  '(100, 100, 0, 10) and V50.
                SETAREA 2         'Makes area check of number 2 valid.
                RESETAREA 2       'Makes area check of number 2 invalid.
```

9.3 User Function

DEF FN (Statement) [Conforms to SLIM]

Function

Declares a user-defined function.

Format

DEF FN <Function name>[<Postposition>] = <Constant>
DEF FN <Function name>[<Postposition>](<Argument>[,<Argument>...]) = <Arithmetic expression>

Explanation

This statement declares a <Function name> starting with FN as the user defined function.
Designate a variable name used in <Arithmetic expression> for <Argument>.
<Postposition> can be ignored. However, if it is added the variable type can be declared with it. For postpositions, the following can be used.

Integer type postposition: %
Single precision type postposition: !
Double precision type postposition: #
Character string type postposition: $

If the postposition is ignored, the single precision real type is applied.
A different variable type with the same variable name cannot be declared.

Example

```
DEF FND$ = “DENSO”                      'Declares FND$ as a user defined function.
DEF FNLAP# (radius) = 2 * PI * radius   'Declares FNLAP# (radius) as a user defined
                                        'function of the double precision real type.
DEF FNAREA (radius) = PI * POW(radius, 2)
                                        'Declares FNAREA (radius) as user defined
                                        'function of the single precision real type.
PRINT #1, FND$                          'Outputs “DENSO” from ch1.
PRINT #2, HANKEI
PRINT #1, FNLAP# (HANKEI)               'Outputs the value of (2 * PI * HANKEI) from
                                        'ch1.
PRINT #2, FNAREA (HANKEI)               'Outputs the value of (PI * POW(HANKEI, 2)
                                        'from ch2.
```

9.4 Home Coordinates

HOME (Statement)[Conforms to SLIM]

Function

Declares arbitrary coordinates as a home position.

Format

HOME <Position type>

Explanation

Declares arbitrary coordinates designated with <Position type> as a home position.
Define a home position for each program.
If multiple HOME statements are declared, the most recent declaration is taken as the home position.

Related Terms

GOHOME

Example

6-axis

```
DIM lp1 As Point
HOME (350, 0, 450, 0, 0, 180)
                  'Declares the coordinates of (350, 0, 450, 0, 0, 180)
                  'as a home position.
HOME lp1          'Declares the coordinates of lp1 as a home position.
```

4-axis

```
DIM lp1 As Point
HOME (200, 300, 300, 45, 0)
                  'Declares the coordinates of (200, 300, 300, 45, 0)
                  'as a home position.
HOME lp1          'Declares the coordinates of lp1 as a home position.
```

9.5 Tool Coordinates

TOOL (Statement)

Function

Declares a tool coordinate system.

Format

TOOL <Tool coordinate system number>, <Position type>

Explanation

Declares a position specified with <Position type> as the tool coordinate system specified with <Tool coordinate system number>.
A number from 1 to 63 can be specified for the tool coordinate system number.

Related Terms

CHANGETOOL, TOOLPOS

Example

6-axis

```
DIM lp1 As Point
TOOL 1, lp1      'Declares lp1 as the tool coordinate system of tool
                 'coordinate system number 1.
TOOL 2, (100, 100, 50, 0, 90, 0)
```

4-axis

```
DIM lp1 As Point
TOOL 1, lp1      'Declares lp1 as the tool coordinate system of tool
                 'coordinate system number 1.
TOOL 2, (100, 100, 50, 0)
```

Notes

Values changed by this command are maintained while power is on. You should save the system parameters (see P5-153 in “Setting-ups”) if you want to keep values after power is turned off.

9.6 Work Coordinates

WORK (Statement)

Function

Declares a user coordinate system.

Format

WORK <User coordinate system number>, <Position type>

Explanation

Declares the user coordinates assigned to the position type variable shown in <Position type> as the user coordinate system specified by <User coordinate system number>.
A number from 1 to 7 can be used for the user coordinate system number.

Related Terms

CHANGEWORK, WORKPOS

Example

```
6-axis     DEFINT li1 li2
           WORK 1, P1       'Declares coordinates assigned to position type
                            'variable number 2 as the user coordinate system in
                            'user coordinate system number 1.
           WORK li1, P[li2] 'Declares coordinates assigned to the position type
                            'variable expressed with li2 as the user coordinate
                            'system in the 'user coordinate system number
                            expressed 'by li1.
           WORK li1, (100, 100, 50, 0, 0, 90)

4-axis     DEFINT li1 li2
           WORK 1, P1       'Declares coordinates assigned to position type
                            'variable number 2 as the user coordinate system in
                            'user coordinate system number 1.
           WORK li1, P[li2] 'Declares coordinates assigned to the position type
                            'variable expressed with li2 as the user coordinate
                            'system in the 'user coordinate system number
                            expressed 'by li1.
           WORK li1, (100, 100, 50, 0)
```

Notes

(1) If values for the robot work area are set beyond the X, Y and Z elements of the work coordinates, the specified robot position may shift due to an arithmetic overflow. Use values within the robot work area for the X, Y and Z elements of the work coordinates.

(2) Values changed by this command are maintained while power is on. You should save the system parameters (see P5-153 in "Setting-ups") if you want to keep values after power is turned off.

9.7 Local Variable

DEFINT (Statement)

Function

Declares an integer type variable. The range of the integer is from –2147483648 to 2147483647.

Format

DEFINT <Variable name>[=<Constant>][,<Variable name>[=<Constant>]...]

Explanation

This statement declares the variable designated by <Variable name> as the integer type variable. By writing a constant after <Variable name>, initialization can be carried out simultaneously with the declaration.
Multiple variable names can be declared at a time by delineating the names using “,”.

Related Terms

DEFDBL, DEFSNG, DEFSTR

Example

```
DEFINT lix, liy, liz       'Declares lix, liy, and liz as integer type variables.
DEFINT lix = 1             'Declares lix as an integer type variable and sets
                           'the initial value to 1.
```

DEFSNG (Statement)

Function

Declares a single precision real type variable. The range of single precision real variables is from -3.402823E+38 to 3.402823E+38.

Format

DEFSNG <Variable name>[=<Constant>][,<Variable name>[=<Constant>]...]

Explanation

This statement declares a variable designated by <Variable name> as a single precision real type variable. By writing a constant after <Variable name>, initialization can be done simultaneously with the declaration.
Multiple variable names can be declared at a time by separating them with a comma ",".

Related Terms

DEFDBL, DEFINT, DEFSTR

Example

```
DEFSNG lfx, lfy, lfz    'Declares lfx, lfy, and lfz as single precision real type
                        'variables.
DEFSNG lfx = 1.0        'Declares lfx as a single precision real type variables and
                        'sets the initial value to 1.0.
```

DEFDBL (Statement)

Function

Declares a double precision real type variable. The range of double precision real type variables is from -1.79769313486231D + 308 to 1.79769313486231D + 308.

Format

DEFDBL <Variable name>[=<Constant>][,<Variable name>[=<Constant>]...]

Explanation

Declares the variable designated by <Variable name> as a double precision real type variable. By writing a constant after <Variable name>, initialization can be performed simultaneously with the declaration.
Multiple variable names can be declared at a time by separating each variable name by a comma (“,”).

Related Terms

DEFINT, DEFSNG, DEFSTR

Example

```
DEFDBL ldx, ldy, ldz     'Declares ldx, ldy, and ldz as double precision real type
                         'variables.
DEFDBL ldx = 1.0         'Declares ldx as a double precision real type variable and
                         'sets the initial value to 1.0.
```

DEFSTR (Statement)

Function

Declares a character string type variable. You can enter 247 characters or less as a character string.

Format

DEFSTR <Variable name>[=<Constant>][,<Variable name>[=<Constant>]...]

Explanation

Declares a variable designated by <Variable name> as a character string. By writing a constant after <Variable name>, initialization can be done simultaneously with the declaration.
Multiple variable names can be declared at a time by separating each variable with a comma (“,”).

Related Terms

DEFDBL, DEFINT, DEFSNG

Example

```
DEFSTR lsx, lsy, lsz     'Declares lsx, lsy, and lsz as character string type
                         'variables.
DEFSTR lsx = “DENSO”     'Declares lsx as a character string type variable and sets
                         'the initial value to “DENSO”.
```

DEFVEC (Statement)

Function

Declares a vector type variable.

Format

DEFVEC <Variable name>[=<Vector type constant>][,<Variable name> [=<Vector type constant>]...]

Explanation

This statement declares a variable designated by <Variable name> as a vector type variable. By writing a constant after <Variable name>, initialization can be carried out simultaneously with the declaration.
Multiple variable names can be declared at a time by delineating the names using ",".

Related Terms

DEFJNT, DEFPOS, DEFTRN

Example

```
DEFVEC lvx, lvy, lvz       'Declares lvx, lvy, and  lvz as vector type variables.
DEFVEC lvx = (10, 10, 5)   'Declares lvx as a vector type variable and sets the
                           'initial value to (10, 10, 5).
```

DEFPOS (Statement)

Function

Declares a position type variable.

Format

DEFPOS <Variable name>[=<Position type constant>][,<Variable name>[=<Position type constant>]...]

Explanation

Declares a variable designated by <Variable name> as a position type variable. By writing a constant after <Variable name>, initialization can be carried out simultaneously with the declaration.
Multiple variable names can be declared at a time by delineating the names using ",".

Related Terms

DEFJNT, DEFTRN, DEFVEC

Example

```
6-axis        DEFPOS lpx, lpy, lpz
                          'Declares lpx, lpy, and lpz as position type
                          variables.
              DEFPOS lpx = (10, 10, 5, 0, 9, 0, 1)
                          'Declares lpx as a position type variable and sets
                          the 'initial value = (10, 10, 5, 0, 9, 0, 1).

6-axis        DEFPOS lpx, lpy, lpz
                          'Declares lpx, lpy, and lpz as position type
                          variables.
              DEFPOS lpx = (100, 100, 300, 45, 0)
                          'Declares lpx as a position type variable and sets
                          the 'initial value = (100, 100, 300, 45, 0).
```

DEFJNT (Statement)

Function

Declares a joint type variable.

Format

DEFJNT <Variable name>[=<Joint type constant>][,<Variable name>[=<Joint type constant>]...]

Explanation

This statement declares a variable designated by <Variable name> as a joint type variable. By writing a constant after <Variable name>, initialization can be carried out simultaneously with the declaration.
Multiple variable names can be declared at a time by delineating the names using “,”.

Related Terms

DEFPOS, DEFTRN, DEFVEC

Example

```
6-axis          DEFJNT ljx, ljy, ljz
                                 'Declares ljx, ljy, and ljz as joint type variables.
                DEFJNT ljx = (10, 10, 5, 0, 9, 0)
                                 'Declares ljx as a joint type variable and sets the
                                 'initial 'value to (10, 10, 5, 0, 9, 0).

4-axis          DEFJNT ljx, ljy, ljz
                                 'Declares ljx, ljy, and ljz as joint type variables.
                DEFJNT ljx = (10, 10, 5, 0)
                                 'Declares ljx as a joint type variable and sets the
                                 'initial 'value to (10, 10, 5, 0).
```

DEFTRN (Statement)

Function

Declares a homogeneous transformation type variable.

Format

DEFTRN <Variable name>[=<Homogeneous transformation type constant>] [,<Variable name>[=<Homogeneous transformation type constant>]...]

Explanation

This statement declares a variable designated by <Variable name> as a homogeneous transformation type variable. By writing a constant after <Variable name>, initialization can be carried out simultaneously with the declaration.
Multiple variable names can be declared at a time by delineating the names using “,”.

Related Terms

DEFJNT, DEFPOS, DEFVEC

Example

```
DEFTRN ltx, lty, ltz   'Declares ltx, lty, and ltz as homogeneous transformation type
                       'variables.
DEFTRN ltx = (10, 10, 5, 20, 20, 10, 30, 30, 15)
                       'Declares ltx as a homogeneous transformation type variable
                       'and sets the initial value to
                       '(10, 10, 5, 20, 20, 10, 30, 30, 15).
```

DEFIO (Statement) [Conforms to SLIM]

Function

Declares an I/O variable corresponding to the input/output port.

Format

DEFIO <Variable name> = <I/O variable type>,<Port address>[,<Mask data>]

Explanation

This statement declares a variable designated by <Variable name> as an I/O variable.
<I/O variable type> Selects the type of the I/O variable. The I/O variable types include BIT, BYTE, WORD and INTEGER. Designate a range of 1 bit for a BIT type, 8 bits for a BYTE type, 16 bits for a WORD type and 32 bits for an INTEGER type.
<Port address> Designates the starting input/output port number.
<Mask data> In the case of an input port, the AND (product set) from input data and mask data is taken.
In the case of an output port, the AND (product set) from output data and mask data is output, however, the output status of a bit where no mask has been set does not change.

Related Terms

IN, OUT, SET, RESET

Example

```
DEFIO samp1 = BIT, 1
                       'Declares samp1 as a BIT type I/O variable which starts from
                       'port 1.  The return value of samp1 becomes a 1-bit integer
                       'of 1 or 0 that expresses the status of port 1.
DEFIO samp2 = BYTE, 10, &B00010000
                       'Declares samp2 with mask data as a BYTE type I/O
                       'variable which starts from port 10.  The return value of
                       'samp2 becomes an 8-bit integer of 0 or 16 that expresses
                       'the status of port 10.
DEFIO samp3 = WORD, 15
                       'Declares samp3 as a WORD type I/O variable which starts
                       'from port 15.  The return value of samp3 becomes a 16-bit
                       'integer of 0~&Hffff which expresses the status of the ports
                       'from 15 to 30.
DEFIO samp4 = INTEGER, 1
                       'Declares samp4 as an INTEGER type I/O variable which
                       'starts from port 1.  The return value of samp4 becomes a
                       '32-bit integer of 0~&Hffffffff which expresses the
                       'status of the ports from 1 to 32.
```

Notes

For WORD and INTEGER, a port used as the MSB is assumed to be a sign bit.
The table below lists the allowable range of numeric values and pot numbers used as the MSB.

WORD	Allowable range of numeric values MSB port No.: Starting port address + 15
INTEGER	Allowable range of numeric values MSB port No.: Starting port address + 31

9.8 Array

DIM (Statement) [Conforms to SLIM]

Function

Declares an array.

Format

DIM <Variable name>[<Postposition>] [(<Number of elements>[,<Number of elements>[,<Number of elements>]])][AS<Variable type>][,<Variable name>[<Postposition>]...]

Explanation

This statement declares a variable designated by <Variable name> as an array variable.
By adding <Postposition>, the system can declare the variable type together.
The following postpositions are available.

Integer type postposition: %
Single precision real type postposition: !
Double precision real type postposition: #
Character string type postposition: $

If the postposition is omitted, the system regards the statement as a statement of a single precision real number type.
Specify the maximum number of elements to be arrayed in <Number of elements>. The maximum number must be 1 or larger.
The total number of elements must not exceed 32767.
Up to three dimensions are usable for DIM statements.
The subscript can be specified in the range from 0 to (number of elements – 1).
You can declare the variable type by specifying AS <Variable type>.
Note that the AS expression and the postposition cannot be specified at the same time.

The table below shows the <Variable types> usable in AS expression.

Variable type	Identifier	Variable type	Identifier
Long integer type	INTEGER	Vector type	VECTOR
Single precision real type	SINGLE	Position type	POSITION
Double precision real type	DOUBLE	Joint type	JOINT
Character string type	STRING	Homogeneous transformation type	TRANS

Example

```
DIM samp1(5)           'Declares samp1 as an array variable of a single precision
                       'real type with size (5).
DIM samp2(10, 10)      'Declares samp2 as an array variable of a single precision
                       'real type with size (10, 10).
DIM samp3(20, 5, 10)   'Declares samp3 as an array variable of a single precision
                       'real type with size (20, 5, 10).
DIM samp4% (3, 3, 3)   'Declares samp4 as an array variable of an integer type with
                       'size (3, 3, 3).
DIM samp5! (4, 3)      'Declares samp5 as an array variable of a single precision
                       'real type with size (4, 3).
DIM samp6# (3)         'Declares samp6 as an array variable of a double precision
                       'real type with size (3).
```

Chapter 10

Assignment Statements

Use an assignment statement command when assigning a value to variables. Use commands properly according to the type or contents of the value to be handled.

10.1 Variables

LET (Statement) [Conforms to SLIM]

Function

Assigns a value to a variable.

Format

[LET] <Variable name> = <Arithmetic expression>

Explanation

You can ignore [LET].
As a rule the <variable name> type and the <arithmetic expression> type must be the same.
If the variable name type and the arithmetic expression type are different, they are converted as follows.

- <Variable name> is converted to the variable type.
- When a real variable is converted to an integer, the decimal places are rounded down.
- When a double precision variable is converted to a single precision real variable, the value is rounded to 7 significant digits.
- Calculations are performed based on the precision of the type with the higher precision.

Example

```
6-/4-axis      DEFINT li1, li2
               LET li1 = li2 + 1 'Assigns the value of (li2 + 1) to li1.
               li1 = li2 + 1     'Assigns the value of (li2 + 1) to li1 (same as the
                                 above 'instruction statement).

6-axis         DEFPOS lp1, lp2
               DEFJNT lj1, lj2
               lp1, = lp2 + (10, 10, 10, 0, 0, 0)
                                 'Assigns the value of (lp2 + (10,10,10,0,0,0)) to
                                 lp1
               lj1, = lj2 + (10, 20, 30, 40, 0, 0)
                                 'Assigns the value of (lj2 + (10,20,30,40,0,0)) to
                                 lj1

4-axis         DEFPOS lp1, lp2
               DEFJNT lj1, lj2
               lp1, = lp2 + (10, 10, 10, 20)
                                 'Assigns the value of (lp2 + (10, 10, 10, 20) ) to
                                 lp1
               lj1, = lj2 + (10, 20, 30, 40)
                                 'Assigns the value of (lj2 + (10, 20, 30, 40) ) to
                                 lj1
```

10.2 Vector

LETA (Statement)

Function

Assigns a value to an approach vector of the homogeneous transformation type.

Format

LETA <Homogeneous transformation type variable> = <Vector type>

Explanation

The assignment statement starts with LETA and the right side of the statement is a vector. By the execution of this assignment the approach vector of <Homogeneous transformation type variable> is changed to <Vector type>.

Related Terms

LETO, LETP

Example

```
DEFTRN lt1, lt2, lt3
DEFVEC lv1, lv2
LETA lt1 = AVEC(lt3)    'Assigns approach vector lt3 to approach vector lt1.
LETA lt2 = lv1 x lv2    'Assigns value of (lv1 x lv2) to approach vector lt2.
```

LETO (Statement)

Function

Assigns a value to an orientation vector of the homogeneous transformation type.

Format

LETO <Homogeneous transformation type variable> = <Vector type>

Explanation

The assignment statement starts with LETO and the right side of the expression is a vector. By the execution of this assignment the orientation vector of <Homogenous transformation type variable> is changed to <Vector type>.

Related Terms

LETA, LETP

Example

```
DEFTRN lt1, lt2, lt3
DEFVEC lv1, lv2
LETO lt1 = OVEC(lt3)   'Assigns orientation vector lt3 to orientation vector lt1.
LETO lt2 = lv1 x lv2   'Assigns a value of (lv1 x lv2) to orientation vector lt2.
```

LETP (Statement)

Function

Assigns a value to a position vector of the position type or homogenous transformation type.

Format

LETP {<Position type variable>|<Homogeneous transformation type variable >} = <Vector type>

Explanation

The statement starts with LETP and the right side of the expression is a vector. By the execution of this assignment, the position vector of <Position type variable> or <Homogenous transformation type variable> is changed to <Vector type>.

Related Terms

LETO, LETA

Example

```
DEFTRN lt1, lt2
LETP lt1 = PVEC(lt2)   'Assigns position vector lt2 to position vector lt1.
```

10.3 Figure

LETF (Statement)

Function

Assigns a value to a figure component of the position type or homogenous transformation type.

Format

LETF <Position type variable> | <Homogeneous transformation type variable>

Explanation

The statement starts with LETF and the right side of the expression is <Figure>. By the execution of this assignment, the figure component of <Position type variable> is changed to the value of <Figure>.

Related Terms

CURFIG, FIG, robot figure (Appendix 2)

Example

```
DEFPOS lp1, lp2
LETF lp1 = 1           'Sets figure lp1 to LEFTY-ABOVE-FLIP.
LETF lp2 = CURFIG      'Sets figure lp2 to the current posture.
```

10.4 Link Angle

LETJ (Statement)

Function

Assigns a value to a designated link angle of the joint type.

Format

LETJ <Axis number>, <Joint type variable> = <Arithmetic expression>

Explanation

The statement starts with LETJ <Axis number> and the right side of the expression is <Arithmetic expression>. By the execution of this assignment the link angle designated by <Axis number> of <Joint type variable> is changed to the value of <Arithmetic expression>.

Related Terms

JOINT

Example

```
        DEFJNT lj1, lj2, lj3
        DEFSNG lf1, lf2
        LETJ 1, lj1 = JOINT(2, lj3)   'Assigns the 2nd axis link angle of lj3 to the 1st
                                      'axis of lj1.
        LETJ 3, lj2 = lf1 - lf2       'Assigns the value of (lf1 - lf2) to the 3rd axis
of
                                      'lj2.
```

10.5 Posture

LETR (Statement)

Function

Assigns a value to three rotation components of the position type.

Format

LETR <Position type variable> = <Vector type>

Explanation

The statement starts with LETR and the right side of the expression is a vector. By the execution of this assignment, the figure of <Position type variable> is changed to <Vector type>.

Related Terms

LETP, LETRX, LETRY, LETRZ

Example

```
DEFPOS lp1, lp2
LETR lp1 = RVEC(lp2)   'Assigns the figure of lp2 to that of lp1.
```

10.6 Rotation Component

LETRX (Statement)

Function

Assigns a value to the X axis rotation component of the position type.

Format

LETRX <Position type variable> = <X axis rotation angle>

Explanation

The statement starts with LETRX and the right side of the expression is an X axis rotation angle. By the execution of this assignment, the X axis rotation component of <Position type variable> is changed to the value of <X-axis rotation angle>.

Related Terms

LETRY, LETRZ, LETR

Example

```
        DEFPOS lp1, lp2, lp3
        DEFSNG lf1, lf2
        LETRX lp1 = POSRX(lp3)  'Assigns the X axis rotation component of lp3 to that of
lp1.
        LETRX lp2 = lf1 - lf2   'Assigns the value of (lf1 - lf2) to the X axis rotation
                                'component of lp2.
```

LETRY (Statement)

Function

Assigns a value to the Y axis rotation component of the position type.

Format

LETRY <Position type variable> = <Y axis rotation angle>

Explanation

The statement starts with LETRY and the right side of the expression is an Y axis rotation angle. By the execution of this assignment, the Y axis rotation component of <Position type variable> is changed to the value of <Y-axis rotation angle>.

Related Terms

LETRX, LETRZ, LETR

Example

```
        DEFPOS lp1, lp2, lp3
        DEFSNG lf1, lf2
        LETRY lp1 = POSRY(lp3)  'Assigns the Y axis rotation component of lp3 to that of
lp1.
        LETRY lp2 = lf1 - lf2   'Assigns the value of (lf1 - lf2) to the Y axis rotation
                                'component of lp2.
```

LETRZ (Statement)

Function

Assigns a value to the Z axis rotation component of the position type.

Format

LETRZ <Position type variable> = <Z axis rotation angle>

Explanation

The statement starts with LETRZ and the right side of the expression is a Z axis rotation angle. By the execution of this assignment, the Z axis rotation component of <Position type variable> is changed to the value of <Z-axis rotation angle>.

Related Terms

LETRX, LETRY, LETR

Example

```
       DEFPOS lp1, lp2, lp3
       DEFSNG lf1, lf2
       LETRZ lp1 = POSRZ(lp3)  'Assigns the Z axis rotation component of lp3 to that of
lp1.
       LETRZ lp2 = lf1 - lf2   'Assigns the value of (lf1 - lf2) to the Z axis rotation
                               'component of lp2.
```

LETT (Statement)

Function

Assigns a value to the T axis component of the position type.

Format

LETT <Position type variable> = <T axis rotation angle>

Explanation

The statement starts with LETT and the right side of the expression is a T axis rotation angle. By the execution of this assignment, the T axis rotation component of <Position type variable> is changed to the value of <T-axis rotation angle>.

Example

```
DEFPOS lp1
DEFSNG lf1, lf2
LETT lp2 = lf1 - lf2    'Assigns the value of (lf1 - lf2) to the T axis rotation
                        'component of lp1.
```

10.7 Axis Component

LETX (Statement) [Conforms to SLIM]

Function

Assigns a value to the X axis component of the Vector type/ Position type/ Homogenous transformation type.

Format

LETX {<Vector type variable>|<Position type variable>|<Homogenous transformation type variable>}= <X axis component>

Explanation

The statement starts with LETX and the right side of the expression is an X axis component. By the execution of this assignment, the X-axis component of <Vector type variable>, <Position type variable> or <Homogenous transformation type variable> is changed to the value of <X-axis component>.

Related Terms

LETP, LETY, LETZ

Example

```
DEFPOS lp1, lp2
DEFVEC lv1, lv2
LETX lv1 = POSX(lv2)    'Assigns the X-axis component of lv2 to that of lv1.
LETX lp2 = POSX(lp2)    'Assigns the X-axis component of lp2 to that of lp1.
```

LETY (Statement) [Conforms to SLIM]

Function

Assigns a value to the Y axis component of the Vector type/ Position type/ Homogenous transformation type.

Format

LETY {<Vector type variable>|<Position type variable>|<Homogenous transformation type variable>}= <Y axis component>

Explanation

The statement starts with LETY and the right side of the expression is Y axis component. By the execution of this assignment, the Y-axis component of <Vector type variable>, <Position type variable> or <Homogenous transformation type variable> is changed to the value of <Y-axis component>.

Related Terms

LETP, LETX, LETZ

Example

```
DEFPOS lp1, lp2
DEFVEC lv1, lv2
LETY lv1 = POSY(lv2)    'Assigns the Y-axis component of lv2 to that of lv1.
LETY lp2 = POSY(lp2)    'Assigns the Y-axis component of lp2 to that of lp1.
```

LETZ (Statement)[Conforms to SLIM]

Function

Assigns a value to the Z axis component of the vector type/ position type/ homogeneous transformation type.

Format

LETZ {<Vector type variable>|<Position type variable>|<Homogeneous transformation type variable>}= <Z axis component>

Explanation

The statement starts with LETZ and the right side of the expression is a Z axis component. By the execution of this assignment, the Z-axis component of <Vector type variable>, <Position type variable> or <Homogenous transformation type variable> is changed to the value of <Z-axis component> value.

Related Terms

LETP, LETX, LETY

Example

```
DEFPOS lp1, lp2
DEFVEC lv1, lv2
LETZ lv1 = POSZ(lv2)    'Assigns the Z-axis component of lv2 to that of lv1.
LETZ lp2 = POSZ(lp2)    'Assigns the Z-axis component of lp2 to that of lp1.
```

Chapter 11

Flow Control Statements

A flow control statement is used to change the program flow depending on the situation. There are many ways to have the program proceed to the next process.

11.1 Program Stop

END (Statement) [Conforms to SLIM]

Function

Declares the motion end by a program.

Format

END

Explanation

The motion by a program will end if this command is executed.
This does not mean the end of the program file.
When subroutines are used, the subroutines will be arranged after the main routine in some cases. Use this END instruction to delimit the main routine from the subroutines.
When subroutines are not used and the END instruction is ignored, system processing will proceed as if the final line includes END.

Related Terms

PROGRAM

Example

```
DEFSNG lf1, lf2, lf3
PROGRAM prog1(lf1, lf2, lf3)
END                            'prog1 ends.
```

STOP (Statement) [Conforms to SLIM]

Function

Ends program execution.

Format

STOP

Explanation

During program execution, if the system executes a STOP statement, the program execution ends there.

Related Terms

DELAY, HALT, HOLD, STATUS

Example

```
        REM   Executes plural condition decision.
        SELECT CASE Index       'The command is executed if the index value and the CASE
                                'statement value match.
        CASE 0                  'When the index is 0.
          STOP                  'Ends a program.
        CASE 1                  'When the index is 1.
          HALT “STOP”           'Suspends program execution.
        CASE 2                  'When the index is 2.
          HOLD “STOP”           'Suspends program execution.
        CASE 3                  'When the index is 3.
          STOPEND               'Stops a continuous executed program after a cycle.
        CASE 4                  'When the index is 4.
          ON li1 + li2 GOSUB *samp1, *samp2, *samp3
                                'Calls a subroutine of the label name written at the same level as
the
                                'value of li1 + li2.
        CASE 5                  'When the index is 5.
          ON li1 + li2 GOTO *samp1, *samp2, *samp3
                                'Jumps to a label written at the same level as the value of li1 + li2.
        CASE 6                  'When the index is 6.
          END                   'Declares the end of motion by the program.
        END SELECT              'Declares the end of a plural condition decision statement.
```

STOPEND (Statement)

Function

This statement stops a continuously executed program or stops a program with a cycle option after a cycle. When a cycle of a program that includes this statement is started, the motion will not be affected even if this statement is executed.

Format

STOPEND

Explanation

If a program in execution encounters a STOPEND statement, the system stops the program being executed after a cycle.

Related Terms

STOP, HALT, END

Example

```
       REM Executes a plural condition decision.
       SELECT CASE Index       'The command is executed if the index value matches the CASE statement
value.
         CASE 0                'When the index is 0.
           STOP                'Ends a program.
         CASE 1                'When the index is 1.
           HALT "STOP"         'Suspends execution of the program.
         CASE 2                'When the index is 2.
           HOLD "STOP"         'Suspends execution of the program.
         CASE 3                'When the index is 3.
           STOPEND             'Stops a continuously executed program or stops the
                                program after a cycle.
         CASE 4                'When the index is 4.
       ON li1 + li2 GOSUB *samp1, *samp2, *samp3
                               'Calls a subroutine of the label name written at the same level as the
value
                               'of li1 + li2.
        CASE 5                 'When the index is 5.
       ON li1 + li2 GOTO *samp1, *samp2, *samp3
                               'Jumps to a label written at the same level as the value of li1 + li2.
         CASE 6                'When the index is 6.
           END                 'Declares the end of motion by a program.
       END SELECT              'Declares the end of a plural condition decision
statement.
```

11.2 Call

CALL (Statement)

Function

Calls a program and executes it.

Format

CALL <Program name> [(<Argument>[,<Argument>…])]

Explanation

A CALL statement calls the program designated by <Program name> and transfers control.
An END statement in a CALL program has the same meaning as a RETURN statement in a subroutine and returns control to the calling program.
Designate an argument to send the program designated by <Program name> for <Argument>.
<Argument> can be sent either by "calling with a value" which uses a constant or expression, or by "calling with reference" which sends a variable. Refer to Part 1 "2.16 Calling with a Value and with Reference."

1. Calling with a value
   A constant, an arithmetic expression and a character expression with a value are sent. A variable even when enclosed in parentheses ( ) is regarded as an expression and can be sent as a value.
   For numbered variables, an integer type, single precision type, double precision type or character string type can be enclosed in parentheses ( ) and sent with a value.

Example: Calling a program of PROGRAM SUB1(AA#)

• If a variable is sent as a value	CALL SUB1((D1))
• If a constant is sent	CALL SUB1(10#)
• If an arithmetic expression is sent	CALL SUB1(D1 + D2)

Note: If an arithmetic expression is sent, note the result type of expression. The type must be the same as the argument in the called program.

2. Calling with reference
   In calling with reference, a variable can be sent as an argument.
   When you wish to designate a whole array as <Argument>, add parentheses ( ) to the array name.
   For a variable sent by calling with reference, if its contents are modified in the called program, the modification is valid even if it returns to the calling program.

Example 1: Calling the program of PROGRAM SUB1(AA#)

- If a local variable is sent 1   CALL SUB1(DD#)
- If a local variable is sent 2   CALL SUB1(DA)
  (DA has been declared with DEFDBL.)

Note: A value must be assigned to a local variable beforehand.

Example 2: Calling the program of PROGRAM SUB2(BB%(10))

- If a whole array is sent   CALL SUB2(AB%())
  (AB%(10) has been declared with DIM.)

Note (1): If there is no value assigned to a variable, an error will occur in execution.
Note (2): If the program name is PRO <Figure>, an argument cannot be sent.
Note (3): The number of arguments on the calling side must match that on the called side.

Related Terms

PROGRAM

Example

```
DEFDBL ld1, ld2
CALL SUB1((ld1))            'When a variable is sent as a value.
CALL SUB1(10#)              'When a constant is sent.
CALL SUB1(ld1 + ld2)        'When an arithmetic expression is sent.
```

GOSUB (Statement) [Conforms to SLIM]

Function

Calls a subroutine.

Format

GOSUB <Label name>

Explanation

Calls a subroutine specified by the designated <Label name>.
Additional subroutines can be called from one subroutine (nested subroutines).

Related Terms

GOTO, RETURN

Example

```
DIM li1 As Integer
IF li1 = 0 THEN        'When li1 is 0.
  STOP                 'Stops program execution.
ELSEIF li1 = 1 THEN    'When li1 is 1.
  GOTO *samp1          'Jumps to the label of *samp1.
  GO TO *samp2         'Jumps to the label of *samp2.
ELSEIF li1 = 2 THEN    'When li1 is 2.
  GOSUB *samp3         'Calls a subroutine with the label name*samp3.
ELSE                   'When li1 is another value.
  RETURN               'Returns to the program calling subroutine.
END IF                 'Declares the end of the IF statement.
```

Notes

Use the RETURN statement to return the control from the subroutine called with GOSUB (ON-GOSUB) to the program that called the subroutine.

ON-GOSUB (Statement) [Conforms to SLIM]

Function

Calls a corresponding subroutine to the value of an expression.

Format

ON <Expression> GOSUB <Label name>[,<Label name>]…

Explanation

This statement makes control jump to the label written in the same order as the value of <Expression> to continue program execution. The labels are counted in the order of 1, 2, … from the left.
When the value of <Expression> is real, the system rounds down to the maximum integer that does not exceed the value and processes it.

Note: If the result of an expression exceeds the order, nothing is executed.

Related Terms

ON-GOTO, RETURN, SELECT CASE

Example

```
REM  Executes a plural condition decision.
SELECT CASE Index    'The command is executed when the index value matches the CASE
                     'statement value.
  CASE 0             'When the index is 0.
    STOP             'Ends the program.
  CASE 1             'When the index is 1.
    HALT "STOP"      'Suspends execution of the program.
  CASE 2             'When the index is 2.
    HOLD "STOP"      'Suspends execution of the program.
  CASE 3             'When the index is 3.
    STOPEND          'Stops a continuous program or stops the program after a cycle.
  CASE 4             'When the index is 4.
ON li1 + li2 GOSUB *samp1, *samp2, *samp3
                     'Calls the subroutine of a label name written at the same level as the
                     'value of li1 + li2.
 CASE 5              'When the index is 5.
ON li1 + li2 GOTO *samp1, *samp2, *samp3
                     'Jumps to the label written at the same level as the value of li1 + li2.
  CASE 6             'When the index is 6.
    END              'Declares the end of movement by a program.
END SELECT           'Declares the end of a plural conditional decision statement.
```

Notes

Use the RETURN statement to return the control from the subroutine called with GOSUB (ON-GOSUB) to the program that called the subroutine.

RETURN (Statement) [Conforms to SLIM]

Function

Returns from a subroutine.

Format

RETURN

Explanation

This statement ends the execution of a subroutine to which control has been transferred with a GOSUB statement and returns to the calling program.

Related Terms

GOSUB

Example

```
DIM li1 As Integer
IF li1 = 0 THEN        'When li1 is 0.
  STOP                 'Stops the execution of the program.
ELSEIF li1 = 1 THEN    'When li1 is 1.
  GOTO *samp1          'Jumps to the label of *samp1.
  GO TO *samp2         'Jumps to the label of *samp2.
ELSEIF li1 = 2 THEN    'When li1 is 2.
  GOSUB *samp3 'Calls the subroutine of the label name*samp3.
ELSE                   'When li1 is another value.
  RETURN               'Returns to the calling program.
END IF                 'Declares the end of the IF statement.
```

11.3 Repeat

DO-LOOP (Statement)

Function

Executes a decision iteration (repetition).

Format

```
DO [{WHILE|UNTIL}[<Conditional expression>]]
  :
LOOP

Or

DO
  :
LOOP [{WHILE|UNTIL}[<Conditional expression>]]
```

Explanation

DO WHILE and DO UNTIL are head decision iterations.
LOOP WHILE and LOOP UNTIL are tail decision iterations.
A WHILE statement repeats while a conditional expression is satisfied (true (except for 0)) and an UNTIL statement repeats until a conditional expression is satisfied.
If the right side of <Conditional expression> is ignored, the system determines whether the value is true (except for 0).
If <Conditional expression> is ignored the conditional expression is regarded as true (except for 0) and the loop becomes infinite in a WHILE statement.
In the UNTIL statement, a head decision is not processed and a tail decision executes the loop once.
There is also a WHILE-WEND statement which serves the same function as DO WHILE-LOOP, however, only DO WHILE-LOOP should be used.
There is also a REPEAT-UNTIL statement which serves the same function as DO-LOOP UNTIL, however, only DO-LOOP UNTIL should be used.
WHILE and UNTIL can be ignored but they mean an infinite loop.

Related Terms

EXIT DO, WHILE-WEND, REPEAT-UNTIL, FOR-NEXT

Example

```
DEFINT li1, li2, li3, li4, li5, li6, li7, li8, li9
DO WHILE li1 > li2          'Executes a head decision iteration.
  IF li1 = 4 THEN EXIT DO   'Exits from DO-LOOP if li1 = 4.
  FOR li3 = 0 TO 5          'Repeats the process of FOR-NEXT 5 times.
  FOR li4 = li5 TO li6      'Repeats the process of FOR-NEXT by adding 1 to the value of
                            'li5 every time the repetition is done until li5 becomes the value
                            'of li6.
  FOR li7 = 1 TO li8 STEP 2 'Repeats the process of FOR-NEXT by adding 2 to a value
                            'every time the repetition is done from 1 until it becomes li8.

        IF li2 = 2 THEN EXIT FOR       'Exits from FOR-NEXT if li2 < 0.
        DO WHILE li2 < li9     'Executes a head decision iteration.
          GOSUB *samp2
          li9 = li9 + 1
        LOOP                   'Calls a GOSUB *samp2 statement until li2 < li9.
      NEXT li7                 'Repeats.
    NEXT                       'Repeats.
  NEXT                         'Repeats.
  li9 = 0
  DO                           'Executes a tail decision iteration.
    GOSUB *samp2
    li9 = li9 + 1
  LOOP UNTIL li9 < 5           'Calls a GOSUB *samp2 statement until li9 < 5.
LOOP                           'Repeats.
```

EXIT DO (Statement)

Function

Forcibly exits from DO-LOOP.

Format

EXIT DO

Explanation

This statement forcibly exits from DO-LOOP and proceeds to the next instruction of a DO-LOOP statement.

Related Terms

DO-LOOP

Example

```
        DEFINT li1, li2, li3, li4, li5, li6, li7, li8, li9
        DO WHILE li1 > li2              'Executes a head decision iteration.
          IF li1 = 4 THEN EXIT DO       'Escapes from DO-LOOP if li1 = 4.
          FOR li3 = 0 TO 5              'Repeats the process of FOR-NEXT 5 times.
            FOR li4 = li5 TO li6        'Repeats the process of FOR-NEXT by adding 1 to the value of li5
                                        'every time the repetition is done until li5 becomes a value
                                        'of li6.
            FOR li7 = 1 TO li8 STEP 2   'Repeats the process of FOR-NEXT by adding 2 to a
  value
                                        'every time the repetition is done from 1 until it becomes li8.
               IF li2 = 2 THEN EXIT FOR 'Escapes from FOR-NEXT if li2 < 0.
               DO WHILE li2 < li9       'Executes a head decision iteration.
                 GOSUB *samp2
                 li9 = li9 + 1
               LOOP                     'Calls a GOSUB *samp2 statement until li2 < li9.
             NEXT li7                   'Repeats.
            NEXT                        'Repeats.
          NEXT                          'Repeats.
          li9 = 0
          DO                            'Executes a tail decision iteration.
            GOSUB *samp2
            li9 = li9 + 1
          LOOP UNTIL li9 < 5            'Calls a GOSUB *samp2 statement until li9 < 5.
        LOOP                            'Repeats.
```

FOR-NEXT (Statement) [Conforms to SLIM]

Function

Repeatedly executes a series of instructions between FOR-NEXT sections.

Format

```
FOR <Variable name> = <Initial value> TO <Final value> [STEP <Increment>]
  :
NEXT [<Variable name>]
```

Explanation

This statement repeatedly executes a series of instructions between FOR-NEXT according to the condition designated on the FOR line.
Set the initial value of the variable designated by <Variable name> for <Initial value>.

Set the final value of the variable designated by <Variable name> for <Final value>.

Set an increment value between the initial value and the final value for <Increment>. The increment is regarded as 1 if STEP is ignored.

In the following cases, FOR-NEXT is not executed and execution proceeds to the next statement of NEXT.

(1) If <Increment> is a positive value and <Initial value> is larger than <Final value>
(2) If <Increment> is a negative value and <Initial value> is smaller than <Final value>.

However, <Initial value> is assigned to <Variable>.
You can put another FOR-NEXT in one FOR-NEXT (referred to as a nested construction).
In this case, a different variable must be used for each <Variable name>.
Additionally, one FOR-NEXT must be completely inside the other FOR-NEXT.

**Note : FOR and NEXT must be a pair.
If a program jumps into a FOR-NEXT loop or jumps out of the loop, its operation is not guaranteed. If the increment is set to 0, the loop becomes infinite.**

Related Terms

DO-LOOP, EXIT FOR

Example

```
DEFINT li1, li2, li3, li4, li5, li6, li7, li8, li9
DO WHILE li1 > li2              'Executes a head decision iteration.
  IF li1 = 4 THEN EXIT DO       'Exits from DO-LOOP if li1 = 4.
  FOR li3 = 0 TO 5              'Repeats the process of FOR-NEXT 5 times.
    FOR li4 = li5 TO li6        'Repeats the process of FOR-NEXT by adding 1 to the
                                'value of li5 every time the repetition is done until
                                'li5 becomes the value of li6.
      FOR li7 = 1 TO li8 STEP 2 'Repeats the process of FOR-NEXT by adding 2 to the value
                                'every time the repetition is done from 1 until it becomes li8.
       IF li2 = 2 THEN EXIT FOR 'Exits from FOR-NEXT if li2 < 0.
       DO WHILE li2 < li9       'Executes a head decision iteration.
          GOSUB *samp2
          li9 = li9 + 1
        LOOP                    'Calls a GOSUB *samp2 statement until li2 < li9.
      NEXT li7                  'Repeats.
    NEXT                        'Repeats.
  NEXT                          'Repeats.
  li9 = 0
  DO                            'Executes a tail decision iteration.
    GOSUB *samp2
    li9 = li9 + 1
  LOOP UNTIL li9 < 5            'Calls a GOSUB *samp2 statement until li9 < 5.
LOOP                            'Repeats.
```

EXIT FOR (Statement)

Function

Forcibly exits from FOR-NEXT.

Format

EXIT FOR

Explanation

This statement forcibly exits from FOR-NEXT and proceeds to the next instruction after a FOR-NEXT statement.

Related Terms

FOR-NEXT

Example

```
DEFINT li1, li2, li3, li4, li5, li6, li7, li8, li9
DO WHILE li1 > li2             'Executes a head decision iteration.
  IF li1 = 4 THEN EXIT DO      'Exits from DO-LOOP if li1 = 4.
  FOR li3 = 0 TO 5             'Repeats the process of FOR-NEXT 5 times.
    FOR li4 = li5 TO li6       'Repeats the process of FOR-NEXT by adding 1 to the value of li5
                               'until li5 becomes the value of li6.
      FOR li7 = 1 TO li8 STEP 2 'Repeats the process of FOR~NEXT by adding 2 to the value
                               'from 1 until it becomes li8.
       IF li2 = 2 THEN EXIT FOR 'Exits from FOR-NEXT if li2 < 0.
       DO WHILE li2 < li9      'Executes a head decision iteration.
          GOSUB *samp2
          li9 = li9 + 1
        LOOP                   'Calls a GOSUB *samp2 statement until li2 < li9.
      NEXT li7                 'Repeats.
    NEXT                       'Repeats.
  NEXT                         'Repeats.
  li9 = 0
  DO                           'Executes a tail decision iteration.
    GOSUB *samp2
    li9 = li9 + 1
  LOOP UNTIL li9 < 5           'Calls a GOSUB *samp2 statement until li9 < 5.
LOOP                           'Repeats.
```

REPEAT-UNTIL (Statement)

Function

Executes a tail decision iteration.

Format

REPEAT
  :
UNTIL [<Conditional expression>]

Explanation

This statement repeats statements between a REPEAT statement and an UNTIL statement until <Conditional expression> is satisfied.

If <Conditional expression> is ignored, it is regarded as true (except for 0) and a loop is executed only once.
There is also a DO-LOOP UNTIL statement which serves the same function as REPEAT-UNTIL, but only DO-LOOP UNTIL should be used.

Related Terms

DO-LOOP, WHILE-WEND

Example

```
        DEFINT li1, li2, li3, li4, li5, li6, li7, li8, li9
        DO WHILE li1 > li2                'Executes a head decision iteration.
          IF li1 = 4 THEN EXIT DO         'Exits from DO-LOOP if li1 = 4.
          FOR li3 = 0 TO 5                'Repeats a process of FOR-NEXT 5 times.
            FOR li4 = li5 TO li6          'Repeats the process of FOR-NEXT by adding 1 to the
value
                                          'of li5 every time the repetition is done until li5
becomes
                                          'the value of li6.
              FOR li7 = 1 TO li8 STEP 2   'Repeats the process of FOR-NEXT by adding 2 to the
                                          'value every time the repetition is done from 1 until
                                          'it becomes li8.
               IF li2 = 2 THEN EXIT FOR   'Exits from FOR-NEXT if li2 < 0.
               WHILE li2 < li9            'Executes a head decision iteration.
                  GOSUB *samp2
                  li9 = li9 + 1
                WEND                      'Calls a GOSUB *samp2 statement until li2 < li9.
              NEXT li7                    'Repeats.
            NEXT                          'Repeats.
          NEXT                            'Repeats.
          li9 = 0
          REPEAT                          'Executes the tail decision iteration.
            GOSUB *samp2
            li9 = li9 + 1
          UNTIL li9 < 5                   'Calls a GOSUB *samp2 statement until li9 < 5.
        LOOP                              'Repeats.
```

WHILE-WEND (Statement)

Function

Executes a head decision iteration.

Format

WHILE [<Conditional expression>]
  :
WEND

Explanation

This statement repeats statements between a WHILE statement and a WEND statement while <Conditional expression> is satisfied.

If <Conditional expression> is ignored, it is regarded as true (except for 0) and the loop is infinitely repeated.
If a statement branches into a WHILE statement and a WEND statement with a GOTO statement, for example, it normally executes the WEND statement and returns to the WHILE statement. The program is then executed normally so that it enters this syntax.

There is also a DO WHILE-LOOP statement which serves the same function as WHILE-WEND, but only DO WHILE-LOOP should be used.

Related Terms

DO-LOOP, REPEAT-UNTIL

Example

```
DEFINT li1, li2, li3, li4, li5, li6, li7, li8, li9
DO WHILE li1 > li2              'Executes a head decision iteration.
  IF li1 = 4 THEN EXIT DO       'Exits from DO-LOOP if li1 = 4.
  FOR li3 = 0 TO 5              'Repeats the process of FOR-NEXT 5 times.
   FOR li4 = li5 TO li6         'Repeats the process of FOR-NEXT by adding 1 to the
                                'value of li5 every time the repetition is done until li5
                                'becomes the value of li6.
     FOR li7 = 1 TO li8 STEP 2  'Repeats the process of FOR-NEXT by adding 2 to the
                                'value every time the repetition is done from 1 until
                                'it becomes li8.
       IF li2 = 2 THEN EXIT FOR 'Exits from FOR-NEXT if li2 < 0.
       WHILE li2 < li9          'Executes a head decision iteration.
          GOSUB *samp2
          li9 = li9 + 1
        WEND                    'Calls a GOSUB *samp2 statement until li2 < li9.
      NEXT li7                  'Repeats.
    NEXT                        'Repeats.
  NEXT                          'Repeats.
  li9 = 0
  REPEAT                        'Executes a tail decision iteration.
    GOSUB *samp2
    li9 = li9 + 1
  UNTIL li9 < 5                 'Calls a GOSUB *samp2 statement until li9 < 5.
LOOP                            'Repeats.
```

11.4 Conditional Branch

IF-END IF (Statement)

Function

Conditionally decides a conditional expression between IF-END IF.

Format

```
IF <Conditional expression> THEN
   :
[ELSEIF <Conditional expression> THEN]
   :
[ELSE]
   :
END IF
```

Explanation

The execution of a program is controlled with the condition of <Conditional expression>.

If <Conditional expression> of an IF statement is true (except for 0), then the statements between the IF-ELSEIF statement are executed. If the <Conditional expression> is false (0), then <Conditional expression> of an ELSEIF statement is decided. In the same manner as this, ELSEIF-ELSE and ELSE-END IF are executed.

Related Terms

IF-THEN-ELSE

Example

```
DIM li1 As Integer
IF li1 = 0 THEN         'When li1 is 0.
  STOP                  'Stops the execution of the program.
ELSEIF li1 = 1 THEN     'When li1 is 1.
  GOTO *samp1           'Jumps to the label of *samp1.
  GO TO *samp2          'Jumps to the label of *samp2.
ELSEIF li1 = 2 THEN     'When li1 is 2.
  GOSUB *samp3          'Calls the subroutine of the label name*samp3.
ELSE                    'When li1 is another value.
  RETURN                'Returns to the calling program.
END IF                  'Declares the end to the IF statement.
```

IF-THEN-ELSE (Statement)[Conforms to SLIM]

Function

Executes a conditional decision of a logical expression.

Format

IF <Conditional expression> THEN {<Statement>|<Label name>} [ELSE {<Statement>|<Label name>}]

Explanation

This statement controls the execution of a program depending on the condition of <Conditional expression>.

If <Conditional expression> is true (except for 0), then the latter section of THEN is executed. If the <Conditional expression> is false (0), then the latter section of ELSE is executed.

Related Terms

IF-END IF

Example

```
IF l0 = 0 THEN STOP ELSE GOSUB *samp1
                        'If i1 is 0, control stops program execution. If il is
                        'another value, control calls the subroutine with a
                        'label name of *sampl.
il = il + 1             'il is added.
END                     'Defines the program end.
*sampl:                 'Defines the subroutine label.
i0 =0                   'Substitute 0 for i0.
RETURN                  'Returns to the calling program.
```

SELECT CASE (Statement)

Function

Executes a plural condition decision.

Format

```
SELECT CASE <Expression>
  CASE <Item>[,<Item>...]
    :
  [CASE ELSE]
END SELECT
```

Explanation

This statement executes a series of instructions after CASE if the value of <Expression> matches <Item> of the CASE statement.

An arithmetic expression or character string can be designated for <Expression>.
A variable, a constant, an expression or a conditional expression can be designated for <Item>.
A conditional expression can be designated as follows.

- <Arithmetic expression 1> TO < Arithmetic expression 2>
  The result of <Expression> is checked if it is <Arithmetic expression 1> or higher, or if it is <Arithmetic expression 2> or lower.
- This statement cannot be used in the case of a character string.
  IS <Comparison operator><Arithmetic expression>
  The result of <Expression> and the value of <Arithmetic expression> are compared.

In the case of a character string, <Comparison operator> is “ = ”.
A CASE ELSE statement is executed if all CASE statements are not satisfied.
A CASE ELSE statement must be put before an END SELECT statement.

Related Terms

IF-END IF

Example

```
REM  Executes a plural condition decision.
SELECT CASE Index     'The command is executed if the index value matches the CASE
                      'statement value.
  CASE 0              'When the index is 0.
    STOP              'Ends the program.
  CASE 1              'When the index is 1.
    HALT “STOP”       'Suspends the execution of the program.
  CASE 2              'When the index is 2.
    HOLD “STOP”       'Suspends the execution of the program.
  CASE 3              'When the index is 3.
    STOPEND           'Stops a continuous program or stops the program after a cycle.
  CASE 4              'When the index is 4.
                      ON li1 + li2 GOSUB *samp1, *samp2, *samp3
                      'Calls the subroutine of the label name written at the same level as the
                      'value of li1 + li2.
  CASE 5              'When the index is 5.
ON li1 + li2 GOTO *samp1, *samp2, *samp3
                        'Jumps to the label written at the same level as the value of li1 + li2.
  CASE 6 TO 8           'When the index is 6 to 8.
PRINTDBG “Reservation“  'Outputs a message to the debug window.
  CASE IS ≥ 9           'When the index is 9 or more.
    END                 'Declares the end of motion by the program.
END SELECT              'Declares the end of the plural conditional decision statement.
```

11.5 Unconditional Branch

GOTO (Statement) [Conforms to SLIM]

Function

Unconditionally branches a program.

Format

{GOTO|GO TO}<Label name>

Explanation

This statement jumps to the label designated by <Label name> and continues execution there.
GO TO can be used instead of GOTO.

Related Terms

GOSUB

Example

```
DIM li1 As Integer
IF li1 = 0 THEN        'When li1 is 0.
  STOP                 'Stops the execution of the program.
ELSEIF li1 = 1 THEN    'When li1 is 1.
  GOTO *samp1          'Jumps to the label of *samp1.
  GO TO *samp2         'Jumps to the label of *samp2.
ELSEIF li1 = 2 THEN    'When li1 is 2.
  GOSUB *samp3         'Calls the subroutine of the label name*samp3.
ELSE                   'When li1 is another value.
  RETURN               'Returns to the calling program.
END IF                 'Declares the end to the IF statement.
```

ON-GOTO (Statement) [Conforms to SLIM]

Function

Executes an unconditional branch due to the value of an expression.

Format

ON <Expression> GOTO <Label name> [,<Label name>]…

Explanation

This statement jumps to the line number written at the same level as the value of <Expression> and continues the execution of the program there. The order of this is counted as 1, 2, … from the left.
The system rounds down the value of <Expression> to an integer and processes it.

Note: If the result of the expression exceeds the order, nothing is executed.

Related Terms

ON-GOSUB

Example

```
REM Executes a plural condition decision.
SELECT CASE Index       'The command is executed when the index value matches the CASE
                        'statement value.
  CASE 0                'When the index is 0.
    STOP                'Ends the program.
  CASE 1                'When the index is 1.
    HALT “STOP”         'Suspends the execution of the program.
  CASE 2                'When the index is 2.
    HOLD “STOP”         'Suspends the execution of the program.
  CASE 3                'When the index is 3.
    STOPEND             'Stops a continuous program or stops the program after a cycle.
  CASE 4                'When the index is 4.
   ON li1 + li2 GOSUB *samp1, *samp2, *samp3
                        'Calls the subroutine of the label name written at the same
                        'level as the value of li1 + li2.
 CASE 5                 'When the index is 5.
   ON li1 + li2 GOTO *samp1, *samp2, *samp3
                        'Jumps to the label written at the same level as the value
                        'of li1 + li2.
  CASE 6                'When the index is 6.
    END                 'Declares the end of motion by the program.
END SELECT              'Declares the end of a plural condition decision statement.
```

11.6 Comment

REM (Statement)[Conforms to SLIM]

Function

Describes a comment.

Format

{REM|'}[<Comment>]

Explanation

This statement is added when <Comment> is described in a program.
A character string after REM does not affect program execution.
A single quote (') can be used instead of REM.

Example

```
REM   Executes a plural condition decision.
SELECT CASE Index       'The command is executed when the index value matches the CASE
                        'statement value.
  CASE 0                'When the index is 0.
    STOP                'Ends the program.
  CASE 1                'When the index is 1.
    HALT “STOP”         'Suspends the execution of the program.
  CASE 2                'When the index is 2.
    HOLD “STOP”         'Suspends the execution of the program.
  CASE 3                'When the index is 3.
    STOPEND             'Stops a continuous program or stops the program after a cycle.
  CASE 4                'When the index is 4.
    END                 'Declares the end of motion by the program.
END SELECT              'Declares the end of a plural condition decision statemen
```

Chapter 12

Robot Control Statements

This chapter provides an explanation of the commands and robot control statements used for robot motion control.

12.1 Motion Control

APPROACH (Statement)

Function

Executes the absolute movement designated in the tool coordinate system.

Format

APPROACH <Interpolation method>, <Base position>,[<Path start displacement>]<Approach length>[,<Motion option>][,NEXT]

Explanation

The position type, joint type or homogeneous type can be used for <Base position>.

6-axis The robot moves to a position away from the <Base position> by <Approach length> in the -Z direction of the tool coordinate system.

4-axis The robot moves to a position away from the <Base position> by <Approach length> in the +Z direction of the base coordinate system.

Either P (or PTP) or L can be selected for <Interpolation method>.

Interpolation method	Meaning
P (or PTP)	Moves in PTP control.
L	Moves in CP control.

The <Path start displacement> value is expressed by the radius of a globe with the target position centered. If the motion instruction value is entered the robot proceeds to the next control. Designate the value in millimeters. The aim is to change the pass start timing with this value.
Also note that if the end of the arm enters the globe, the robot does not proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.
For <Motion option>, there are SPEED, ACCEL, and DECEL options.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the SPEED statement.
ACCEL	Designates acceleration. The meaning is the same as the ACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the DECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions are not executed until robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with a movement option, the NEXT option is no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after the movement ends. Therefore care needs to be exercised since it requires a long distance to stop.

Remarks:
The APPROACH statement can be rewritten using the MOVE statement.

APPROACH <Interpolation method>,[<Pass start displacement>]<Base position>,<Approach length> [,<Motion option>][,NEXT]

The following shows the statement if the above APPROACH statement is rewritten using MOVE.

6-axis MOVE <Interpolation method>,[<Pass start displacement>]<Base position>+(0, 0, -<Approach length>)H[,<Motion option>][,NEXT]
Example : APPROACH P, P3, 100
'The same as MOVE P, P3+(0, 0, -100)H.

4-axis MOVE <Interpolation method>,[<Pass start displacement>]<Base position>+(0, 0, <Approach length>)[,<Motion option>][,NEXT]
Example : APPROACH P, P3, 100
'The same as MOVE P, P3+(0, 0, 100).

Related Terms

DEPART, SPEED

Example

```
      DEFSNG lf1, lf2
      DEFPOS lp1, lp2, lp3
6-axis            APPROACH P, (740, 0, 480, 180, 0, 180, 5), 70
                      'The robot moves (PTP control) to a point 70 mm away from the position of
                      'robot figure 5 at (740, 0, 480, 180, 0, 180) in the –Zm direction.
                  APPROACH L, lp1, lf1, SPEED = 100
                      'The robot moves  (CP control, internal speed = 100 %) to a position at lf1
                      'distance from the position of lp1 in the –Zm direction.
                  APPROACH P, lp2, @P lf2, S = 50
                      'The robot moves to a position lf2 distance from the lp2 position in the –Zm
                      'direction (PTP control, internal speed = 50 %) via the pass movement.
                  APPROACH L, lp3, 80
                      'The robot moves (CP control) to a position 80 mm away from the position of lp3
                      'in the –Zm direction.
```

```
4-axis              APPROACH P, (100, 200, 300, 45, 1), 70
                              'Moves to a position 70mm far form a point (100,
                              200,
                              '300, 45,1) with posture 1 in +Zb direction (PTP
                              'control)
                    APPROACH L, lp1, lf1, SPEED=100
                              'Moves to a position lf1 far form lp1 in +Zb
                              direction
                              '(CP control, internal speed=100%)
                    APPROACH P, lp2, @P, lf2, S=50
                              'Moves to a position lf2 far form lp2 in +Zb
                              direction
                              'along a path (PTP control, internal speed=50%)
                    APPROACH L, lp3, 80 'Moves to a position 80 mm far from lp3 in +Zb
                              'direction (CP control)
```

Notes

(1) There is a possibility that the approach position obtained from the base position may lie beyond the motion space of the robot. In such a case, an error with a level of 6070 (J * software motion limit over, beyond motion space, a singular point) may occur.

(2) The figure of the approach position becomes that of the base position. Therefore, there is a possibility that the approach position is beyond the motion space and “error 667* software motion limit over, beyond the motion space 2” may occur. In this case, use FIGAPRL and FIGAPRP (refer to p.12-33 “ FIGAPRL” and p.12-35 “ FIGAPRP”) to calculate the figure of the approach position, or change the figure using LETF (refer to “10.3 LETF”) by replacing it using the MOVE instruction as described in REMARKS.

(3) In CP motion, if the current figure (refer to the Owner's Manual “Setting-up,” Section 4.2, “Figures of the Shoulder, Elbow and Wrist”) and the figure of the base position are different, error 607F (Robot figure inconsistency) occurs. However, if the robot can move to change figures, the error does not occur.

(4) In CP motion, if the robot passes in the vicinity of a singular point (refer to the “Setting-up Guide,” Subsection 4.1.3 “Boundaries of Robot Figures”), an error with a level of 6080 (designated speed limit over) may occur and the motion may stop. In this case, slow down the speed or set 2 or 3 in optimal load capacity setting mode (refer to p.4-8 “4.6 Optimal Load Capacity Setting Function”). If the error still occurs, evade the path near this singular point.

(5) In CP motion, there is a possibility that a 601C warning (change figure) may occur because the figure of the approach position and that of the base position do not meet. Change the figure of the base position to the figure when the motion ends (note that operation is not affected even if the warning occurs).

DEPART (Statement)

Function

Executes the relative motion in the tool coordinate system.

Format

DEPART <Interpolation method>,[<Pass start displacement>]<Depart length>[,<Motion option>][,NEXT]

Explanation

6-axis

The robot moves by <Depart length> distance from the current position in the –Z direction of the tool coordinate system.

4-axis

The robot moves by <Depart length> distance from the current position in the –Z direction of the tool coordinate system.

P (or PTP) or L can be selected for <Interpolation method>.

Interpolation method	Meaning
P (or PTP)	Moves in PTP control.
L	Moves in CP control.

The value of <Pass start displacement> is expressed using the radius of the globe with the target position centered. If the motion instruction value is entered, the robot proceeds to the next control. Designate the value in millimeters. This value aims to change the pass start timing, and if the end of the arm enters the globe, the robot does not always proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.

The SPEED, ACCEL, and DECEL options are available for <Motion option>.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the SPEED statement.
ACCEL	Designates acceleration. The meaning is the same as the ACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the DECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions will not be executed until robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with the movement option, the NEXT option is no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after movement ends. Therefore, care must be exercised since it requires a long distance to stop.

Remarks: The DEPART statement can be rewritten using the MOVE statement.
DEPART <Interpolation method>,[<Pass start displacement amount>]<Depart length>[,<Motion option>][,NEXT]
The following shows the statement if the above DEPART statement is rewritten using the MOVE statement.

6-axis

MOVE<Interpolation method>,[<Pass start displacement amount>]<Current position>+(0, 0, -<Depart length>)H[,<Motion option>][,NEXT]

Example 1: DEPART P, 70
'The same as MOVE P, P0+(0, 0, -70)H ;P0 is the current position.
Example 2: DEPART P, @P 70
'The same as MOVE P, @P P0+(0, 0, -70)H.;P0 is the current position.

4-axis

MOVE<Interpolation method>,[<Pass start displacement amount>]<Current position>+(0, 0, <Depart length>) [,<Motion option>][,NEXT]

Example 1: DEPART P, 70
'The same as MOVE P, P0+(0, 0, 70) ;P0 is the current position.
Example 2: DEPART P, @P 70
'The same as MOVE P, @P P0+(0, 0, 70).;P0 is the current position.

Related Terms

APPROACH, SPEED

Example

```
                    DEFSNG lf1, lf2
    6-axis          DEPART P, 70         'The robot moves (PTP control) to a position 70 mm
                                         'away from the current position in the  –Zm direction.
                    DEPART L, lf1, SPEED = 100
                                         'The robot moves (CP control, S = 100) to a position lf1
                                         'distance away from the current position in the  –Zm
                                         'direction.
                    DEPART P, lf2, S = 50'The robot moves (PTP control, S = 50) to a position lf2
                                         'distance away from the current position in the –Zm
                                         'direction.
                    DEPART L, 80         'The robot moves (CP control) to a position  80 mm away
                                         'from the current position in the  –Zm direction.

    4-axis          DEPART P, 70         'The robot moves (PTP control) to a position 70 mm
                                         'away from the current position in the Zb direction.
                    DEPART L, lf1, SPEED = 100
                                         'The robot moves (CP control, S = 100) to a position lf1
                                         'distance away from the current position in the  Zb
                                         'direction.
                    DEPART P, lf2, S = 50'The robot moves (PTP control, S = 50) to a position lf2
                                         'distance away from the current position in the Zb
                                         'direction.
                    DEPART L, 80         'The robot moves (CP control) to a position  80 mm away
                                         'from the current position in the  Zb direction.
```

Notes

The figure of the DEPART motion position is that of motion start. As a result there is a possibility that “error 667* software motion limit over, beyond motion space 2” may occur since the DEPART operation position will be beyond the operation space. In this case, replace the instruction with the MOVE instruction as described in REMARKS and change the figure using LETF (refer to “10.3 Figure”).

DRAW (Statement)

Function

Executes the relative movement designated in the work coordinate system.

Format

DRAW <Interpolation method>,[<Pass start displacement amount>]<Parallel movement distance>[,<Motion option>][,NEXT]

Explanation

The robot moves from the current position by a distance of <Translation movement distance>.
Either P (or PTP) or L can be selected for <Interpolation method>.

Interpolation method	Meaning
P (or PTP)	Moves in PTP control.
L	Moves in CP control.

The value of <Pass start displacement> is expressed using the radius of the globe with the target position centered. If the motion instruction value is entered, the robot proceeds to the next control. Designate the value in millimeters. This value aims to change the pass start timing, and if the end of the arm enters the globe, the robot does not always proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.

The SPEED, ACCEL, and DECEL options are available for <Motion option>.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the SPEED statement.
ACCEL	Designates acceleration. The meaning is the same as the ACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the DECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions will not be executed until the robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with the movement option, the NEXT option is no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after movement ends. Therefore, care must be exercised since it requires a long distance to stop.

Remarks: The DRAW statement can be rewritten using the MOVE statement.
DRAW <Interpolation method>,[<Pass start displacement>]<Translation movement distance>[,<Motion option>] [,NEXT]
The following shows the statement if the above DRAW statement is rewritten using the MOVE statement.
MOVE <Interpolation method>,[<Pass start displacement>]<Current position>+<Translation movement distance>

Example: DRAW L, (50, 10, 50) 'The same as MOVE L, P0+(50, 10, 50)

Related Terms

SPEED, TOOL, CHANGEWORK

Example

```
DEFVEC lv1, lv2
DRAW L, (50, 10, 50)    'The robot moves (CP control) to a position
             '(X = 50, Y = 10, Z = 50) away from the current position.
DRAW L, lv1, SPEED=90   'The robot moves (CP control, S = 90) to a position
             'lv1 away
             'from the current position.
DRAW L, lv2, S = 50     'The robot moves (CP control, S = 50) to a position
             'lv2 away from the current position.
```

Notes

The figure of the DRAW motion position is that of motion start. As a result there is a possibility that “error 667* software motion limit over, beyond motion space 2” may occur since the DRAW operation position will be beyond the motion space. In this case, replace the instruction with the MOVE instruction as described in REMARKS and change the figure using LETF (refer to “10.3 Figure”).

DRIVE (Statement) [Conforms to SLIM]

Function

Executes the relative motion of each axis.

Format

DRIVE[<Pass start displacement>](<Axis number>,<Relative movement amount>)[,(<Axis number>,<Relative movement amount>)…][,<Motion option>][,NEXT]

Explanation

This statement moves the axis designated by <Axis number> to the angle (DEG) designated by <Relative movement amount>. If <Relative movement amount> is positive, the designated axis moves in the positive direction and if negative it moves in the negative direction.

To execute this command, you need to get an arm group involving a joint(s) to be moved. If a same axis is designated several times the latest designation becomes valid.

The value of <Path start displacement> is expressed using the radius of the globe with the target position centered. If the motion instruction value is entered, the robot proceeds to the next control. Designate the value in millimeters. This value aims to change the pass start timing, and if the end of the arm enters the globe, the robot does not always proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.

The SPEED, ACCEL, and DECEL options are available for <Motion option>.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the JSPEED statement.
ACCEL	Designates acceleration. The meaning is the same as the JACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the JDECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions will not be executed until robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with the movement option, the NEXT option is no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after movement ends. Care should therefore be exercised since it requires a long distance to stop.

Related Terms

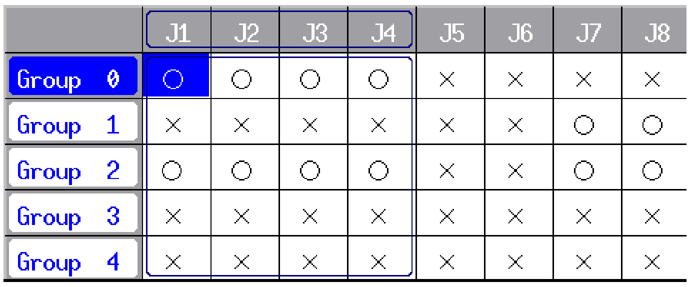
`DRIVEA`, `MOVE` with EX or EXA option

(Commands applicable to the extended-joints include `MOVE` with `EX` or `EXA` option, `DRIVE` and `DRIVEA` only.)

Example

```
Ex1     DEFINT li1, li2, li3
        DEFSNG lf1, lf2, lf3
        DRIVE (li1, 30)            'Moves li1 distance of 30 degrees (deg) from the
                                   'current position.
        DRIVE (li1, lf1)           'Moves the axis with value li1 from the current
                                   'position.
        DRIVE (li1, 0.78RAD), (li2, lf2), (li3, lf3)
                                   'Moves li1 by 0.78 (rad), li2 by a distance of lf2,
                                   'and li3 by a distance of lf3 from the current
                                   'position.
```

Ex2 (extended-joint)



	J1	J2	J3	J4	J5	J6	J7	J8
Group 0	○	○	○	○	×	×	×	×
Group 1	×	×	×	×	×	×	○	○
Group 2	○	○	○	○	×	×	○	○
Group 3	×	×	×	×	×	×	×	×
Group 4	×	×	×	×	×	×	×	×

```
        PROGRAM PRO1
        TAKEARM1     'Arm Group 1 involves 7th and 8th joints.
        DRIVE (7,30),(8,50)     'Operate 7th and 8th joints
        END
```

In the above example, to move the 7th and/or 8th extended-joint, the program needs to get Arm Group 1 or Arm Group 2.

DRIVEA (Statement)

Function

Executes the absolute motion of each axis.

Format

DRIVEA[<Pass start displacement>] (<Axis number>,<Axis coordinate>)[,(<Axis number>,<Axis number>)…][,<Motion option>][,NEXT]

Explanation

This statement moves the axis designated by <Axis number> to the angle (DEG) designated by <Axis coordinate>.

To execute this command, it is necessary to get an arm group including a joint(s) to be moved. If a same axis is designated several times the latest designation becomes valid.

The value of <Pass start displacement> is expressed using the radius of the globe with the target position centered. If the motion instruction value is entered, the robot proceeds to the next control. Designate the value in millimeters. This value aims to change the pass start timing, and if the end of the arm enters the globe, the robot does not always proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.

The SPEED, ACCEL, and DECEL options are available for <Motion option>.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the JSPEED statement.
ACCEL	Designates acceleration. The meaning is the same as the JACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the JDECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions will not be executed until robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with the movement option, the NEXT option is no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after movement ends. Care should therefore be exercised since it requires a long distance to stop.

Related Terms

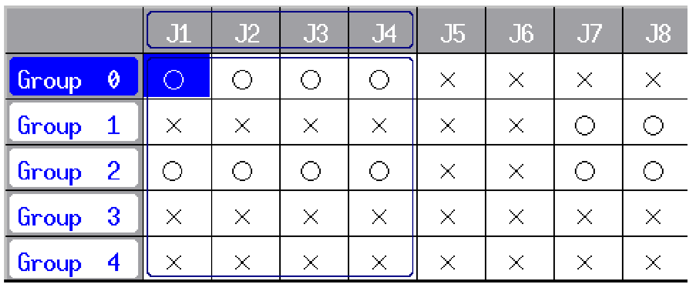
`DRIVE,` `MOVE` with EX or EXA option

(Commands applicable to the extended-joints include `MOVE` with `EX` or `EXA` option, `DRIVE` and `DRIVEA` only.)

Example

```
Ex1     DEFINT li1, li2, li3
        DEFSNG lf1, lf2, lf3
        DRIVEA (li1, 30)             'Moves li1 a distance of  30 degrees (deg).
        DRIVEA (li1, lf1)            'Moves the axis with value li1 to the value of lf1
                                     'from the current position.
        DRIVEA @P (li1, 0.78RAD), (li2, lf2), (li3, lf3)
                                     'Moves li1 0.78 (rad), li2 by a distance of lf2 and
                                     'li3 by a distance of lf3 from the current position.
```

Ex2



	J1	J2	J3	J4	J5	J6	J7	J8
Group 0	○	○	○	○	×	×	×	×
Group 1	×	×	×	×	×	×	○	○
Group 2	○	○	○	○	×	×	○	○
Group 3	×	×	×	×	×	×	×	×
Group 4	×	×	×	×	×	×	×	×

```
PROGRAM PRO1
TAKEARM1     'Arm Group 1 involves 7th and 8th joints.
DRIVEA (7,30),(8,50)    'Operate 7th and 8th joints
END
```

```
In the above example, to move the 7th and/or 8th extended-joint, the program
 needs to get Arm Group 1 or Arm Group 2.
```

Notes

(1) If a numerical value is set to `<@PassStartOffset>` for the specified extended-joint, the joint will move in pass motion regardless of the entered value.

(2) This command is not applicable to any joints specified for boundless rotation.

GOHOME (Statement) [Conforms to SLIM]

Function

Moves to the position (home position) defined by the HOME statement.

Format

GOHOME

Explanation

This statement moves the robot from the current position to the home position using PTP control.
Use the HOME statement to declare a home position.
An error will occur if this statement is executed without setting HOME.

Related Terms

HOME

Example

```
        GOHOME       'The robot moves from the current position to the home position.
```

MOVE (Statement) [Conforms to SLIM]

Function

Moves the robot flange to the specified coordinates.

If specified with an EX option (relative motion of extended-joints) or EXA option (absolute motion of extended-joints), the MOVE can move both the robot flange and the extended-joints synchronously. (i.e. Synchronized start and stop from/at the specified positions is possible.)

Format

MOVE <Interpolation method>,[@<Path start displacement>]<Pose>[,[@<Path start displacement>]<Pose>…][,<Motion option>][,NEXT]

Explanation

This statement moves the robot from the current position to the designated coordinate <Pose>.

For <Pose>, the position type (P type), joint type (J type) or homogeneous transformation type (T type) can be used.
For the position type, a variable, a pose array by numbered variables, a constant or the current position (*, CURPOS) can be used.
For the joint type, a variable, a pose array by numbered variables, or the current angle (CURJNT) can be used.
For the homogeneous transformation type, a variable or a pose array by numbered variables can be used.
Expression of the pose array: P[3 TO 6] From P[3] to P[6].

P, L, or C can be selected for the For <Interpolation method>.

Interpolation method	Meaning
P (or PTP)	The robot moves from the current position to the designated coordinates using PTP control.
L	The robot moves from the current position to the designated coordinates using CP control.
C	The robot moves to a purpose pose performing arc interpolation via a relay point pose from the current position. The robot performs an interpolation motion from the figure of the current position to that of the purpose pose (the figure of the relay point pose is ignored). In arc interpolation, a relay point pose and a purpose pose must be designated. (A pose array cannot be used for C.) Even if pass start displacement is designated to a relay point pose, the motion does not change. Use MOVE C, P1, @P P2 to designate the pass taken when the arc interpolation motion is finished.

The value of <Path start displacement> is expressed using the radius of the globe with the designated coordinates centered. If the motion instruction value is entered, the robot proceeds to the next control. Designate the value in millimeters. This value aims to change the pass start timing, and if the end of the arm enters the globe, the robot does not always proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.

For <Motion option>, there are SPEED, ACCEL, and DECEL options.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the SPEED statement.
ACCEL	Designates acceleration. The meaning is the same as ACCEL or JACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the DECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions are not executed until robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with the movement option, the NEXT option is no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after movement ends. Care should therefore exercised since it requires a long distance to stop.

Expressions such as MOVE P,P[3 TO 5] or MOVE P,P3,P6,P9 have the same expression as

```
MOVE P,P[3 TO 5] →  MOVE P, P3, NEXT
                    MOVE P, P4, NEXT
                    MOVE P, P5
```
or

```
MOVE P,P3,P6,P9  →  MOVE P, P3, NEXT
                    MOVE P, P6, NEXT
                    MOVE P, P9
```

(The left expressions have higher priority in processing.)
Therefore,

(1) If these expressions are present between IOBLOCK ON and OFF, the next non-motion instruction is not executed until the motion of the final pose (P5 or P9) motion starts. Refer to Part 2 “6.1.3 IOBLOCK ON/OFF.”

(2) If the NEXT option is added, the next non-motion instruction is not executed until the final pose (P5 or P9) motion starts.

The syntax of an EX or EXA option is shown below.

`<EX/EXAoption>` syntax

```
EX((<JntNumber>,<RelativeDistance>)[,(<JntNumber>,
<RelativeDistance>)…])

EXA((<JntNumber>,<AxisCoordinates>)[,(<JntNumber>,
<AxisCoordinates>)…])
```

To `<JntNumber>`, you can specify only an extended-joint, never specify any robot joint.

For details about other options, refer to the PROGRAMMER'S MANUAL, Section 12.1 "MOVE."

Related Terms

SPEED, DRIVE, DRIVEA

(Commands applicable to the extended-joints include MOVE with EX or EXA option, DRIVE and DRIVEA only.)

Example

Ex1

```
DIM li1 As Integer
```

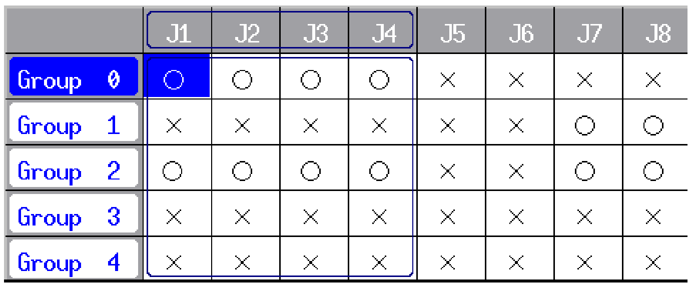
6-axis

```
MOVE P, (740, 0, 480, 180, 0, 180, 5),NEXT
    'Moves (PTP control) to the coordinates of robot figure 5 with (740,
    '0, 480, 180, 0, 180).  After the motion starts, the next instruction
    'is executed.
```

4-axis

```
MOVE P, (100, 200, 300, 45, 1),NEXT
    'Moves (PTP control) to the coordinates of robot figure 1 with (100, 200,
    300,
    '45, 1).  After the motion starts, the next instruction is executed.

MOVE L, lp1, SPEED = 100
    'Moves (CP control, internal speed = 100) to the coordinates of lp1.
MOVE P, @30 lp2, lp3, S = lil
    'Sequentially moves (PTP control, internal speed = li1) to the
    'coordinates of lp2(@30) and lp3 .
MOVE L, @20 lp4, @50 lp5, @100 lp6
    'Sequentially moves (CP control) to the coordinates of lp4(@20),
    'lp5(@50), and lp6(@100).
MOVE L, @P P[6 TO 15], lp7
    'Sequentially moves from P[6] to  P[15] in pass motion and moves
    '(CP motion) to the coordinates of lp7.
MOVE C, lp1, @p lp2
    'Executes an arc interpolation motion via lp1 to lp2.
    'Executes the pass motion at lp2 and proceeds to the next control.
```

Ex2



	J1	J2	J3	J4	J5	J6	J7	J8
Group 0	○	○	○	○	×	×	×	×
Group 1	×	×	×	×	×	×	○	○
Group 2	○	○	○	○	×	×	○	○
Group 3	×	×	×	×	×	×	×	×
Group 4	×	×	×	×	×	×	×	×

```
PROGRAM PRO1
TAKEARM 2                        'Get Arm Group 2 involving both robot
                                 'joints and extended-joints.
MOVE P, P0 EX ((7,30),(8,10))    'Move robot flange to P0 as well as
                                 'moving 7th and 8th extended-joints to
                                 'relative coordinates synchronously.
MOVE P, P1 EXA ((7,30))          'Move robot flange to P1 as well as
                                 'moving 7th extended-joint to absolute
                                 'coordinates synchronously.
END
```

Notes

(1) If a pose is designated in the position type and the homogeneous transformation type, the designated pose goes beyond the robot motion space. As a result of this an error with level 6070 (J* software motion limit over, out of motion space, singular point) may occur. Be careful when designating specific figures of 16 to 31.

(2) In CP motion or arc interpolation motion, if the current figure (refer to the "Setting-up Guide, 4.1.3 Figures of the Shoulder, Elbow and Wrist") and the figure at the designated coordinates are wrong, error 607F (Robot figure incompatibility) may occur. However, no error will occur if it is possible for the robot to change its figure.

(3) In CP motion and arc interpolation motion, if the robot passes in the vicinity of a singular point (refer to the "Setting-up Guide, 4.1.3 [2] Boundaries of Robot Figures"), an error with a level of 6080 (Command speed limit over) will occur and the robot may stop. In this case, reduce the speed or set 2 or 3 in the optimal load capacity setting mode (refer to p.4-8 "4.6 Control Set of Motion Optimization"). If the error still occurs, avoid the path in the vicinity of the singular point.

(4) In CP motion, warning 601C (Change a figure.) may occur if a figure at the end of movement is incompatible with the designated figure. Teach the robot again with a figure at the end of movement (if the warning occurs it will not affect movement).

(5) For a pass motion in an arc interpolation movement or an encoder value checking movement, designate the pass start displacement amount to the destination pose. If the pass start displacement amount is designated as the relay pose, the movement does not change.

(6) The arc interpolation movement ignores the figure of the relay pose. Therefore, in order to let the tool end pass the relay pose, set the tool coordinates at the tool end using the tool definition.

(7) In the arc interpolation movement, if the movement is restarted after an instantaneous stop during the pass movement when the previous movement is a pass movement, error 60de "The robot executes rotation movement different from the designated one." may occur.

(8) In the arc interpolation movement, if the current pose and the target pose are the same, the robot does not move. If the current pose and the relay pose are the same, or the relay pose and the target pose are the same, the robot moves toward the target pose in CP motion.

(9) (Notes of extended-joint.)
The `MOVE` with `EXA` option (absolute motion) is not applicable to any extended-joints specified for boundless rotation.

(10)(Notes of extended-joint.)
Given below is an example handling a `POSE` array.

Example: `MOVE P,P[3 TO 5]EX((7,30))`

The above sample will produce the same result as the following; that is, the motion of the 7th joint will synchronize with that of the robot flange to P5.

```
MOVE P,P3,NEXT
MOVE P,P4,NEXT
MOVE P,P5 EX((7,30))
```

ROTATE (Statement) [Conforms to SLIM]

Function

Executes a rotation movement around the designated axis.

Format

ROTATE <Rotation plane>,[@<Pass start displacement>],<Relative rotation angle> [,[<Rotation center point>] [,<Rotation option>] [,<Movement option>][,NEXT]]
Rotation plane format

6-axis	{{XY|YZ|ZX}|{XYH|YZH|ZXH}|(Vector type, vector type, vector type)}
4-axis	{{XY}|{XYH}}

Explanation

The hand rotates around the axis vertically created in <Rotation plane> by the angle designated <Rotation angle>. There are two types of rotation axes in the rotation plane. The axis with the smaller angle made in the approach vector is selected.
The rotation plane can be selected from the following seven planes.

Rotation plane format

6-axis

If the rotation plane is parallel to the XY, YZ and ZX planes of the work coordinates, designate XY|YZ|ZX.

If the rotation plane is parallel to the XY, YZ and ZX planes of the tool coordinates, designate XYH|YZH|ZXH.

A plane seen from the base coordinates is created from the three points of the XYZ coordinates (Vector type, Vector type, Vector type).

4-axis

If the rotation plane is parallel to the XY planes of the work coordinates, designate XY.

If the rotation plane is parallel to the XY planes of the tool coordinates, designate XYH.

A plane seen from the base coordinates is created from the three points of the XYZ coordinates (Vector type, Vector type, Vector type).

The value of <Pass start displacement> is expressed using the radius of the globe with the designated coordinates (pause) centered. If the motion instruction value is entered, the robot proceeds to the next control. Designate the value in millimeters. This value aims to change the pass start timing, and if the end of the arm enters the globe, the robot does not always proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.
The unit of measurement of <Relative rotation angle> is degrees (DEG) and the sign is plus (+) for the right-handed screw.

6-axis

For <Rotation center point>, designate a work coordinate point if the rotation plane is of {XY|YZ|ZX} and(Vector type, Vector type, Vector type). And if the rotation plane is of {XYH|YXH|ZXH}, designate a tool coordinate point.

If <Rotation center point> is ignored, the rotation center will be (0,0,0) when the rotation plane is of {XY|YZ|ZX}. And when the rotation plane is of (Vector type, Vector type, Vector type), the first vector becomes the rotation center. However, if a rotation plane of {XYH|YZH|ZXH} is designated, the robot cannot rotate around the rotation center of (0, 0, 0). Be sure to designate a rotation center point.

4-axis

For <Rotation center point>, designate a work coordinate point if the rotation plane is of {XY} and(Vector type, Vector type, Vector type). And if the rotation plane is of {XYH}, designate a tool coordinate point.

If <Rotation center point> is ignored, the rotation center will be (0,0,0) when the rotation plane is of {XY}. And when the rotation plane is of (Vector type, Vector type, Vector type), the first vector becomes the rotation center. However, if a rotation plane of {XYH } is designated, the robot cannot rotate around the rotation center of (0, 0, 0). Be sure to designate a rotation center point.

Designate <Rotation option> with pose=1 or pose=2.
With pose=1, the robot moves to the rotation center using the posture constant. The range of the rotation angle is ±540°. With pose=2, the robot keeps the current posture. If no option is designated, the robot moves in the same way as in the case of pose=2.

For <Movement option> there are SPEED, ACCEL and DECEL options.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the SPEED statement.
ACCEL	Designates acceleration. The meaning is the same as the ACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the DECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions will not be executed until robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with the movement option, the NEXT option is no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after movement ends. Care should therefore be exercised since it requires a long distance to stop.

Related Terms

ROTATEH

Example

```
                  ROTATE XY,45,V1     'The robot rotates by 45 degrees at a constant
                      posture
                                      'around the axis passing through point V1 and
                      vertical
                                      'to the XY plane.
    6-axis only   ROTATE(V2, V3, V4),F1
                                      'The robot rotates around the axis vertical to the
                      plane
                                      'created from (V2, V3, V4) passing point V2 by the
                                      'value of F1.
                  ROTATE XYH,43,V1,S=100
                                      'The robot rotates around an approach vector which
                             passes
                                      'the tool coordinates V1 by 43 degrees at a moving
                             speed
                                      'of 100 %.
```

Notes

When you execute instantaneous stop during path movement and restart the system, error 60de “Robot may execute rotation movement different from the designated.” may occur.

ROTATEH (Statement)

Function

Executes rotary motion by taking an approach vector as an axis.

Format

ROTATEH [@<Pass start displacement>]<Relative rotation angle around approach vector>[,<Motion option>][,NEXT]

Explanation

This statement rotates the hand end by <Relative rotation angle around approach vector> taking the approach vector as the axis.

The unit of measurement for <Relative rotation angle around approach vector> is degrees (DEG). However, designate the rotation angle in a range from -180(DEG) to 180(DEG).

The value of <Pass start displacement> is expressed using the radius of the globe with the designated coordinate (pause) centered. If the motion instruction value is entered, the robot proceeds to the next control. Designate the value in millimeters. This value aims to change pass start timing, and if the end of the arm enters the globe, the robot does not always proceed to the next control.
If the value is ignored, it is processed as the default value @0.
If the value is @0, the robot moves in the end movement.
If @P, it moves in the pass movement.
If @E, the robot checks the arrival at the target position with the value of the encoder and then proceeds to the next movement.

For <Motion option> there are SPEED, ACCEL, and DECEL options.

Motion option	Meaning
SPEED (or S)	Designates the movement speed. The meaning is the same as the SPEED statement.
ACCEL	Designates acceleration. The meaning is the same as the ACCEL statement. However, deceleration cannot be designated. Use the DECEL statement to designate deceleration.
DECEL	Designates deceleration. The meaning is the same as the DECEL statement.

If <NEXT option> is added, the robot proceeds to the next no-movement instruction without waiting for movement to finish. However, the following instructions are not executed until the robot movement ends (pass start).
Robot motion instructions (CHANGETOOL, CHANGEWORK, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL), optimal carrying mass setting library (aspACLD, aspChange), arm movement library (mvSetPulseWidth, etc.)
If this command is used with the movement option, the NEXT option in no longer valid. When <NEXT option> is added and if step stop is executed in the waiting status for the next movement instruction, the robot will stop after movement ends. Care should therefore be taken since a long distance is required to stop.

Remarks: The ROTATEH statement can be rewritten using the MOVE statement. If you rewrite the ROTATE statement of ROTATEH, [<Pass start displacement>]<Rotation angle>[, <Motion option>][NEXT] using the MOVE statement, it can be described as follows.
MOVE L, [<Pass start displacement>]<Current position>+(0, 0, 0, 0, 0, <Rotation angle>)H[, NEXT]
Example: The same as
ROTATEH @P, F1 'MOVE L, @P PO+(0, 0, 0, 0, 0, F1)H:PO is a current position.

Related Terms

ROTATE

Example

```
DEFSNG FF1=50       'Sets the relative rotation angle to 50 degrees.
TAKEARM             'Obtains the robot control priority.
MOVE P,P1           'Moves to point P1 in PTP motion.
CHANGETOOL 1        'Makes 1 of TOOL valid.
ROTATEH @50 FF1     'Sets pass start displacement to 50, and the relative rotation
                    'angle FF1.
CHANGETOOL 0        'Sets TOOL to 0.
```

CURJNT (System Variable)

Function

Obtains the current angle of the robot using type J.

Format

{CURJNT | *}

Explanation

The Joint angles detected by each axis encoder of the robot are stored using type J data.
If the robot is in operation the values are obtained when this instruction is executed.
If the destination pose is obtained use DESTJNT.

Related Terms

DESTJNT, CURPOS, CURTRN

Example

```
                 DIM lj1 As Joint
                 lj1 = CURJNT                    'Assigns  the  current  joint  angle  to
                                lj1.
   6-axis        lj1 = CURJNT + (10, 10, 0, 0, 0, 10)
                                                 'Assign the current joint angles +
                                                 '(10, 10, 0, 0, 0, 10) to lj1
   4-axis        lj1 = CURJNT + (10, 10, 0, 0)
                                                 'Assign the current joint angles +
                                                 '(10, 10, 0, 0) to lj1
```

Notes

During operation with the machine lock function, the joint angles detected by the encoder of each axis are not stored but virtual joint angles (instruction angles) are stored.

CURPOS (System Variable)[Conforms to SLIM]

Function

Obtains the current position in the tool coordinate system using type P.

Format

{CURPOS|*}

Explanation

The current positions detected by each axis encoder in the tool coordinate system are stored using type P data.
If the robot is in operation the values are obtained when this instruction is executed.
If the destination pose is obtained use DESTPOS.

Related Terms

DESTPOS, CURJNT, CURTRN

Example

```
                DEFPOS lp1, lp2
                lp1 = CURPOS     'Assign the current position in the tool
                                 'coordinate system to lp1
                lp2 = *          'Assign the current position in the tool
                                 'coordinate system to lp2
6-axis          lp1 = CURPOS + (100, 200, 0, 10, 10, 0)
                                 'Assign the current position + (100, 200, 0, 10,
                                 '10, 0) in the tool coordinate system to lp1
4-axis          lp1 = CURPOS + (100, 200, 0, 10)
                                 'Assign the current position + (100, 200, 0, 10)
                                 'in the tool coordinate system to lp1
```

Notes

During operation with the machine lock function, the joint angles detected by the encoder of each axis are not stored but virtual joint angles (instruction angles) are stored.

CURTRN (System Variable) [Conforms to SLIM]

Function

Obtains the current position in the tool coordinate system using type T.

Format

{CURTRN | *}

Explanation

The current positions detected by each axis encoder in the tool coordinate system are stored using type T data.
If the robot is in operation the values are obtained when this instruction is executed.
If the destination pose is obtained use DESTTRN.

Related Terms

DESTTRN, CURJNT, CURPOS

Example

```
DEFPOS lp1, lp2
lp1 = CURPOS      'Assigns a position in the current tool coordinate system to
                  'lp1.
Lp2 = *           'Assigns a position in the current tool coordinate system to
                  'lp2.
```

Notes

During machine lock operation, the joint angles detected by the encoder of each axis are not stored but virtual joint angles (instruction angles) are stored.

CUREXJ (Statement)

Function

Gets the current angle of an extended-joint into a floating-point variable.

Format

```
CUREXJ(<JntNumber>)
```

Explanation

CUREXJ reads an angle detected by the encoder of an extended-joint specified by <JntNumber> into a floating-point variable. If the specified joint is in motion, this command will get the current angle of the joint detected when this command executes.

To get the target angle of an extended-joint, use a DESTEXJ command.

Related Terms

CURJNT, CURPOS, CURTRN, and DESTEXJ

Example

```
PROGRAM PRO1
DIM lf1 AS SINGLE
TAKEARM 1
DRIVEA (7,100)        'Move the 7th joint to an angle of 100 degrees.
lf1 = CUREXJ(7)       'Assign current position of 7th joint to lf1.
END
```

Notes

When the machine is locked (Machine Lock state), the CUREXJ command will get not an angle detected by an encoder but a virtual angle (commanded angle).

DESTJNT (System Variable)

Function

Obtains the current movement instruction destination position using type J.
The current position (instruction value) is obtained when the robot stops.

Format

DESTJNT

Explanation

The destination position of the previous movement instruction is stored using a type J data format. Because the data can be obtained with a system variable, the transfer of data to another program using local variables or global variables is not required.
Use CURJNT to obtain the positions detected by each axis encoder.

Related Terms

CURJNT, DESTPOS, DESTTRN

Example

```
                  DEFJNT lj1, lj2
                  MOVE P, @P lj1, NEXT
6-axis            lj2 = DESTJNT+(100, 0, 0, 0, 0, 0) 'In this case, DESTJNT = lj1.
4-axis            lj2 = DESTJNT+(100, 0, 0, 0)       'In this case, DESTJNT = lj1.
```

Notes

A stop position is fetched when the movement stops after the movement stop instruction (refer to Part 2 “5.3.3 INTERRUPT ON/OFF”) is entered.

(Example)

```
    INTERRUPT ON
    MOVE P, J1  ←An interrupt signal turns ON during movement.
    INTERRUPT OFF
    J2=DESTJNT
    J1=J2 is not satisfied.  J2 is a stop position.
```

DESTPOS (System Variable)

Function

Obtains the current movement instruction destination position with type P.
When the robot stops, the current value (instruction value) is obtained.

Format

DESTPOS

Explanation

The destination position of the previous movement instruction is stored with a format of a type P data. Because the data can be obtained with a system variable, it does not require to transfer the data to another program with variables such as local variables or global variables.
Use CURPOS to obtain positions detected with each axis encoder.

Related Terms

CURPOS, DESTJNT, DESTTRN

Example

```
                 DEFPOS lp1, lp2
                 MOVE P, @P lp1, NEXT
  6-axis         lp2 = DESTPOS+(100, 10, 10, 0, 0, 0) 'In this case, DESTPOS = lp1.
  4-axis         lp2 = DESTPOS+(100, 10, 10, 0)       'In this case, DESTPOS = lp1.
```

Notes

A stop position is fetched when the movement stops after the movement stop instruction (refer to Part 2 “5.3.3 INTERRUPT ON/OFF”) is entered .

(Example)
INTERRUPT ON
MOVE P, P1 ←An interrupt signal turns ON during movement.
INTERRUPT OFF
P2=DESTPOS
P1=P2 is not satisfied. P2 is a stop position.

DESTTRN (System Variable)

Function

Obtains the current movement instruction destination position with type T.
When the robot stops, the current position (instruction value) is obtained.

Format

DESTTRN

Explanation

The destination position of the previous movement instruction is stored using a type T data format. Because the data can be obtained with a system variable, it does not require to transfer the data to another program with variables such as local variables or global variables.
Use CURTRN to obtain positions detected with each axis encoder.

Related Terms

CURTRN, DESTJNT, DESTPOS

Example

```
DEFPOS lp1, lp2
MOVE P, @P lp1, NEXT
lp2 = DESTTRN+(100, 10, 10)       'In this case, DESTTRN = lp1.
```

Notes

When the movement stop instruction (refer to Part 2 “5.3.3 INTERRUPT ON/OFF”) is entered and the movement stops, the stop position is stored.

(Example) INTERRUPT ON
MOVE P, T1   ←An interrupt signal turns ON during movement.
INTERRUT OFF
T2=DESTTRN
T1=T2 is not satisfied. T2 is a stop position.

DESTEXJ (Statement)

Function

Gets the target position of an extended-joint invoked by the current motion command into a floating-point variable. If the robot is on halt, this command will get the current position (commanded value).

Format

```
DESTEXJ(<JntNumber>)
```

Explanation

DESTEXJ reads the target position of an extended-joint invoked by the current motion command and specified by <JntNumber> into a floating-point variable.

To get a position detected by the encoder of an individual joint, use a CUREXJ command.

Related Terms

CUREXJ, DESTJNT, DESTPOS, and DESTTRN

Example

```
PROGRAM PRO1
DIM lf1 AS SINGLE
TAKEARM 1
DRIVEA (7,100),NEXT      'Move 7th joint to an angle of 100 degrees.
                         'NEXT advances the process to the next command
                         'before the motion is completed.
lf1 = DESTEXJ(7)         'Assign target angle 100 of previously
                         'commanded motion into lf1.
END
```

Notes

If a robot motion is stopped by entering Stop motion command (Refer to INTERRUPT ON/OFF stated later), the DESTEXJ will get the joint angle where the motion is stopped.

Example

```
INTERRUPT ON
DRIVEA(7,100)            'Interrupt signal turns ON during motion.
                         'The 7th joint stops and the process advances
                         'to the next command.
INTERRUPT OFF
F1=DESTEXJ(7)            'The value of F1 will not be 100 but the value
                         'of the angle where the joint stopped.
```

ARRIVE (Statement) [Ver.1.2 or later]

Function

Defines the motion ratio relative to the programmed full travel distance to the target point in order to make the current program stand by to execute the next step until the robot reaches the defined motion ratio.

Format

ARRIVE <Motionratio>

Explanation

When an usual motion command is executed, any command on the subsequent step cannot be executed until the completion of the current motion or the start of pass motion. If a motion command includes an IOBLOCK or NEXT option, however, the program may proceed to the subsequent step halfway through the execution of the current command. This ARRIVE command makes the program stand by to execute the next step until the robot reaches the defined motion ratio.

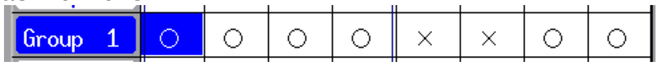
<Motionratio> is the motion ratio relative to the programmed full travel distance instructed by a motion command. The entry range is from 1 to 99 (%) which may be set with numerals, integer variables, or floating-point variables.

ARRIVE takes effect only for robot joints. Therefore, when operating only extended-joints by DRIVE or DRIVEA, this ARRIVE command does not work.

Example

```
Ex1     PROGRAM PRO1
        TAKEARM
        MOVE P, P1, NEXT
        ARRIVE 50           'If the motion ratio reaches 50%,
        SET IO[240]         'turn on IO[240].
        ARRIVE I1           'If the motion ratio reaches the percentage assigned to
        RESET IO[240]       'integer 1, turn off IO[240].
        END
```

```
Ex2(extended-joint)
        If an arm group is set in 4-joint robots as shown below, the program sample
        below works as follows.
```



```
PROGRAM PRO1
TAKEARM 1
DRIVE(1,30)(7,30),NEXT
ARRIVE 50
MOVE P,P0 EX((7,30)),NEXT
ARRIVE 50
DRIVE(7,30),NEXT
ARRIVE 50
END
```

Since the previous command involves robot joints also, the ARRIVE works.

Synchronized motion with extended-joints. So the ARRIVE will works.

Since the previous DRIVE command involves an extended-joint only, the ARRIVE does not work and the process advances to the next line.

Notes

An ARRIVE command defines the motion ratio for the immediately preceding motion command in a TAKEARMed task that has obtained arm-semaphore.

If an ARRIVE command is executed after arm-semaphore is obtained and before execution of a motion command, Error 648C will result.

If an ARRIVE command is executed without arm-semaphore obtained, Error 21F7 will result.

If the robot has stopped instantaneously during execution of an ARRIVE command and the positioning error exceeds 10 mm between the stop position and the restart position at restarting, Error 6486 will result.

If the robot has stopped instantaneously during execution of an ARRIVE command and no motion command has been executed at restarting, then the robot will not reach <Motionratio>, resulting in Error 6489.

The <Motionratio> refers to the ratio relative to the robot travel distance. However, depending upon the robot operating conditions (e.g., speed and acceleration), the actual robot position when the ARRIVE command is completed may vary. On the contrary, changing the <Motionratio> may bring no change of the actual robot position when the ARRIVE command is completed. If you want to use the ARRIVE command and synchronize the robot with the peripherals, check the timing.

If you use an ARRIVE command with any current limit function, the robot may not pass the <Motionratio> due to its limited drive current. If this happens, the program will infinitely wait for the completion of the ARRIVE command. You need to stop the program and resume it.

If you use an ARRIVE command with an INTERRUPT command, any motion command following INTERRUPT ON will not be executed by INTERRUPT SKIP signals but the ARRIVE command will be executed. Therefore, depending upon the timing of the INTERRUPT SKIP signals, the ARRIVE command may be executed for an unexpected motion command or the robot may not pass the <Motionratio>. If either of them happens, the program will infinitely wait for the completion of the ARRIVE command. You need to stop the program and resume it.

In teach check, the NEXT option and IOBLOCK command are invalid, and the ARRIVE command has no meaning.

POSCLR (Statement)

Function

Forcibly restores the current position of a joint to 0 mm or 0 degree.

Format

`POSCLR<JntNumber>`

Explanation

POSCLR forcibly restores the angle of a joint specified by `<JntNumber>` to 0 mm or 0 degree.

This command is applicable only to joints specified for boundless rotation.

Use this command if a joint keeps on rotating in the same direction so that any of the following happens:

- The current position value becomes too large to handle.
- The current position value jumps to a large negative value (due to overflow or wrap-around of a variable value).

To execute this command, you need to get an arm group including a joint whose position is to be restored to its origin.

Related Terms

Example

```
PROGRAM PRO1
TAKEARM 1
DRIVEA (7,100)   'Move 7th joint to an angle of 100 degrees.
POSCLR 7         'Force restore the current angle of the 7th
                 'joint to 0 degree.
END
```

Notes

(1) This command is not applicable to robot joints (Only to extended-joints).

(2) The controller runs this command after the robot has completely stopped. Therefore, any pass motion command written preceding `POSCLR` will cause no pass motion.

(3) The Step Back function cannot return the program control back to any command written preceding the `POSCLR` command.

12.2 Figure Control

CURFIG (System variable)

Function

Obtains the current value of the robot figure.

Format

CURFIG

Explanation

The current robot figure is stored with integers. The relation between the integer value and the figure is listed in the following table.

Robot Figures

Value	Figure (For 6-axes robots)	Figure (For 4-axes robots)
0	SINGLE4 SINGLE6 FLIP ABOVE RIGHTY	SINGLE RIGHTY
1	SINGLE4 SINGLE6 FLIP ABOVE LEFTY	SINGLE LEFTY
2	SINGLE4 SINGLE6 FLIP BELOW RIGHTY	
3	SINGLE4 SINGLE6 FLIP BELOW LEFTY	
4	SINGLE4 SINGLE6 NONFLIP ABOVE RIGHTY	
5	SINGLE4 SINGLE6 NONFLIP ABOVE LEFTY	
6	SINGLE4 SINGLE6 NONFLIP BELOW RIGHTY	
7	SINGLE4 SINGLE6 NONFLIP BELOW LEFTY	
8	SINGLE4 DOUBLE6 FLIP ABOVE RIGHTY	DOUBLE RIGHTY
9	SINGLE4 DOUBLE6 FLIP ABOVE LEFTY	DOUBLE LEFTY
10	SINGLE4 DOUBLE6 FLIP BELOW RIGHTY	
11	SINGLE4 DOUBLE6 FLIP BELOW LEFTY	
12	SINGLE4 DOUBLE6 NONFLIP ABOVE RIGHTY	
13	SINGLE4 DOUBLE6 NONFLIP ABOVE LEFTY	
14	SINGLE4 DOUBLE6 NONFLIP BELOW RIGHTY	
15	SINGLE4 DOUBLE6 NONFLIP BELOW LEFTY	
16	DOUBLE4 SINGLE6 FLIP ABOVE RIGHTY	
17	DOUBLE4 SINGLE6 FLIP ABOVE LEFTY	
18	DOUBLE4 SINGLE6 FLIP BELOW RIGHTY	
19	DOUBLE4 SINGLE6 FLIP BELOW LEFTY	
20	DOUBLE4 SINGLE6 NONFLIP ABOVE RIGHTY	
21	DOUBLE4 SINGLE6 NONFLIP ABOVE LEFTY	

22	DOUBLE4 SINGLE6 NONFLIP BELOW RIGHTY	
23	DOUBLE4 SINGLE6 NONFLIP BELOW LEFTY	
24	DOUBLE4 DOUBLE6 FLIP ABOVE RIGHTY	
25	DOUBLE4 DOUBLE6 FLIP ABOVE LEFTY	
26	DOUBLE4 DOUBLE6 FLIP BELOW RIGHTY	
27	DOUBLE4 DOUBLE6 FLIP BELOW LEFTY	
28	DOUBLE4 DOUBLE6 NONFLIP ABOVE RIGHTY	
29	DOUBLE4 DOUBLE6 NONFLIP ABOVE LEFTY	
30	DOUBLE4 DOUBLE6 NONFLIP BELOW RIGHTY	
31	DOUBLE4 DOUBLE6 NONFLIP BELOW LEFTY	

Related Terms

LETF, Robot figure (Appendix 2)

Example

```
DIM li1 As Integer
li1 = CURFIG  'Assigns the current robot figure to integer type variable li1.
```

FIGAPRL (Function)

Function

Calculates figures at an approach position and a standard position available to move in CP motion.

Format

FIGAPRL (<Reference position>, <Approach length>)

Explanation

For <Reference position>, you can use only a position type.

6-axis

Calculate the figure of <Reference position> which can perform CP motion from the position (approach position) away from <Approach length> to <Reference position> in the -Z direction of the hand coordinate system.
The system automatically searches a figure available for the CP motion from the approach position to <Reference position> in the following procedure order until the movement becomes available.
(1)The figure of <Reference position> (If the figure of <Reference position> isindefinite, the current figure is applied.)
(2) Exchange the wrist figure (flip-non flip).
(3) Exchange an elbow figure (above-below) with a non flip wrist figure.
(4) Set the wrist figure to flip.
(5) Exchange the arm figure (left-right) with the elbow figure above and with the wrist figure non flip.
(6) Set the wrist figure to flip.
(7) Set the elbow figure to below and the wrist to non flip.
(8) Set the wrist figure to flip.
If the system cannot move even after the 8th search, an error of level 6070 (J* software motion limit over) may occur. In this case, change the current position or approach length.

4-axis

Calculate the figure of <Reference position> which can perform CP motion from the position (approach position) away from <Approach length> to <Reference position> in the +Z direction of the base coordinate system.
The system automatically searches a figure available for the CP motion from the approach position to <Reference position> in the following procedure order until the movement becomes available.
(1) The figure of <Reference position> (If the figure of <Reference position> is indefinite, the current figure is applied.)

Related Terms

FIGAPRP, APPROACH

Example

```
6-/4-axis          I1=FIGAPRL(P1, 100.0)
                   LETF  P1,  I1
                   APPROACH  P, P1, 100.0
                   MOVE  L, P1
6-axis             I1=FIGAPRL(P1 + (100.200, 0, 0, 10, 0), 100)
                   LETF  P1,  I1
                   APPROACH  P, P1, 100.0
                   MOVE  L, P1
4-axis             I1=FIGAPRL(P1 + (100.200, 0, 0), 100)
                   LETF  P1,  I1
                   APPROACH  P, P1, 100.0
                   MOVE  L, P1
```

Notes

(1) Use FIGAPRL if the movement action after the approach is the CP motion. If it is PTP motion, use FIGAPRP.

(2) <Reference position> and the approach length used in FIGAPRL should be consistent with <Reference position> and the approach length designated in APPROACH motion. If <Reference position> or approach length is different, an error of level 6070 may occur in CP motion after approach.

(3) Even if you obtained a figure with FIGAPRL, the robot possibly stops in CP motion after approach with the occurrence of an error of level 6080 (command speed limit over). In this case, slow down the speed or set 2 or 3 in optimal load capacity setting mode (refer to p.4-8, "4.6 Control Set of Motion Optimization”). If an error still occurs, adjust the approach length.

FIGAPRP (Function)

Function

Calculates an approach position where the PTP motion is available, and a reference position figure.

Format

FIGAPRP (<Reference position>, <Approach length>)

Explanation

For <Reference position>, you can use only a position type.

6-axis

Calculate the figure of <Reference position> which can perform PTP motion from the position (approach position) away from <Approach length> to <Reference position> in the -Z direction of the hand coordinate system.
The system automatically searches a figure available for PTP motion from the approach position to <Reference position> in the following procedure order until the movement becomes available.
(1)The figure of <Reference position> (If the figure of <Reference position> is indefinite, the current figure is applied.)
(2)Exchange the wrist figure (flip-non flip) and if the 4th axis movement angle from the approach position to <Reference position> is within ±90 degrees, the motion is assumed to be available.
If the 4th axis movement angle exceeds ±90 degrees or the movement is not available, an error of level 6070 (J* software motion limit over) may occur. In this case, change the current position or approach length.

4-axis

Calculate the figure of <Reference position> which can perform PTP motion from the position (approach position) away from <Approach length> to <Reference position> in the +Z direction of the base coordinate system.
The system automatically searches a figure available for PTP motion from the approach position to <Reference position> in the following procedure order until the movement becomes available.
(1) The figure of <Reference position> (If the figure of <Reference position> is indefinite, the current figure is applied.)

Related Terms

FIGAPRL, APPROACH

Example

```
I1 = FIGAPRP(P1, 100.0)
LETF  P1, I1
APPROACH  P, P1, 100.0
MOVE  P, P1
```

```
6-axis      I1 = FIGAPRP(P1 + (100, 200, 0, 0, 0, 10), 100, 0)
4-axis      I1 = FIGAPRP(P1 + (100, 200, 0, 0), 100, 0)
```

Notes

(1) Use FIGAPRP if the movement action after the approach is a PTP motion. Use FIGAPRL if it is CP motion.
(2) <Reference position> and the approach length used in FIGAPRP should be consistent with <Reference position> and the approach length designated in APPROACH motion. If <Reference position> or approach length is different, an error of level 6070 may occur in PTP motion after approach.

12.3 Stop Control

HOLD (Statement) [Conforms to SLIM]

Function

Holds program processing for a time.

Format

HOLD <Message>

Explanation

This statement holds program processing and outputs the contents designated in <Message> to the pendant. For contents of <Message>, refer to the RINTMSG statement.
If you restart the system, it executes the suspended program from the next statement after the HOLD statement.
The number of characters for a message is 60 letters (One-byte character).

Related Terms

DELAY, HALT, STOP

Example

```
DEFINT li1, li2
HOLD li1 + li2 'Holds program processing to set the system to the stop status in step
                  'mode and outputs value of (li1 + li2) to the pendant.
HOLD “stop”    'Holds program processing to set the system to the stop status in step
                  'mode and outputs a character string “stop” to the pendant.
```

Notes

When you use a type F variable and a type D variable as a message, the system displays up to 4 digits after the decimal point.

HALT (Statement) [Conforms to SLIM]

Function

Stops executing a program.

Format

HALT <Message>

Explanation

This statement stops program execution and outputs the contents designated by <Message> to the pendant. For contents of <Message>, refer to the PRINTMSG statement.

If you restart the system, the system starts the program from the first line.

The maximum number of letters available for a message is 60.

Related Terms

DELAY, HOLD, STOP

Example

```
DEFINT li1, li2
HALT li1 + li2 'Stops the program and outputs the value of (li1 + li2) to the pendant.
HALT “end”     'Stops the program and outputs the character string “end” to the
                  'pendant.
```

Notes

If you use a type F variable and a type D variable, the screen shows only 4 digits after the decimal point.

INTERRUPT ON/OFF (Statement)

Function

Interrupts a robot motion.

Format

INTERRUPT {ON|OFF}

Explanation

`INTERRUPT ON` and `INTERRUPT OFF` are used as a pair. In program lines sandwiched by the pair, if an interrupt skip signal turns ON during execution of motion commands, then the robot controller will interrupt execution of the current motion command and proceeds to the next program step.

To execute the `INTERRUPT` command, the task must have gotten an arm group semaphore.

Without `INTERRUPT ON` written earlier, even if an interrupt skip signal turns ON, the controller will not interrupt execution of any motion commands.

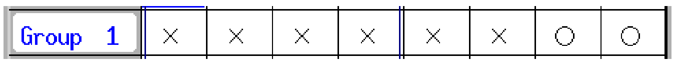
If the program comes to a stop or `GIVEARM` command is executed, then `INTERRUPT` will be set to OFF automatically

Related Terms

Example

```
Ex1     DIM lp1 As Position
        INTERRUPT ON       'Proceeds to the next step after interrupting a motion instruction in
                           'execution when the interruption signal of the special I/O port is turned
                           'ON.
        MOVE P, lp1
        INTERRUPT OFF
```

Ex2



```
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1 involving 7th and 8th
                     'extended-joints.
        INTERRUPT ON
        DRIVE (7,100), (8,30)
                     'If interrupt skip signal turns ON during
                     'execution of this motion command between
                     'INTERRUPT ON/OFF program lines, then the
                     'controller interrupts the command and
                     'proceeds to the next program step.
        INTERRUPT OFF
        END
```

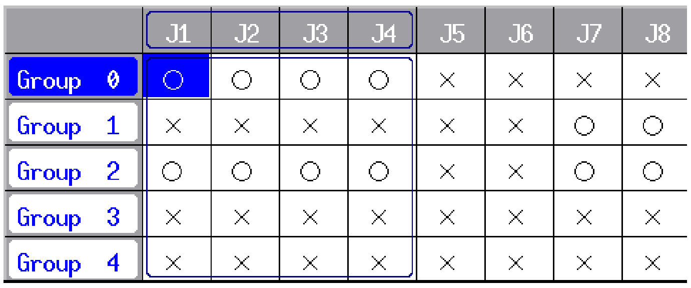
Notes

(1) If the controller executes any relative motion command immediately following an interrupt skip, then the subsequent relative motion will start from the position where the robot stops. In program lines sandwiched by the `INTERRUPT` pair, therefore, use an absolute motion command.

(2) The system does not perform a pass motion during INTERRUPT ON. If the system finds the pass motion designated, all of then are executed in the end motion.

(3) Turning an interrupt skip signal ON interrupts all motion commands sandwiched by the `INTERRUPT` pair and stops all robot motions. Therefore carefully design your robot system for multitasking if you use the `INTERRUPT`.

Program Example



	J1	J2	J3	J4	J5	J6	J7	J8
Group 0	○	○	○	○	×	×	×	×
Group 1	×	×	×	×	×	×	○	○
Group 2	○	○	○	○	×	×	○	○
Group 3	×	×	×	×	×	×	×	×
Group 4	×	×	×	×	×	×	×	×

```
PRO1
TAKEARM 0
INTERRUPT ON
MOVE P,P0      'Motion command
   .
   .
   .
INTERRUPT OFF
END
```

```
PRO2
TAKEARM 1
INTERRUPT ON
DRIVE(7,30)      'Motion command
   .
   .
   .
INTERRUPT OFF
END
```

When the controller is running PRO1 and PRO2 programs concurrently in multitasking mode, if an interrupt skip signal turns ON, then the controller will interrupt all commands (`MOVE` in PRO1 and `DRIVE` in PRO2 in the above example) running in both programs and make the programs simultaneously proceed to the next step.

12.4 Speed Control

SPEED (Statement) [Conforms to SLIM]

Function

Specifies the internal composite speed of joints included in a currently held arm group.

Format

SPEED <Movement speed>

Explanation

The `<SpeedRatio>` should be the target ratio (%) of the maximum internal composite speed of joints in a currently held arm group. The entry range is from 0.1 to 100 of a real number.

NOTE: If less than 0.1 is specified, no error will occur, but the actual speed may differ from the specification. If 0 or less is specified, an error will result.

The actual speed value is (external × internal ÷ 100).

If SPEED is set, then ACCEL and DECEL are also changed.

	CP control	**PTP control**
Speed setting	SPEED	JSPEED
Acceleration setting	ACCEL	JACCEL
Deceleration setting	DECEL	JDECEL
Current speed obtain	CURSPD	CURJSPD
Current acceleration obtain	CURACC	CURJACC
Current deceleration obtain	CURDEC	CURJDEC

Example: If you write `SPEED 50`, the following will be set automatically:

```
JSPEED 50 (same value as SPEED)
ACCEL 25 (SPEED*SPEED÷100)
JACCEL 25 (SPEED*SPEED÷100)
DECEL 25 (SPEED*SPEED÷100)
JDECEL 25 (SPEED*SPEED÷100)
```

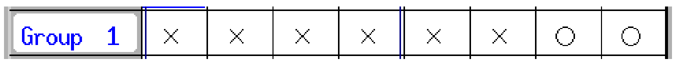
If you write `SPEED` without getting any arm group beforehand, an error will result.

Related Terms

ACCEL, DECEL, JSPEED, MPS

Example

```
Ex1     DIM li1 As Integer
        SPEED 100      'Sets the movement speed of the hand to 100.
        SPEED li1/100  'Sets the movement speed of the hand to a value of (li1/100).

Ex2(extended-joint)
```



Group 1	×	×	×	×	×	×	○	○

```
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1 (including 7th and 8th joints).
        SPEED 100    'Specify composite speed of joints (7th and 8th)
                     'involved in Arm Group 1.
        END
```

JSPEED (Statement)

Function

Specifies the internal speed of individual joints included in a currently held arm group.

Format

JSPEED <Movement speed>

Explanation

The `<JointSpeedRatio>` should be the target ratio (%) of the maximum internal speed of individual joints in a currently held arm group. The entry range is from 0.1 to 100 of a real number.

NOTE: If less than 0.1 is specified, no error will occur, but the actual speed may differ from the specification. If 0 or less is specified, an error will result.

The actual speed value is (external × internal ÷ 100).

If JSPEED is set, then JACCEL and JDECEL are also changed.

Example: If you write `JSPEED 50`, the following will be set automatically:

```
JACCEL 25 (JSPEED*JSPEED÷100)
JDECEL 25 (JSPEED*JSPEED÷100)
```

If you write `JSPEED` without getting any arm group beforehand, an error will result.

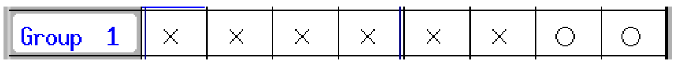
Related Terms

CURJSP, JACCEL, JDECEL, SPEED

Example

```
Ex1     DIM li1 As Integer
        JSPEED 100     'Sets the movement speed of an axis to 100.
        JSPEED li1/100 'Sets the movement speed of an axis to the value of (li1/100).
```

```
Ex2(extended-joint)
```



Group 1	×	×	×	×	×	×	○	○

```
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1 (involving 7th and 8th joints).
        JSPEED 100   'Specify speed of joints (7th and 8th) involved
                     'in Arm Group 1.
        END
```

ACCEL (Statement) [Conforms to SLIM]

Function

Designates internal acceleration and internal deceleration.

Format

ACCEL <Acceleration> [,<Deceleration>]

Explanation

The `<AccelerationRatio>` or `<DecelerationRatio>` should be the target ratio (%) of the maximum internal composite acceleration or deceleration of joints in a currently held arm group, respectively. The entry range is from 0.0001 to 100 of a real number.

NOTE: If less than 0.0001 is specified, no error will occur, but the actual acceleration/deceleration may differ from the specification. If 0 or less is specified, an error will result.

The actual acceleration/deceleration values are (external × internal ÷ 100).

If the speed is changed, the acceleration/deceleration values are automatically changed to a value expressed by (SPEED^2 ÷ 100).

Note: If an axis speed interlock is valid in the "Using condition" parameter and ACCEL is set, JACCEL becomes the same value.

Example: If you write `ACCEL 50`, the `JACCEL 50` (same value as `ACCEL`) will be set automatically:

```
JACCEL 25 (JSPEED*JSPEED÷100)
JDECEL 25 (JSPEED*JSPEED÷100)
```

If you write `ACCEL` without getting any arm group beforehand, an error will result.

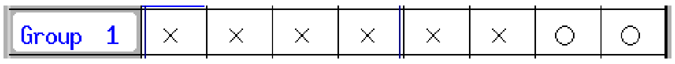
Related Terms

DECEL, SPEED

Example

```
Ex1     DEFINT li1, li2
        ACCEL 100              'Sets the acceleration to 100.
        ACCEL 50, 25           'Sets the acceleration to 50 and the deceleration to 25.
        ACCEL li1/100, li2/100 'Sets the acceleration to (li1/100) and the deceleration to (li2/100).
```

Ex2



Group 1	×	×	×	×	×	×	○	○

```
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1 (involving 7th and 8th joints).
        ACCEL 100    'Specify composite acceleration ratio of joints
                     '(7th and 8th) involved in Arm Group 1.
        END
```

JACCEL (Statement) [Conforms to SLIM]

Function

Specifies the internal acceleration and deceleration of individual joints included in a currently held arm group.

Format

JACCEL <Axis acceleration> [,<Axis deceleration>]

Explanation

This statement designates the maximum internal axis acceleration/deceleration rates (%) to <Axis acceleration>/<Axis deceleration> in a range from 0.0001 to 100.

NOTE: If less than 0.0001 is specified, no error will occur, but the actual acceleration/deceleration may differ from the specification. If 0 or less is specified, an error will result.

The actual axis acceleration/deceleration values are (external × internal ÷ 100).

If the axis speed is changed, the axis acceleration/deceleration values are automatically changed to a value expressed by ($\text{JSPEED}^2 \div 100$).

If you write `JACCEL` without getting any arm group beforehand, an error will result.

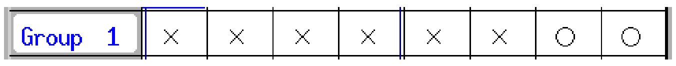
Related Terms

JDECEL, JSPEED, SPEED

Example

```
Ex1    DEFINT li1, li2
       JACCEL 100               'Sets the axis acceleration to 100.
       JACCEL 50, 25            'Sets the axis acceleration to 50 and the axis
                                'deceleration to 25.
       JACCEL li1/100, li2/100  'Sets the axis acceleration to the value of (li1/100)
                                'and the axis deceleration to that of (li2/100).
```

Ex2



Group 1								
	×	×	×	×	×	×	○	○

```
       PROGRAM PRO1
       TAKEARM 1    'Get Arm Group 1 (involving 7th and 8th joints).
       JACCEL 100   'Specify acceleration ratio of joints (7th and 8th)
                    'involved in Arm Group 1.
       END
```

DECEL (Statement) [Conforms to SLIM]

Function

Specifies the internal composite deceleration of joints involved in a currently held arm group.

Format

DECEL <Deceleration>

Explanation

The `<DecelerationRatio>` should be the target ratio (%) of the maximum internal composite deceleration of joints in a currently held arm group. The entry range is from 0.0001 to 100 of a real number.

NOTE: If less than 0.0001 is specified, no error will occur, but the actual deceleration may differ from the specification. If 0 or less is specified, an error will result.

The actual deceleration value is (external × internal ÷ 100).

If the speed is changed, the deceleration value is automatically changed to a value expressed by ($SPEED^2 \div 100$).

Note: If an axis speed interlock is valid in the "Using condition" parameter and DECEL is set, JDECEL becomes the same value.

Example: If you write `DECEL 50`, the `JDECEL 50` (same value as `DECEL`) will be set automatically:

If you write `DECEL` without getting any arm group beforehand, an error will result.

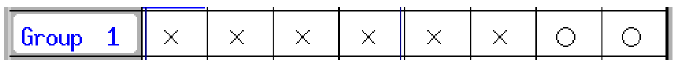
Related Terms

ACCEL, SPEED

Example

```
Ex1     DIM li1 As Integer
        DECEL 100              'Sets the deceleration to 100.
        DECEL li1/100          'Sets the deceleration to the value of (li1/100).
```

Ex2(extended-joint)



Group 1	×	×	×	×	×	×	○	○

```
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1 involving 7th and 8th joints.
        DECEL 100    'Specify deceleration ratio of joints (7th and 8th)
                     'in Arm Group 1.
        END
```

JDECEL (Statement) [Conforms to SLIM]

Function

Specifies the internal deceleration ratio of individual joints included in a currently held arm group.

Format

JDECEL <Axis deceleration>

Explanation

The `<DecelerationRatio>` should be the target ratio (%) of the maximum internal deceleration of individual joints in a currently held arm group. The entry range is from 0.0001 to 100 of a real number.

NOTE: If less than 0.0001 is specified, no error will occur, but the actual deceleration may differ from the specification. If 0 or less is specified, an error will result.

The actual axis deceleration value is (external $\times$ internal $\div$ 100).

If the axis speed is changed, the system automatically changes the axis deceleration to a value obtained by ($JSPEED^2 \div 100$).

If you write `JDECEL` without getting any arm group beforehand, an error will result.

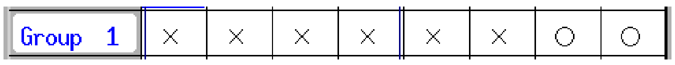
Related Terms

JACCEL, JSPEED, SPEED

Example

```
Ex1     DIM li1 As Integer
        JDECEL 100              'Sets the axis deceleration to 100.
        JDECEL li1/100          'Sets the axis deceleration to the value of (li1/100).
```

```
Ex2(extended-joint)
```



```
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1 involving 7th and 8th joints.
        JDECEL 100   'Specify deceleration ratio of joints (7th and 8th)
                     'involved in Arm Group 1.
        END
```

CURACC (System Variable)

Function

Gets the current internal composite acceleration of joints included in a currently held arm group.

Format

CURACC

Explanation

Executing this command in a task holding no arm group will return a value of 100.

Related Terms

ACCEL, DECEL, CURDEC, CURJACC, CURJDEC, CURJSPD, CURSPD

Example

```
Ex1    DIM lf1 As Single
       lf1 = CURACC          'Assigns the current acceleration value to lf1.
       ACCEL CURACC * 0.5    'Sets the acceleration to 50% of the current speed.

Ex2(extended-joint)
       PROGRAM PRO1
       TAKEARM 1    'Get Arm Group 1.
       ACCEL 70     'Specify composite acceleration of joints included in
                    'Arm Group 1 at 70.
       I0=CURACC    'Return current acceleration 70 of Arm Group 1 to I0.
       END
```

CURJACC (System Variable)

Function

Gets the current internal acceleration of individual joints included in a currently held arm group.

Format

CURJACC

Explanation

Executing this command in a task holding no arm group will return a value of 100.

Related Terms

JACCEL, JDECEL, JSPEED, SPEED, CURDEC, CURJDEC, CURJSPD, CURSPD

Example

```
Ex1    DIM lf1 As Single
       lf1 = CURJACC          'Assigns the current axis acceleration value to lf1.
       JACCEL CURJACC * 0.5   'Sets the axis acceleration to 50% of the current speed.

Ex2(extended-joint)
       PROGRAM PRO1
       TAKEARM 1    'Get Arm Group 1.
       JACCEL 70    'Specify acceleration of individual joints included
                    'in Arm Group 1 at 70.
       I0=CURJACC   'Return current acceleration 70 of Arm Group 1 to I0.
       END
```

CURDEC (System Variable)

Function

Gets the current internal composite deceleration of joints included in a currently held arm group.

Format

CURDEC

Explanation

Executing this command in a task holding no arm group will return a value of 100.

Related Terms

ACCEL, DECEL, CURACC, CURJACC, CURJDEC, CURJSPD, CURSPD

Example

```
Ex1    DIM lf1 As Single
       lf1 = CURDEC           'Assigns the current deceleration value to lf1.
       DECEL CURDEC * 0.5     'Sets the deceleration to 50% of the current value.

Ex2(extended-joint)
       PROGRAM PRO1
       TAKEARM 1    'Get Arm Group 1.
       DECEL 70     'Specify composite deceleration of joints included
                    'in Arm Group 1 at 70.
       I0=CURDEC    'Return current deceleration 70 of Arm Group 1 to I0.
       END
```

CURJDEC (System Variable)

Function

Gets the current internal deceleration of individual joints included in a currently held arm group.

Format

CURJDEC

Explanation

Executing this command in a task holding no arm group will return a value of 100.

Related Terms

JACCEL, JDECEL, JSPEED, SPEED, CURACC, CURDEC, CURJACC, CURJSPD, CURSPD

Example

```
Ex1     DIM lf1 As Single
        lf1 = CURDEC           'Assigns the current deceleration value to lf1.
        DECEL CURDEC * 0.5     'Sets the deceleration to 50% of the current value.

Ex2(extended-joint)
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1.
        JDECEL 70    'Specify current deceleration of individual joints
                     'included in Arm Group at 70.
        I0=CURJDEC   'Return current deceleration 70 of Arm Group 1 to I0.
        END
```

CURJSPD (System Variable)

Function

Gets the current internal speed of individual joints included in a currently held arm group.

Format

CURJSPD

Explanation

Executing this command in a task holding no arm group will return a value of 100.

Related Terms

JSPEED, CURACC, CURDEC, CURJACC, CURJDEC, CURSPD

Example

```
Ex1     DIM lf1 As Single
        lf1 = CURJSPD           'Assigns the current axis movement speed value to lf1.
        JSPEED CURJSPD * 0.5    'Sets the axis movement speed to 50% of the current value.

Ex2(extended-joint)
        PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1.
        JSPEED 70    'Specify speed of individual joints in Arm Group 1
                     'at 70.
        I0=CURJSPD   'Return current speed 70 of Arm Group 1 to I0.
        END
```

CURSPD (System Variable)

Function

Gets the current internal composite speed of joints included in a currently held arm group.

Format

CURSPD

Explanation

Executing this command in a task holding no arm group will return a value of 100.

Related Terms

CURACC, CURDEC, CURJSPD, CURJACC, CURJDEC

Example

```
Ex1     DIM lf1 As Single
        lf1 = CURJSPD          'Assigns the current axis movement speed.
        JSPEED CURJSPD * 0.5   'Sets the axis movement speed to 50% of the current value.

Ex2     PROGRAM PRO1
        TAKEARM 1    'Get Arm Group 1.
        SPEED 70     'Specify composite speed of joints included in
                     'Arm Group 1 at 70.
        I0=CURSPD    'Return current speed 70 of Arm Group 1 to I0.
        END
```

CUREXTACC (System Variable) [Ver.1.4 or later]

Function

Obtains the current value of the external acceleration

Format

CUREXTACC

Explanation

Stores the external acceleration currently set

Related Terms

ACCEL, DECEL, CUREXTDEC

Example

```
DIM lf1 As Single
lf1 = CUREXTACC
ACCEL CUREXTACC * 0.5
```

CUREXTDEC (System Variable) [Ver.1.4 or later]

Function

Obtains the current value of the external deceleration

Format

CUREXTDEC

Explanation

Stores the external deceleration currently set

Related Terms

ACCEL, DECEL, CUREXTACC

Example

```
DIM lf1 As Single
lf1 = CUREXTDEC
DECEL CUREXTDEC * 0.5
```

CUREXTSPD (System Variable) [Ver.1.4 or later]

Function

Obtains the current value of the external speed

Format

CUREXTSPD

Explanation

Stores the external speed currently set

Related Terms

SPEED

Example

```
DIM lf1 As Single
lf1 = CUREXTSPD
SPEED CUREXTSPD * 0.5
```

12.5 Time Control

DELAY (Statement) [Conforms to SLIM]

Function

Suspends program processing for a designated period time.

Format

DELAY <Delay time>

Explanation

The program processing stops until the time designated by <Delay time> elapses.
<Delay time> is expressed in ms, however, the actual delay time changes in increments of 1/60. If multiple tasks are processed at the same time, the delay time may possibly be longer than the designated value.

Related Terms

HOLD, WAIT

Example

```
DIM li1 As Integer
DELAY 100              'Waits until 100ms(0.1s) elapses.
DELAY li1 + 10         'Waits until time of  (li1 + 10) elapses.
```

Notes

When using delay time, if an instantaneous stop during execution of an instruction is executed and the system is restarted, the delay time will elapse even during suspension.

WAIT (Statement) [Conforms to SLIM]

Function

Stops program processing based on a condition.

Format

WAIT <Conditional expression> [,<Timeout time> **[,<Storage variable>]]**

Explanation

This statement stops program processing until <Conditional expression> is satisfied.
If <Timeout time> is set, control stops the execution of a WAIT statement after the designated time elapses and proceeds to the next command. Infinite stoppage can be avoided by using this.
<Timeout time> is expressed in ms.
The reevaluation interval for monitoring <Conditional expression> or <Timeout time> depends on the priority of the task.

In Version 1.8 or later, when <Storage variable> is set, the WAIT command will assign TRUE (1) or FALSE (0) to the designated variable if control passes out of the WAIT statement by the satisfied <Conditional expression> or by timeout, respectively.

Related Terms

DELAY

Example

```
DEFINT li1, li2, li3, li4, li5
WAIT li1 = 1        'Waits until li1 = 1 is satisfied.
WAIT li2 = 0, 2000  'Waits until li2 = 0 is satisfied.  Even if it is not satisfied
                    'after 2 seconds, the system proceeds to the next statement.
WAIT li3 = li4, li5 'Waits until li3 = li4 is satisfied.  Even if it is not
                    'satisfied after the time of
                    'li5, the system proceeds to the next statement.
WAIT IO[10] = ON    'Waits until the 10th IO comes ON.
```

[Version 1.8 or later]

```
WAIT li3 = li4, li5, li6  'Wait until li3 = li4. If the conditional expression
                          'is not satisfied within li5 period, pass control to
                          'the next statement and assign FALSE to li6.
                          'If satisfied within li5 period, pass control to the
                          'next statement and assign TRUE to li6.
```

Notes

When using timeout time, if an instantaneous stop during execution of an instruction is executed and the system is restarted, the designated time will elapse even during suspension.

12.6 Coordinate Transformation

CHANGETOOL (Statement)

Function

Changes the tool coordinate system.

Format

CHANGETOOL <Tool coordinate system number>

Explanation

This statement changes the tool coordinate system to the coordinate system designated by <Tool coordinate system number>.
This declaration is valid until the next CHANGETOOL statement is executed.
Numbers from 0 to 63 are valid for <Tool coordinate system number>.
Tool 0 is a mechanical interface coordinate system.

Related Terms

TOOL, TOOLPOS

Example

```
DIM li1 As Integer
DIM lp1 As Position
Li1 = 1
Lp1 = (10, 10, 5, 0, 9, 0, 1)
TOOL 1, lp1             'Declares the tool coordinate system designated by position type
                        'variable lp1.
CHANGETOOL li1          'Changes to the tool coordinate system denoted by the tool
                        'coordinate system  number designated in li1.
```

Notes

If TAKEARM is executed, TOOL0 is set.

CHANGEWORK (Statement)

Function

Changes the user coordinate system.

Format

CHANGEWORK <User coordinate system number>

Explanation

This statement changes the user coordinate system to the coordinate system designated by <User coordinate system number>.
This declaration is valid until the next CHANGEWORK statement is executed.
Numbers from 0 to 7 are valid for <User coordinate system number>.
User 0 signifies the base coordinate system.

Related Terms

WORK, WORKPOS

Example

```
DIM li1 As Integer
DIM lp1 As Position
Li1 = 1
Lp1 = (10, 10, 5, 0, 9, 0, 1)
WORK 1, lp1            'Declares the user coordinate system designated by position
                       'type variable lp1 in user coordinate system 1.
CHANGEWORK li1         'Changes to the user coordinate system denoted by the user
                       'coordinate system number designated in li1.
```

Notes

If TAKEARM is executed, WORK0 is set.
(However, this is not applicable to a subroutine.)

CURTOOL (System Variable) [Ver.1.4 or later]

Function

Obtains the TOOL number currently set.

Format

CURTOOL

Explanation

Stores the TOOL number currently set.

Related Terms

TOOL, CHANGETOOL, TOOLPOS

Example

```
DIM li1 As Integer
li1 = CURTOOL
TOOL CURTOOL+Il, Pl
CHANGETOOL CURTOOL+Il
Pl = TOOLPOS (CURTOOL)
```

CURWORK (System Variable) [Ver.1.4 or later]

Function

Obtains the WORK number currently set.

Format

CURWORK

Explanation

Stores the WORK number currently set.

Related Terms

WORK, CHANGEWORK, WORKPOS

Example

```
DIM li1 As Integer
li1 = CURWORK
WORK CURWORK+Il, Pl
CHANGEWORK CURWORK+Il
Pl = WORKPOS (CURWORK)
```

12.7 Interference Check

SETAREA (Statement)

Function

Selects the area where an interference check is performed.

Format

SETAREA <Interference check area number>

Explanation

<Interference check area number> selects the interference check area previously defined. The valid area numbers are from 0 to 7. This must be declared beforehand using the AREA command.
An interference check is performed during the time after the SETAREA command is executed and prior to the execution of the RESETAREA command. Once interference is detected, the RESETAREA command is executed. The next interference is not detected until SETAREA is executed again.
An interference check can be executed simultaneously in a maximum of 8 areas specified using the area numbers from 0 to 7, if the SETAREA command has been executed.
The SETAREA command does not initialize the designated I/O declared by the AREA command. In such a case, the I/O is directly set in the input/output control statement and initialization of the RESETAREA command is required.

Related Terms

AREA, RESETAREA, AREAPOS, AREASIZE

Example

```
DIM lp1 As Position
DIM lv1 As Vector
Lp1 = (10, 10, 5, 0, 9, 0, 1)
Lv1 = (50, 10, 50)
AREA 2, lp1, lv1, 104, 1   'Declares I/O number 104 in the area specified by lv1
                           'at the position specified by lp1 in area number 2.
SETAREA 2                  'Makes the area check of number 2 valid.
RESETAREA 2                'Initializes the area check of number 2.
```

RESETAREA (Statement)

Function

Initializes an interference check.

Format

RESETAREA <Initializing area number>

Explanation

This statement resets the I/O set when interference was detected and makes an interference check invalid.
When the input/output control statement directly resets an I/O even if interference occurs again, the I/O will not be set. To check interference again, execute the RESETAREA command to initialize, and then execute the SETAREA command again.
Valid area numbers are from 0 to 7.

Related Terms

AREA, SETAREA, AREAPOS, AREASIZE

Example

```
DIM lp1 As Position
DIM lv1 As Vector
Lp1 = (10, 10, 5, 0, 9, 0, 1 )
Lv1 = (50, 10, 50 )
AREA 2, lp1, lv1, 104, 1    'Declares I/O number 104 specified by lv1 at the
                            'position specified by lp1 in area number 2.
SETAREA 2                   'Makes the area check of number 2 valid.
RESETAREA 2                 'Initializes the area check of number 2.
```

Notes

Since the robot is operating in a multitasking operation environment, if RESET is instructed just after SETAREA execution to check an area, there is a possibility that RESET may be executed prior to SETAREA due to the timing.

12.8 Supervisor Task

INIT [Ver.1.7 or later]

Function

Turns on motors, carrier out CAL, and sets the speed according to the preset supervisor task parameters.

Format

```
INIT
```

Explanation

(1) If the supervisor task is disabled ("Not Use Supervisor TASK" parameter is selected), then the `INIT` command causes no operation.

(2) If the supervisor task is enabled ("Use Supervisor TASK" parameter is selected), then the `INIT` command causes the following:

When the INIT run mode is set to "without motor on and CAL":

If the INIT speed has been set to 10 or 100, this command sets the external speed of the robot controller to 10 or 100, respectively.

When the INIT run mode is set to "with motor on and CAL":

If the INIT speed has been set to 10 or 100, this command sets the external speed of the robot controller to 10 or 100, respectively, turns motors on and carries out CAL.

Example

```
                         '!TITLE "Initialization"
PROGRAM TSR1
      INIT               'Turn motors on, execute CAL,
                         'and set the speed.
END
```

Notes

(1) Do not concurrently run robot operation programs and task programs which run only the INIT command in an infinite loop.

(2) During execution of an INIT command, the status display of running programs may show " On standby." Be careful with restart of those programs.

(3) Do not run INIT commands simultaneously in more than one supervisor task.

12.9 Internal Servo Data

GetSrvData (System Variable) [Ver.1.5 or later]

Function

Gets the internal servo data of robot joints.

Format

`<InternalServoData> = GetSrvData(<DataNumber>)`

Explanation

`GetSrvData` gets the internal servo data specified by `<DataNumber>` into `<InternalServoData>`.

`<InternalServoData>` is a joint type data of robot. `<DataNumber` should be any of the following:

`<DataNumber>`	`<InternalServoData>`
1	Current motor speed (Actual speed) in rpm
2	Motor rotation angle error in pulses
4	Motor current absolute value in ratio (%) to the rated value
5	Motor torque control value (excluding torque offset) in ratio (%) to the rated value
8	Joint position or angle control value in mm or degrees
17	Tool-end speed (3 position elements only in the work coordinates) in mm/s
18	Tool-end positioning speed (3 position elements only in the work coordinates) in mm
19	Tool-end speed (3 position elements only in the tool coordinates) in mm/s
20	Tool-end positioning speed (3 position elements only in the tool coordinates) in mm

Related Terms

`GetJntData`

Notes

(1) Data numbers other than those given above are reserved. Do not use any other number other than the above, although no error will result if you specify any number up to 30.

(2) If you attempt to fetch the servo data when the single-joint servo data monitor is running, the fetching process may become very slow. Take care when using the single-joint servo data monitor.

(3) If you change `<DataNumber>`, the modification may take time. Do not change it so frequently.

(4) Execute this command in a TAKEARMed task that holds an arm semaphore. If not in a TAKEARMed task, the error "21F7: Cannot take arm semaphore" will result.

Example

```
defjnt vel
defsng absv,xvel,yvel,zvel
vel=GetSrvData(17)                    'Get tool-end speed.
xvel=JOINT(1,vel)                     'Select X component in work coordinates.
yvel=JOINT(2,vel)                     'Select Y component in work coordinates.
zvel=JOINT(3,vel)                     'Select Z component in work coordinates.
absv = SQR(xvel*xvel+yvel*yvel+zvel*zvel) 'Calculate total tool-end speed.
```

GetJntData (System Variable) [Ver.1.5 or later]

Function

Gets the internal servo data of a specified joint.

Format

```
<JntInternalServoData> = GetJntData(<DataNumber>,<JntNumber>)
```

Explanation

`GetJntData` gets the internal servo data (specified by `<DataNumber>`) of a joint specified by `<JntNumber>` into `<JntInternalServoData>`.

`<JntInternalServoData>`.is a floating point type data of the specified joint. `<DataNumber>` should be any of the following:

`<DataNumber>`	`<JntInternalServoData>`
1	Current motor speed (Actual speed) in rpm
2	Motor rotation angle error in pulses
4	Motor current absolute value in ratio (%) to the rated value
5	Motor torque control value (excluding torque offset) in ratio (%) to the rated value
8	Joint position or angle control value in mm or degrees

Related Terms

`GetSrvData`

Notes

(1) Data numbers other than those given above are reserved. Do not use any other number other than the above, although no error will result if you specify any number up to 30.

(2) If you attempt to fetch the servo data when the single-joint servo data monitor is running, the fetching process may become very slow. Take care when using the single-joint servo data monitor.

(3) If you change `<DataNumber>`, the modification may take time. Do not change it so frequently.

(4) Execute this command in a TAKEARMed task that holds an arm semaphore. If not in a TAKEARMed task, the error "21F7: Cannot take arm semaphore" will result.

Example

```
defsng vel
vel=GetJntData(1,7)      'Get motor speed of J7.
```

12.10 Particular Control

This section describes newly added commands (statements) that have been used as servo-related PAC libraries. Using these commands will improve the efficiency of program development.

ST_aspACLD (Statement) [Ver.1.9 or later]

Function

Changes the internal load condition values. There are the mass of payload, noted in grams (g), and the payload center of gravity, noted in millimeters (mm), for the load condition values. Designate both of them. (See **Note1**.)

Format

```
ST_aspACLD <Mass of payload>, <Payload center of gravity coordinate X >,
<Payload center of gravity coordinate Y>, <Payload center of gravity
coordinate Z>
```

Note1: For 4-axes robot, <Payload center of gravity coordinate Z> is replaced with <Inertia of payload (kgcm^2)>

Explanation (Example for 6-axces robot)

The mass of payload is the mass of load (tool and workpiece) mounted on the 6th axis of the robot. This unit is designated as (g).

For the load center of gravity position, designate the payload center of gravity using the TOOL0 coordinates. The unit is millimeters (mm). (See **Note1**.)

The reference position of the TOOL0 coordinates is in the center of the 6th axis flange. For component Y, the direction is from the flange center to the pinhole of ϕ5H7 (orientation vector direction). For component Z, the direction is vertical to the flange surface through the flange center (approach vector direction). For component X, the direction of the X axis (normal vector direction) is the right-hand coordinate system, when the orientation vector is set to the Y axis and the approach vector is set to the Z axis. Refer to "4.7 Control Set of Motion Optimization in User Preferences."

Even if you change only one of the four values of the mass of payload, the payload center of gravity X6, the payload center of gravity Y6, and payload center of gravity Z6 ,describe all of the 4 values again.

It takes about 0.1 sec. to switch the load condition values. Frequently switching the load condition may cause operational delays. Do not change the mode during pass motion while near an obstacle because the path locus may shift. This may delay switching if you change the load condition values.

Related Terms

Refer to the Programmer's Manual, " 4.7 Control Set of Motion Optimization in User Preferences."

Example

```
ST_aspACLD 8500,-50,100,80    'Sets the internal payload conditions.
                              'Mass of payload:8500(g), Payload center of
                              'gravity component X: -50(mm), component Y:
                              '100(mm),component Z: 80(mm)
```

Notes

(1) For the mass of payload, designate it with a numerical value of the specified range for each robot type. If you designate a value out of this range, the error message "60d2 Mass of payload out of setting range" will be displayed.

(2) For the payload center of gravity, enter it so that it satisfies the specified range for each robot type. If it is out of this range, the error message "60d2 Mass of payload out of setting range" will be displayed.

(3) When setting the internal payload condition, observe the following rule relative to the external payload condition. If not, the error message "60d2 Mass of payload out of setting range" will be displayed.

0.5 x External payload condition ≤ Internal payload condition ≤ External payload condition

ST_aspChange (Statement) [Ver.1.9 or later]

Function

Selects the internal mode for proper control setting of motion optimization.

Format

```
ST_aspChange <Mode>
```

Explanation

This statement switches the mode for control setting of motion optimization.

<Setting value>

0 → Invalid
1 → Valid only for PTP
2 → Valid only for CP
3 → Valid for both PTP and CP.

It takes about 0.1 sec. to switch the load condition values. Frequently switching the load condition may cause operational delays. Do not change the mode during pass motion, near an obstacle because the path locus may shift.

This may delay switching if you change the load condition values.

Related Terms

Refer to the Programmer's Manual, " 4.7 Control Set of Motion Optimization in User Preferences."

Example

```
ST_aspChange 1            'Sets the internal mode in the control sets of
                          'motion optimization to 1.
```

Notes

For <Mode>, designate it with a numerical value between 0 and 3. If it is out of this range, the error message "6003 Excess in effective value range" will be displayed.

ST_SetGravity (Statement) [Ver.1.9 or later]

Function

Compensates for the static load (gravity torque) applied to each joint and attains balance with gravity torque.

Format

```
ST_SetGravity
```

Explanation

Each joint of the robot undergoes downward static load (gravity torque) due to earth gravity. The effects of the gravity torque will vary depending upon the mass of payload (tool and workpiece), the payload center of gravity, and robot figures.

If you limit the motor output torque by setting its drive current limit so that the limited torque becomes lower than the gravity torque, then the robot will move down towards the earth. To prevent it, this statement compensates the limited torque for the gravity torque, keeping the balance of torque.

Related Terms

ST_SetCurLmt, ST_ResetGravity, ST_SetGrvOffset

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm-semaphore. If this command is executed without arm-semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) Set the mass of payload and the payload center of gravity accurately. Otherwise, the robot may move down due to gravity if you set a low current limit value (e.g., less than 30). For the entry procedure of the mass of payload and the payload center of gravity, refer to the PROGRAMMER'S MANUAL "4.7 Setting the Master Control Parameters in User Preferences."

(3) f you do not know the accurate mass of payload or its center of gravity or if the robot moves down in spite of accurate settings, then use the gravity offset function (ST_SetGrvOffset) that compensates for the gravity compensation value.

(4) If you set the gravity offset setting to "1" on the teach pendant, the gravity offset function becomes enabled. The setting made on the teach pendant will take effect immediately following the completion of calibration after the robot controller is turned on.

Example

```
ST_SetGravity               'Enable the gravity compensation function.
Delay 100                   'Wait for gravity compensation to go into
                            'effect.
ST_SetCurLmt 2,30           'Set the current limit value of the 2nd axis
                            'to 30%.
```

ST_ResetGravity (Statement) [Ver.1.9 or later]

Function

Disables the balance setting between the limited motor torque and gravity torque, which is made with `ST_SetGravity`.

Format

```
ST_ResetGravity
```

Explanation

This command disables the balance setting between the motor torque limited by the current limit function and gravity torque.

Related Terms

ST_ResetCurLmt, ST_SetEralw

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm-semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) If this command is executed when the current limit function is enabled, Error "665B Cannot disable the gravity compensation" will result. Disable the current limit function and then try it again.

(3) If you set the gravity offset setting to "0" on the teach pendant, the gravity offset function becomes disabled. If you do it when the current limit function is enabled, Error 665b will result, as in step (2).

Example

```
ST_ResetGravity
```

ST_SetGrvOffset (Statement) [Ver.1.9 or later]

Function

Compensates the torque of each joint programmed with `ST_SetGravity` for gravity torque.

Format

```
ST_SetGrvOffset
```

Explanation

Each joint of the robot undergoes downward static load (gravity torque) due to earth gravity. Although gravity compensation command `ST_SetGravity` allows you to adjust the balance between the limited torque and gravity torque, the balance may be off-balance due to the difference between the mass of payload you set and the actual one.

This offset function presumes the gravity torque when the robot is on halt and calculates the gravity offset value.

Related Terms

ST_SetCurLmt, ST_SetGravity, ST_ResetGrvOffset

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This command should be executed when the motor power is on and the robot is on halt. If it is executed when the motor power is off, Error "6006 Motor power is off" will result. If it is executed when the robot is in motion, Error "600B Robot is running" will result.

(3) If the robot attitude is greatly changed after execution of this command, execute this command again.

(4) If the current limit reset value in User Preferences is set to any value other than "1", "3", "5", or "7", the compensation value will be reset to "0" when you turn on the motor power.

Example

```
ST_SetGrvOffset
```

ST_ResetGrvOffset (Statement) [Ver.1.9 or later]

Function

Disables the gravity offset function.

Format

```
ST_ResetGrvOffset
```

Explanation

Disables the gravity offset function which has been enabled with `ST_SetGrvOffset`.

Related Terms

ST_SetGrvOffset

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore.

If this command is executed without arm semaphore obtained, Error 21F7 "Arm semaphore cannot be fetched." will result.

(2) This command should be executed when the robot is on halt. If it is executed when the robot is in motion, Error "600B Robot is running" will result. This command is executable even when the motor power is off.

Example

```
ST_ResetGrvOffset
```

ST_SetCurLmt (Statement) [Ver.1.9 or later]

Function

Sets the limit of motor current to be applied to the specified axis.

Format

```
ST_SetCurLmt <AxisNumber>, <Value>
```

Explanation

Limits the value of motor current (torque) to be applied to the axis specified by `<AxisNumber>` to the value specified by `<Value>`. This command is useful when you want to limit torque that a workpiece will undergo during insertion or butting jobs.

The maximum value of `<Value>` is 100 which refers to the motor rating current.

If any value exceeding the allowable limit for each axis is specified, the value will be automatically limited to that allowable limit.

Set a value of 1 or above. If 0 or a negative number is set, Error "6003 Excess in effective value range" will result.

Related Terms

ST_ResetCurLmt, ST_SetGravity, ST_SetGrvOffset, ST_SetEralw

Notes

(1) When the motor current is limited with ST_SetCurLmt, the robot cannot move at the maximum speed or acceleration. Use ST_SetCurLmt only at steps that need the current limit. When using ST_SetCurLmt, decrease the acceleration.

(2) If a workpiece bumps against something at high speed even if the driving force is controlled by limiting the motor current, the impact is considerable due to the inertia of the workpiece, end-effector and axis. Set the current limit just before the workpiece comes into contact with the object and reduce the speed.

(3) Set the current limit when the robot is on halt. If it is set during a pass motion, an error is likely to occur.

(4) Execute this command in a TAKEARMed task that has obtained arm-semaphore. If this command is executed without arm-semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(5) If the current limit reset value in User Preferences is set to any value other than "1", "3", "5", or "7", the compensation value will be reset to "0" when you turn on the motor power.

To make the current limit function effective immediately after switching on the motor power, set the current limit reset value to "1."

6-axis

(6) When setting the current limit, be sure to enable the gravity compensation function. If the current limit is set when the gravity compensation function is disabled, Error "665A Cannot set current limit" will result. For the gravity compensation function, refer to `ST_SetGravity`.

6-axis (7) Set the mass of payload and the payload center of gravity accurately.

Otherwise, the robot may move down due to gravity if you set a low current limit value (e.g., less than 30). For the entry procedure of the mass of payload and the payload center of gravity, refer to the Programmer's Manual, " 4.7 Control Set of Motion Optimization in User Preferences."

6-axis (8) If the current limit reset value is set to "1," the robot might move down due to gravity the moment you turn on the motor power. Reset the current limit by executing `ST_ResetCurLmt` when the motor power is off and then switch on the motor power.

6-axis (9) If you do not know the accurate mass of payload or its center of gravity or if the robot moves down in spite of accurate settings, then use the gravity offset function (`ST_SetGrvOffset`) that compensates for the gravity compensation value.

4-axis HS-E (10) When setting the current limit to the Z-axis or the T-axis of the 4-axis robot without an air balance mechanism, the Z-axis may move down or the T-axis may rotate if you set a low current limit value. Set current limit after execution the gravity compensation function (`ST_SetZBalance`) for the Z and the T-axis.

Example

6-axis
```
ST_SetGravity        'Enable the gravity offset.
ST_SetGrvOffset      'Compensate the gravity offset value
ST_SetEralw 2, 20    'Set the allowable deviation of the 2nd axis to 20
                     'degrees
ST_SetCurLmt 2, 30   'Set the current limit of the 2nd axis to 30%
```

4-axis
```
ST_SetEralw 2, 20    'Set the allowable deviation of the 2nd axis to 20
                     'degrees
ST_SetCurLmt 2, 30   'Set the current limit of the 2nd axis to 30%
```

4-axis HS-E
```
ST_SetZBalance       'Set the gravity compensation value of the Z-axis
ST_SetEralw 3, 100   'Set the allowable deviation of the Z-axis to 100 mm
ST_SetEralw 4, 30    'Set the allowable deviation of the T-axis to 30
                     'degrees
ST_SetCurLmt 3, 10   'Set the current limit of the Z-axis to 10%
ST_SetCurLmt 4, 10   'Set the current limit of the T-axis to 10%
```

ST_ResetCurLmt (Statement) [Ver.1.9 or later]

Function

Resets the motor current limit of the specified axis.

Format

```
ST_ResetCurLmt <AxisNumber>
```

Explanation

`ResetCurLmt` releases the drive current limit set for the motor of a joint specified by `<AxisNumber>`. The motor drive current limit and positioning error allowances will revert to the defaults.

[For Ver. 1.4 or earlier]	If you set "0" to `<AxisNumber>`, the drive current limit set for all joints will revert to the default.
[For Ver. 1.5 or later]	If you set "0" to `<AxisNumber>`, the drive current limit set for all joints involved in an arm group semaphore held by the current task running `ST_ResetCurLmt`, will revert to the default.

Related Terms

ST_SetCurLmt, ST_ResetEralw

Notes

(1) When resetting the current limit, this command carries out deviation elimination process. If there is angle deviation due to external force, the time required for deviation elimination process will vary depending upon the set speed and acceleration. To shorten the time, set higher speed and acceleration.

(2) The command can be executed even when the motor power is off. For resetting the current limit when motor power is off, run the following program after finishing the task that is obtaining arm semaphore.

```
PRO999
TAKEARM
ST_ResetCurLmt 0
END
```

(3)

[For Ver. 1.4 or earlier]	Execute this command in a TAKEARMed task that has got robot arm semaphore. If you specify any joints not in the arm semaphore to `<AxisNumber>`, then error "21F7 Cannot take arm semaphore" will result.
[For Ver. 1.5 or later]	Execute this command in a TAKEARMed task that has got an arm group. If you specify any joints not included in the arm group to `<AxisNumber>`, then error "27D* Cannot take J* semaphore" will result.

Example

```
ST_ResetCurLmt 0          'Reset the current limit of all the axes.
ST_ResetGrvOffset 0       'Disable the gravity offset function.
```

ST_SetEralw (Statement) [Ver.1.9 or later]

Function

Modifies the allowable deviation of the specified axis.

Format

```
ST_SetEralw <AxisNumber>, <Value>
```

Explanation

Sets the allowable deviation of the axis specified by `<AxisNumber>`. Use this command if angle deviation occurs due to external force when the current limit function is enabled.

The `<Value>` is the arm joint angle and specified in degrees.

"Allowable deviation value" refers to the allowable range of the "Error 611* J* excess error" which will occur for safety if the servo deviation exceeds the specified value.

During assembling operation with the current limit enabled, if servo deviation occurs due to external force, the above error may occur. To avoid this, you may use this command temporarily to increase the allowable deviation value.

This command can also be used to reduce the allowable deviation value for helping quick detection of the downward movement of the robot due to gravity when the current limit function is enabled.

Related Terms

ST_SetCurLmt, ST_ResetEralw

Notes

(1) Run this command in a TAKEARMed task which has obtained arm semaphore.

If the command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

Example

```
ST_SetEralw 2,20           'Set the permissible deviation of the 2nd
                           'axis to 20 degrees.
```

ST_ResetEralw (Statement) [Ver.1.9 or later]

Function

Resets the allowable deviation value of the specified axis to the initial value.

Format

```
ResetEralw <AxisNumber>
```

Explanation

Resets the allowable deviation value of the axis specified by `<AxisNumber>` to the default value.

If `<AxisNumber>` is specified to "0," the allowable deviation values of all the axes will be reset.

[For Ver. 1.4 or earlier]	If you set "0" to `<AxisNumber>`, the positioning error allowance set for all joints will revert to the default.
[For Ver.1.5 or later]	If you set "0" to `<AxisNumber>`, the positioning error allowance set for all joints involved in an arm group semaphore held by the current task running `ST_ResetEralw`, will revert to the default.

Related Terms

ST_ResetCurLmt, ST_SetEralw

Notes

(1) [For Ver. 1.4 or earlier] Execute this command in a TAKEARMed task that has got robot arm semaphore. If you specify any joints not in the arm semaphore to `<AxisNumber>`, then error "21F7 Cannot take arm semaphore" will result.

[For Ver. 1.5 or later] Execute this command in a TAKEARMed task that has got an arm group. If you specify any joints not included in the arm group to `<AxisNumber>`, then error "27D* Cannot take J* semaphore" will result.

(2) Like this command, execution of `ST_ ResetCurLmt` will also reset the allowable deviation values to the initial values.

Example

```
ST_ResetEralw 0            'Return the allowable deviation values of all
                           'axes to initial values.
```

ST_OnSrvLock (Statement) [Ver.1.9 or later]

Function

Servo-locks a specified axis (exclusively designed for four-axis robots).

Format

```
ST_OnSrvLock <specified axis>
```

Explanation

Provides a function similar to that of the `ON SVLOCK` instruction in the conventional language.

Servo lock means that robot arms are controlled and their positions are held.

Related Term

ST_OffSrvLock

Notes

(1) Set servo lock as the robot stops. If it is set during path operation, an error may occur.

(2) Execute this command in a TAKEARMed task which has obtained arm semaphore.

If the command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

Example

```
ST_OnSrvLock 1              'Servo lock for the 1st axis.
ST_OnSrvLock 0              'Servo lock for all axes.
```

ST_OffSrvLock (Statement) [Ver.1.9 or later]

Function

Releases servo lock for the specified axis. (Exclusively designed for four-axis robots)

Format

```
ST_OffSrvLock <specified axis>
```

Explanation

Provides a function similar to the `OFF SVLOCK` instruction in the conventional language.

Servo lock refers to the state where the robot arm is controlled to keep its position. When it is released, the robot arm is not kept in its position but moved by an external force applied to it.

Related Term

ST_OnSrvLock

Notes

(1) No operation command can be executed for an axis for which servo lock is released.

(2) Set release of servo lock while the robot is in stopped state. If set during path operation, an error may result.

(3) Execute this command in a TAKEARMed task that has obtained arm semaphore. If the command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(4) If bit 2 of the value set to "25: Current limit reset" in the operating conditions is "0" (initial value), servo lock release is reset (to cause servo lock) upon motor power on. To validate servo lock release immediately after motor power on, set "+2" as the current limit reset value.

Note: Setting example of operating condition "25: Current limit reset"

	PWM	SVLock	Curlmt	
	*	*	*	
If only SVLock is effective	0	1	0	= 2
If all is effective	1	1	1	= 7

Example

```
ST_OffSrvLock 1          'Release servo lock for the 1st axis.
```

ST_SetCompControl (Statement) [Ver.1.9 or later]

Function

Enables the compliance function (exclusively designed for 6-axis robots)

Format

```
ST_SetCompControl
```

Explanation

Enables the compliance function. Enables the compliance conditions set by `ST_SetFrcLimit`, `ST_SetCompRate`, and `ST_SetFrcCoord`.

Related Terms

ST_SetFrcLimit, ST_SetCompRate, ST_SetFrcCoord, ST_ResetCompControl, ST_SetCompFControl

Notes

(1) You will receive an error "60F5 Compliance control is not executable", when this statement is executed while the gravity offset is disabled and the current limiting is enabled. Execute again after you enable the gravity offset and disable the current limiting. See `ST_ResetCurLmt` and `ST_SetGravity` for disabling the current limiting and enabling the gravity offset respectively.

(2) The compliance control will not be enabled while motors are off. The compliance control will be disabled when you turned off motors under the compliance control.

(3) Execute this command in a TAKEARMed task has obtained arm semaphore. If this command is executed without arm semaphore obtained, an error "21F7 Cannot take arm semaphore" will result.

(4) Execute this command when your robot is on halt. Executing this command in a pass motion will cause an end motion. If executing this command in a pass motion causes an error "600B Robot is running," then stop the robot with a Delay command and then execute this command.

(5) If the robot is moved by any external force under compliance control, an error "611* J* excess error" may occur. In such a case, change the allowable deviation by using the `ST_SetEralw`.

(6) This command should not be executed when the robot undergoes any force, e.g., in contact with any surrounding facility. To enable the compliance control in such conditions, use the `ST_SetCompFControl`.

(7) If the robot posture greatly changes after execution of the ST_SetCompControl, then an error may be generated in the gravity offset compensation value and the robot may move in the direction of gravity. If the posture changes greatly under compliance control, use the `ST_ResetCompControl` to disable the compliance control and then execute the `ST_SetCompControl` again to enable the compliance control.

Example

```
ST_SetFrcCoord 1            'Set the compliance control coordinate system.
ST_SetFrcLimit 100, 0, 100, 100, 100, 100
                            'Set the compliance rate
ST_SetCompControl           'Enable the compliance control
ST_SetEralw 1, 90           'Set the allowable deviation
```

ST_SetCompFControl (Statement) [Ver.1.9 or later]

Function

Enables the compliance control function (exclusively designed for 6-axis robots).

Format

```
ST_SetCompFControl
```

Explanation

Enables the compliance control function, just like the `ST_SetCompControl`. Note that this command will not execute the gravity offset compensation.

Related Terms

ST_SetCompControl

Notes

(1) If this command is executed when the gravity offset is disabled and the current limiter is disabled, then an error "60F5 Cannot execute compliance control" will occur.

(2) Executing this command when the motors are off will not enable the compliance control. Under the compliance control, turning off the will disable the compliance control.

(3) Execute this command in a TAKEARMed task has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(4) Execute this command when the robot is on halt. Executing this command in a pass motion will cause an end motion. If executing this command in a pass motion causes Error "600B Robot is running," then stop the robot with a Delay command and then execute this command.

(5) Set the payload exactly. If the setting and actual payload differ, the robot arm may fall down in the direction of gravity. To prevent such a fall, execute the `ST_SetGrvOffset`.

Example

```
ST_SetGrvOffset            'Calculate the gravity offset compensation
                           'value.
ST_SetFrcCoord 1           'Set the compliance control coordinate system.
ST_SetFrcLimit 100, 0, 100, 100, 100, 100
                           'Set the compliance rate
ST_SetCompFControl         'Enable the compliance control
```

ST_ResetCompControl (Statement) [Ver.1.9 or later]

Function

Disables the compliance control function (exclusively designed for 6-axis robots).

Format

```
ST_ResetCompControl
```

Explanation

Disables the compliance control function.

Related Terms

ST_SetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) Execute this command when the robot is on halt. Executing this command in a pass motion will cause an end motion. If executing this command when the robot is in motion immediately stops the robot or causes Error "612* J* overcurrent," then set the value to "1" or stop the robot by using the Delay command.

(3) If the robot comes to a momentary stop during execution of this command so that you perform a Step back or Program reset, then Error "60F9 Improper compliance set/reset operation" will occur.

(4) If you use ST_SetEralw to change the allowable deviation values while the compliance control is enabled, the allowable deviation values will return to their initial values. The allowable deviation values may not be reset to the initial values when an error occurs while executing ST_ResetCompControl. If this is the case, use ST_ResetEralw to initialize the allowable deviation values after disabling the compliance control.

(5) If Error " 608* J* command speed limit over" occurs, use the ST_aspChange to change the optimal load capacity mode to 2 or 3 before execution of the ST_ResetCompControl. After execution of this command, return the optimal load capacity mode to the previous value.

Example

```
ST_ResetCompControl        'Disable the compliance control.
ST_ResetEralw              'Initialize the allowable deviation values
```

ST_SetFrcCoord (Statement) [Ver.1.9 or later]

Function

Selects a force limiting coordinate system (exclusively designed for 6-axis robots).

Format

```
ST_SetFrcCoord <Set value>
```

Explanation

Selects a coordinate system for force limiting values specified by ST_SetFrcLimit and ST_SetCompRate. You can use a set value 0 for the base coordinate system, a set value 1 for the tool coordinate system, and a set value 2 for the work coordinate system of your robot.

Related Terms

ST_SetFrcLimit, ST_SetCompRate, ST_SetFrcCoord, ST_ResetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This statement is not executable under the compliance control. If this command is executed under the compliance control, Error " 60FA Not Executable in compliance control" will result.

(3) When you specify 1 for <Set value> to select the tool coordinate system, the tool coordinate will be the tool coordinate for enabling the compliance control (executing ST_SetCompControl). When you use the changetool command to change the tool coordinate while the compliance control is enabled, the force limiting coordinate will not be changed.

(4) When you specify 2 for <Set value> to select the work coordinate system, the work coordinate will be the work coordinate for enabling the compliance control (executing ST_SetCompControl). When you use the changework command to change the work coordinate while the compliance control is enabled, the force limiting coordinate will not be changed.

(5) The set value will be initialized to 0 (the base coordinate system) after the controller is turned on.

Example

```
ST_SetFrcCoord 1           'Set the compliance coordinate system to
                           'the tool coordinate
Changetool 2               'Set the tool coordinate to tool2
ST_SetFrcLimit 100, 0, 100, 100, 100, 100
                           'Set the compliance rate
ST_SetCompControl          'Set the compliance rate in Y direction
                           'of the tool 2 coordinate system to 0% and
                           'enable the compliance control
```

ST_SetFrcLimit (Statement) [Ver.1.9 or later]

Function

Sets the force limiting rates (exclusively designed for 6-axis robots).

Format

```
ST_SetFrcLimit <Limiting rate along X>, <Limiting rate along Y>, <Limiting
rate along Z>, <Limiting rate about X>, <Limiting rate about Y>, <Limiting
rate about Z>
```

Explanation

Sets the force limiting rates along and about X, Y, and Z axes of a coordinate system specified by ST_SetFrcCoord.

Setting ranges from 0 to 100. Up to two decimal places are valid.

Related Terms

ST_ResetFrcLimit, ST_SetFrcCoord, ST_SetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This statement is not executable under the compliance control. If this command is executed under the compliance control, Error " 60FA Not Executable in compliance control" will result.

(3) All the set values for along and around the X, Y and Z-axes will be initialized to 100 after the controller is turned on.

Example

```
ST_SetFrcCoord 1           'Set the compliance coordinate system to
                           'the tool coordinate
ST_SetFrcLimit 100, 0, 100, 100, 100, 100
                           'Set the compliance rates
ST_SetCompControl          'Set the compliance rate in Y direction
                           'of the tool coordinate system to 0% and
                           'enable the compliance control
```

ST_ResetFrcLimit (Statement) [Ver.1.9 or later]

Function

Initializes the force limiting rates (exclusively designed for 6-axis robots).

Format

```
ST_ResetFrcLimit
```

Explanation

Initializes the force limiting rates. All rates along and about X, Y, and Z axes are set to 100%.

Related Terms

ST_SetFrcLimit

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This statement is not executable under the compliance control. If this command is executed under the compliance control, Error " 60FA Not Executable in compliance control" will result.

Example

```
ST_ResetCompControl        'Disable compliance control
ST_ResetFrcLimit           'Initialize the force limiting rates
```

ST_SetCompRate (Statement) [Ver.1.9 or later]

Function

Sets the compliance rates under the compliance control (exclusively designed for 6-axis robots).

Format

```
ST_SetCompRate <Compliance along X>, <Compliance along Y>, <Compliance
along Z>, <Compliance about X>, <Compliance about Y>, <Compliance about Z>
```

Explanation

Sets the compliance rates along and about X, Y, and Z axes of a coordinate system specified by SetFrcCoord.

Setting ranges from 0 to 100 and 0 gives the maximum compliance. Up to two decimal places are valid.

Related Terms

ST_ResetCompRate, ST_SetFrcCoord, ST_SetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This statement is not executable under the compliance control. If this command is executed under the compliance control, Error " 60FA Not Executable in compliance control" will result.

(3) All the set values for along and around the X, Y and Z-axes will be initialized to 100 after the controller is turned on.

Example

```
ST_SetFrcCoord 1           'Set the force limiting coordinate system to
                           'the tool coordinate
ST_SetCompRate 100, 0, 100, 100, 100, 100
                           'Set the compliance rate
ST_SetCompControl          'Set the compliance rate in Y direction of
                           'the tool coordinate system to 0% and enables
                           'the compliance control
```

ST_ResetCompRate (Statement) [Ver.1.9 or later]

Function

Initializes the compliance rates (exclusively designed for 6-axis robots).

Format

```
ST_ResetCompRate
```

Explanation

Initializes the compliance rates along and about X, Y, and Z axes to 100%.

Related Terms

ST_SetCompRate

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This statement is not executable under the compliance control. If this command is executed under the compliance control, Error " 60F9 Improper compliance set/reset operation" will result.

Example

```
ST_ResetCompControl         'Disable the compliance control
ST_ResetCompRate            'Initialize the compliance rates
```

ST_SetFrcAssist (Statement) [Ver.1.9 or later]

Function

Sets the force assistance under the compliance control (special compliance control function statement) (exclusively designed for 6-axis robots).

Format

```
SetFrcAssist <Force assistance along X>, <Force assistance along Y>,
<Force assistance along Z>, <Moment assistance about X>, <Moment
assistance about Y>, <Moment assistance about Z>
```

Explanation

Sets the force assistance along and the moment assistance about X, Y, and Z-axes of a coordinate system specified by ST_SetFrcCoord. The maximum set value is 10% of the maximum force limiting value.

The unit for the force setting is [N]. The unit for the moment setting is [Nm]. Up to one decimal place is valid.

Related Terms

ST_ResetFrcAssist, ST_SetFrcCoord, ST_SetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) Your robot may move toward the direction to which the force assistance and the moment assistance are applied. If this is the case, reduce the set values.

(3) All the set values for along and around the X, Y and Z-axes will be initialized to 0 after the controller is turned on.

Example

```
ST_SetFrcCoord 1           'Set the force limiting coordinate system to
                           'the tool coordinate
ST_SetFrcAssist -30, 0, 0, 0, 0, 0
                           'Set the force assistance to 30 [N] toward -X
                           'direction
ST_SetFrcLimit 0, 100, 100, 100, 100, 100
                           'Set the force limiting rates
ST_SetCompControl          'Enable the compliance control function.
                           'Force limiting in X direction is 0% and a
                           'force of 30 [N] is applied toward -X
                           'direction
```

ST_ResetFrcAssist (Statement) [Ver.1.9 or later]

Function

Initializes the force assistance (special compliance control function statement) (exclusively designed for 6-axis robots).

Format

```
ST_ResetFrcAssisit
```

Explanation

Initializes the force assistance along and the moment assistance about X, Y, and Z-axes of a coordinate system specified by ST_SetFrcCoord are set to 100%.

Related Terms

ST_SetFrcAssist

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

Example

```
STResetCompControl          'Disable the compliance control
ST_ResetFrcAssist           'Initialize the force assistance and the
                            'moment assistance
```

ST_SetCompJLimit (Statement) [Ver. 1.9 or later]

Function

Sets the current limit under the compliance control (special compliance control function statement) (exclusively designed for 6-axis robots).

Format

```
ST_SetCompJLimit <J1 current limit>, <J2 current limit>, <J3 current
limit>, <J4 current limit>, <J5 current limit>, <J6 current limit>
```

Explanation

Sets the current limit under the compliance control. The rated current of a motor corresponds to 100. When you use SetFrcLimit to set 0 to all the directions, the motor currents are limited to values less than the setting.

Setting ranges from 0 to 100.

Related Terms

ST_ResetCompJLimit, ST_SetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) The set values will be initialized and all the current limits will be 0 after the controller is turned on.

(3) When you use ST_SetCompJLimit to set relatively large values, your robot may present an oscillation resulting in an error. If this is the case, use ST_SetCompRate and ST_SetDumpRate to adjust the compliance.

Example

```
ST_SetFrcCoord 1           'Set the force limiting coordinate system to
                           'the tool coordinate
ST_SetCompJLimit 30, 0, 0, 0, 0, 0
                           'Set the current limit for J1 to 30%
ST_SetFrcLimit 0, 100, 100, 100, 100, 100
                           'Set the force limiting rates
ST_SetCompControl          'Enable the compliance control function.
```

ST_ResetCompJLimit (Statement) [Ver.1.9 or later]

Function

Initializes the current limit under the compliance control (special compliance control function statement) (exclusively designed for 6-axis robots).

Format

```
ST_ResetCompJLimit
```

Explanation

Initializes the current limit under the compliance control and set 0 to all axes.

Related Terms

ST_SetCompJLimit, ST_SetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

Example

```
ST_ResetCompControl        'Disable the compliance control
ST_ResetCompJLimit         'Initialize the current limits
```

ST_SetCompVMode (Statement) [Version 1.9 or later]

Function

Sets the velocity control mode under the compliance control (special compliance control function statement) (exclusively designed for 6-axis robots).

Format

```
ST_SetCompVMode
```

Explanation

Enables the compliance velocity control mode when ST_SetCompControl is executed.

Related Terms

ST_ResetCompVMode

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

Example

```
ST_SetCompVMode            'Enable the compliance velocity control mode
ST_SetCompControl          'Enable the compliance control
```

ST_ResetCompVMode (Statement) [Ver.1.9 or later]

Function

Disables the velocity control mode under the compliance control (special compliance control function statement) (exclusively designed for 6-axis robots).

Syntax

```
ST_ResetCompVMode
```

Explanation

Disables the compliance velocity control mode when ST_SetCompControl is executed.

Related Terms

ST_SetCompControl

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

Example

```
ST_ResetCompVMode          'Disable the compliance velocity control mode
ST_SetCompControl          'Enable the compliance control
```

ST_SetCompEralw (Statement) [Ver.1.9 or later]

Function

Sets the allowable deviation values of the position and the posture of the tool tip under the compliance control (exclusively designed for 6-axis robots).

Format

```
ST_SetCompEralw <Allowable deviation along X>, <Allowable deviation Y>,
<Allowable deviation Z>, <Allowable deviation X>, <Allowable deviation Y>,
<Allowable deviation Z>
```

Explanation

Sets the allowable deviation values of the position and the posture of the tool tip under the compliance control. The unit for the allowable deviation along X, Y, and Z is (mm), and the unit for the allowable deviation about X, Y, and Z is (degree). Up to one decimal place is valid.

Related Terms

ST_ResetCompEralw, ST_SetFrcCoord

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) The initial values of allowable deviation are 100 (mm) along X, Y, and Z and 30 (degree) about X, Y, and Z. The maximum value about X, Y, and Z-axes is 175 (degree). If you set larger values than the maximum value, you will receive an error " 6003 Excess in effective value range ".

(3) If the position or the posture deviation of the tool tip exceeds the allowable value, you will receive an error " 60F8 Compliance deviation excess error ".

(4) The coordinate system used for setting the deviation is the one set by ST_SetFrcCoord. When you specify as STSetFrcCoord 1, the setting coordinate system for ST_SetCompEralw is the tool coordinate system.

Example

```
ST_SetFrcCoord 2            'Set the force limiting coordinate system to
                            'the work coordinate system
ST_SetFrcLimit 100, 0, 100, 100, 100, 100
                            'Set the force limiting rate for the Y
                            'direction of the work coordinate system to 0%
ST_SetCompEralw 10, 150, 10, 5, 5, 5
                            'Set the allowable deviation values along X
                            'and Z of the work coordinate to 10 (mm),
                            'along Y to 150 (mm), and about X, Y, and Z to
                            '5 (degree).
```

ST_ResetCompEralw (Statement) [Ver.1.9 or later]

Function

Initializes the allowable deviation values of the position and the posture of the tool end under the compliance control (exclusively designed for 6-axis robots).

Format

```
ST_ResetCompEralw
```

Explanation

Initializes the allowable deviation values of the position and the posture of the tool tip under the compliance control. The initial values of allowable deviation are 100 (mm) along X, Y, and Z and 30 (degree) about X, Y, and Z.

Related Terms

ST_SetCompEralw

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

Example

```
ST_ResetCompEralw
```

ST_SetDampRate (Statement) [Ver.1.9 or later]

Function

Sets the damping rates under the compliance control (exclusively designed for 6-axis robots).

Fomat

```
ST_SetDampRate <DampRate along X>, <DampRate along Y>, <DampRate along Z>,
<DampRate about X>, <DampRate about Y>, <DampRate about Z>
```

Explanation

Sets the damping rates along and about X, Y, and Z axes on the coordinate system specified by `ST_SetFrcCoord`.

The entry range is from 0 to 100. Zero gives the maximum damping. Up to two decimal places are valid.

Related Terms

ST_ResetDampRate, ST_SetFrcCoord, ST_SetCompRate

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore " will result.

(2) This statement is not executable under the compliance control. If this command is executed under the compliance control, Error " 60FA Not Executable in compliance control" will result.

(3) When the controller is turned on, all the damping rates will revert to the initial values (100).

(4) Do not set the damping rates to less than the compliance rates specified by the `ST_SetCompRate`. Doing so will cause the robot to vibrate; in some cases, the robot will stop due to an error.

(5) If the `ST_SetCompRate` is executed after execution of the `ST_SetDampRate`, then the damping rates will change to the setting made by `ST_SetCompRate`.

Example

```
ST_SetFrcCoord 1           'Set the compliance coordinate system to
                           'the tool coordinate system
ST_SetCompRate 100, 0, 100, 100, 100, 100
                           'Set the compliance rate
ST_SetDampRate 100, 20, 100, 100, 100, 100
                           'Set the damping rate
ST_SetCompControl          'Set the compliance rate and the damping rate
                           'in Y direction of the tool coordinate system
                           'to 0% and 20%, respectively, and enable the
                           'compliance control
```

ST_ResetDampRate (Statement) [Ver.1.9 or later]

Function

Initializes the damping rates under the compliance control (exclusively designed for 6-axis robots).

Format

```
ST_ResetDampRate
```

Explanation

Initializes all damping rates along and about X, Y, and Z axes to 100.

Related Terms

ST_SetDampRate

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore " will result.

(2) This command is not executable under the compliance control. If this command is executed under the compliance control, then Error " 60FA Not Executable in compliance control" will result.

Example

```
ST_ResetDampRate           'Initialize the damping rates
```

ST_SetZBalance (Statement) [Ver.1.9 or later]

Function

Sets the gravity compensation value of the Z and T axes (exclusively designed for 4-axis robots).

Format

```
ST_SetZBalance
```

Explanation

Having no air balance mechanism, the Z and T axes of a 4-axis robot undergo a downward static load (gravity torque). If you set the current limit value less than the gravity torque in the current limit function, then the Z axis will move down and the T axis will rotate.

This command estimates the gravity torque when the robot is on halt and sets the gravity compensation value, preventing unexpected Z-axis downward movement and T-axis rotation.

Related Terms

ST_ResetZBalance, ST_SetCurLmt

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This command should be executed when the motor power is on and the robot is on halt. If it is executed when the motor power is off, Error "6006 Motor power is off" will result. If it is executed when the robot is in motion, Error "600B Robot is running" will result.

(3) If the work weight changes after execution of this command, the preset gravity compensation value will deviate. You need to execute this command again.

Example

```
ST_SetZBalance
```

ST_ResetZBalance (Statement) [Ver.1.9 or later]

Function

Disables the gravity compensation function (exclusively designed for 4-axis robots).

Format

```
ST_ResetZBalance
```

Explanation

Disables the gravity compensation function set by the `ST_SetZBalance` for Z and T axes of 4-axis robots.

Related Terms

ST_SetZBalance

Notes

(1) Execute this command in a TAKEARMed task that has obtained arm semaphore. If this command is executed without arm semaphore obtained, Error "21F7 Cannot take arm semaphore" will result.

(2) This command should be executed when the robot is on halt. If it is executed when the robot is in motion, Error "600B Robot is running" will result. This command is executable even when the motor power is off.

Example

```
ST_ResetZBalance
```

Chapter 13

Input/Output Control Statements

This chapter provides an explanation of the commands used to control various I/Os.

13.1 I/O Port

IN (Statement)[Conforms to SLIM]

Function

Reads data from the I/O port designated by an I/O variable.

Format

IN <Arithmetic variable name> = <I/O variable>

Explanation

This statement assigns the I/O port data designated by <I/O variable> to the variable designated by <Arithmetic variable name>.
The <I/O variable> is declared using a DEFIO statement or an I/O type variable.

Related Terms

OUT, DEFIO

Example

```
DEFINT Li1,  Li2
DEFIO samp1 = INTEGER, 220  'Declares samp1 as an INTEGER type I/O variable
                            'beginning at port 220.
IN Li1 = samp1              'Assigns the samp1 data to Li1.
IN Li2 = IO[240]            'Assigns the port 240 data to Li2.
OUT samp1 = Li1             'Outputs the Li1 data from the port declared in samp1.
OUT IO[240] = Li2           'Outputs the Li2 data from port 240.
```

OUT (Statement) [Conforms to SLIM]

Function

Outputs data to the I/O port designated by an I/O variable.

Format

OUT <I/O variable> = <Output data>

Explanation

This statement outputs the value of <Output data> to the port address designated by <I/O variable>.
<I/O variable> is declared using a DEFIO statement or I/O type variable.

Related Terms

IN, DEFIO

Example

```
DEFINT Li1,  Li2
DEFIO samp1 = INTEGER, 220  'Declares samp1 as an INTEGER type I/O variable
                            'beginning at port 220.
IN Li1 = samp1              'Assigns the samp1 data to Li1.
IN Li2 = IO[240]            'Assigns the port 240 data to Li2.
OUT samp1 = Li1             'Outputs theLi1 data from the port declared in samp1.
OUT IO[240] = Li2           'Outputs the Li2 data from port 240.
```

IOBLOCK ON/OFF (Statement) [Conforms to SLIM]

Function

Concurrently executes a non-motion instruction such as an I/O or calculation instruction during execution of a motion instruction.

Format

IOBLOCK {ON|OFF}

Explanation

Use IOBLOCK ON and IOBLOCK OFF as a pair. Non-motion instructions such as plural I/O instructions or calculation instructions that follow a motion instruction, can be executed concurrently during execution of a robot motion instruction.
When a robot motion instruction is issued, the controller interrupts the concurrent execution and waits the currently executed operation (pass start in the case of pass motion) to be completed. Then, the controller executes the next motion instruction. If a non-motion instruction follows the next motion instruction, it is also concurrently executed with the motion instruction. If IOBLOCK OFF is executed during execution of a motion instruction in IOBLOCK, the system proceeds to the next step after execution of the motion instruction.

Related Terms

Example

```
TAKEARM                 'Obtains robot control priority.
IOBLOK ON               'Concurrently executes an I/O instruction with the next
             'motion instruction.
MOVE P  (902.7,0,415.3,180,50,180,1)
             'Moves (PTP control) to the coordinates
             '(902.7,0,415.3,180,50,180,1).
SET IO[240]             'Sets the port 240 BIT type to ON.
SET IO[241],40          'Sets the port 241 BIT type to ON for 40 ms.
SET IO[SOL1]            'Sets the port designated by I/O variable SOL1 to ON.
SET IO[104 TO 110]      'Sets the port 104 ~ 110 BIT type to ON.
IF IO[242] THEN
 RESET IO[240]          'Sets the port 240 type to OFF.
 RESET IO[SOL1]         'Sets the port designated by I/O variable SOL1 to OFF.
 RESET IO[104 TO 110]   'Sets the port 104 ~ 110 BIT type to OFF.
ENDIF
IOBLOCK OFF
```

Notes

(1) Concurrent processing is not executed in the following cases.
   i) If a motion option is added to a motion instruction
   ii) If you execute CHANGEWORK, CHANGETOOL, SPEED, JSPEED, ACCEL, or JACCEL.
   iii) If you execute the conventional language library of [aspChange], [aspACLD], arm motion library [mvSetPulseWidth], [mvSetTimeOut], [mvReverseFlip], [mvResetPulsetWidth], or [mvResetTimeOut].

   Execution of the next step should stop until the motion instruction is finished (from designation of the pass motion until the pass motion starts) in all cases.

(2) If the system is restarted after a step or instantaneously stop of the robot during robot movement, the robot may not execute concurrent motion with a non-motion command.

(3) If the robot is stopped after a step during the first motion when a motion instruction is repeated twice in IOBLOCK, the robot stops after a step once the next motion is finished. During execution of the first motion, if you instantaneously stop and run the step, the robot also stops after the step once the next motion is finished.

   Example

```
IOBLOCK ON
MOVE P, JO     ← During movement to JO, even if the robot is
                 stopped after a step, the next motion of MOVE P,
                 J1 is executed.  After that, the robot stops after
                 a step.
MOVE P, J1
SET IO[1]
IOBLOCK OFF
```

(4) The range of IOBLOCK is valid only in a defined program, not in a subprogram.

   Example

```
PROGRAM PRO1
TAKEARM
DEFPOS 1p1, 1p2
IOBLOCK ON
CALL SUB1
MOVE P, 1p1, 1p2
SET IO[1]
SET IO[2]
IOBLOCK OFF
  :
  :
```

For this type of program, IOBLOCK defined in PRO1 is not valid in SUB1. The valid IOBLOCK range is independent for each program.

(5) IOBLOCK is disabled in the teaching check mode.

SET (Statement) [Conforms to SLIM]

Function

Sets an I/O port to ON.

Format

SET <I/O variable>[,<Output time>]

Explanation

This statement sets the designated port in <I/O variable> to ON.
If <Output time> is designated a pulse is output. (The output time unit is ms.)
If <Output time> is designated the system does not proceed to the next instruction until this time elapses. The specified output time value is the minimum output time while the actual output time will change according to task priority.

Related Terms

RESET, DEFIO

Example

```
TAKEARM            'Obtains the robot control priority.
IOBLOK ON          'Concurrently executes an I/O instruction with the next motion
             'instruction.
MOVE P,(902.7,0,415.3,180  50,180,1)
             'Moves (PTP control) to the coordinates
             '(902.7,0,415.3,180,50,180,1).
SET IO[240]             'Sets the port 240 BIT type to ON.
SET IO[241],40          'Sets the port 241 BIT type to ON for 40 ms.
SET IO[SOL1]            'Sets the port designated by I/O variable SOL1 to ON.
SET IO[104 TO 110]      'Sets the port 104 to 110 BIT to ON.
IF IO[242] THEN
 RESET IO[240]          'Sets the port 240 type to OFF.
 RESET IO[SOL1]         'Sets the port designated by I/O variable SOL1 to OFF.
 RESET IO[104 TO 110]   'Sets the port 104 to 110 BIT type to OFF.
ENDIF
IOBLOCK OFF
```

Notes

(1) If output time is designated, it may be extended due to factors such as the presence of another program during movement, pendant operation, or communication with external devices.

(2) When output time is designated, it may possibly shift by ±16.7ms since the standard clock for controller processing is 16.7 ms.

(3) Note the following two points when using the time designation SET.

   1) If you RESET the same port with another task while the port is ON due to the time designation SET, the port is set to OFF from the time of RESET (this means the time designation SET is valid).

   2) If you keep resetting the same port and SET with another task while the port is ON due to the time designation SET, the designated port is set to OFF after the designated time elapses (time designation SET is valid).

(4) When output time is used, note that even during temporary stoppage the output time will elapse after an instantaneous stop during execution of the instruction and restart of the system.

RESET (Statement) [Conforms to SLIM]

Function

Sets an I/O port to OFF.

Format

RESET <I/O variable>

Explanation

Sets the port designated by <I/O variable> to OFF.

Related Terms

SET, DEFIO

Example

```
TAKEARM            'Obtains the robot control priority.
IOBLOK ON          'Executes an I/O instruction concurrently with the next
             'instruction.
MOVE P, (902.7,0,415.3,180,50,180,1)
             'Moves to the coordinates (902.7,0,415.3,180,50,180,1)
             '(PTP control)
SET IO[240]             'Sets the port 240 BIT type to ON.
SET IO[241],40          'Sets the port 241 BIT type to ON for 40 ms.
SET IO[SOL1]            'Sets the port designated by I/O variable SOL1 to ON.
SET IO[104 TO 110]      'Sets the port 104 to 110 BIT type to ON.
IF IO[242] THEN
 RESET IO[240]          'Sets the port 104 to 110 BIT type to OFF.
 RESET IO[SOL1]         'Sets the port designated by I/O variable SOL1 to OFF.
 RESET IO[104 TO 110]   'Sets the port 104 to 110 BIT type to OFF.
ENDIF
IOBLOCK OFF
```

13.2 Command for RS232C and Ethernet (Server/Client) Port

INPUT (Statement)[Conforms to SLIM]

Function

Obtains data from the RS232C or Ethernet port.

Format

INPUT [#<Circuit number>,]<Variable name>[,<Variable name>…]

Explanation

This statement stores data received via the RS232C or Ethernet port into the variable designated by <Variable name>.
Designate a circuit number to use for <Circuit number>. If <Circuit number> is ignored the default value of ch2 is set. Ch1 cannot be designated because it is used for the pendant. (Refer to Section 2.4.1, “ Circuit Number”.)
If plural information is received for the same number of variables add a comma (,) between each variable.
Designate the baud rate using a system parameter.

Note (1):	**Execute a FLUSH command to clear the data remaining in the input buffer of the received data prior to receiving data.**
Note (2):	**If input data exceeds the maximum value of the variable type to which it has been assigned, the result is the maximum value of that type.**

Related Terms

FLUSH, PRINT, WRITE

Example

```
DIM li1 As Integer
DEFSTR ls1, ls2, ls3, ls4
INPUT #1, ls1              'Writes data from ch2 to ls1.
INPUT #1, li1, ls2, ls3    'Writes data from ch2 to li1, ls2, and ls3.
INPUT ls4                  'Writes data from ch2 to ls4.
```

LINEINPUT (Statement)

Function

Reads data to a delimiter through the RS232C or Ethernet port and assigns it to a character string type variable.

Format

LINEINPUT [#<Circuit number>,] <Character string type variable name>

Explanation

All characters, from the data received via the RS232C or Ethernet port to a delimiter (CR or CR + LF), are stored into the variable designated by <Character string type variable name >. Delimiter is not stored into any variable.

For <Circuit number>, designate the circuit number of the RS232C or Ethernet port to be used. If <Circuit number> is ignored, the default value of ch2 is set. Ch1 cannot be designated since it is used for the pendant. (Refer to Section 2.4.1, " Circuit Number".)

Designate the name of the character string type variable for <Character string variable name>.

Related Terms

Example

```
DEFSTR ls1,ls2,ls3
LINEINPUT #0, ls1  'Receives a character string from port 1 and assigns it to ls1.
LINEINPUT #1, ls2  'Receives a character string from port 2 and assigns it to ls2.
LINEINPUT ls3      'Receives a character string from port 2 and assigns it to ls3.
```

PRINT (Statement)[Conforms to SLIM]

Function

Outputs data from the RS232C or Ethernet port.

Format

PRINT [#<Circuit number>,] <Message> [<Separator> <Message>…] [<Separator>]

Explanation

This statement outputs the value of <Message> from the RS232C or Ethernet port to an external device.

For <Circuit number>, designate the circuit number of the RS232C or Ethernet port to be used. If <Circuit number> is ignored, the default value of ch2 is set. Ch1 cannot be designated since it is used for the pendant. (Refer to Section 6.1, "Circuit Number.")

A comma (,) or semicolon (;) can be used for <Separator>.

In the case of a comma (,), insert a blank character between the <Message> and <Message>.

If a comma (,) is designated after <Message> but no <Message> is found, a delimiter (CR or CR+LF) is transferred after the final <Message> once output is finished.

In the case of a semicolon (;), no blank character should be inserted between the semicolon and <Message>.

If a semicolon (;) is designated after <Message> but no <Message> is found, a delimiter (CR or CR+LF) is transferred after the final <Message> and output is finished.

If pose type data is output, each element is separated for output using a blank character.

Related Terms

WRITE

Example

```
DEFINT li1, li2
DEFSTR ls1, ls2
PRINT #1, li1, ls1; ls2      'Outputs the values of li1, ls1, and ls2 from ch2.
                             '(A blank is made between li1 and ls1, and no blank
                               is made between ls1 and ls2.)
PRINT li2                    'Outputs the value of li2 from ch2.
```

WRITE (Statement)

Function

Outputs data from the RS232C or Ethernet port.

Format

WRITE [#<Circuit number>,]<Message>[,<Message>…]

Explanation

This statement outputs the value of <Message> from the RS232C or Ethernet port to an external device.

For <Circuit number>, designate the circuit number of the RS232C or Ethernet port to be used. If <Circuit number> is ignored, the default value of ch2 is set. Ch1 cannot be designated since it is used for the pendant. (Refer to Section 6.1, "Circuit Number.")

If plural messages are written, a comma (,) must be used to separate the messages.

The following are the points that differ from the PRINT statement.

(1) Character string data is output in double quotation marks (").

(2) At the end of output information, a delimiter (CR or CR+LF) is added.

(3) Commas (,) separating messages are output as they are.

(4) If pose type data is output, each element is separated for output using a comma (,).

Related Terms

PRINT

Example

```
DEFINT li1, li2
DEFSTR ls1, ls2
WRITE #1, li1, ls1, ls2     'Outputs the values of li1, ls1, ls2 from ch2.
WRITE li2                   'Outputs the value of li2 from ch2.
```

FLUSH (Statement)

Function

Clears the input buffer.

Format

FLUSH [#<Circuit number>]

Explanation

This statement clears the input buffer of the RS232C or Ethernet port.
Designate a circuit number to clear the input buffer for <Circuit number>.
If <Circuit number> is ignored, the default value of ch2 is set. Ch1 cannot be designated since it is used for the pendant. (Refer to Section 2.4.1, “Circuit Number.”)
Execute a FLUSH command to clear the data remaining in the input buffer prior to receiving data.

Related Terms

INPUT

Example

```
FLUSH #1          'Clears the input buffer of the ch2 circuit.
FLUSH             'Clears the input buffer of the ch2 circuit.
```

13.3 Serial Binary Transmission Commands (RS232C and Ethernet ports)

printb (Version 1.5 or later)

Function

Outputs a single byte of data to the RS-232C or Ethernet port.

Format

`printb #<portnumber>,<integervarnumber>`

`<portnumber>`	Output port number (1: Controller RS-232C port, -1: µVision RS-232C port, 4 to 7: Ethernet server ports, 8 to 15: Ethernet client ports)
`<integervarnumber>`	Integer variable number where output data is stored

Explanation

This command outputs the lower byte of data assigned to `<integervarnumber>` to the port specified by `<portnumber>`.

Example

```
'!TITLE "<Title>"
PROGRAM sample
       .
       .
       .
       printb #1,I10     'Output the lower byte of data stored in I10 to RS-232C port
       .
       .
       .
end
```

inputb (Version 1.5 or later)

Function

Inputs a single byte of data from the RS-232C or Ethernet port.

Format

`inputb #<portnumber>,<integervarnumber>`

`<portnumber>`	Input port number (1: Controller RS-232C port, -1: µVision RS-232C port, 4 to 7: Ethernet server ports, 8 to 15: Ethernet client ports)
`<integervarnumber>`	Integer variable number where input data is to be stored

Explanation

This command stores a single byte of data inputted from the specified port, into `<integervarnumber>`.

NOTE: If no data exists in the specified port, executing this command will result in an error. Before execution of this command, transfer data from external equipment. To check whether any data exists or not, use `com_state` command.

Example

```
'!TITLE "<Title>"
PROGRAM sample
       .
       .
       .
       inputb #1,I10     'Store data inputted from RS-232C port into I10
       .
       .
       .
end
```

lprintb (Version 1.5 or later)

Function

Outputs multiple bytes of data to the RS-232C or Ethernet port.

Format

`lprintb #<portnumber>,<arrayheadelement>,<outputbytes>`

`<portnumber>`	Output port number (1: Controller RS-232C port, -1: µVision RS-232C port, 4 to 7: Ethernet server ports, 8 to 15: Ethernet client ports)
`<arrayheadelement>`	Head element of an array where output data is stored
`<outputbytes>`	Number of bytes to be outputted

Explanation

This command outputs the specified number of bytes of data from the specified element of an array where the output data is stored, to the specified port.

Example

```
'!TITLE "<Title>"
PROGRAM sample
        .
        .
        .
        lprintb #1,I64,30      'Output the lower byte of data from I64 to I93 in
succession
                               'to RS-232C port.
        .
        .
        .
end
```

linputb (Version 1.5 or later)

Function

Inputs multiple bytes of data from the RS-232C or Ethernet port.

Format

```
linputb #<portnumber>,<arrayheadelement>,<inputbytes>
```

`<portnumber>`	Input port number (1: Controller RS-232C port, -1: µVision RS-232C port, 4 to 7: Ethernet server ports, 8 to 15: Ethernet client ports)
`<arrayheadelement>`	Head element of an array where input data is to be stored
`<inputbytes>`	Number of bytes to be inputted

Explanation

This command inputs the specified number of bytes of data from the specified element of an array, to the specified port.

NOTE: If no data exists in the specified port, executing this command will result in an error. Before execution of this command, transfer data from external equipment. To check whether any data exists or not, use `com_state` command.

Example

```
'!TITLE "<Title>"
PROGRAM sample
       .
       .
       .
       linputb #1,I64,30    'Input data from I64 to I93 in succession from RS-232C
port.
       .
       .
       .
end
```

com_encom (Version 1.5 or later)

Function

Enables the RS-232C port only for binary transmission. (Occupies the COM port.)

If the Ethernet client port has been occupied, this command enables it to establish Ethernet connection.

Format

```
com_encom #<portnumber>
```

Explanation

This command discriminates binary data from ASCII data in binary transmission between the PC and robot controller e.g., in WINCAPSII.

After binary transmission is completed, you need to release the communication port by using `com_discom` command.

NOTE: If data is transferred from the PC (e.g., in WINCAPSII) to the robot controller after execution of this command, then the controller will treat it as binary data and will not close the RS-232C port occupied by binary transmission.

NOTE: After executing this command in Ethernet connection, it will not influence data communications with WINCAPSII.

Example

```
'!TITLE "<Title>"
PROGRAM sample
       .
       .
       .
       com_encom #1      'Make port exclusive for binary transmission
       .
       .
       .
end
```

com_discom (Version 1.5 or later)

Function

Releases the RS-232C port from binary transmission. (Releases the COM port.)

If the Ethernet client port has been used, this command disables the Ethernet client port to disconnect the Ethernet connection.

Format

```
com_discom #<portnumber>
```

Explanation

This command disables `com_encom` command to release the RS-232C dedicated to binary transmission for other uses.

NOTE: Executing this command clears the RS-232C port once for preventing data confusion between ASCII and binary data.

NOTE: If this command is executed during Ethernet communication, the connection will be disconnected without waiting for completion of transmission. The receiver may keep waiting for receiving non-transmitted data.

Example

```
'!TITLE "<Title>"
PROGRAM sample
       .
       .
       .
       com_discom #1     'Release port from binary transmission
       .
       .
       .
end
```

com_state (Version 1.5 or later)

Function

Gets the status of RS-232C or Ethernet port.

Format

```
com_state #<portnumber>,<integervar>
```

Explanation

This command gets bytes of data remaining in the transmission buffer, into the integer variable specified by `<integervar>`.

Note that -1 will be returned if a transmission port error occurs. At the time of Ethernet use, -1 will be also returned if network connection of the port is not established.

Example

```
'!TITLE "<Title>"
PROGRAM sample
       .
       .
       .
       com_state #1,I280    'Gets data remaining in transmission buffer into I280
       .
       .
       .
end
```

13.4 Pendant

PRINTMSG (Statement)

Function

Displays a message with a caption and icon on the color LCD of the teach pendant.

Format

PRINTMSG <Message character>,<Icon type>,<Caption character string>

Explanation

The system displays the message designated by each argument with a caption and icon on the color LCD of the teach pendant.

Icon type	Icon
0	ℹ
1	⚠
2	❌
3	❓
4	⏱

A maximum of 60 characters can be used for a message character string and a maximum of 40 characters for a caption character string.

Related Terms

PRINTDBG, PRINTLBL

Example

```
PRINTMSG “Hello World !”, 1, “Message”      'Displays “Hello World !” with a
                                            'caption and icon.
```

PRINTDBG (Statement)

Function

Outputs data to the debug window.

Format

PRINTDBG <Message>[<Separator><Message>…][<Separator>]

Explanation

This statement outputs the value of <Message> in the debug window of the pendant.
For <Separator> a comma (,) or semicolon (;) can be used.
In the case of a comma (,) a blank character should be inserted between the comma and the <Message> that follows.
In the case of a semicolon (;) no blank character must be inserted between the semicolon and <Message>.
If pose type data is output each element is separated with a blank character and displayed.
The line is fed if there is no <Separator> at the end of <Message>.

Related Terms

PRINTMSG, PRINTLBL

Example

```
PRINTDBG “DEBUG”  'Outputs “DEBUG” on the debug window.
```

BUZZER (Statement)

Function

Sounds a buzzer.

Format

BUZZER <Sound time>

Explanation

This statement sounds the buzzer on the pendant for the time designated in <Sound time>.
The unit of <Sound time > is msec.

Related Terms

Example

```
BUZZER 3000       'The buzzer sounds for 3 seconds.
```

PRINTLBL (Statement)

Function

Sets a label (caption) for a user definition button.

Format

PRINTLBL <Panel number>, <Button number>,<Caption character string>

Explanation

This statement sets a label (caption) for each user-defined button on the operation panel of the teach pendant.
For <Panel number>, a number from 0 to 6 can be designated.
For <Button number>, set a number from 0 to 11.
Designate the character string using a maximum of 6 characters in <Caption character string>.

Related Terms

PRINTDBG, PRINTMSG

Example

```
PRINTLBL 3, 1, “E_STOP”   'Sets the label of the first button on the third panel
                          'to “E_STOP”.
```

13.5 Customizing TP Operation Screens

Main software version 1.5 or later allows you to easily customize your own operation screens on the teach pendant for facilitating control of the robot by the robot controller in stand-alone mode.

In PAC language, you may program your own control buttons in size, position, and color and paste them onto the Teach Pendant screen.

Once the PAC program in which you have defined your own screens runs, those screens go into effect and remain in effect as long as you do not clear them, even if you restart the robot system or controller.

■ Buttons and screens

You may customize buttons and screens up to 500 and 50, respectively.

■ Commands for creating TP operation screens

`set_button`	Sets button parameters (incl. an attribute for choosing visible/invisible)
`set_page`	Sets page parameters (incl. an attribute for choosing visible/invisible)
`change_bCap`	Edits captions on buttons
`change_pCap`	Edits captions on pages
`disp_page`	Displays a specified page

■ Parameters set by commands

Button parameters	• Index • Display position (Upper left X coordinate, upper left Y coordinate, lower right X coordinate, and lower right Y coordinate) • Button type (Touch switch with variation in shape, value display box, value entry box, digital switch, lamp with variation in shape, and page switching button) • Status (reserved) • Background color • Text color • Enable/disable flag • Visible/invisible flag • Captions • Variable type • Variable number • I/O number • Page number • Modification flag (reserved) • Result (reserved)
Page parameters	• Index • Screen type (fixed) • Status (reserved) • Background color • Text color • Enable/disable flag • Visible/invisible flag • Captions • Modification flag (reserved) • Result (reserved)

13.5.1 Programming a TP operation screen

Program a TP operation screen as follows:

(1) Setting button parameters

Use `set_button` command to specify button parameters for a button.

(Example) Create a button numbered 1 with background (7) set to black (0)

```
set_button 1,7,0
```

(2) Setting page parameters

Use `set_page` command to specify page parameters for a page.

(Example) Create a page numbered 2 with background (3) set to red (4)

```
set_page 2,3,4
```

(3) Setting a button caption

Use `change_bCap` command to specify a desired button caption.

(Example) Specify caption "Setup" for button numbered 2

```
change_bCap 2,"Setup"
```

(4) Setting a page caption

Use `change_pCap` command to specify a desired page caption.

(Example) Specify caption "Screen 3" for page numbered 3

```
change_pCap 3,"Screen 3"
```

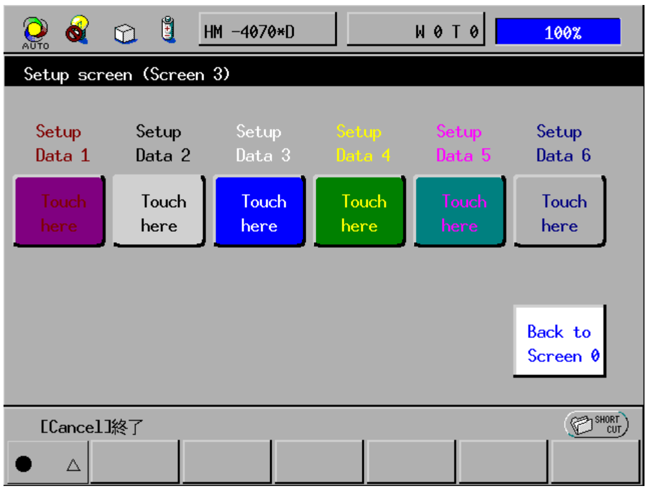
(5) Displaying a specified page

Use `disp_page` command to display the desired page.

(6) Displaying a programmed TP operation screen

From the top screen of the teach pendant, choose [F9: Panel] to display a TP operation screen you have programmed.

TP operation screen sample



set_button (Version 1.5 or later)

Function

Sets button parameters.

Format

```
set_button <ButtonNumber>,<ParameterType>,<NewValue>
```

`<ButtonNumber>`	Number indicating the button location in all button arrangement on a TP operation panel.
`<ParameterType>`	Button attributes including color, position and others. (See the table below.)
`<NewValue>`	Parameter value for making new settings (See the table below.)

`<Parameter Type>`	Explanation	`<NewValue>` **(Note 1)**
1	Upper left X coordinate	0 to 640 in dots
2	Upper left Y coordinate	0 to 350 in dots
3	Lower right X coordinate	0 to 640 in dots
4	Lower right Y coordinate	0 to 350 in dots
5	Button type	0: None 1: Label 2: Line 17: 2D button (Change variable) 18: 3D button (Change variable) 19: 3D button (Change variable) 20: Circle (Change variable) 33: 2D LED (lamp) 34: Circle LED (lamp) 35: 3D button (Change IO) 36: Reserved 37: Reserved 38: Box
6	Button status	**0: Center characters** **1: Left-justify characters** **2: Right-justify characters**
7	Background color	0: Black 1: Blue 2: Green 3: Cyan 4: Red 5: Magenta 6: Brown 7: Light gray 8: Gray 9: Light blue 10: Light green 11: Light cyan 12: Light red 13: Light magenta 14: Yellow 15: White

`<ParameterType>`	Explanation	`<NewValue>`
8	Text color	0: Black 1: Blue 2: Green 3: Cyan 4: Red 5: Magenta 6: Brown 7: Light gray 8: Gray 9: Light blue 10: Light green 11: Light cyan 12: Light red 13: Light magenta 14: Yellow 15: White
9	Usable state	0: Disable 1: Enable
10	Visible/invisible state	0: Invisible 1: Visible
11	Variable type **(Note 2)**	**1: Integer** **2: Floating point** **3: Double-precision floating point** **4: Character string (up to 32 characters)**
12	Variable number	Variable number that may be changed by the change variable button.
13	I/O number	Variable number that may be changed by the change I/O button. (128 to 511)
14	Display page number	Page number in which the buttons are displayed.

(Note 1) Always enter integers to `<ParameterType>`. Any other value will cause a "data tag error."

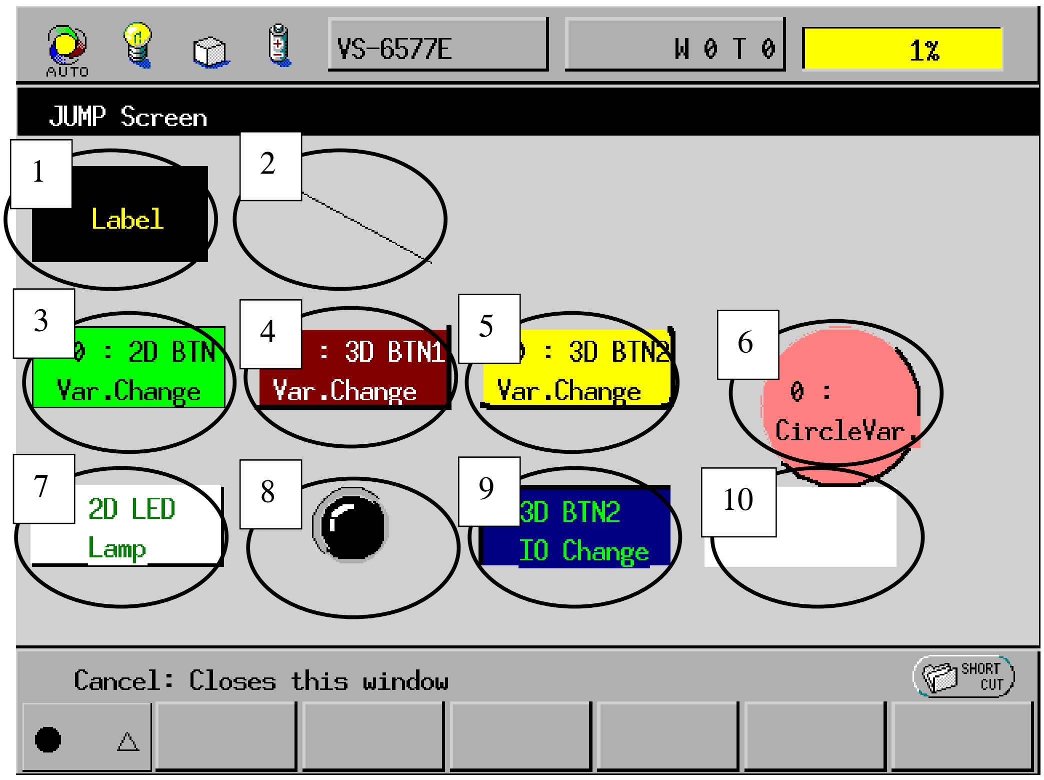
(Note 2) A floating-point or double-precision floating-point number occupies 13- or 22-character space, respectively. Take it into account and reserve suitable spaces when programming a numeric entry button using floating point or double-precision variable.

Explanation

`set_button` changes the current value of a parameter specified by `<ParameterType>` to `<NewValue>` to modify the specifications of a button specified by `<ButtonNumber>`.

*Sample of Button type

1:	Label
2:	Line
3:	2D button (Change variable)
4:	3D button (Change variable)
5:	3D button (Change variable)
6:	Circle
7:	2D LED
8:	Circle LED
9:	3D button (Change IO)
10:	Box



Example

```
'!TITLE "<Title>"
PROGRAM sample1
          .
          .
        set_button (btn_no),(1),(minx)
        set_button (btn_no),(2),(miny)
        set_button (btn_no),(3),(maxx)
        set_button (btn_no),(4),(maxy)
          .
          .
end
```

set_page (Version 1.5 or later)

Function

Sets page parameters.

Format

```
set_page <PageNumber>,<ParameterType>,<NewValue>
```

`<PageNumber>`	Number indicating a page out of all pages arranged on a TP operation panel.
`<ParameterType>`	Page attributes including color, position and others. (See the table below.)
`<NewValue>`	Parameter value for making new settings (See the table below.)

`<Parameter Type>`	Explanation	`<NewValue>`
1	Page type	0 (Fixed)
2	Button status	Not used.
3	Background color	0: Black 1: Blue 2: Green 3: Cyan 4: Red 5: Magenta 6: Brown 7: Light gray 8: Gray 9: Light blue 10: Light green 11: Light cyan 12: Light red 13: Light magenta 14: Yellow 15: White
4	Text color (Not used in Ver. 1.5 or 1.6)	0: Black 1: Blue 2: Green 3: Cyan 4: Red 5: Magenta 6: Brown 7: Light gray 8: Gray 9: Light blue 10: Light green 11: Light cyan 12: Light red 13: Light magenta 14: Yellow 15: White
5	Usable state	0: Disable 2: Enable
6	Visible/invisible state	0: Invisible 1: Visible

Explanation

set_page changes the current value of a parameter specified by <ParameterType> to <NewValue> to modify the specifications of a page specified by <PageNumber>.

Example

```
'!TITLE "<Title>"
PROGRAM sample2
         .
         .
         .
        set_page panel_no, P_BGCOLOR,GRAY    'Set background color of the
                                             'page.
        set_page panel_no, P_USESTATE,ON     'Enable page.
        set_page panel_no, P_VISSTATE,ON     'Make page visible.
         .
         .
         .
end
```

change_bCap (Version 1.5 or later)

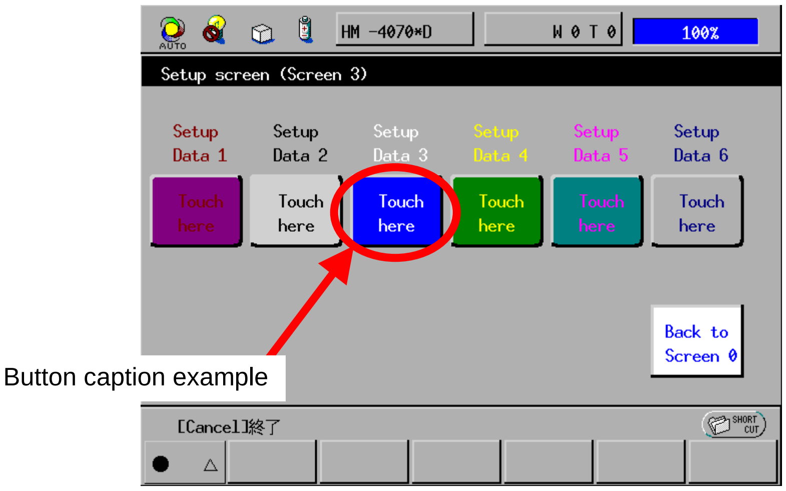
Function

Edits a caption for a specified button.

Format

```
change_bCap <ButtonNumber>,<Caption>
```

`<ButtonNumber>`	Number indicating the button location in all button arrangement on a TP operation panel.
`<Caption>`	Character string to be displayed on the center of a button.



Explanation

`change_bCap` displays a character string specified by `<Caption>` on the center of a button specified by `<ButtonNumber>`.

Example

```
'!TITLE "<Title>"
PROGRAM sample3
           .
           .
           .
        bcap4 = "Cut workpiece"
        btn_no = 3
           .
           .
           .
        change_bCap btn_no,bcap4
           .
           .
           .
end
```

change_pCap (Version 1.5 or later)

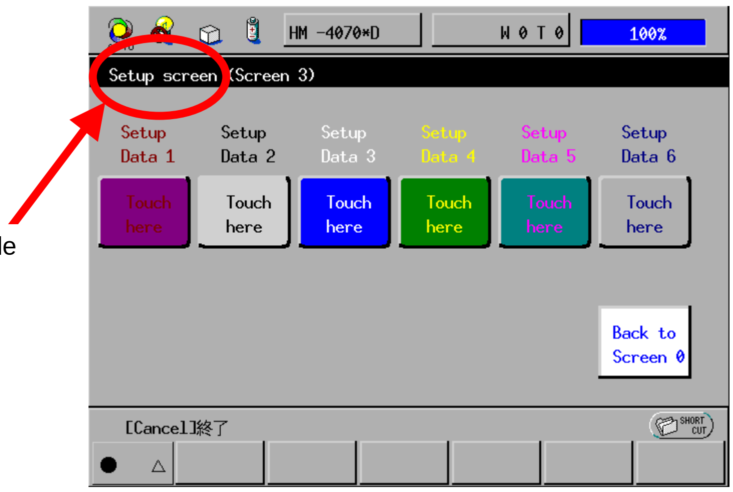
Function

Edits a caption for a specified page.

Format

```
change_pCap <PageNumber>,<Caption>
```

`<PageNumber>`	Number indicating a page out of all pages arranged on a TP operation panel.
`<Caption>`	Character string to be displayed in the title bar of a page.



Page caption example

Explanation

change_pCap displays a character string specified by `<Caption>` in the title bar of a page specified by `<PageNumber>`.

Example

```
'!TITLE "<Title>"
PROGRAM sample4
          .
          .
          .
        pcap4 = "Cut workpiece"
        page_no = 3
          .
          .
          .
        change_pCap page_no,pcap4
          .
          .
          .
end
```

disp_page (Version 1.5 or later)

Function

Displays a specified page of a TP operation screen.

Format

```
disp_page <PageNumber>
```

`<PageNumber>`	Number indicating a page out of all pages arranged on a TP operation panel.

Explanation

disp_page displays the page specified by `<PageNumber>` on the TP operation screen.

Example

```
'!TITLE "<Title>"
PROGRAM sample3
          .
          .
          .
        'disp_page panel_no    'Display the specified page.
          .
          .
          .
end
```

Sample Program: Creating a TP Operation Panel

Shown below is a sample program for creating a TP operation panel.

```
'! TITLE "<Title>"
PROGRAM BUTTON3D_VAL_3
'Color definition
#define BLACK  0    'Black
#define BLUE   1    'Blue
#define GREEN  2    'Green
#define CYAN   3    'Cyan
#define RED    4    'Red
#define MAGENTA     5    'Magenta
#define BROWN  6    'Brown
#define LIGHTGRAY   7    'Light gray
#define GRAY   8    'Gray
#define LIGHTBLUE   9    'Light blue
#define LIGHTGREEN  10   'Light green
#define LIGHTCYAN   11   'Light cyan
#define LIGHTRED    12   'Light red
#define LIGHTMAGENTA     13   'Light magenta
#define YELLOW 14   'Yellow
#define WHITE  15   'White

'Button definition
#define LABEL  1    'Label
#define LINE   2    'Line
#define 2DBUTTON_V  17   '2D button (Change variable)
#define 3DBUTTON_V  18   '3D button (Change variable)
#define 3DBUTTON_V2 19   '3D button 2 (Change variable)
#define CIRCLE 20   'Circle (Change variable)
#define 2DLED  33   '2DLED (Lamp)
#define CIRCLELED   34   'Circle LED (Lamp)
#define 3DBUTTON_IO 35   '3D button (Change IO)

'Page parameters
#define P_BGCOLOR   3    'Page background color
#define P_CHARCOLOR 4    'Page text color
#define P_USESTATE  5    'Enable/disable
#define P_VISSTATE  6    'Visible/invisible

'Button parameters
#define X_UPPERLEFT_P    1    'Upper left X coordinate
#define Y_UPPERLEFT_P    2    'Upper left Y coordinate
#define X_LOWERRIGHT_P   3    'Lower right X coordinate
#define Y_LOWERRIGHT_P   4    'Lower right Y coordinate
#define B_KIND 5    'Button type
#define B_BGCOLOR   7    'Button background color
#define B_FGCOLOR   8    'Button text color
#define B_USESTATUS 9    'Button enable/disable
#define B_VISSTATUS 10   'Button visible/invisible
#define B_VALUEKIND 11   'Button variable type (Fixed)
#define B_VALUE_NO  12   'Button variable number
#define B_IO_NO     13   'Button I/O number
#define B_DISP_PNO  14   'Button display page number
```

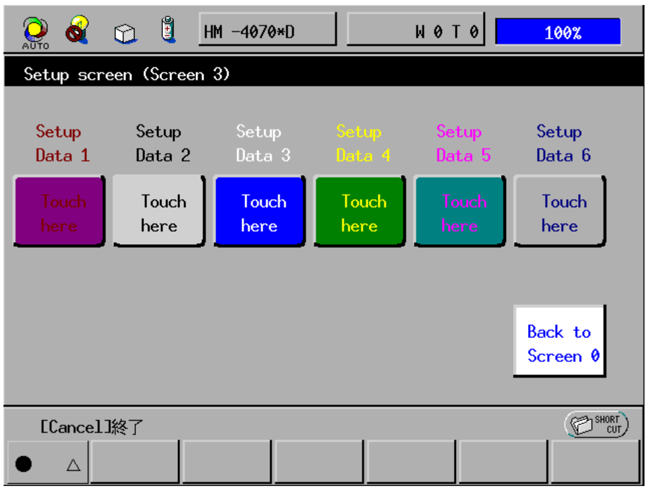
```
'Button status
#define ON     1    'ON
#define OFF    0    'OFF
#define I_VAL  1    'Integer

'Button address
#define IO_PB_ADRS  170  'I/O number assigned to the 1st button
               'on a TP operation panel.

defint btn_no,minx,maxx,miny,maxy,loopcnt
defint enable,visible,var_type,var_index
defint panel_no,io_no,io_adrs,btn_adrs
defstr panel_cap
defstr bcap0,bcap1,bcap2,bcap3,bcap4,bcap5,bcap6,bcap7
       panel_no = 3

       panel_cap = "Setup screen (Screen 3)"
       loopcnt = 0

       change_pCap panel_no,panel_cap    'Set page title.
       set_page panel_no,P_BGCOLOR,GRAY  'Set page background color.
       set_page panel_no,P_USESTATE,ON   'Enable page.
       set_page panel_no,P_VISSTATE,ON   'Make page visible.

'Resetting all parameters
       btn_adrs = 30
       io_no = IO_PB_ADRS
       reset io[128 to 133]
       enable = ON
       visible = ON
       var_type = I_VAL
       var_index = 1

       bcap0 = "plan”+chr$(10)+"Data1"
       bcap1 = "plan”+chr$(10)+"Data2"
       bcap2 = "plan”+chr$(10)+"Data3"
       bcap3 = "plan”+chr$(10)+"Data4"
       bcap4 = "plan”+chr$(10)+"Data5"
       bcap5 = "plan”+chr$(10)+"Data6"
       bcap6 = "Screen0”+chr$(10)+"Back to"
       bcap7 = "here"+chr$(10)+"Touch"

       while loopcnt < 6      'Loop 6 times.
         btn_no = btn_adrs + loopcnt
         minx = 10 + ((loopcnt mod 6)*100)
         miny = 50 + ((loopcnt / 6)*100)
         maxx = 100 + ((loopcnt mod 6)*100)
         maxy = 120 + ((loopcnt / 6)*100)
         io_adrs = IO_PB_ADRS + loopcnt

       'Common process
         set_button (btn_no),(1),(minx)
         set_button (btn_no),(2),(miny)
         set_button (btn_no),(3),(maxx)
         set_button (btn_no),(4),(maxy)
         set_button (btn_no),(9),(enable)
         set_button (btn_no),(10),(visible)
         set_button (btn_no),(11),(var_type)
         set_button (btn_no),(12),(var_index)
         set_button (btn_no),(14),(panel_no)
```

```
'Label display
  select case loopcnt
  case 0
       set_button btn_no,B_KIND,LABEL  'Set button type.
       set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
       set_button btn_no,B_BGCOLOR,GRAY     'Set background color.
       set_button btn_no,B_FGCOLOR,RED 'Set foreground color.
       change_bCap btn_no,bcap0  'Set button number.

  case 1
       set_button btn_no,B_KIND,LABEL  'Set button type.
       set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
       set_button btn_no,B_BGCOLOR,GRAY     'Set background color.
       set_button btn_no,B_FGCOLOR,BLACK    'Set foreground color.
       change_bCap btn_no,bcap1  'Set button number.

  case 2
       set_button btn_no,B_KIND,LABEL  'Set button type.
       set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
       set_button btn_no,B_BGCOLOR,GRAY     'Set background color.
       set_button btn_no,B_FGCOLOR,WHITE    'Set foreground color.
       change_bCap btn_no,bcap2  'Set button number.

  case 3
       set_button btn_no,B_KIND,LABEL  'Set button type.
       set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
       set_button btn_no,B_BGCOLOR,GRAY     'Set background color.
       set_button btn_no,B_FGCOLOR,YELLOW   'Set foreground color.
       change_bCap btn_no,bcap3  'Set button number.

  case 4
       set_button btn_no,B_KIND,LABEL  'Set button type.
       set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
       set_button btn_no,B_BGCOLOR,GRAY     'Set background color.
       set_button btn_no,B_FGCOLOR,LIGHTMAGENTA  'Set foreground. color
       change_bCap btn_no,bcap4  'Set button number.

  case 5
       set_button btn_no,B_KIND,LABEL  'Set button type.
       set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
       set_button btn_no,B_BGCOLOR,GRAY     'Set background color.
       set_button btn_no,B_FGCOLOR,LIGHTBLUE     'Set foreground color.
       change_bCap btn_no,bcap5  'Set button number.
  end select
  loopcnt = loopcnt + 1
wend
```

```
'Display in the lower row
       loopcnt = 0
       while loopcnt < 6 'Loop 6 times.
         btn_no = btn_adrs + 10 + loopcnt
         minx = 10 + ((loopcnt mod 6)*100)
         miny = 120 + ((loopcnt / 6)*100)
         maxx = 100 + ((loopcnt mod 6)*100)
         maxy = 190 + ((loopcnt / 6)*100)
         io_adrs = IO_PB_ADRS+6+loopcnt
         var_index = var_index + 1

       'Common process
         set_button (btn_no),(1),(minx)
         set_button (btn_no),(2),(miny)
         set_button (btn_no),(3),(maxx)
         set_button (btn_no),(4),(maxy)
         set_button (btn_no),(9),(enable)
         set_button (btn_no),(10),(visible)
         set_button (btn_no),(11),(var_type)
         set_button (btn_no),(12),(var_index)
         set_button (btn_no),(14),(panel_no)

       'Label display
         select case loopcnt
         case 0
'             set_button btn_no,B_KIND,3DBUTTON_V  'Set button type.
              set_button btn_no,B_KIND,3DBUTTON_V2 'Set button type.
              set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
              set_button btn_no,B_BGCOLOR,MAGENTA  'Set background color.
              set_button btn_no,B_FGCOLOR,RED 'Set foreground color.
              var_index = loopcnt
              set_button btn_no,B_VALUE_NO,var_index
              change_bCap btn_no,bcap7
         case 1
'             set_button btn_no,B_KIND,3DBUTTON_V  'Set button type.
              set_button btn_no,B_KIND,3DBUTTON_V2 'Set button type.
              set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
              set_button btn_no,B_BGCOLOR,LIGHTGRAY     'Set background color.
              set_button btn_no,B_FGCOLOR,BLACK    'Set foreground color.
              var_index = loopcnt
              set_button btn_no,B_VALUE_NO,var_index
              change_bCap btn_no,bcap7
         case 2
'             set_button btn_no,B_KIND,3DBUTTON_V  'Set button type.
              set_button btn_no,B_KIND,3DBUTTON_V2 'Set button type
              set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
              set_button btn_no,B_BGCOLOR,BLUE     'Set background color.
              set_button btn_no,B_FGCOLOR,WHITE    'Set foreground color.
              var_index = loopcnt
              set_button btn_no,B_VALUE_NO,var_index
              change_bCap btn_no,bcap7
         case 3
'             set_button btn_no,B_KIND,3DBUTTON_V  'Set button type.
              set_button btn_no,B_KIND,3DBUTTON_V2 'Set button type.
              set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
              set_button btn_no,B_BGCOLOR,GREEN    'Set background color.
              set_button btn_no,B_FGCOLOR,YELLOW   'Set foreground color.
              var_index = loopcnt
              set_button btn_no,B_VALUE_NO,var_index
              change_bCap btn_no,bcap7
```

```
        case 4
 '             set_button btn_no,B_KIND,3DBUTTON_V  'Set button type.
               set_button btn_no,B_KIND,3DBUTTON_V2 'Set button type.
               set_button btn_no,B_IO_NO,io_adrs    'Set I/O address.
               set_button btn_no,B_BGCOLOR,CYAN     'Set background color.
               set_button btn_no,B_FGCOLOR,LIGHTMAGENTA  'Set foreground color
               var_index = loopcnt
               set_button btn_no,B_VALUE_NO,var_index
               change_bCap btn_no,bcap7
        case 5
'         set_button btn_no,B_KIND,3DBUTTON_V            'Set button type.
          set_button btn_no,B_KIND,3DBUTTON_V2           'Set button type.
          set_button btn_no,B_IO_NO,io_adrs              'Set I/O address.
          set_button btn_no,B_BGCOLOR,GRAY               'Set background color.
          set_button btn_no,B_FGCOLOR,LIGHTBLUE          'Set foreground color.
          var_index = loopcnt
          set_button btn_no,B_VALUE_NO,var_index
          change_bCap btn_no,bcap7

        end select
        loopcnt = loopcnt + 1
     wend

'Creating a 3D button for returning to screen 0
        io_adrs = 128
        minx = 510
        maxx = 600
        miny = 250
        maxy = 320
        btn_no = 92
        set_button (btn_no),(1),(minx)
        set_button (btn_no),(2),(miny)
        set_button (btn_no),(3),(maxx)
        set_button (btn_no),(4),(maxy)
        set_button (btn_no),(9),(enable)
        set_button (btn_no),(10),(visible)
        set_button (btn_no),(11),(var_type)
        set_button (btn_no),(12),(var_index)
        set_button (btn_no),(14),(panel_no)
        set_button btn_no,B_KIND,3DBUTTON_IO             'Set button type.
        set_button btn_no,B_IO_NO,io_adrs                'Set I/O address.
        set_button btn_no,B_BGCOLOR,BLUE                 'Set background color.
        set_button btn_no,B_FGCOLOR,WHITE                'Set foreground color.
        change_bCap btn_no,bcap6                         'Set button number.

        disp_page panel_no                               'Display specified screen.

END
```

TP Operation Panel Sample: Result of the above sample program



Chapter 14

Multitasking Control Statements

Multitasking control is one of the features of PAC. This chapter provides explanations of the commands used for multitasking control.

14.1 Task Control

RUN (Statement)

Function

Concurrently runs another program.

Format

RUN <Program name> [(<Argument>[,<Argument>···])][,<RUN option>]

Explanation

This statement allows the currently executed program to run a program designated in <Program name>. However, the current program cannot run the program itself.
Only values are usable for <Argument>. Even if you specify reference pass, the reference data will automatically be changed to values. But you cannot use local array.
For <RUN option>, there are PRIORITY (or P) and CYCLE (or C).

PRIORITY (or P)
Designates the priority of a program. If ignored, the default value of 128 is set. The smaller the value, the higher the level of priority. The setting range is from 102 to 255.
Note: The priority over of the supervisory task cannot be changed.
CYCLE (or C)
Designates an alternate cycle (time of each cycle when a program is run repeatedly). This option is expressed in msec. The setting range is from 1 to 2,147,483,647.

You cannot start any program that includes arguments when using the cycle option.

Related Terms

CALL, GOSUB

Example

```
DEFINT Li1 = 1, Li2 =2, Li3 = 3
RUN samp1 C=1000   'Runs samp1 in parallel n (C=1000).
RUN samp2(Li1)     'Runs samp2 using the Li1 argument in parallel.
RUN samp3(Li1,Li2),PRIORITY = 129
                   'Runs samp3 using the Li1 and Li2 arguments in parallel
                   '(P = 129).
RUN samp4(Li1,Li2),PRIORITY = 150
                   'Runs samp4 using the Li1 and Li2 arguments in parallel
                   '(P = 150).
RUN samp5(Li1,Li2,Li3), P = 120
                   'Runs samp5 using the Li1, Li2, and Li3 arguments in parallel
                   '(P = 120)
```

Notes

(1) When a task for which motion is being suspended is run again with a SUSPEND instruction, execute RUN after the motion completely stops. If RUN is executed and the robot is moved again before the motion stop finishes, an error such as a command speed limit over error may occur.
(2) If a CYCLE option is used, note that cycle synchronization elapses even during suspension after an instantaneous stop of the robot during instruction execution followed by a restart of the robot.
(3) RUN command is not executed in the teaching check mode.

KILL (Statement)

Function

Forcibly terminates a task.

Format

KILL <Program name>

Explanation

This statement forcibly terminates the task (program) designated by <Program name>. However, it cannot kill a program that contains the statement. If attempted, an error will occur. To forcibly terminate a statement-containing program, use a STOP instruction.

Related Terms

SUSPEND, STOP

Example

```
RUN samp1              'Concurrently runs samp1.
   .
   .
   .
KILL samp1             'Ends samp1.
```

Notes

If a task in the process of obtaining an arm semaphore is forcibly terminated and an arm semaphore is obtained by another task, an “Arm semaphore obtaining failure” error may occur. In such a case, a timer should be inserted before another task obtains the arm semaphore.

SUSPEND (Statement)

Function

Suspends a task.

Format

SUSPEND <Program name>

Explanation

This statement suspends the processing of a designated task. However, it cannot suspend a program that contains the statement. To suspend a statement-containing program, use a HOLD instruction.

Related Terms

KILL, HOLD

Example

```
SUSPEND samp1          'Suspends task execution of samp1.
```

Notes

When a task for which motion has been suspended using a SUSPEND instruction is RUN again, it should be executed after the motion has completely stopped. If RUN is executed and the robot moves again before motion stop ends, an error such as a command speed limit over may occur.

DEFEND (Statement)

Function

Defends a task.

Format

DEFEND {ON|OFF}

Explanation

A program task usually releases execution priority to another program task with equal or higher priority at fixed intervals.
Use a DEFEND command when a program is processed without releasing execution priority to another task. After DEFEND ON is executed the execution priority is kept until DEFEND OFF is executed. However, if each time designation command for DELAY, WAIT and SET IO is executed, the execution priority is released to another program task.

Note (1): **Set the section of a program that is to be defended with DEFEND ON as short as possible. If the task is in an infinite loop status after execution of DEFEND ON, execution priority will never be transferred to other program tasks.**

Note (2): **Even if a task is defended with DEFEND ON, the defense status is automatically released in the following cases.**

- **When an END command (except for an END command at the end of a called program) is executed**
- **When a KILL command is executed**
- **When the robot controller is initialized using the teach pendant or I/O.**

Related Terms

Example

```
DEFEND ON       'Defends own task.
SET IO[100]     'The following 3 instructions are always continuously executed
                when
                'a task is defended.
SET IO[102]
SET IO[104]
DEFEND OFF      'Releases the defense of own task.
```

STATUS (Function)

Function

Obtains the program status.

Format

STATUS (<Program name>)

Explanation

This statement stores the program status of the program designated in <Program name> using an integer.

Value	Status	
1	Running	Executing
2	Stopping	Stopping in progress
3	Suspend	Suspension in progress
4	Delay	Delay in progress
5	Pending	Currently pending
6	Step Stopped	Step stoppage in progress

Related Terms

DELAY, HALT, HOLD, STOP

Example

```
        DIM li1 As Integer
        li1 = STATUS(samp1)    ' Assigns the program status of samp1 to li1 using an
 integer.
```

Notes

This statement cannot obtain the status of its own.

14.2 Semaphore

A semaphore can be used to communicate (connect a signal) among tasks when multiple tasks are synchronized (synchronized control) or when multiple tasks are not permitted to operate at the same time (exclusive control).
To use a semaphore, create a semaphore with a CREATESEM command to obtain a semaphore ID. Then a specific semaphore can be designated among plural semaphores.
When synchronized control or exclusive control is executed, wait for the task which sends commands to execute a GIVESEM command after a TAKESEM command has been executed for the task waiting for the instruction of another task. If the task sending a command is ready, it executes a GIVESEM command and permits processing of the task which is waiting for a semaphore to execute.
One GIVESEM command is valid only for a task waiting for one semaphore.
If multiple tasks have a semaphore with the same semaphore ID, the sequence of task execution can be selected from among two queuing (execution wait) systems; first-come sequence and priority sequence.

CREATESEM (Function)

Function

Creates a semaphore.

Format

CREATESEM (<Arithmetic expression>)

Explanation

This function creates a semaphore and obtains a semaphore ID.
If there is no semaphore ID, other semaphore related commands cannot be used. Therefore, be sure to execute this CREATESEM command prior to using a semaphore.
Designate a task queuing (execution waiting) system using an argument. Determine the execution order if plural tasks have the same semaphore.
The following two types of queuing systems are available.

Argument	
0	First-come sequence
Other than 0	Priority order of tasks

First-come sequence is the order in which TAKESEM commands are executed.
Task priority is designated with an option (PRIORITY) of the RUN command.
As soon as CREATESEM is executed, the system status changes to the one where a semaphore is present. Therefore, TAKESEM can be executed even if GIVESEM is not executed.
Up to 32 semaphores can be created.

Related Terms

DELETESEM, FLUSHSEM, GIVESEM, TAKESEM

Example

```
DEFINT Li1  Li2  Li3 = 1
Li1 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                       'and the semaphore ID obtained in Li1.
Li2 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                       'and the semaphore ID obtained in Li2.
TAKESEM Li1            'Obtains the semaphore designated in Li1.
TALESEM Li2  100       'Obtains the semaphore designated in Li1.  However, a timeout
                       'occurs after 100 ms.
RUN samp1
GIVESEM Li1            'Releases one task from the wait status which has the semaphore
                       'designated in Li1.
FLUSHSEM Li2           'Releases all tasks from the wait status which have the semaphore
                       'designated in Li2.
DELETESEM Li1          'Deletes the semaphore with the semaphore ID designated in Li1.
DELETESEM Li2          'Deletes the semaphore with the semaphore ID designated in Li2.
```

Notes

Notes on using a **CREATESEM** instruction:

(1) Phenomena which occur due to wrong usage

If one of the following actions is executed when a program which already has a semaphore ID created by a **CREATESEM** instruction is being executed or suspended and in the wait status, the program with the semaphore ID will be left in the wait status without being able to obtain a semaphore.

1) Rewrite a semaphore ID storage variable using **CREATESEM**.
or,
2) Purposely rewrite the variable from the program pendant.

(2) Example

Start up pro1 and instantaneously stop using the STOP key during execution of pro2. After that, if the system is restarted, pro3 will wait for a semaphore indefinitely since the semaphore ID stored in i1 will be changed.

```
PROGRAM PRO1
       i1 = CREATESEM(0)
       RUN PRO2
       RUN PRO3
END

PROGRAM PRO2
       TAKESEM i1
       .
       .
       .
       GIVESEM i1
END

PROGRAM PRO3
       TAKESEM i1
       .
       .
       .
       GIVESEM i1
END
```

(3) Countermeasure when an infinite wait occurs.
To get out of this status, run a calling program (ipro1 in this example) after stopping the program (pro3 in this example) that is in an infinite wait status.

(4) Observe the following for proper use of this statement.
Do not rewrite the ID of a semaphore that is in a wait status. Especially observe the following two points.
1) Create a semaphore that uses the same variable number only once as long as it is not clearly deleted.
2) Do not use a variable which controls a semaphore ID for other purposes.

DELETESEM (Statement)

Function

Deletes a semaphore.

Format

DELETESEM <Semaphore ID>

Explanation

This statement deletes a semaphore with the semaphore ID designated in <Semaphore ID>.

Related Terms

CREATESEM, FLUSHSEM, GIVESEM, TAKESEM

Example

```
        DEFINT Li1  Li2  Li3 = 1
        Li1 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
and
                               'the semaphore ID obtained in Li1.
        Li2 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in
                               'Li3 and the semaphore ID obtained in Li2.
        TAKESEM Li1            'Obtains the semaphore designated in Li1.
        TALESEM Li2  100       'Obtains the semaphore designated in Li1.  However, a timeout
occurs
                               'after 100 ms.
        RUN samp1
        GIVESEM Li1            'Releases one task from the wait status which has the
semaphore
                               'designated in Li1.
        FLUSHSEM Li2           'Releases all tasks from the wait status  which have the
semaphore
                               'designated in Li2.
        DELETESEM Li1          'Deletes the semaphore with the semaphore ID designated in Li1.
        DELETESEM Li2          'Deletes the semaphore with the semaphore ID designated in Li2.
```

FLUSHSEM (Statement)

Function

Releases tasks from waiting for a semaphore.

Format

FLUSHSEM <Semaphore ID>

Explanation

This statement permits all tasks that are waiting for the semaphore designated in <Semaphore ID> to resume processing.

Related Terms

CREATESEM, DELETESEM, GIVESEM, TAKESEM

Example

```
DEFINT Li1  Li2  Li3 = 1
Li1 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                       'and the semaphore ID obtained in Li1.
Li2 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                       'and the semaphore ID obtained in Li2.
TAKESEM Li1            'Obtains the semaphore designated in Li1.
TALESEM Li2  100       'Obtains the semaphore designated in Li1.  However, a timeout
                       'occurs after 100 ms.
RUN samp1
GIVESEM Li1            'Releases one task from the wait status which has the semaphore
                       'designated in Li1.
FLUSHSEM Li2           'Releases all tasks from the wait status which have the semaphore
                       'designated in Li2.
DELETESEM Li1          'Deletes the semaphore with the semaphore ID designated in Li1.
DELETESEM Li2          'Deletes the semaphore with the semaphore ID designated in Li2.
```

GIVESEM (Statement)

Function

Releases a task from waiting for a semaphore.

Format

GIVESEM <Semaphore ID>

Explanation

This statement releases the semaphore designated in <Semaphore ID>.
The system permits a restart of a process if there is one task which has the semaphore designated in <Semaphore ID> when it is released. If there is a task waiting for multiple semaphores, the system determines the execution sequence using the queuing system designated by the CREATESEM command when the semaphores were created.

Related Terms

CREATESEM, DELETESEM, FLUSHSEM, TAKESEM

Example

```
        DEFINT Li1  Li2  Li3 = 1
        Li1 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                               'and the semaphore ID obtained in Li1.
        Li2 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                               'and the semaphore ID obtained in Li2.
        TAKESEM Li1            'Obtains the semaphore designated in Li1.
        TALESEM Li2  100       'Obtains the semaphore designated in Li1.  However, a timeout
                               'occurs after 100 ms.
        RUN samp1
        GIVESEM Li1            'Releases one task from the wait status which has the semaphore
                               'designated in Li1.
        FLUSHSEM Li2           'Releases all tasks from the wait status which have the
 semaphore
                               'designated in Li2.
        DELETESEM Li1          'Deletes the semaphore with the semaphore ID designated in Li1.
        DELETESEM Li2          'Deletes the semaphore with the semaphore ID designated in Li2.
```

TAKESEM (Statement)

Function

Obtains a semaphore with a designated semaphore ID.

Format

TAKESEM <Semaphore ID>[,<Timeout time>]

Explanation

This statement obtains the semaphore designated in <Semaphore ID>.
If another task obtains a semaphore, the system waits for the semaphore to be released before the semaphore is obtained.
Waiting time can be designated in milliseconds (ms) using the option <Timeout time>. If the system cannot obtain a semaphore within the designated time, an error occurs.

Related Terms

CREATESEM, DELETESEM, FLUSHSEM, GIVESEM

Example

```
        DEFINT Li1  Li2  Li3 = 1
        Li1 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                               'and the semaphore ID obtained in Li1.
        Li2 = CREATESEM(Li3)   'Creates a semaphore with the queuing system designated in Li3
                               'and the semaphore ID obtained in Li2.
        TAKESEM Li1            'Obtains the semaphore designated in Li1.
        TALESEM Li2  100       'Obtains the semaphore designated in Li1.  However, a timeout
                               'occurs after 100 ms.
        RUN samp1
        GIVESEM Li1            'Releases one task from the wait status which has the
semaphore
                               'designated in Li1.
        FLUSHSEM Li2           'Releases all tasks from the wait status which have the
semaphore
                               'designated in Li2.
        DELETESEM Li1          'Deletes the semaphore with the semaphore ID designated in Li1.
        DELETESEM Li2          'Deletes the semaphore with the semaphore ID designated in Li2.
```

Notes

When the timeout time option is used, note that the waiting time elapses even in suspension after an instantaneous stop of the robot during execution of an instruction and a subsequent restart of the robot.

14.3 Arm Semaphore

TAKEARM (Statement)

Function

Gets an arm group. Upon execution of this statement, the programmed speed, acceleration and deceleration will be set to 100. If the gotten arm group includes any robot joint, this statement restores the tool coordinates and work coordinates to the origin.

Format

TAKEARM[<ArmGroupNumber>][<KEEP=DefaultValue>]

Explanation

This statement continues the process as it is, if a TAKEARM command in a task which already has control priority, or in a subroutine called by the task is executed.

■ <ArmGroupNumber> [V1.5 or later]

If `<ArmGroupNumber>` is omitted, the `TAKEARM` gets the semaphore of Arm Group 0 in which only robot joints are enabled.

■ <KEEP = Set value for initializing> [V1.4 or later]

Set value for initializing	0:	The tool coordinate and the work coordinate are returned to the origin, and the internal speed, the internal acceleration, and the internal deceleration are set to 100.
	1:	The tool coordinate, the work coordinate, the internal speed, the internal acceleration, and the internal deceleration are maintained to their current setting.

If <KEEP = Set value for initializing> is omitted, KEEP=0 (the tool coordinate and the work coordinate are returned to the origin, and the internal speed, the internal acceleration, and the internal deceleration is set to 100) is assumed.

(1) Arm group includes any robot joint

An error will occur if a task without robot control priority attempts to execute a robot motion instruction in the following table. Be sure to obtain a control priority with a TAKEARM command for programs that are used to execute these motion instructions.

Robot motion instructions requiring control priority

Type	Commands
Declaration statement	HOME, TOOL, WORK
Robot control statement	APPROACH, DEPART, DRAW, DRIVE, DRIVEA, GOHOME, MOVE, ROTATEH, ROTATE, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL, CHANGETOOL, CHANGEWORK, LETENV Proper portable mass setting library, Arm motion library

Note 1:	**Robot control priority is automatically released in the following cases.** **• If an END command is executed (Except for an END command at the end of a called program)** **• If a KILL command is executed** **• If a HALT command is executed** **• If a STOP command is executed** **• If the robot controller is initialized with the teach pendant or I/O.**
Note 2:	**If a TAKEARM command is executed, the system automatically executes the following process.** **• The TOOL definition is initialized to TOOL 0. The work coordinates are set to the base coordinates of the robot.** **• The internal speed, internal acceleration and internal deceleration are set to 100.**
Note 3:	**The system does not release during program suspension.**

(2) extended-joints

If a task holding no arm group attempts to execute any of the following motion commands, an error will occur. Before executing those commands, get the arm semaphore (Arm Group) by using the TAKEARM command.

Commands Requiring Arm Group

Commands	Requires:
HOME, TOOL, WORK, APPROACH, DEPART, DRAW, GOHOME, MOVE, ROTATEH, ROTATE, CHANGETOOL, CHANGEWORK, DRIVE, DRIVEA, SPEED, JSPEED, ACCEL, JACCEL, DECEL, JDECEL, INTERRUPT, LETENV, Motion optimization library, and Arm motion library	Arm group involving robot joints
DRIVE, DRIVEA, SPEED. JSPEED. ACCEL, JACCEL, DECEL, JDECEL, INTERRUPT, LETENV, and POSCLR	Arm group that may or may not involve robot joints

Notes

(1) The DRIVE and DRIVEA commands require an arm group involving a joint(s) to move.

Example: `DRIVE (7,10)`

To move the 7th joint, the task should hold the arm group involving the 7th joint.

(2) The MOVE command with EX (EXA) option requires the arm group involving robot joints and extended-joints which are invoked by the EX (EXA) option.

Example: `MOVE P, P0 EX ((7,10))`

The arm group should involve robot joints as well as the 7th joint.

(3) The speed setting commands will only change the speed of joints involved in an active arm group currently held in the task.

(4) The LETENV command requires an arm group involving joints associated with parameters to be changed.

Related Terms

GIVEARM, TAKEVIS, GIVEVIS

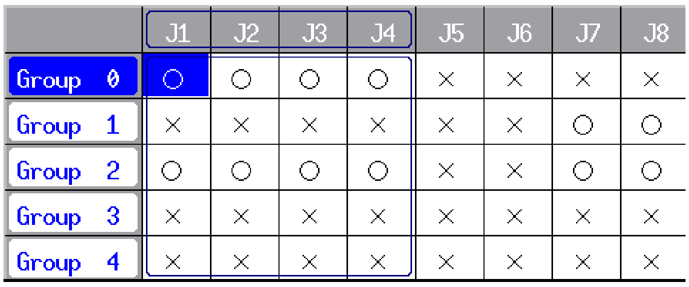
Example

```
Example 1:
       PROGRAM PRO1          '
       TAKEARM               'Executes TAKEARM on the first line of the program which
                             'instructs the robot motion.
       MOVE P, P1            '
       MOVE P, P2            '
       GIVEARM 1             'Releases robot control priority with GIVEARM when this is
                             'finished.
                             'This is not always required since the priority is automatically
                             'released with END just after this statement.
       END                   '

Example 2:
       PROGRAM PRO2          '
       MOVE P, P3            '×: If a MOVE instruction is executed without execution of
                             'TAKEARM, an error occurs.
                             '
       END                   '

Example 3:
       PROGRAM PRO3          '
       TAKEARM               '
       MOVE P, P4            '
       CALL SUB1             '
       END                   '
       PROGRAM SUB1          '
       MOVE P, P5            'An error does not occur since TAKEARM has already been executed
                             'by PRO3.
       END                   '

Example 4:
       PROGRAM PRO4          '
       TAKEARM               '
       SPEED 50              '
       CHANGEWORK 3          '
       CHANGETOOL 1          '
       MOVE P, P5            '
       CALL PRO5             '
       END                   '

       PROGRAM PRO5          '
       TAKEARM               'An error does not occur even if TAKEARM is instructed
twice
                             'by PRO4 since this is called as a subroutine of PRO4.

       MOVE P, P6            'However, the tool coordinates and the work coordinates are 0 and the
internal
                             'speed is 100.
       END                   '
```

```
Example 5:
       PROGRAM PRO6          '
       TAKEARM               '
       RUN PRO7              '
       MOVE P, P7            '
       END                   '

       PROGRAM PRO7          '
       TAKEARM               '×: An error occurs when an attempt is made to obtain the robot
                             'execution priority with PRO7 which is run as another task
of
                             'PRO6, since PRO6 already has robot control priority.
       MOVE P, P7            '
       END                   '
```

Example 6:(*extended-joints*)_

Shown below are program samples for the TAKEARM command when arm groups are arranged as listed below (for 4-axis robots).



	J1	J2	J3	J4	J5	J6	J7	J8
Group 0	○	○	○	○	×	×	×	×
Group 1	×	×	×	×	×	×	○	○
Group 2	○	○	○	○	×	×	○	○
Group 3	×	×	×	×	×	×	×	×
Group 4	×	×	×	×	×	×	×	×

```
       PROGRAM PRO1
       TAKEARM 1      'Get Arm Group 1 (7th extended-joint involved).
       DRIVEA (7,100) 'Move the 7th extended-joint to an angle of 100
                      'degrees.
       END


       PROGRAM PRO2
       TAKEARM 2      'Get Arm Group 2 (all robot joints and 7th
                      'extended-joint involved).
       MOVE P,P0 EX ((7,10))
                      'Simultaneously move robot joints and 7th
                      'extended-joint.
       DRIVEA (7,100) 'Move the 7th extended-joint to an angle of
                      '100 degrees.
       END
```

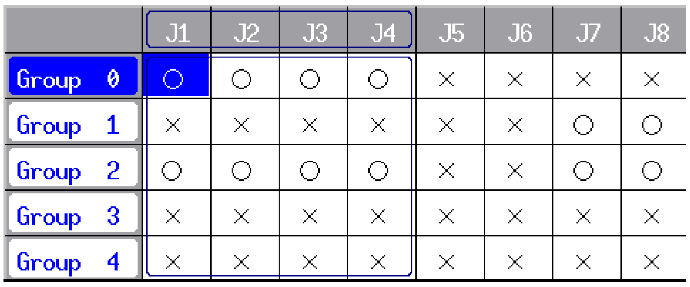
Notes

(1) One program cannot hold more than one different arm group. However, it can get the same arm group again in one program.

```
Example:  TAKEARM 0
          MOVE P, P0
          TAKEARM 0      'Can get Arm Group 0 again, even if this
                         'program has got it.
          TAKEARM 1      'Error occurs since TAKEARM attempts to
                         'get Arm Group 1 while Arm Group 0 has been
                         'held.
```

(2) If TAKEARM with KEEP option being set to "1" gets an arm group, the arm speed will not be initialized and remain as that of the old arm group.

Example: If arm groups are arranged as listed below and the three programs exist:



	J1	J2	J3	J4	J5	J6	J7	J8
Group 0	○	○	○	○	×	×	×	×
Group 1	×	×	×	×	×	×	○	○
Group 2	○	○	○	○	×	×	○	○
Group 3	×	×	×	×	×	×	×	×
Group 4	×	×	×	×	×	×	×	×

```
PROGRAM PRO1          PROGRAM PRO2          PROGRAM PRO3
TAKEARM 1             TAKEARM 2             TAKEARM 1 keep=1
SPEED 10              SPEED 20              DRIVE(7,10)
DRIVE(7,10)           DRIVE(7,10)           END
END                   END
```

First run PRO1. The 7th-joint will move at speed 10.

Next run PRO2. The 7th-joint will move at speed 20.

Then run PRO3. Since the KEEP option is "1", the 7th-joint will move at speed 10 keeping the speed defined by SPEED command for Arm Group 1 in PRO1.

GIVEARM (Statement)

Function

Releases robot control priority.

Format

GIVEARM

Explanation

This statement releases the robot control priority. With this, other tasks can obtain a control task.

If an attempt is made to execute a GIVEARM command although another task has already obtained robot control priority, an error occurs.

Note: Robot control priority is automatically released in the following cases. Therefore, it is possible to ignore a GIVEARM command.

- **If an END command is executed (Except for an END command at the end of the program called)**
- **If a KILL command is executed.**
- **If the robot controller is initialized with the teach pendant or I/O.**

Related Terms

TAKEARM, TAKEVIS, GIVEVIS

Example

```
TAKEARM        'Executes TAKEARM at the head of the program which executes robot motion.
MOVE P, lp1    '
MOVE P, lp2    '
GIVEARM        'Releases robot control priority with GIVEARM when 1 is finished.  This does
               'not always have to be executed since the robot is automatically released at the
               'END just after this.
```

Notes

The system waits until the robot completely stops before executing GIVEARM. Therefore, even if a pass motion is designated before GIVEARM, the pass motion does not execute.

TAKEVIS (Statement)

Function

Obtains visual process priority.

Format

TAKEVIS

Explanation

This statement obtains visual process priority on the μVISION board optionally installed in the robot controller. Without a μVISION board installed, an error will occur if the TAKEVIS command is executed.
If another task has already obtained visual process priority and the system cannot obtain it, an error occurs.
If a task that does not obtain visual process priority attempts to execute a visual instruction, an error occurs. In a program in which a visual instruction is executed, visual process priority must be obtained with the TAKEVIS command prior to the visual instruction.
If a TAKEVIS command is executed in a task with visual process priority or in a subroutine called from the task, the processing continues without change.

Note: Visual control priority is automatically released in the following cases.

- **If an END command is executed (Except for an END command at the end of the program called)**
- **If a KILL command is executed**
- **If the robot controller is initialized with the teach pendant or I/O**

Related Terms

TAKEARM, GIVEARM, GIVEVIS

Example

```
DEFINT Li1, Li2                       'Obtains visual process priority.
TAKEVIS
VISSCREEN 1, 0, 1
VISCLS
FOR Li1 = 0 TO 255
   Li2 = VISREFTABLE(1, Li1)          'Obtains data from table 1.
   VISLOC 10, 10                      'Sets the display position.
   VISDEGCHAR 1, 1, 2                 'Sets the display character.
   VISPRINT ″Data″; Li1; ″=″; Li2     'Displays.
NEXT Li1
GIVEVIS                               'Releases visual process priority.
```

GIVEVIS (Statement)

Function

Releases visual process priority.

Format

GIVEVIS

Explanation

This statement releases visual process priority on the μVISION board optionally installed in the robot controller. With this, another task can obtain visual process priority. Without a μVISION board installed, an error will occur if the GIVEVIS command is executed.
If an attempt is made to execute the GIVEVIS command although another task has already obtained visual process priority, an error will occur.

Note: Robot control priority is automatically released in the following cases. Therefore, it may be possible to ignore the GIVEVIS command.
- **If an END command is executed (Except for an END command at the end of the program called)**
- **If a KILL command is executed**
- **If the robot controller is initialized with the teach pendant or I/O**

Related Terms

TAKEARM, GIVEARM, TAKEVIS

Example

```
DEFINT Li1, Li2                       'Obtains visual process priority.
TAKEVIS
VISSCREEN 1, 0, 1
VISCLS
FOR Li1 = 0 TO 255
   Li2 = VISREFTABLE (1, Li1)         'Obtains data from table 1.
   VISLOC 10, 10                      'Sets the display position.
   VISDEGCHAR 1, 1, 2                 'Sets the display character.
   VISPRINT ″Data″; Li1; ″=″; Li2     'Displays.
NEXT Li1
GIVEVI                                'Releases visual process priority.
```

Chapter 15

Functions

This chapter provides an explanation of various functions prepared in PAC.

15.1 Arithmetic Function

ABS (Function) [Conforms to SLIM]

Function

Obtains the absolute value of an expression value.

Format

ABS (<Expression>)

Explanation

This statement obtains the absolute value of the value designated in <Expression>.

If <Expression> includes a double precision real numeral, the value obtained becomes double precision. Otherwise, a single precision value is obtained.

Explanation:	**The absolute value is a numeric value of which the sign is removed. For example, both ABS (-1) and ABS (1) return 1.**

Related Terms

Example

```
DEFSNG lf1, lf2, lf3, lf4
lf1 = ABS(-2)                'Assigns the absolute value of –2 to If1.
lf2 = ABS(lf3/lf4)           'Assigns the absolute value of (lf3/lf4) to lf2.
```

EXP (Function) [Conforms to SLIM]

Function

Obtains an exponential function with a natural logarithm taken as a base.

Format

EXP (<Expression>)

Explanation

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

Explanation:	**If the value of an argument number exceeds 709.782712893 , an overflow error occurs. The constant "e" is approximately 2.718282.**
Memo:	**The EXP function is an inverse function of the logarithm and is often referred to as an inverse logarithm.**

Related Terms

LOG, LOG10

Example

```
DEFSNG lf1, lf2, lf3, lf4
lf1 = EXP(2)        'Assigns the 2nd power of the natural logarithm base to lf1.
lf2 = EXP(lf3/lf4)  'Assigns the (lf3/lf4) power of the natural logarithm base to lf2.
```

INT (Function) [Conforms to SLIM]

Function

Obtains the maximum integer value possible from a designated value.

Format

INT (<Expression>)

Explanation

This statement returns the maximum integer that does not exceed the value of <Expression>.
If the value overflows, the maximum integer value with the same sign as <Expression> is applied.

Example

```
DIM li1 As Integer
li1 = INT(123.456)      'Rounds down after the decimal point and assigns the value to
                        'integer variable li1.
                        '123.456->123
```

LOG (Function) [Conforms to SLIM]

Function

Obtains a natural logarithm.

Format

LOG (<Expression>)

Explanation

This statement obtains the natural logarithm of the value designated in <Expression>.

Designate a value that is greater than 0 for <Numeric value>.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

Explanation:	**The natural logarithm is a logarithm with the constant "e" as the base. The value of the constant "e" is approximately 2.718282. The logarithm of an arbitrary numeric value of x with n as the base can be obtained by dividing the natural logarithm of x by the natural logarithm of n as shown below.** **$Log_n x = Log_e x / Log_e n$**

Related Terms

EXP, LOG10

Example

```
DEFSNG lf1, lf2, lf3, lf4
lf1 = LOG(2)          'Assigns the natural logarithm of 2 to lf1.
lf2 = LOG(lf3/lf4)     'Assigns the natural logarithm of (lf3/lf4) to lf2.
```

LOG10 (Function) [Conforms to SLIM]

Function

Obtains a common logarithm.

Format

LOG10 (<Expression>)

Explanation

This statement obtains the common logarithm of the value designated in <Expression>. The base of the common logarithm is 10.

Designate a value larger than 0 for <Numeric value>.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

Related Terms

EXP, LOG

Example

```
DEFSNG lf1, lf2, lf3, lf4
lf1 = LOG10(2)         'Assigns the common logarithm of 2 to lf1.
lf2 = LOG10(lf3/lf4)   'Assigns the common logarithm of (lf3/lf4) to lf2.
```

POW (Function) [Conforms to SLIM]

Function

Obtains an exponent.

Format

POW (<Base>,<Exponent>)

Explanation

This statement obtains the exponent of the value designated in <Base>of <Exponent>.

If <Base> or <Exponent> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

Related Terms

EXP

Example

```
DEFSNG lf1, lf2
DEFINT li1, li2
li1 = POW(5, 2)         'Assigns the 2nd power of 5 to li1.
lf1 = POW(lf2, li2)     'Assigns the li2 power of lf2 to lf1.
```

Notes

In an exponential calculation, a domain error occurs if the first argument is negative.
If <Base> and <Exponent> include a double precision real numeral, the precision is guaranteed up to 15 digits.
If <Base> and <Exponent> do not include a double precision real numeral, the precision is guaranteed only up to 7 digits.

MAX (Function) [Conforms to SLIM]

Function

Extracts the maximum value.

Format

MAX (<Expression>,<Expression>[,<Expression>…])

Explanation

This statement extracts the maximum value from an arbitrary number of <Expression>'s.
The maximum number of expressions is 32.

Explanation:	**If the MIN function and the MAX function are used, the minimum or maximum value of the designated accumulation method or group fields can be obtained. For example, this function can be used to check the maximum and minimum shipping charges. If there is no designation of the accumulation method, the whole table becomes an object.**

Related Terms

MIN

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5, lf6
DEFINT li1, li2, li3, li4, li5, li6
li1 = MAX(1, 2)                     'Assigns the maximum value between (1, 2) to
                                    'li1.
li2 = MAX(li3, li4, li5, li6)       'Assigns the maximum value among (li3, li4,
                                    'li5, li6) to li2.
lf1 = MAX(lf2, lf3, lf4, lf5, lf6)  'Assigns the maximum value among (lf2, lf3,
                                    'lf4, lf5, lf6) to lf1.
```

MIN (Function) [Conforms to SLIM]

Function

Extracts the minimum value.

Format

MIN (<Expression>,<Expression>[,<Expression>…])

Explanation

This statement extracts the minimum value from an arbitrary number of <Expression>'s.
The minimum number of expressions is 32.

Explanation:	**If the MIN function and the MAX function are used, the minimum or maximum value of the designated accumulation method or group fields can be obtained. For example, this function can be used to check the maximum and minimum shipping charges. If there is no designation of the accumulation method, the whole table becomes an object.**

Related Terms

MAX

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5, lf6
DEFINT li1, li2, li3, li4, li5, li6
li1 = MIN(1, 2)                     'Assigns the minimum value between (1, 2) to li1.
li2 = MIN(li3, li4, li5, li6)       'Assigns the minimum value among (li3, li4,
                                    'li5, li6) to li2.
lf1 = MIN(lf2, lf3, lf4, lf5, lf6)  'Assigns the minimum value among (lf2, lf3,
                                    'lf4, lf5, lf6) to lf1.
```

RND (Function)

Function

Generates random numbers from 0 to 1.

Format

RND (<Expression>)

Explanation

According to the value in <Expression>, processing varies as shown in the table below.
<Expression> applies to integer values. If a real value is designated, it is rounded down and converted to an integer.

Value of Expression	Processing
Expression < 0	<Expression> is applied as the seed value for the random number. If the seed value is the same, the return value of the RND function is always the same.
Expression = 0	A random number previously generated is taken. Zero is returned if no random number is generated after the robot controller power is turned ON.
Expression > 0	The next random number in the random number sequence is generated.

Explanation: **For the RND function, a value from 0 to 1 inclusive is returned. Depending on the argument value, the random number returned by the RND function will vary. As long as the initial seed value is the same, the random number sequence returned by a series of RND functions is the same. This is because each consecutive RND function generates the next random number using the previous random number in the random number system as the seed value.**

Remark: **When the seed value in the random number is the same, the random number sequence obtained is the same. To obtain different random numbers each time, use the return value of the TIMER function as a seed value.**

Example

```
DIM array(10) As Single
array(0) = RND(-TIMER) 'The seed value for the random number is set using the
                       'TIMER function.
FOR I1 = 1 TO 9
  array(I1) = RND(1)   'Obtains random numbers.
NEXT I1
```

SGN (Function)

Function

Checks a sign.

Format

SGN (<Expression>)

Explanation

This statement checks the sign of <Expression> and returns the following numeric value.

If positive	1
If 0	0
If negative	-1

Example

```
DEFSNG lf1, lf2
lf2 = SGN (lf1)        'Returns the sign of the real variable lf1.
```

SQR (Function) [Conforms to SLIM]

Function

Obtains the square root.

Format

SQR (<Expression>)

Explanation

This statement obtains the square root of the value in <Expression>.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

<Expression> must be a value greater than or equal to 0.

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5, lf6, lf7
lf1 = SQR (2)                  'Assigns the square root of 2 to lf1.
lf2 = SQR (lf4)                'Assigns the square root of lf4 to lf2.
lf3 = SQR (lf5 + lf6) * lf7    'Assigns the value of the square root of (lf5 +
                               'lf6) multiplied by lf7 to lf3.
```

15.2 Trigonometric Function

ACOS (Function) [Conforms to SLIM]

Function

Obtains an arc cosine.

Format

ACOS (<Expression>)

Explanation

This statement obtains the arc cosine of the value in <Expression>.
The obtained value is expressed in degrees and ranges from 0 to 180.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

Related Terms

SIN, TAN, ASIN, ATN, ATN2

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5, lf6, lf7
lf1 = ACOS (0.5)              'Assigns the arc cosine value of 0.5 to lf1.
lf2 = ACOS (lf4/2)            'Assigns the arc cosine value of (lf4/2) to lf2.
lf3 = ACOS (lf5/lf6) * lf7    'Assigns the arc cosine value of (lf5/lf6)
                              'multiplied by lf7 to lf3.
```

ASIN (Function) [Conforms to SLIM]

Function

Obtains an arc sine.

Format

ASIN (<Expression>)

Explanation

This statement obtains the arc sine of the value in <Expression>.
The obtained value is expressed in degrees and ranges from -90 to 90.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

Related Terms

SIN, COS, TAN, ACOS, ATN, ATN2

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5, lf6, lf7
lf1 = ASIN (0.5)              'Assigns the arc sine value of 0.5 to lf1.
lf2 = ASIN (lf4/2)            'Assigns the arc sine value of (lf4/2) to lf2.
lf3 = ASIN (lf5/lf6) * lf7    'Assigns the arc sine value of (lf5/lf6)
                              'multiplied by lf7 to lf3.
```

ATN (Function) [Conforms to SLIM]

Function

Obtains an arc tangent.

Format

ATN (<Expression>)

Explanation

This statement obtains the arc tangent of the value in <Expression>.
The obtained value is expressed in degrees and ranges from -90 to 90.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

Explanation:	**The ATN function receives the ratio of 2 sides of a right triangle as an argument (number) and returns the corresponding angle. The 2 sides mentioned here include the right angle. The ratio of the 2 sides is the value of the opposite side length to the obtained angle divided by the adjacent side (base, or side adjacent to the obtained angle) length. The return value will range from $-\pi/2$ to $\pi/2$ (expressed in radians). To convert degrees to radians, multiply the degree by $\pi/180$. To convert radians to degrees, multiply the radian by $180/\pi$.**
Memo:	**The ATN function is an inverse trigonometric function of the Tan function. The Tan Function receives an angle as an argument, and returns the ratio of the 2 sides that include the right angle of a right triangle. Note the difference between the ATN function and the cotangent (1/tangent) of the reciprocal tangent.**

Related Terms

SIN, COS, TAN, ASIN, ACOS, ATN2

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5, lf6, lf7
lf1 = ATN(0.5)               'Assigns the arc tangent value of 0.5 to lf1.
lf2 = ATN(lf4/2)             'Assigns the arc tangent value of (lf4/2) to lf2.
lf3 = ATN(lf5/lf6) * lf7     'Assigns the arc tangent value of (lf5/lf6)
                             'multiplied by lf7 to lf3.
```

ATN2 (Function) [Conforms to SLIM]

Function

Obtains the arc tangent of expression 1 divided by expression 2.

Format

ATN2 (<Expression1>, <Expression2>)

Explanation

This statement obtains the arc tangent value of <Expression1> divided by <Expression2>.
The unit of the obtained value is degrees and its range is from -180 to 180.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.

The following is a value range of ATN2.

	First quadrant	**Second quadrant**	**Third quadrant**	**Fourth quadrant**
Lower limit value	0	90	-180	-90
Upper limit value	90	180	90	- 0

Related Terms

SIN, COS, TAN, ASIN, ACOS, ATN

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5, lf6, lf7, lf8
lf1 = ATN2(1, 2)            'Assigns the arc tangent value of (1, 2) to lf1.
lf2 = ATN2(lf4, lf5)        'Assigns the arc tangent value of (lf4, lf5) to lf2.
lf3 = ATN2(lf6, lf7) * lf8  'Assigns the arc tangent value of (lf6, lf7)
                            'multiplied by lf8 to lf3.
```

COS (Function) [Conforms to SLIM]

Function

Obtains a cosine.

Format

COS (<Expression>)

Explanation

This statement obtains the cosine value of the value in <Expression>.

Designate the unit of <Expression> in degrees.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.
If an argument is entered in radians, add RAD followed by the constant.

Explanation:	**The COS function receives an angle as an argument and returns the ratio of the 2 sides of a right triangle including the right angle. The 2 sides mentioned include the angle designated to the argument number. The ratio of the 2 sides is the value of the adjacent side length (base) to the hypotenuse side (oblique side) length. The return value ranges from -1 to 1. To convert degrees to radians, multiply the degrees by π/180. To convert radians to degrees, multiply the radians by 180/π.**

Related Terms

SIN, TAN, ASIN, ACOS, ATN, ATN2

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5
lf1 = COS(0.78525)          'Assigns the cosine value of 0.78525 to lf1.
lf2 = COS(lf4)              'Assigns the cosine value of lf4 to lf2.
lf3 = COS(45) * lf5         'Assigns the cosine value of 45 degrees multiplied
                            'by lf5 to lf3.
```

SIN (Function) [Conforms to SLIM]

Function

Obtains a sine.

Format

SIN (<Expression>)

Explanation

Obtains the sine value of the value in <Expression>.

Designate the unit of <Expression> in degrees.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.
If an argument is entered in radians, add RAD after the constant.

Explanation:	**The SIN function receives an angle as an argument and the ratio of the 2 sides of a right triangle including the right angle. The 2 sides mentioned here are the opposite side to the designated angle and the hypotenuse side. The ratio of the 2 sides is the value of the opposite side length divided by the hypotenuse side length. The return value ranges from -1 to 1. To convert degrees to radians, multiply the degrees by π/180. To convert radians to degrees, multiply the radians by 180/π.**

Related Terms

COS, TAN, ASIN, ACOS, ATN, ATN2

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5
lf1 = SIN(0.78525)          'Assigns the sine value of 0.78525 to lf1.
lf2 = SIN(lf4)              'Assigns the sine value of lf4 to lf2.
lf3 = SIN(45) * lf5         'Assigns the sine value of 45 degrees multiplied by
                            'lf5 to lf3.
```

TAN (Function) [Conforms to SLIM]

Function

Obtains a tangent.

Format

TAN (<Expression>)

Explanation

This statement obtains the tangent value of the value in <Expression>.

Designate the unit of <Expression> in degrees.

If <Expression> includes a double precision real numeral, the obtained value becomes double precision. Otherwise, a single precision value is obtained.
If an argument is entered in radians, add RAD after the constant.

Explanation: **The TAN function receives an angle as an argument and returns the ratio of 2 sides of a right triangle including the right angle. The 2 sides mentioned here include the right angle. The ratio of the 2 sides is the value of the opposite side length from the obtained angle divided by the adjacent side (base, or side adjacent to the obtained angle) length. To convert degrees to radians, multiply the degrees by π/180. To convert radians to degrees, multiply the radians by 180/π.**

Related Terms

SIN, COS, ASIN, ACOS, ATN, ATN2

Example

```
DEFSNG lf1, lf2, lf3, lf4, lf5
lf1 = TAN(0.78525)      'Assigns the tangent value of 0.78525 to lf1.
lf2 = TAN(lf4)          'Assigns the tangent value of lf4 to lf2.
lf3 = TAN(45) * lf5     'Assigns the tangent value of 45 degrees multiplied by
                        'lf5 to lf3.
```

15.3 Angle Conversion

DEGRAD (Function) [Conforms to SLIM]

Function

Converts the unit to a radian.

Format

DEGRAD (<Expression>)

Explanation

This statement converts the unit of the value designated in <Expression> from degrees to radians.

Related Terms

RADDEG

Example

```
DEFSNG lf1, lf2, lf3
lf1 = DEGRAD(90)             'Assigns the value of 90 converted to radians to lf1.
lf2 = SIN(DEGRAD(lf3 + 20))  'Assigns the sign value of (lf3 + 20) converted to
                             'radians to lf2.
```

RAD (Function)

Function

Converts a value set in radians to degrees.

Format

<Numeric value> RAD

Explanation

This statement converts a <Numeric value> set in radians to degrees and calculates it.

Related Terms

RADDEG

Example

```
DIM lf1 As SINGLE
lf1 = 2RAD   'Converts radian 2 to degrees and assigns it to lf1.
```

RADDEG (Function) [Conforms to SLIM]

Function

Converts the unit to degrees.

Format

RADDEG (<Expression>)

Explanation

This statement converts the unit of the value designated in <Expression> from radians to degrees.

Related Terms

RAD, DEGRAD

Example

```
DEFSNG lf1, lf2
lf1 = RADDEG(1.5705)    'Assigns the value of 1.5705 converted to degrees to lf1.
lf2 = RADDEG(PI/2)      'Assigns the sine value of (π/2) converted to degrees to lf2.
```

15.4 Speed Conversion

MPS (Function)

Function

Converts an expression of speed.

Format

MPS (<Expression>)

Explanation

This statement converts the <Expression> speed value (percentage) to the arm end movement speed value %.

<Expression> is expressed in mm/sec.

Related Terms

SPEED

Example

```
SPEED MPS(50/2)        'Converts the internal movement speed to 50/2 (mm/sec).
```

15.5 Time Function

SEC (Function)

Function

Converts a value expressed in seconds to milliseconds.

Format

<Numeric value> SEC

Explanation

This statement converts <Numeric value> set in seconds to milliseconds and calculates it. Use this statement for an instruction set in milliseconds.

Example

```
DELAY(10SEC) 'Waits until 10 seconds elapse.
```

15.6 Vector

AVEC (Function)

Function

Extracts an approach vector.

Format

AVEC (<Homogeneous transformation type>)

Explanation

This statement extracts an approach vector from homogeneous transformation type coordinates.

Related Terms

OVEC, PVEC

Example

```
DEFTRN lt1, lt2, lt3
DEFVEC lv1, lv2
lv1 = AVEC(lt1)         'Assigns the approach vector of lt1 to lv1.
lv2 = AVEC(lt2 * lt3)   'Assigns an approach vector with a value of (lt2 * lt3) to lv2.
```

OVEC (Function)

Function

Extracts an orient vector.

Format

OVEC (<Homogeneous transformation type>)

Explanation

This statement extracts an orient vector from homogeneous transformation type coordinates.

Related Terms

AVEC, PVEC

Example

```
DEFTRN lt1, lt2, lt3
DEFVEC lv1, lv2
lv1 = OVEC(lt1)         'Assigns the orient vector of lt1 to lv1.
lv2 = OVEC(lt2 * lt3)   'Assigns an orient vector with a value of (lt2 * lt3) to lv2.
```

PVEC (Function)

Function

Extracts a position vector.

Format

PVEC ({<Homogeneous transformation type>|<Position type>})

Explanation

This statement extracts a position vector from homogeneous transformation type coordinates or from position type coordinates.

Related Terms

AVEC, OVEC, RVEC

Example

```
                    DIM lt1 As Trans
                    DIM lv1 As Vector
                    DIM lp1 As Position
                    lv1 = PVEC(lt1)    'Assigns the position vector of lt1 to lv1.

    6-axis          lv1 = PVEC(lp1 + (100, 200, 0, 0, 0, 0) )
                                       'Assigns the position vector of lp1 +
                                       '(100, 200, 0, 0,0, 0) to lv1.

    4-axis          lv1 = PVEC(lp1 + (100, 200, 0, 0) )
                                       'Assigns the position vector of lp1+(100, 200, 0,
                        0)
                                       'to lv1.
```

MAGNITUDE (Function)

Function

Obtains the vector size.

Format

MAGNITUDE (<Vector type>)

Explanation

This statement obtains the vector size of a vector type coordinate value.

Related Terms

DIST

Example

```
DEFSNG lf1, lf2
DIM lv1 As Vector
lf1 = MAGNITUDE((10, 10, 10))     'Assigns the size of vector (10, 10, 10) to lf1.
lf2 = MAGNITUDE(lv1)              'Assigns the size of vector lv1 to lf2.
```

15.7 Pose Data Type Transformation

J2P (Function)

Function

Transforms joint type data to position type data.

Format

J2P (<Joint type>)

Explanation

This statement transforms the joint type data designated in <Joint type> to position type data. The value to be obtained reflects the tool and work coordinate systems that are set at the moment.

Related Terms

J2T, P2J, P2T, T2J, T2P

Example

```
DEFPOS lp1, lp2
DIM lj1 As Joint
lp1 = J2P(lj1)     'Assigns lj1 data transformed to position type data to
    lp1.
```

6-axis
```
lp2 = J2P((0, 0, 90, 0, 0, 0))
                   'Assigns the data of (0, 0, 90, 0, 0, 0)
                   'transformed to position type data to lp2.
```

4-axis
```
lp2 = J2P((0, 0, 300, 0))
                   'Assigns the data of (0, 0, 300, 0)
                   'transformed to position type data to lp2.
```

J2T (Function)

Function

Transforms joint type data to homogeneous transformation type data.

Format

J2T (<Joint type>)

Explanation

This statement transforms the joint type data designated in <Joint type> to homogeneous transformation type data. The value to be obtained reflects the tool and work coordinate systems that are set at the moment.

Related Terms

J2P, P2J, P2T, T2J, T2P

Example

```
DEFTRN lt1, lt2
DIM lj1 As Joint
lt1 = J2T(lj1)     'Assigns lj1 data transformed to homogeneous
                   'transformation type data to lt1.
```

6-axis

```
lt2 = J2T((0, 0, 90, 0, 0, 0))
                   'Assigns the data (0, 0, 90, 0, 0, 0) transformed
                   'to homogeneous transformation type data to lt2.
```

4-axis

```
lt2 = J2T((0, 0, 300, 0))
                   'Assigns the data (0, 0, 300, 0) transformed
                   'to homogeneous transformation type data to lt2.
```

P2J (Function)

Function

Transforms position type data to joint type data.

Format

P2J (<Position type>)

Explanation

This statement transforms the data designated in <Position type> to joint type data.
If the FIG value in the position type data is -1 (undetermined), transformation is executed with the current figure. The value to be obtained reflects the tool and work coordinate systems that are set at the moment.

Related Terms

J2P, J2T, P2T, T2J, T2P, CURFIG

Example

```
DEFJNT lj1, lj2
DIM lp1 As Point
lj1 = P2J(lp1)      'Assigns lp1 data transformed to joint
                    'type data using the current figure to lj1.
```

6-axis

```
lj2 = P2J((0, 0, 90, 0, 0, 180))
                    'Assigns the data of (0, 0, 90, 0, 0, 180)
                    'transformed to joint type data using the
                    'current type to lj2.
```

4-axis

```
lj2 = P2J((100, 100, 300, 45))
                    'Assigns the data of (100, 100, 300, 45)
                    'transformed to joint type data using the
                    'current type to lj2.
```

P2T (Function)

Function

Transforms position type data to homogeneous transformation type data.

Format

P2T (<Position type>)

Explanation

This statement transforms the data designated in <Position type> to homogeneous transformation type data. The value to be obtained reflects the tool and work coordinate systems that are set at the moment.

Related Terms

J2P, J2T, P2J, T2J, T2P

Example

```
                    DEFTRN lt1, lt2
                    DIM lp1 As Point
                    Lt1 = P2T(lp1)     'Assigns lp1 data transformed to
                                       'homogeneous transformation type data to lt1.

    6-axis          lt2 = P2T((350, 0, 450, 0, 0, 180))
                                       'Assigns the data of (350, 0, 450, 0, 0, 180)
                                       'transformed  to  homogeneous  transformation  type
                        data
                                       'to lt2.

    4-axis          lt2 = P2T((100, 100, 300, 45))
                                       'Assigns the data of (100, 100, 300, 45)
                                       'transformed  to  homogeneous  transformation  type
                        data
                                       'to lt2.
```

T2J (Function)

Function

Transforms homogeneous transformation type data to joint type data.

Format

T2J (<homogeneous transformation type>)

Explanation

This statement transforms the data designated in <Homogeneous transformation type> to joint type data.
If “-1” (indefinite) is set in <Figure> in homogeneous transformation type data, the data is transformed using the current robot figure.
The value to be obtained reflects the tool and work coordinate systems selected at the moment.

Related Terms

J2P, J2T, P2J, P2T, T2P, CURFIG

Example

```
DEFJNT lj1, lj2, lj3
DEFTRN lt1, lt2
DIM li1 As Integer
lj1 = T2J(lt1)    'Assigns lt1 data transformed to joint type data
                  'using the current figure to lj1.
lj2 = T2J(lt2)    'Assigns lt2 data transformed to joint type data
                  'using the figure of 0 to lj2.
lj3 = T2J(350, 0, 450, 0, 1, 0, 0, 0, -1)
                  'Assigns the homogeneous transformation type data
                  '(350, 0, 450, 0, 1, 0, 0, 0, -1) transformed to
                  'joint type data using the figure value li1 to lj3.
```

T2P (Function)

Function

Transforms homogeneous transformation type data to position type data.

Format

T2P (<homogeneous transformation type>)

Explanation

This statement transforms the data designated in <homogeneous transformation type> to position type data. The value to be obtained reflects the tool and work coordinate systems that are set at the moment.

Related Terms

J2P, J2T, P2J, P2T, T2J

Example

```
DEFPOS lp1, lp2
DIM lt1 As Trans
lp1 = T2P(lt1)    'Assigns lt1 data transformed to position type data to lp1.
lp2 = T2P(350, 0, 450, 0, 1, 0, 0, 0, -1)
                  'Assigns the homogeneous transformation type data (350, 0,
                  '450, 0, 1, 0, 0, 0, -1) transformed to position type data
                  'to lp2.
```

TINV (Function)

Function

Calculates an inverse matrix of homogeneous transformation type data.

Format

TINV (<homogeneous transformation type>)

Explanation

This statement inversely transforms the data designated in <homogeneous transformation type>.

Example

```
DEFTRN lt1, lt2, Lt3
lt1 = TINV(350, 0, 450, 0, 1, 0, 0, 0, -1)
                  'Assigns the inverse matrix of (350, 0, 450, 0, 1, 0, 0, 0,
                  '-1) to lt1.
lt2 = TINV(lt3)   'Assigns the inverse matrix of lt3 to lt2.
```

NORMTRN (Function) [Ver.1.8 or later]

Function

Normalizes homogeneous-transformation data.

Syntax

```
NORMTRN (<H-TransData>)
```

Description

This function normalizes data designated by <H-TransData>.

"Normalize" refers to transforming an orient vector to orthogonal vector against the base approach vector or transforming an approach or orient vector to its norm vector.

Example

```
DEFTRN 1t1,1t2
1t1=NORMTRN((350,0,450,0,1,0,0,0,-1))

1t1=NORMTRN(1t2)
```

15.8 Distance Extraction

DIST (Function) [Conforms to SLIM]

Function

Returns the distance between two points.

Format

DIST (<Position type1>,<Position type2>)

Explanation

This statement obtains the distance between <Position type1> and <Position type2>.

Example

```
                  DEFSNG lf1, lf2
                  DEFPOS lp1, lp2, lp3

    6-axis        lf1 = DIST((350, 0, 450, 0, 0, 180), lp1)
                                    'Assigns the distance between (350, 0, 450, 0, 0,
                      180)
                                    'and lp1 to lf1.

    4-axis        lf1 = DIST((350, 0, 300, 45), lp1)
                                    'Assigns the distance between (350, 0, 300, 45)
                                    'and lp1 to lf1.
                  lf2 = DIST(lp2, lp3)
                                    'Assigns the distance between lp2 and lp3 to lf2.
```

15.9 Figure Component

FIG (Function)

Function

Extracts a figure.

Format

FIG ({<Position type>|<homogeneous transformation type>})

Explanation

This statement extracts a figure from position type data and homogeneous transformation type data.

Related Terms

CURFIG, LETF, Robot figure (Appendix 2)

Example

```
                DIM li1 As Integer
                DIM lp1 As Point
                li1 = FIG(lp1)     'Assigns the figure of lp1 to li1.

    6-axis      li1 = FIG(lp1 + (0, 0, 100, 0, 0, 0) )
                                   'Assigns the figure of lp1 + (0,0,100,0,0,0) to
                    li1.

    4-axis      li1 = FIG(lp1 + (0, 0, 100,0) )
                                   'Assigns the figure of lp1 + (0, 0, 100,0) to li1.
```

15.10 Angle Component

JOINT (Function)

Function

Extracts an angle from joint type coordinates.

Format

JOINT (<Axis number>, <Joint type>)

Explanation

Extracts the joint angle of the axis designated in <Axis number> from the joint type coordinates designated in <Joint type>.

Related Terms

LETJ

Example

```
DEFJNT lj1, lj2
DEFSNG lf1, lf2
DIM li1 As Integer
lf1 = JOINT(1, lj1)   'Assigns the 1st axis joint angle of lj1 to lf1.
lf2 = JOINT(li1, lj2) 'Assigns the axis joint angle with values li1 and
    lj2
      to lf2.
```

6-axis

```
lf1 = JOINT(1, lj1 + (10, 10, 0, 0, 0, 0) )
                      'Assigns the 1st axis joint angle of lj1 +
                      '(10, 10, 0, 0, 0, 0) to lf1.
```

4-axis

```
lf1 = JOINT(1, lj1 + (10, 10, 0, 0) )
                      'Assigns the 1st axis joint angle of lj1 +
                      '(10, 10, 0, 0) to lf1.
```

15.11 Axis Component

POSX (Function) [Conforms to SLIM]

Function

Extracts the X-component.

Format

POSX ({<Position type>|<Vector type>})

Explanation

This statement extracts the X-component from position type or vector type coordinates.

Related Terms

POSY, POSZ

Example

```
                DIM lf1 As Single
                DIM lp1 As Position
                lf1 = POSX(lp1)    'Assigns the X-component of lp1 to lf1.
6-axis          lf1 = POSX(lp1 + (100, 100, 100, 0, 0, 0) )
                                   'Assigns the X-component of lp1 +
                                   '(100, 100, 100, 0, 0, 0)to lf1.
4-axis          lf1 = POSX(lp1 + (100, 100, 100, 0) )
                                   'Assigns the X-component of lp1 +
                                   '(100, 100, 100, 0)to lf1.
```

POSY (Function) [Conforms to SLIM]

Function

Extracts the Y-component.

Format

POSY ({<Position type>|<Vector type>})

Explanation

This statement extracts the Y-component from position type or vector type coordinates.

Related Terms

POSX, POSZ

Example

```
                DIM lf1 As Single
                DIM lp1 As Position
                lf1 = POSY(lp1)    'Assigns the Y-component of lp1 to lf1.

6-axis          lf1 = POSY(lp1 + (100, 100, 100, 0, 0, 0) )
                                   'Assigns the Y-component of lp1 to lp1 +
                                   '(100, 100, 100, 0, 0, 0).

4-axis          lf1 = POSY(lp1 + (100, 100, 100, 0) )
                                   'Assigns the Y-component of lp1 to lp1 +
                                   '(100, 100, 100, 0).
```

POSZ (Function) [Conforms to SLIM]

Function

Extracts the Z-component.

Format

POSZ ({<Position type>|<Vector type>})

Explanation

This statement extracts the Z-component from position type or vector type coordinates.

Related Terms

POSX, POSY

Example

```
                DIM lf1 As Single
                DIM lp1 As Position
                lf1 = POSZ(lp1)    'Assigns the Z-component of lp1 to lf1.

6-axis          lf1 = POSZ(lp1 + (100, 100, 100, 0, 0, 0) )
                                   'Assigns the Z-component of lp1 to lp1 +
                                   '(100, 100, 100, 0, 0, 0).

4-axis          lf1 = POSZ(lp1 + (100, 100, 100, 0) )
                                   'Assigns the Z-component of lp1 to lp1 +
                                   '(100, 100, 100, 0).
```

15.12 Rotation Component

POSRX (Function)

Function

Extracts the X-axis rotation component.

Format

POSRX (<Position type>)

Explanation

This statement extracts the X-axis rotation component from the position type coordinates designated in <Position type>.

Related Terms

POSRY, POSRZ

Example

```
DIM lf1 As Single
DIM lp1 As Position
lf1 = POSRX(lp1)     'Assigns the X-axis rotation component of lp1 to lf1.
```

POSRY (Function)

Function

Extracts the Y-axis rotation component.

Format

POSRY (<Position type>)

Explanation

This component extracts the Y-axis rotation component from the position type coordinates designated in <Position type>.

Related Terms

POSRX, POSRZ

Example

```
DIM lf1 As Single
DIM lp1 As Position
lf1 = POSRY(lp1)     'Assigns the Y-axis rotation component of lp1 to lf1.
```

POSRZ (Function)

Function

Extracts the Z-axis rotation component.

Format

POSRZ (<Position type>)

Explanation

This statement extracts the Z-axis rotation component from the position type coordinates designated in <Position type>.

Related Terms

POSRX, POSRY

Example

```
DIM lf1 As Single
DIM lp1 As Position
lf1 = POSRZ(lp1)     'Assigns the Z-axis rotation component of lp1 to lf1.
```

POST (Function)

Function

Extracts the T-axis rotation component.

Format

POST (<Position type>)

Explanation

This statement extracts the T-axis rotation component from the position type coordinates designated in <Position type>.

Example

```
DIM lf1 As Single
DIM lp1 As Position
lf1 = POST(lp1)      'Assigns the T-axis rotation component of lp1 to lf1.
```

15.13 Figure Component

RVEC (Function)

Function

Extracts a figure.

Format

RVEC (<Position type>)

Explanation

This statement extracts a figure from position type coordinates.

Related Terms

PVEC

Example

```
DIM lp1 As Point
DIM lv1 As Vector
lv1 = RVEC(lp1)    'Assigns the figure of lp1 to lv1.
```

15.14 Position Function

AREAPOS (Function)

Function

Returns the center position and direction of a rectangular parallelepiped with the position type for an area where an interference check is performed.

Format

AREAPOS (<Area number>)

Explanation

This statement designates <Area number> declared using the AREA command and returns the current setting (center position) with the position type.
<Area number> Area number (0 to 7)

Related Terms

AREA, SETAREA, RESETAREA, AREASIZE

Example

```
DIM lp1 As Point
lp1 = AREAPOS(1)     'Assigns the center position and direction of the cube for
                     'an area where an interference check is performed to lp1.
```

AREASIZE (Function)

Function

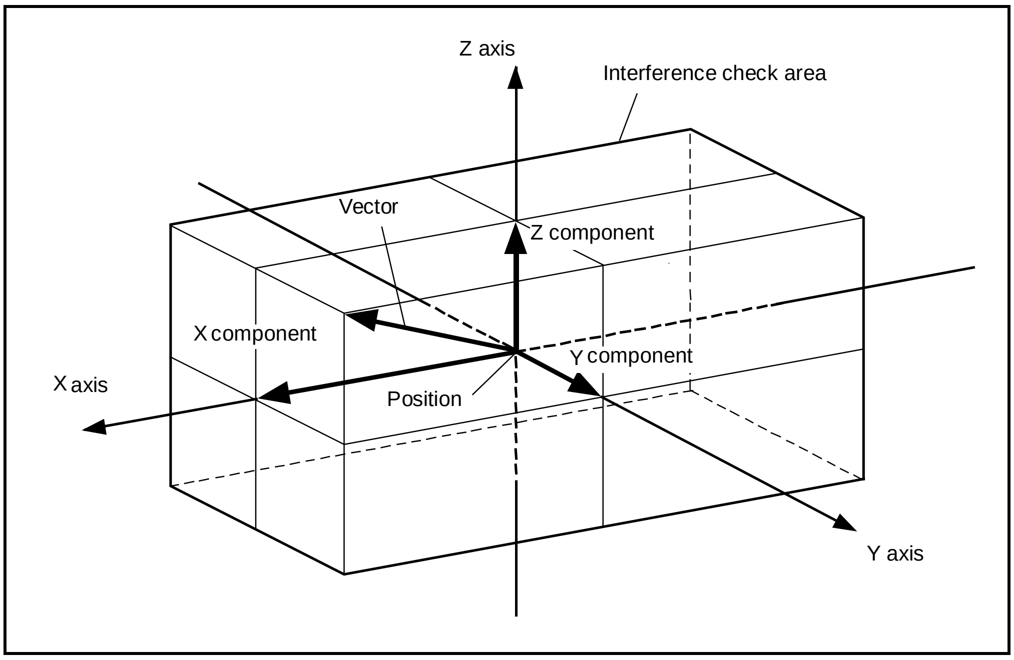
Returns the size (each side length) of a rectangular parallelepiped which defines the interference check area with the vector type.

Format

AREASIZE (<Area number>)

Explanation

Designate <Area number> declared using the AREA command, and the statement will return the size (each side length) of the rectangular parallelepiped which defines the area with the vector type.
The length of each side of the rectangular parallelepiped is double the length of each component of vectors X, Y and Z.



Related Terms

AREA, SETAREA, RESETAREA, AREAPOS

Example

```
        DIM lv1 As Vector
        lv1 = AREASIZE(1)       'Assigns the size of the rectangular parallelepiped defining
the
                                'interference check area to lv1.
```

TOOLPOS (Function)

Function

Returns a tool coordinate system as the position type.

Format

TOOLPOS (<Tool coordinate system number>)

Explanation

Designate <Tool coordinate system number> declared using the TOOL command, and this statement will return a tool coordinate system setting with the position type. In this case, -1 (indefinite) is entered for a FIG component of the position data.
<Tool coordinate system number> tool coordinate system number (1 to 63)

Related Terms

TOOL, CHANGETOOL

Example

```
DIM lp1 As Point
lp1 = TOOLPOS(1)       'Assigns the tool coordinate system to lp1.
```

WORKPOS (Function)

Function

Returns the user coordinate system as the position type.

Format

WORKPOS (<user coordinate system number>)

Explanation

Designate <User coordinate system number> declared using the WORK command, and this statement will return a work coordinate system setting with the position type. In this case, -1 (indefinite) is entered for a FIG component of the position data.
<User coordinate system number> User coordinate system number (1 to 7)

Related Terms

WORK, CHANGEWORK

Example

```
DIM lp1 As Point
lp1 = WORKPOS(1)       'Assigns the user coordinate system to lp1.
```

15.15 Character String Function

ASC (Function)

Function

Converts to a character code.

Format

ASC (<Character string >)

Explanation

This statement converts the first character of <Character string > to a character code.

Note: This function returns only the first byte value of a character string. Therefore, even if the first character is kanji, the first 1 byte of the Shift-JIS code is returned.

Related Terms

CHR$, character code table (Appendix 1)

Example

```
DIM li1 As Integer
li1 = ASC( “ABCDEFGH” )        'Assigns character code 65(&H41) of A to li1.
```

BIN$ (Function) [Conforms to SLIM]

Function

Converts the value of an expression to a binary character string.

Format

BIN$ (<Expression>)

Explanation

This statement converts the value designated in <Expression> to a binary form and converts the value to a character string.

Related Terms

CHR$, HEX$, STR$, VAL

Example

```
DIM li1 As Integer
DEFSTR ls1, ls2
ls1 = BIN$(20)         'Converts 20 to a binary form and assigns it to ls1.
ls2 = BIN$(li1)        'Converts li1 to a binary form and assigns it to ls2.
```

CHR$ (Function) [Conforms to SLIM]

Function

Converts an ASCII code to a character.

Format

CHR$ (<Expression>)

Explanation

This statement obtains a character with the character code of the value designated in <Expression>.

Related Terms

BIN$, HEX$, STR$, VAL, Character code table (Appendix 1)

Example

```
DEFSTR ls1, ls2
ls1 = CHR$(49)          'Assigns a character with the character code of 49 to ls1.
ls2 = CHR$(&H4E)        'Assigns a character with the character code of &H4E to ls2.
```

SPRINTF$ (Function)

Function

Converts an expression to a designated format and returns it as a character string.

Format

SPRINTF$ (<Format>, <Expression>)

Explanation

<Format> includes a character string for output as it is, and a conversion designation character string for converting and outputting the contents of <Expression> (as a part of a character string).

The first character of the conversion designation character string is % and a character (string) follows it.

- A flag of 0 or more signifies a conversion designation character string (no special order). The minimum field width (option) for writing a character string. If the number of converted character values is less than the minimum field width, the left side (right side if the following left justification flag is designated) of the field is embedded with blanks (default) to fill the minimum field width. The field width value is denoted as an asterisk (*) (described in latter section) or an integer value.
- Precision (Option). The precision option designates the minimum number of digits displayed in conversion using conversion designation symbols d, i, o, x and X. It designates the number of digits after the decimal point displayed in conversion using conversion designation symbols e, E and f, and the maximum effective number of digits displayed in conversion using conversion designation symbols g and G. It also designates the maximum number of characters written from a character string in conversion using conversion designation symbol s. A period (.) is used as the precision value followed by an asterisk (*) (described in the latter section) or an integer value (option). If only a period is designated, the precision is designated as 0. If precision is designated with other conversion designation symbols, the motion is not defined.
- Conversion designation symbol

As just described, an asterisk (*) can be designated for field width and precision. In the case of an integer type argument, designate the value of width and precision. Arguments which designate the field width or precision, or a value of both must be designated before (put field width before precision) an argument (only if this is present) can be converted. If a negative value is designated for the field width, it becomes the same designation as the positive field width designated after a negative conversion designation symbol. If a negative value is designated for precision, it is the same as if the precision is ignored.

The meanings of the flags are as follows.

- :	The conversion result is left justified in the field. (If this flag is not designated, it is right justified.)
+ :	In conversion with a sign, the first figure always has a + or - sign (If this flag is not designated, a sign of - is added only for a negative value.)

<space>
: If <space> and a + flag at the head of the result are designated when the first character is not a sign in conversion with a sign, or when no characters are created after a conversion with a sign, <space> is ignored.

# : Conversion is done using the "Replacement format." In conversion with conversion designation symbol o, the precision is changed so that the leading digit of the result becomes 0. In conversion with a conversion designation symbol x (or X), "0x" (or 0X) is added so that the first digit of the result is not 0. In conversion with conversion designation symbols e, E, f, g or G, (even if there are no figures after the decimal point) the decimal point character is always added to the result. (In such conversion, the decimal point character is usually added only when figures are present after the decimal point.) In conversion with conversion designation symbols g and G, the o at the end is not deleted. The operation in other conversion is not defined.

0 : In conversion with conversion designation symbols d, i, o, x, X, e, E, f, g and G, the minimum field width is ensured by embedding 0 at the head (after a sign or base). There is no embedding with <space>. If a 0 flag and a - flag are designated at the same time, the 0 flag is ignored. If conversion of precision is designated with conversion designation symbols d, i, o, x, and X, a 0 flag is ignored. The operation in cases where other conversion designation symbols are used is not defined.

The meanings of the conversion designation signs is as follows.

d, i : Convert the value of an integer type argument to a character string of decimals with a sign in a "[-] dddd" format. The minimum number of digits displayed is determined by the designated precision. If a converted value does not fill the minimum number of digits, the head is embedded with 0s. The default precision is 1. If a value of 0 is converted with precision 0, no character is output.

o, x, X
: Convert an integer type argument to a character string of an octal number (o) or hexadecimal number (x or X)without a sign in a "dddd" or hexadecimal number (x or X) format. The lower case letters (abcdef) are used for the conversion designation symbol x and upper case letters (ABCDEF) for the conversion designation symbol X. The minimum number of digits displayed is determined by the designated precision. If a value after conversion does not reach the minimum number of digits, the head is embedded with 0s. The default precision is 1. If a value of 0 is converted with precision 0, no characters are output.

f :	Converts a real type argument to a character string of decimals displayed in a “[-] ddd.ddd” format. The number of digits after the decimal point is determined by the designated precision. If the precision is not designated, the number of digits after the decimal point is 6. If the precision is 0 and a # flag is not designated, the characters after the decimal point are not displayed. If characters after the decimal point are displayed, at least one digit before the decimal point is displayed. The value is rounded to a proper number of digits.
e, E :	Convert a real type argument to a character in a “[-] d.ddde+/-dd” format. One digit (other than 0 if the argument is not 0) is displayed before the decimal point character. The number of digits after the decimal point is determined according to the designated precision. If the precision is not designated, the number of digits after the decimal point is 6. If the precision is 0 and a # flag is not designated, the characters after the decimal point are not output. The value is rounded to a proper number of digits. If the conversion designation symbol E is used, the exponent is expressed not with e but E. The exponent is always expressed with 2 digits or more. If the value is 0, the exponential part also becomes 0.
g, G :	Convert a real type argument to a type of f or e (In the case of G, E is used). The valid number of digits depends on the precision. If the precision is 0, the valid number of digits is 1. The format used is determined by the value to be converted. Conversion of type e (or E) is used only when the exponential part of the conversion result is less than -4, or greater than or equal to the precision. If there is a 0 as the last digit after the decimal point, it is deleted. Figures with a decimal point are displayed only when there is a digit after the decimal point.
C :	Converts an integer type argument to an ASCII character byte and outputs the characters after conversion.
S :	System reservation
% :	Outputs a character of %. The argument is not converted. The designation of complete conversion is %%.

There is no regulation for operation if the conversion designation is wrong.
If the result of conversion is longer than the field width, it may be cut it short but the field is never extended with the conversion result.

Related Terms

HEX$, STR$

Example

```
S1 = SPRINTF$("% d",123)            'Assigns "123" to S1.
S2 = SPRINTF$("%-6.3f", 1.23)       'Assigns "1.230 " to S2.
S3 = SPRINTF$("%e",123.456#)        'Assigns "1.234560e+002" to S3.
S4 = SPRINTF$("%g",12345678#)       'Assigns "1.23457e+007" to S4.
S5 = SPRINTF$("%#x",128)            'Assigns "0x80" to S5.
```

HEX$ (Function) [Conforms to SLIM]

Function

Obtains a value converted from a decimal to a hexadecimal number as a character string.

Format

HEX$ (<Expression>)

Explanation

This statement converts the designated value in <Expression> from a decimal number to a hexadecimal number and converts the value to a character string.

Explanation: If an argument is not an integer, the argument is rounded down to an integer which does not exceed the value prior to conversion.

Related Terms

BIN$, CHR$, STR$, VAL

Example

```
DIM li1 As Integer
DEFSTR ls1, ls2
ls1 = HEX$(20)          'Converts 20 to a hexadecimal number and assigns it to ls1.
ls2 = HEX$(li1)         'Converts li1 to a hexadecimal number and assigns it to ls2.
```

LEFT$ (Function) [Conforms to SLIM]

Function

Extracts the left part of a character string.

Format

LEFT$ (<Character string >, <Number of digits>)

Explanation

This statement extracts a character string for <Number of digits> from the left side of <Character string>.

If the character string includes a NULL value, the NULL value is returned.
If a value longer than the character string is designated in <Number of digits>, the whole character string is returned.

Note: <Number of digits> is handled as byte counts.

Related Terms

LEN, MID$, RIGHT$

Example

```
DIM li1 As Integer
DEFSTR ls1, ls2
ls1 = LEFT$( “abcdefg”, 3 )    'Assigns 3 characters “abc” from the left of the
                               'character string in “abcdefg” to ls1.
ls2 = LEFT$( ls1, li1 )        'Assigns a character string for the value of the number
                               'of characters in li1 from the left of ls1 to ls2.
```

LEN (Function) [Conforms to SLIM]

Function

Obtains the length of a character string in bytes.

Format

LEN (<Character string >)

Explanation

This statement obtains the total sum byte count of the character string length designated in <Character string>.

Related Terms

MID$, LEFT$, RIGHT$

Example

```
DEFINT li1, li2
DIM ls1 As String
li1 = LEN( “abcdefg” )  'Assigns 7 characters of the character string “abcdefg” to li1.
li2 = LEN( ls1 )        'Assigns the byte count of ls1 to li2.
```

MID$ (Function) [Conforms to SLIM]

Function

Extracts a character string for the designated number of characters from a character string.

Format

MID$ (<character string >, <Start position>[, <Number of digits>])

Explanation

This statement extracts a character string for <Number of digits> from <Start position> of <Character string>.
If the character string includes a NULL value, the NULL value is returned.
If a value longer than the character string is designated in <Number of digits>, the whole character string is returned.
If <Number of digits> is ignored, or if the character string has fewer characters than the number of digits designated, all characters after the start position are returned.
If a value longer than the character string is designated in <Start position>, the whole character string is returned.

Note: <Number of digits> is handled as byte counts.

Related Terms

LEN, LEFT$, RIGHT$

Example

```
DEFSTR ls1, ls2
ls1 = MID$( “abcdefg”, 2, 3 )   'Assigns the character string “bcd” to ls1.
ls2 = MID$( ls1, 2, 2 )         'Assigns the 2 digits from the second character of ls1 to
                                'ls2.
```

ORD (Function) [Conforms to SLIM]

Function

Converts to a character code.

Format

ORD (<Character string >)

Explanation

This statement converts the first character in <Character string > to a character code.

Note: This function returns only the first byte value of a character string. Therefore, even if the first character is kanji, the first byte of the Shift-JIS code is returned. If the character string is " ", it returns 0.

Related Terms

CHR$, Character code table (Appendix 1)

Example

```
DIM li1 As Integer
li1 = ORD( “ABCDEFGH” )        'Assigns character code 65(&H41) of A to li1.
```

RIGHT$ (Function) [Conforms to SLIM]

Function

Extracts the right part of a character string.

Format

RIGHT$ (<Character string >, <Number of digits>)

Explanation

This statement extracts a character string from the right side of <Character string > for <Number of digits>.
If the character string includes a NULL value, the NULL value is returned.
If a value longer than the character string is designated in <Number of digits>, the whole character string is returned.

Note: <Number of digits> is handled as byte counts.

Related Terms

LEN, MID$, LEFT$

Example

```
DIM li1 As Integer
DEFSTR ls1, ls2
ls1 = RIGHT$( “abcdefg”, 3 )   'Assigns the character string “efg” for 3 characters
                               'from the right in “abcdefg” to ls1.
ls2 = RIGHT$( ls1, li1 )       'Assigns a character string for the number of
                               'characters from the right of the value ls1 to ls2.
```

STRPOS (Function) [Conforms to SLIM]

Function

Obtains the position of a character string.

Format

STRPOS (<Character string 1>, <Character string 2>)

Explanation

This statement obtains the position of <Character string 2> in <Character string 1>.
For the order, count 1, 2, … from the left.
If the string is not found, 0 is returned.

Related Terms

Example

```
DIM li1 As Integer
li1 = STRPOS(“abcdefg”, “bc”)   'Assigns position (2) of “bc” in “abcdefg” to li1.
```

STR$ (Function) [Conforms to SLIM]

Function

Converts a value to a character string.

Format

STR$ (<Expression>)

Explanation

This statement converts the value designated in <Expression> to a character string.

Explanation:	**If a value is converted to a character string, there is always a blank to display a sign at the head of the return value. If the value is positive, a blank is inserted at the head of the return value of the Str function. This blank denotes the plus sign. The Str function recognizes only a period (.) as a valid decimal point symbol.**

Related Terms

BIN$, CHR$, HEX$, VAL

Example

```
DIM li1 As Integer
DEFSTR ls1, ls2
ls1 = STR$(20)          'Converts 20 to a character string and assigns it to ls1.
ls2 = STR$(li1)         'Converts li1 to a character string and assigns it to ls2.
```

VAL (Function) [Conforms to SLIM]

Function

Converts a character string to a numeric value.

Format

VAL (<Character string >)

Explanation

This statement converts a character string designated in <Character string > to a numeric value.

If the first character of <character string > is not +, -, &, or numeric value, VAL becomes 0.

Explanation:	**If the system finds a character other than the figures in the character string, the Val Function stops reading. The Val function does not interpret symbols or letters which are normally regarded as part of a numeric value such as the yen symbol (\) or comma (,). However, the Val function does recognizes prefixes &H (hexadecimal number) and &B (binary number). Blanks, tabs and line feeds in the character string of an argument are ignored.**

Related Terms

BIN$, CHR$, HEX$, STR$

Example

```
DEFINT li1, li2, li3
li1 = VAL(“&B100”)      'Converts “&B100” to a numeric value
                        '(4 in decimal) and assigns it to li1.
li2 = VAL(“&H20”)       'Converts “&H20” to a numeric value
                        '(32 in decimal) and assigns it to li2.
li3 = VAL(“-30”)        'Converts “-30” to a numeric value (-30 in decimal) and assigns
                        'it to li3.
```

Chapter 16

Constants

This chapter provides an explanation about PAC prepared constants.

16.1 Built-in Constants

OFF (Built-in Constant)

Function

Sets an OFF (0) value.

Format

OFF

Explanation

This statement sets an OFF (0) value in an expression.

Related Terms

ON

Example

```
1F I1 = TRUE THEN              'Sets the Boolean value to true (1).
  I1 = ON                      'Sets ON(1) to the integer type variable.
ELSEIF I1 = FALSE THEN         'Sets the Boolean value to true (1).
  I1 = OFF                     'Sets OFF(0) to the integer type variable.
ELSE
  D1 = PI                      'Assigns π to the real type variable.
ENDIF
```

ON (Built-in constant)

Function

Sets an ON (1) value.

Format

ON

Explanation

This statement sets an ON (1) value in an expression.

Related Terms

OFF

Example

```
1F I1 = TRUE THEN              'Sets the Boolean value to true (1).
  I1 = ON                      'Sets ON(1) to the integer type variable.
ELSEIF I1 = FALSE THEN         'Sets the Boolean value to true (1).
  I1 = OFF                     'Sets OFF(0) to the integer type variable.
ELSE
  D1 = P                       'Assigns π to the real type variable.
ENDIF
```

PI (Built-in constant)

Function

Sets a π value.

Format

PI

Explanation

This statement returns a double-precision type value of π.

Example

```
1F I1 = TRUE THEN              'Sets the Boolean value to true (1).
  I1 = ON                      'Sets ON(1) to the integer type variable.
ELSEIF I1 = FALSE THEN         'Sets the Boolean value to true (1).
  I1 = OFF                     'Sets OFF(0) to the integer type variable.
ELSE
  D1 = PI                      'Assigns π to the real type variable.
ENDIF
```

FALSE (Built-in constant)

Function

Sets a value of false (0) to a Boolean value.

Format

FALSE

Explanation

This statement sets a value of false (0) to a Boolean value in an expression.

Related Terms

TRUE

Example

```
1F I1 = TRUE THEN              'Sets the Boolean value to true (1).
  I1 = ON                      'Sets ON(1) to the integer type variable.
ELSEIF I1 = FALSE THEN         'Sets the Boolean value to true (1).
  I1 = OFF                     'Sets OFF(0) to the integer type variable.
ELSE
  D1 = PI                      'Assigns π to the real type variable.
ENDIF
```

TRUE (Built-in constant)

Function

Sets a value of true (1) to a Boolean value.

Format

TRUE

Explanation

This statement sets a value of true (1) to a Boolean value.

Related Terms

FALSE

Example

```
1F I1 = TRUE THEN               'Sets the Boolean value to true (1).
  I1 = ON                       'Sets ON(1) to the integer type variable.
ELSEIF I1 = FALSE THEN          'Sets the Boolean value to true (1).
  I1 = OFF                      'Sets OFF(0) to the integer type variable.
ELSE
  D1 = PI                       'Assigns π to the real type variable.
ENDIF
```

Chapter 17

Time/Date Control

This chapter provides an explanation of commands necessary to understand time, date or elapsed time and other commands to control interruptions due to time.

17.1 Time/Date

DATE$ (System Variable) [Conforms to SLIM]

Function

Obtains the current date.

Format

DATE$

Explanation

This statement stores the current date in the following format: “yyyy/mm/dd”(year/month/day).

Related Terms

TIME$

Example

```
DIM ls1 As String
ls1 = DATE$             'Assigns the current date to ls1.
```

TIME$ (System Variable) [Conforms to SLIM]

Function

Obtains the current time.

Format

TIME$

Explanation

This statement stores the current time in the following format: “hh:mm:ss” (Time: minute: second).
Time is displayed using the 24 hour system.

Related Terms

DATE$

Example

```
DIM ls1 As String
ls1 = TIME$             'Assigns the current time to ls1.
```

TIMER (System Variable) [Conforms to SLIM]

Function

Obtains the elapsed time.

Format

TIMER

Explanation

This statement obtains the elapsed time, measured in milliseconds from the time, when the controller power is ON (0).

Note: If the elapsed time exceeds 2147483647 milliseconds, the elapsed time will be displayed from -214148.3648 milliseconds.

Related Terms

Example

```
DEFINT li1, li2, li3
li1 = TIMER            'Assigns the elapsed time from the reference time to li1.
li2 = TIMER + li3      'Assigns the value of the elapsed time with li3 added from
                       'the reference time to li2.
```

Chapter 18

Error Controls

When an error occurs, you can check the contents of the error, or program a procedure to recover. This chapter provides an explanation of commands necessary to handle an error.

18.1 Error Information

ERL (System Variable)

Function

Obtains the line number where an error occurred.

Format

ERL

Explanation

This program stores the line number of the program where an error occurred. The initial status is quite unstable and even if you can read the contents of the ERL before an error occurs, it does not have any meaning.
The ERL does not include any error line number of other programs being executed in multitasking operation.

Remarks:	This command has no meaning when "Error interruption process code deletion" is set to ON (1) in [Program] of [Project setting] of PAC manager in WINCAPSII. The same setting has been prepared in the teach pendant.

Remarks: **This command has no meaning when "Error interruption process code deletion" is set to ON (1) in [Program] of [Project setting] of PAC manager in WINCAPSII. The same setting has been prepared in the teach pendant.**

Related Terms

ERR, ON ERROR GOTO

Example

```
DIM Li1 As INTEGER
DIM Li2% (2, 3)
ON ERROR GOTO *Error1   'Branches to the *Error1 processing routine when the error
                        'occurs.
FOR Lil = 0 TO 3
  Li2 (0, Li1) = 0      'An error occurs when Li1 is 3, and this branches to the *Error1
                        'processing 'routine.
NEXT Li1
*R_Label:
END

*Errorl:                'Declares the label *Errorl.
 S1 = "Line"+STR$(ERL)+ ":" +ERRMSG$(ERR)
                        'Edits the error message.
 PRINTMSG S1, 2, "Error"'Outputs error information.
 IF ERR = &H3B3E THEN
   RESUME NEXT          'Returns to the line following the line where the error
                        'occurred.
 ELSE
   RESUME *R_Label      'Returns to the line of *R_Label.
ENDIF
```

ERR (System Variable)

Function

Obtains an error number that occurred.

Format

ERR

Explanation

This program stores an error number that occurred.
The ERR does not include any error number of other programs being executed in multitasking operation.

**Remarks: This command has no meaning when "Error interruption process code deletion" is set to ON (1) in [Program] of [Project setting] of PAC manager in WINCAPSII.
The same setting has been prepared in the teach pendant.**

Related Terms

ERL, ERRMSG$, ON ERROR GOTO

Example

```
DIM Li1 As INTEGER
DIM Li2% (2, 3)
ON ERROR GOTO *Error1   'Branches to the process routine of *Error1 when the error
                        'occurred.
FOR Lil = 0 TO 3
  Li2 (0, Li1) = 0      'When Li1 is 3, an error occurs and it branches to process
                        'routine of *Error1.
NEXT Li1
*R_Label:
END

*Errorl:                'Declares the label *Errorl.
 S1= “Line” +STR$(ERL)+ “:” +ERRMSG$(ERR)
                        'Edit the error message.
 PRINTMSG S1,2, “error” 'Outputs error information.
 IF ERR = &H3B3E THEN
   RESUME NEXT          'Returns to the line following the line where the error
                        'occurred.
 ELSE
   RESUME *R_Label      'Returns the line of *R_Label.
ENDIF
```

ERRMSG$ (Function)

Function

Sets an error message.

Format

ERRMSG$ (<Arithmetic expression>)

Explanation

This statement sets the error message corresponding to the error number designated with <Numeric expression>.

Related Terms

ERL, ERR, ON ERROR GOTO

Example

```
Ex. 1: DIM ls1 As String
       ls1 = ERRMSG$(&H600C)   'Assigns the error message with an error number of &H600C to ls1.
Ex. 2: DIM Li1 As INTEGER
       DIM Li2% (2, 3)
       ON ERROR GOTO *Error1   'Branches to the process routine *Error1 when the error
                               'occurred.
       FOR Lil = 0 TO 3
          Li2 (0, Li1) = 0     'When Li1 is 3, an error occurs and it then branches to the process
                               'routine of *Error1.
       NEXT Li1
       *R_Label:
       END

       *Errorl:                'Declares the *Errorl label.
        S1= “Line” +STR$(ERL)+ “:” +ERRMSG$(ERR)
                               'Edits the error message.
        PRINTMSG S1,2, “error” 'Outputs error information.
        IF ERR = &H3B3E THEN
          RESUME NEXT          'Returns to the line following the line where the
                               'error occurred.
        ELSE
          RESUME *R_Label      'Returns a line of *R_Label.
       ENDIF
```

18.2 Error Interruption

ON ERROR GOTO (Statement)

Function

Interrupts when an error occurs.

Format

ON ERROR {GOTO|GO TO}<Label name>

Explanation

This statement defines and executes an interruption process routine when an error occurs. If this interruption occurs, the program with the error process routine designated with <Label name> is executed. To return from the error process routine to the program, execute the RESUME statement.
When an error occurs while the error process routine is being executed, the ongoivy program stops.

Remarks: This command has no meaning when “Error interruption process code deletion” is set to ON (1) in [Program] of [Project setting] of PAC Manager in WINCAPSII.
The same setting has been prepared in the teach pendant.

Related Terms

ERR, ERL, RESUME

Example

```
DIM Li1 As INTEGER
DIM Li2% (2, 3)
ON ERROR GOTO *Error1      'When an error occurs, the program branches to the
                           'process routine of Error1.
FOR Lil = 0 TO 3
  Li2 (0, Li1) = 0         'When Li1 is 3, an error occurs and the program branches
                           'to the process routine *Error1.
NEXT Li1
*R_Label:
END

*Errorl:                   'Declares the *Errorl label
 S1= “Line” +STR$(ERL)+ “:” b+ERRMSG$(ERR)
                           'Edits the error message.
 PRINTMSG S1,2, “error”    'Outputs error information.
 IF ERR = &H3B3E THEN
   RESUME NEXT             'Returns to line following the line where the
                           'error occurred.
 ELSE
   RESUME *R_Label         'Returns the line of *R_Label.
ENDIF
```

RESUME (Statement)

Function

Returns from an interruption process routine.

Format

RESUME [NEXT|<Label name>]

Explanation

This statement returns to the program before it has been branched from an interruption process routine, as defined in the ON ERROR GOTO statement.
With RESUME NEXT, the program returns to the line following the line where an error occurred.
With RESUME <Label name>, the program passes control to a designated label line.
If you ignore all of the argument options in the RESUME statement, the program returns to the line where the error occurred.

Remarks (1): This command has no meaning when "Error interruption process code deletion" is set to ON (1) in [Program] of [Project setting] of PAC manager in WINCAPSII. The same setting has been prepared in the teach pendant.
(2): If the program returns to the line where the error occurred, without removal of the error cause, the program may execute an infinite loop.
(3): You cannot use this statement outside of the interruption process routine.

Related Terms

ON ERROR GOTO

Example

```
DIM Li1 As INTEGER
DIM Li2% (2, 3)
ON ERROR GOTO *Error1     'When an error occurs, the program branches to the
                          'process routine of Error1.
FOR Lil = 0 TO 3
  Li2 (0, Li1) = 0        'When Li1 is 3, an error occurs and the program branches
                          'to the process routine *Error1.
NEXT Li1
*R_Label:
END

*Errorl:                  'Declares the *Errorl label
 S1= "Line" +STR$(ERL)+ ":" b+ERRMSG$(ERR)
                          'Edits the error message.
 PRINTMSG S1,2, "error"   'Outputs error information.
 IF ERR = &H3B3E THEN
   RESUME NEXT            'Returns to the line following the line where the
                          'error occurred.
 ELSE
   RESUME *R_Label        'Returns the line of *R_Label.
ENDIF
```

Chapter 19

System Information

This chapter provides an explanation of commands necessary to obtain robot system information.

19.1 System

GETENV (Function)

Function

Obtains the environment setting values of the system.

Format

GETENV (<Table number>, <Element number>)

Explanation

This statement obtains the environment setting values of the system designated with <Table number> and <Element number>. For the items of the environment setting values, refer to Appendix 3 “Environment Setting Value.”

Related Terms

VER$, Environment setting value (Appendix 3)

Example

```
DIM li1 As Integer
li1 = GETENV (9, 1)  'Assigns the contents of the environment setting values of
                     'number
                     '9 and 1 to li1.
```

LETENV (Statement)

Function

Sets the environment setting values of the system.

Format

LETENV <Table number>, <Element number>, <Setting value>

Explanation

This statement sets the environment setting values of the system designated with <Table number> and <Element number> to <Setting value>
For the items of the environment setting values, refer to Appendix 3 “Environment Setting Value.”
An error may occur when execution starts, if you set an element number or any set value exceeds the setting range.

Remarks: The easiest way to tell if setting is possible is to open the manager of WINCAPSII, which controls the table corresponding to <Table number>, and check the table screen. If a column of the property does not have a symbol of “*,” the element in that item can be set. However, you should log-in with the password level of <programmer>.

Note: If you change the environment setting values, it is recommended that you restart the controller.

Related Terms

VER$, GETENV

Example

```
LETENV 6, 22, 5600  'Sets 5600 for the environment setting values of number 6 and 22.
```

VER$ (Function)

Function

Obtains the version of each module.

Format

VER$ (<Expression>)

Explanation

This statement stores the version of each module corresponding to the value of <Expression> with a character string.
Refer to Appendix 9 “Version Corresponding Table.”

Related Terms

GETENV, Version corresponding table (Appendix 9)

Example

```
DEFSTR ls1, ls2, ls3
DIM li1 As Integer
li1 = 1
ls1 = VER$ (1)      'Assigns the main board version to ls1.
ls2 = VER$ (2)      'Assigns the version of ROM on the DIO board to ls2.
ls3 = VER$ (li1)    'Assigns the version information that corresponds to the li1
                    'value to ls3.
```

In this example, data is stored in ls1 and ls2 in the following format as a character string (the date below was the date when the version was published).

ls1	1.000 07/30/1998
ls2	V1.00 08/03/1998

19.2 Log

NOTE: Control log is greatly enhanced in Ver. 1.20 or later. If you use Ver. 1.20 or later, refer to "WINCAPSII Guide", Section 10.7, "New Control Log" on page 10-27.

STARTLOG (Statement)

Function

Starts recording of the servo control log.

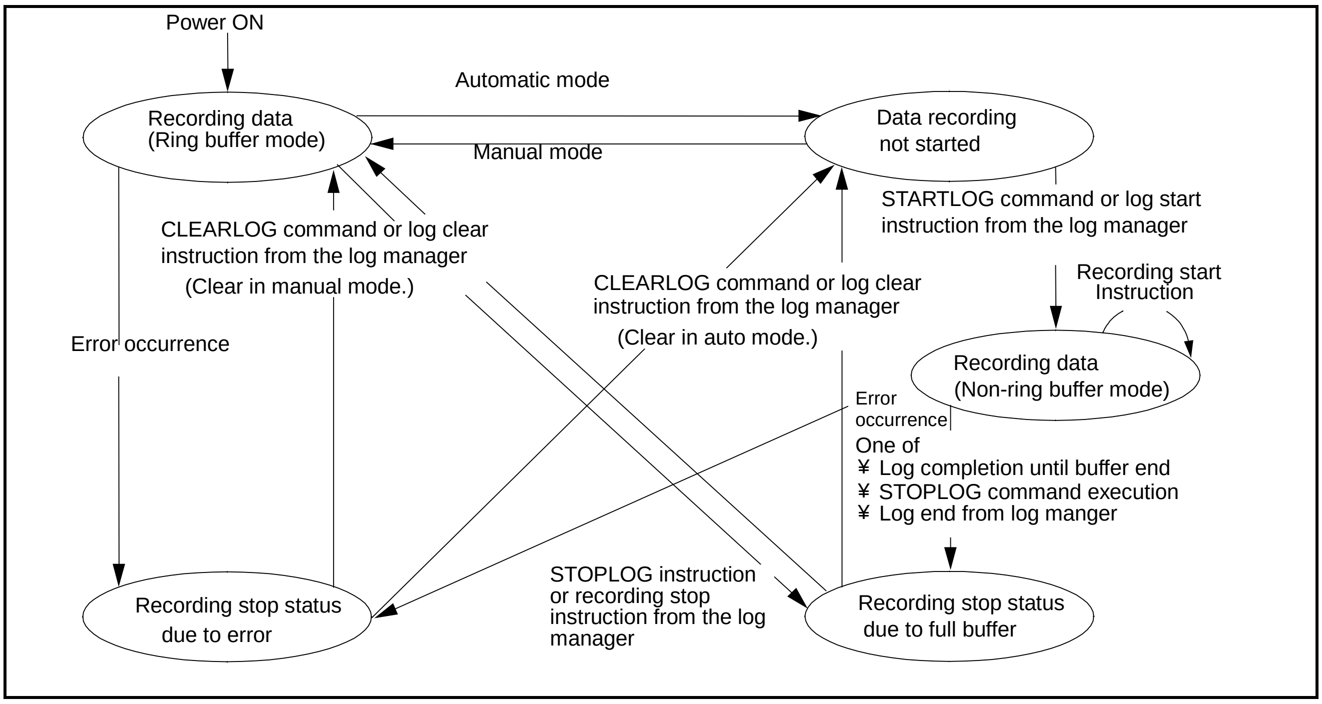
Format

STARTLOG

Explanation

Use the STARTLOG command to start recording of the servo control log in the program.
To ensure recording of the servo control log, execute the CLEARLOG command beforehand or perform a servo log clear operation in the log manager before starting the STARTLOG command. Once servo control log recording has been started, recording is not possible even if you execute the STARTLOG command.

In manual mode and teach check mode, the system automatically starts recording of the servo control log.
In automatic mode, the system starts recording of the servo control log with instructions to start recording in the program or by starting recording in the log manager.
If an error occurs or the buffer is full (10 seconds), recording of the servo control log stops. In manual mode, the system keeps the log for the last 10 seconds until the program is instructed to stop recording.



Power ON
Automatic mode
Recording data (Ring buffer mode)
Manual mode
Data recording not started
STARTLOG command or log start instruction from the log manager
CLEARLOG command or log clear instruction from the log manager
(Clear in manual mode.)
Recording start Instruction
CLEARLOG command or log clear instruction from the log manager
(Clear in auto mode.)
Error occurrence
Recording data (Non-ring buffer mode)
Error occurrence
One of
¥ Log completion until buffer end
¥ STOPLOG command execution
¥ Log end from log manger
STOPLOG instruction or recording stop instruction from the log manager
Recording stop status due to error
Recording stop status due to full buffer

Log Operation Status Transition Diagram

Related Terms

CLEARLOG, STOPLOG

Example

```
STARTLOG            'Starts recording of the servo control log.
```

CLEARLOG (Statement)

NOTE: Control log is greatly enhanced in Ver. 1.20 or later. If you use Ver. 1.20 or later, refer to "WINCAPSII Guide", Section 10.7, "New Control Log" on page 10-27.

Function

Initializes recording of the servo control log.

Format

CLEARLOG

Explanation

Use the CLEARLOG command to instruct initialization of the servo control log in the program.
You must clear (initialize) the contents of the log before restarting recording, when the servo log record buffer is full or when program execution stops because of an error. Refer to p.19-4 " Log Operation Status Transition Diagram."
To record the servo control log without fail, execute the CLEARLOG command before executing the STARTLOG command. After recording has started, recording will not be possible even if you execute the STARTLOG command.

Related Terms

STARTLOG, STOPLOG

Example

```
CLEARLOG            'Initializes servo control log recording.
```

STOPLOG (Statement)

NOTE: Control log is greatly enhanced in Ver. 1.20 or later. If you use Ver. 1.20 or later, refer to "WINCAPSII Guide", Section 10.7, "New Control Log" on page 10-27.

Function

Stops servo control log recording.

Format

STOPLOG

Explanation

Use the STOPLOG command to instruct the servo control log to stop in a program.
In automatic mode, if the buffer is full after recording starts, the log recording automatically stops. Therefore, you do not need to execute the STOPLOG command in the program.

Related Terms

STARTLOG, CLEARLOG

Example

```
STOPLOG             'Stops servo control log recording.
```

Chapter 20

Preprocessor

If you create a program with the PAC manager, you can use the preprocessor commands described in this chapter.
The PAC manager automatically replaces designated character strings or files according to the definitions of the preprocessor commands and then compiles them.
By using the preprocessor commands, you can use the library program or you can describe a program that is easy to read.

20.1 Symbol Constants · Macro Definitions

#define (Preprocessor Statement)

Function

Replaces a designated constant or macro name in the program with a designated character string.

Format

#define <Symbol constant> <Character string>
or
#define <Macro name (Argument)> <Argument included character string>

Explanation

This statement replaces <Symbol constant> or <Macro name> in the program with a designated character string. In the case of a macro name, it is replaced with the arguments already included.
<Symbol constant> or character strings of <Macro name> in “ ” (double quotations) are not replaced.
You must describe the #define statement on one line.
You must place 1 or more space characters between <Symbol constant> and <Character string>.
Do not place a space between a macro name and the parentheses of an argument.
You can redefine <Symbol constant> and <Macro name>, however, you need to make them invalid with #undef at least once. The most recently defined ones become valid.
<Symbol constant> and <Macro name> must be within 64 characters.
You can use a maximum of 2048 macro names in one program. There is no limitation to the number of macro function arguments you may use.

Related Terms

#undef

Example

```
#DEFINE NAME “Denso Corporation”
                       'Assigns “Denso Corporation” to the symbol constant NAME.
#DEFINE mAREA(radius) PI * POW(radius, 2)
                       'Declares mAREA(radius) as a macro function.

S1 = NAME              'Assigns “Denso Corporation” to S1.
D1 = mAREA(10)         'Assigns the calculation value of PI*POW(10,2) to D1.
```

#undef (Preprocessor Statement)

Function

Makes a symbol constant defined with #define or macro definition invalid.

Format

#undef {<Symbol constant>|<Macro name>}

Explanation

This statement makes a symbol constant defined with #define or macro definition invalid in the program after this #undef. Designate only the macro name for a macro with an argument.

Related Terms

#define

Example

```
#UNDEF NAME    'Makes NAME defined with a symbol definition or macro definition
               'in the #DEFINE statement invalid.
```

#error (Preprocessor Statement)

Function

Forcibly generates a compiling error if the #error command is executed.

Format

#error [<Message>]

Explanation

Use this statement when you purposely want to generate an error to test a program.
If you compile a line using the #error command, an error occurs.
At this time, an error message appears, showing the contents defined in <Message>.

Example

```
#error “Error Occur”   'If compiling is executed, the message “Error Occur”
                       'appears.
```

20.2 File Fetch

#include (Preprocessor Statement)

Function

Fetches the preprocessor program.

Format

#include “[Path] file name”

#include <[Path] file name>

Explanation

This statement fetches the preprocessor program file, at a position where the #include statement is placed. In the case of “ ”, if the path of the file is ignored the system searches for the file in the current directory first and then the system directory. In the case of < >, it searches only the system directory. If the path is designated with a full path, it searches only in the directory designated.
You can include the #include statement for a file designated with the #include statement. You can nest up to 8 levels.
There are H and PAC file extensions available to designate.

Example

```
#include “samp1.h”     'Expands the samp1.h file on this line.
```

20.3 Optimization

#pragma optimize (Preprocessor Statement)

Function

Designates optimization to be executed for each program.

Format

#pragma optimize ("<Option list>", {on/off})

Explanation

This statement designates optimization to be executed for each program. Describe this statement on the line before the PROGRAM declaration statement or on a valid statement line.
Designate an arbitrary number of parameters, listed on the following table for <Option list>.

Parameter	Optimization type
A	Deletes the array inspection code.
C	Deletes the cycle time calculation code.

Remarks: If you effectively use the optimization option, you can increase the execution speed of a non-action instruction by 10% to 20 %. When you select [File] and then [Project setting] in the PAC manager, you can find the program setting table. There is also a program optimization option there.

Example

```
#pragma optimize( “ac”, ON )   'Deletes the array inspection code and makes the
                               'cycle time calculation code valid.
```

Note

This command has priority over the status set in “Project setting” of the PAC manager. Therefore, if the array inspection code is deleted, the system does not check the range of the array subscripts although the error process is set with ON ERROR GOTO.

Chapter 21

Vision Control (Option)

This chapter lists all the commands available for use with the µVision board and µVision-21.

21.1 Precautions for using vision commands.

(1) To use vision commands, an optional μVision board is required.

(2) A vision command should be preceded by a vision process priority command (TAKEVIS).

Example:
```
TAKEVIS
CAMIN 1
VISPLNOUT 0
    :
    :
```

(3) If an error occurs during execution of a vision command except camera input commands, the error message will appear when the next vision command is executed.

Example:
```
WINDMAKE R,1,100,10,0,2
VISPRJ 1,100,100,1,128   At this point, a "window shape
                         error" occurs.
WINDDISP 1               At execution of this command,
    :                    the error message will appear.
    :
    :
```

(4) If a TAKEVIS command is executed during communications from the WINCAPSII Vision Manager to the μVision board, an error will result.

21.2 Compatibility with the Conventional μVision-15

The functions of the conventional μVision-15 are inherited, except for commands related to output (parallel I/O, RS232C). However, there is a difference in the format of instructions. If you edit a program which refers to a conventional program, refer to the correspondence table below.

	μVision-15	μVision board	Description	Page
Image Input/output	VIN	CAMIN	Camera input	21-3
	AOUT	VISCAMOUT	Camera image display	21-7
	VOUT	VISPLNOUT	Process screen display	21-8
		VISOVERLAY	Overlay setting	21-9
Window Setting	WNDALN	WINDMAKE	Sets window data.	21-14
	WNDCIR			
	WNDDPT			
	WNDELP			
	WNDRCT			
	WNDSCT			
	HWIND			
	CLRWND	WINDCLR	Clears set window setting data.	21-19
	WNDCPY	WINDCOPY	Copies set window data.	21-20
	WDISP	WINDDISP	Window display	21-23
Draw	SCREEN	VISSCREEN	Sets drawing condition.	21-24
	CLS	VISCLS	Clears screens.	21-27
	PUTP	VISPUTP	Draws points.	21-29
	LINE	VISLINE	Draws lines (length and angle).	21-30
	LNDPT	VISPTP	Draws lines (2 point).	21-31
	RECT	VISRECT	Draws rectangles.	21-32
	CIRCLE	VISCIRCLE	Draws circles.	21-33
	ELIPSE	VISELLIPSE	Draws ellipses.	21-34
	SECT	VISSECT	Draws sectors.	21-35
	PAINT	VISRECT	Draws rectangles.	21-32
		VISCIRCLE	Draws circles.	21-33
		VISELLIPSE	Draws ellipses.	21-34

	µVision-15	µVision board	Description	Page
Draw	CROSS	VISCROSS	Draws cross symbols.	14-36
	CRSALN			
	LOC	VISLOC	Locates character display positions.	14-37
	PRINT	VISDEFCHAR	Draw character setting	14-39
		VISPRINT	Draws characters.	14-40
Image Process	GETP	VISGETP	Obtains brightness of designated coordinates.	14-42
	HIST	VISHIST	Executes histograms.	14-43
	HCLR			
		VISREFHIST	Obtains histogram results.	14-44
	LEVEL	VISLEVEL	Calculates binary code levels.	14-45
	BINA	VISBINA	Binary processing	14-47
	RBINA	VISBINAR	Display binary code	14-49
	AREA	VISMEASURE	Calculates features (area, center of gravity, main axis angle and so on).	14-55
	BIGT			
	CENTR			
	MOMENT			
	STRT			
	PROJ	VISPROJ	Projection process	14-58
	EDGE	VISEDGE	Measures edge	14-60
Search Function	CORN	SHCORNER	Searches corners.	14-86
	CIRC	SHCIRCLE	Searches circles.	14-89

21.3 Image Input and Output

CAMIN (Statement)

Function

Stores an image from the camera in the image memory (process screen).

Format

CAMIN <Camera number>[, <Storage memory number> [, <Table number>]]

Explanation

<Camera number>	Designates the camera number (1 or 2).
<Storage memory number>	Designates the number of the storage memory (process screen) (0 to 3). If this is ignored, 0 is set as the default.
<Table number>	Designates the number of the look-up table to store from 0 to 15. If this is ignored, 0 is set as the default.

Note (1): If a camera is not connected, or if input is not available due to malfunction, an error will occur.
Note (2): If the table number is other than 0 when the image is stored, the table is changed. When this happens, the screen may appear disordered; however, this is not a failure.
Note (3): After execution, the number of the table automatically returns to 0.
Note (4): To execute this instruction, a μVision board (option) is required.

Related Terms

CAMMODE, CAMLEVEL, VISDEFTABLE

Example

```
CAMIN 1, 0, 0    'Converts an image from camera number 1, with table number
                 '0 (with the same brightness as of the camera image) and stores
                 'it in storage memory 0.
DELAY 2000       'Stops for 2 seconds.
CAMIN 1          'The same result can be obtained as CAMIN 1, 0, 0.
DELAY 2000       'Stops for 2 seconds.
I1 = 1           '
I2 = 0           '
I3 = 3           '
CAMIN I1, I2, I3 'Converts an image from camera number 1, with the table 3
                 '(reverse) and stores it in storage memory 0.
VISPLNOUT 0      'Outputs an image in storage memory number 0 to the monitor
                 'as a still-image.
```

CAMMODE (Statement)

Function

Sets the function used to store a camera image.

Format

CAMMODE <Camera number>, <Function>, <Storage method>

Explanation

<Camera number> Designates the number of the camera (1 or 2).

<Function> Designates the function of the camera (0 or 1).

- 0: Normal (in the case of the normal setting)
- 1: Reset function. (After the camera operation is reset, a camera image is stored.)
  For further details, refer to the "2.5.2.1 General Information about the Camera" in Owner's Manual (Installation & Maintenance).

<Storage method> Designate storage method (0 or 1).

- 0: Frame reading
  Stores an image from camera for 1 frame. The resolution in the vertical direction is the maximum.
- 1: Field reading
  When using the shutter function of the field shutter camera, set this.
  Store an image without distortion and with virtually no delay (1/60 second) between fields.
  However, the resolution in the vertical direction is half.

Note (1): If you do not set this instruction, the initial setting value is used.
Note (2): This instruction does not change the initial setting. If you restart the system with the power OFF, the set values are lost.
Note (3): Check the camera connection. If the camera is faulty, check the status of VISSTATUS. If the status of VISSTATUS (0) is -1, the camera is faulty, and if the camera is not faulty, 0 is returned.
Note (4): To execute this instruction, a μVision board (option) is required.

Related Terms

CAMIN, VISSTATUS

Example

```
CAMMODE 1, 0, 0     'Sets the function of camera 1 to normal and sets the storage
                    'method to frame.
I1 = VISSTATUS(0)  'When normal,  I1 = 0
IF I1 = 0 THEN
    CAMIN 1         'Converts an image from camera 1 with table 0 (with the same
                    'brightness as of the camera image) and stores it in storage
                    'memory 0.
    VISPLNOUT 0     'Outputs an image (still image) in storage memory 0 on the
                    'monitor.
    VISLOC 10, 10   'Sets the position to display.
    VISPRINT “Reading normal”
                    'Displays characters on the screen.
ELSE
    VISLOC 10, 10   'Sets the position to display.
    VISPRINT “camera malfunction”
                    'Displays characters on the screen.
END IF
```

CAMLEVEL (Statement)

Function

Sets the camera image input level.

Format

CAMLEVEL <Camera number>, <Lower limit level>, <Upper limit level>

Explanation

<Camera number>	Designates the number of the camera (1 or 2).
<Lower limit level>	Sets the lower limit level for reading camera images (0 to 93).
<Upper limit level>	Sets the upper limit level for reading camera images (7 to 100).

Note (1): This instruction sets the lower limit of the maximum input range to 0% and the upper limit to 100%.
Note (2): The range between the set lower limit and upper limit is divided into 256 intensity levels.
Note (3): It is necessary that the setting be between $0 \leq$ lower limit value $<$ upper limit value ≤ 100 and upper limit – lower limit ≥ 7.
Note (4): To obtain more detail image information, use this command to adjust a dark image or bright image, or to partly increase the resolution of the brightness.
Note (5): If you do not set this instruction, the initial set values are used.
Note (6): This instruction does not change the initial setting. The setting values are lost if you restart the system with the power OFF.
Note (7): To execute this instruction, a μVision board (option) is required.
Note (8): This command takes effect at execution of the next camera input command (CAMIN).

Related Terms

CAMIN, VISCAMOUT

Example

```
CAMLEVEL 1, 0, 100  'Sets the input level range of camera 1 to the maximum.
VISCAMOUT 1         'Displays an image (dynamic image) from the camera on the
                    'monitor.
CAMIN 1             'Converts an image of camera 1 with table 0 (with the same
                    'brightness as of the camera image) and stores it in
                    'storage memory 0.
DELAY 2000          'Stops for 2 seconds.
CAMLEVEL 1, 30, 80  'Sets the lower input level limit to 30% and the upper limit
                    'to 80% for camera 1.
VISCAMOUT 1         'Displays an image (dynamic image) from the camera on the
                    'monitor.
CAMIN 1
```

VISCAMOUT (Statement)

Function

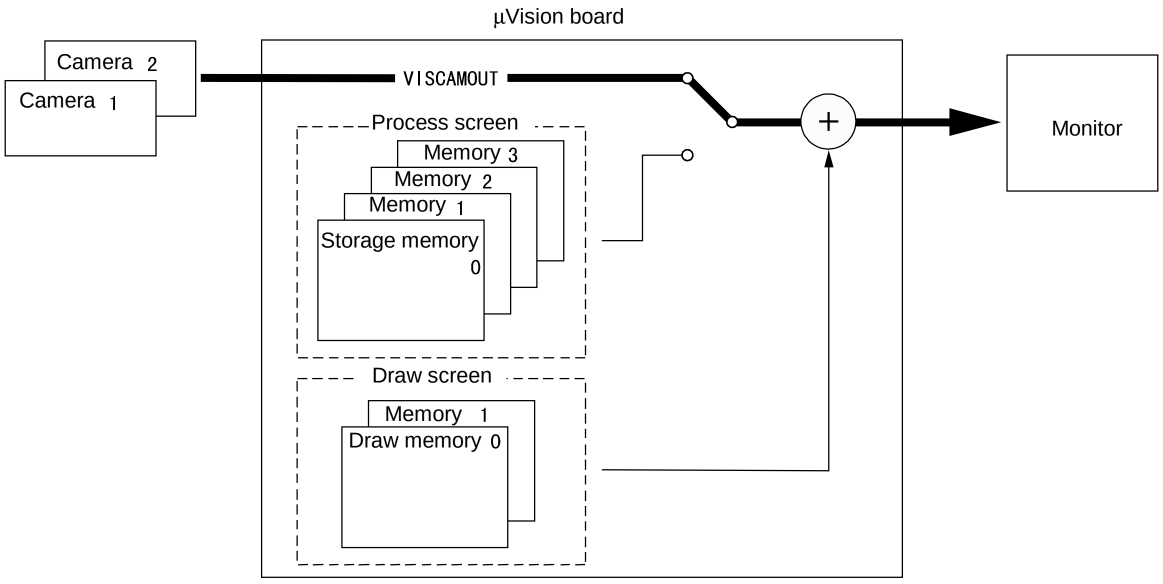
Displays an image from the camera on the monitor.

Format

VISCAMOUT <Camera number>[, <Table number>]

Explanation

<Camera number>	Designates the number of the camera (1 or 2).
<Table number>	Designates the number of the look-up table to display (0~15). If this is ignored, 1 is set as the default.



Note : **To execute this instruction, a μVision board (option) is required.**

Related Terms

VISDEFTABLE, VISPLNOUT, VISOVERLAY, CAMMODE

Example

```
VISCAMOUT 1, 1      'Converts an image (dynamic image) from camera 1 with
                    'table 1 (0~175, 70% brightness compressed) and displays
                    'it on the monitor.
VISCAMOUT 1         'The same result as that of VISCAMOUT 1, 1 can be obtained.
```

VISPLNOUT (Statement)

Function

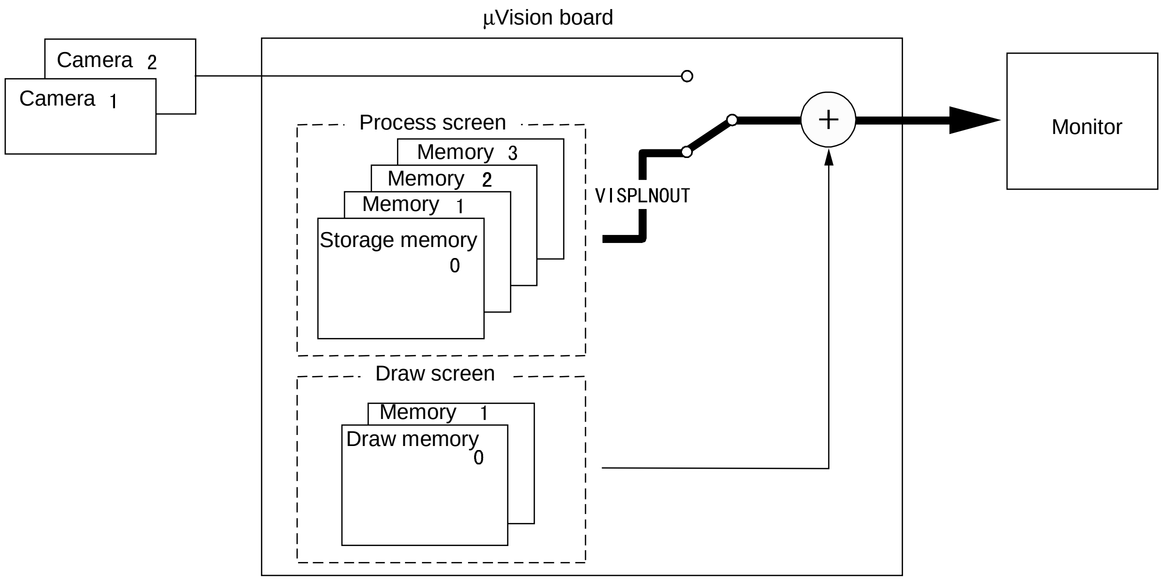
Displays an image in the storage memory on the monitor.

Format

VISPLNOUT <Storage memory number>[, <Table number>]

Explanation

<Storage memory number>	Designates the number of the storage memory (process screen number) (0 to 3).
<Table number>	Designates the number of the look-up table to display (0~15). If this is ignored, 1 is set as the default.



Related Terms

VISDEFTABLE, VISCAMOUT, VISOVERLAY

Example

```
VISPLNOUT 0, 1      'Converts an image (still image) in storage memory 0 with
                    'table 1 (0~175, 70% brightness compressed) and displays
                    'it on the monitor.
VISPLNOUT 0         'The same result as that of VISPLNOUT 0, 1 can be obtained.
```

VISOVERLAY (Statement)

Function

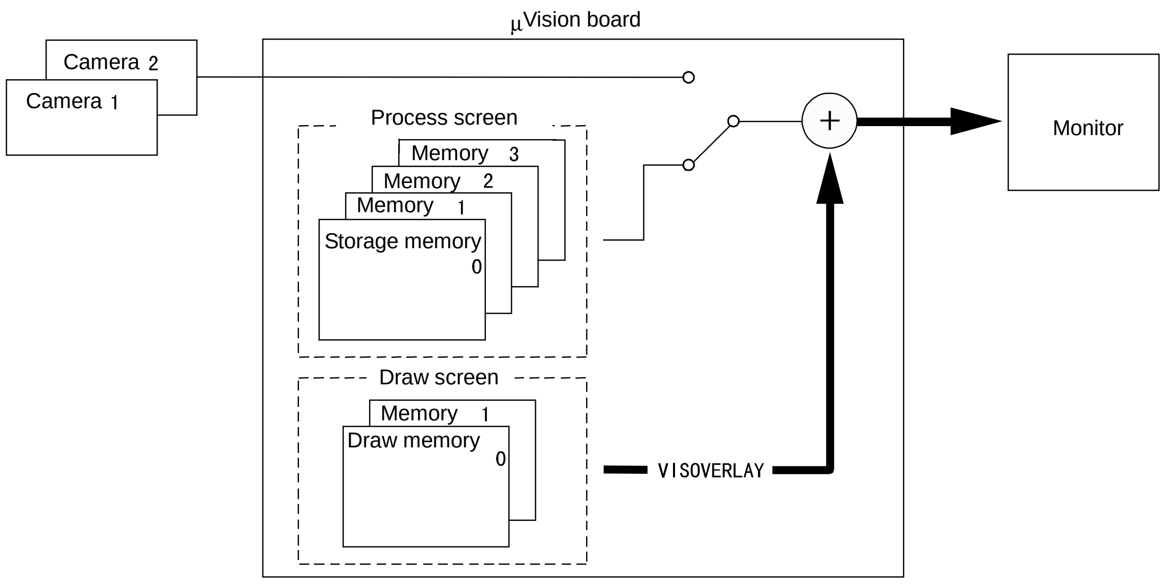
Displays draw screen information on the monitor.

Format

```
VISOVERLAY <Number>
```

Explanation

<Number> Sets draw screen display (0 to 3).
0: Does not display the draw screen.
1: Displays draw screen 0.
2: Displays draw screen 1.
3: Displays both draw screens 0 and 1 at the same time.



Related Terms

VISCAMOUT, VISPLNOUT

Example

```
VISOVERLAY 3            'Sets the destination screen to draw.
VISSCREEN 1, 0          '
VISCLS 0                '
VISLOC 10, 10           'Sets the position to display.
VISPRINT “Draw on the draw screen 0”
                        'Draws characters on the screen.
VISSCREEN 1, 1          'Sets the destination screen to draw.
VISLOC 10, 11           'Sets the position to display.
VISPRINT “Draw on draw screen 0”
                        'Draws characters on the screen.
VISOVERLAY 0            'Stops displaying the draw screen.
DELAY 5000              'Stops for 5 seconds.
VISOVERLAY 1            'Displays draw screen 0 on the monitor.
DELAY 5000              'Stops for 5 seconds.
VISOVERLAY 2            'Displays draw screen 1 on the monitor.
DELAY 5000              'Stops for 5 seconds.
VISOVERLAY 3            'Displays draw screens 0 and 1 on the monitor.
```

VISDEFTABLE (Statement)

Function

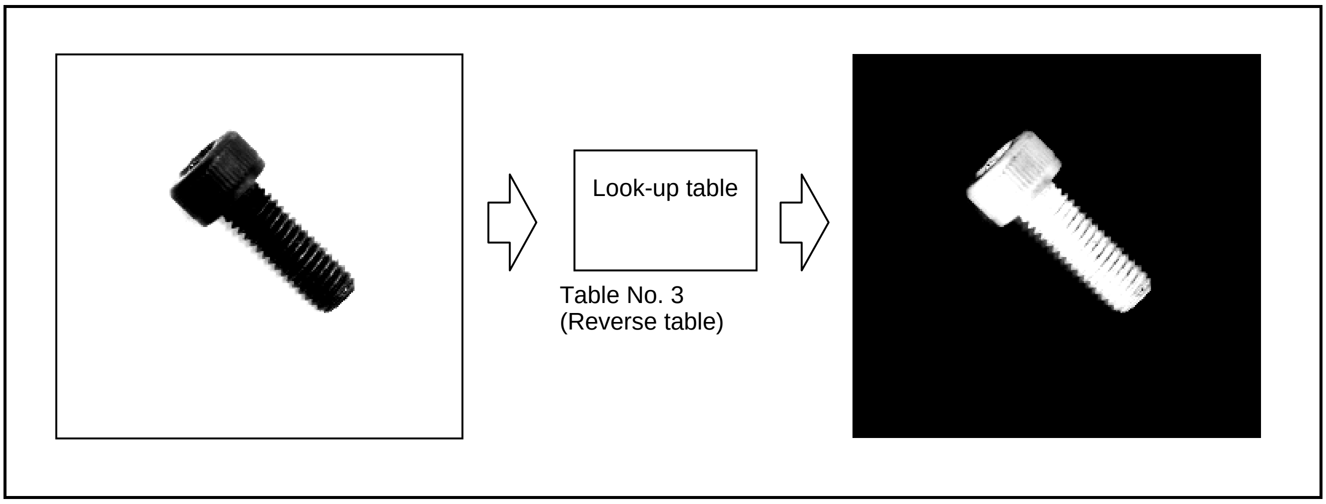
Reads images on the camera and sets the look-up table data for image output.

Format

VISDEFTABLE <Table number>, <Input value>, <Output value>

Explanation

<Table number>	Designates the number of the look-up table (5 to 15).
<Input value>	Designates the input value of the table (0 to 255).
<Output value>	Designates the output value of the table (0 to 255).



Example of conversion using the look-up table

Note (1): If you do not set this instruction, the statement follows the initial setting values.
Note (2): This instruction requires 2 to 3 seconds to complete.
Note (3): Tables considered useful are set for the table numbers 0 to 4 beforehand. With this command, you cannot edit.
Table 0: Normal (0 to 255)
Table 1: 70% brightness compressed (0 to 175)
Table 2: γ compensation
Table 3: Reversed
Table 4: 70% brightness compressed and reversed
Note (4): To execute this instruction, a μVision board (option) is required.
Note (5): During execution of this instruction, do not power off the controller. If you do so, the controller will recognize in the next powering-on sequence that it has not been normally terminated, so it will initialize the vision-related information.

Related Terms

CAMIN, VISCAMOUT, VISPLNOUT, VISREFTABLE

Example

```
VISSCREEN 1, 0, 1    '
VISCLS 0             '
VISCAMOUT 1, 1       'Converts an image (dynamic image) from camera 1 with table
                     '1 (0~175, 75% brightness compressed) and displays it on
                     'the monitor.
DELAY 5000           'Stops for 5 seconds.
VISDEFCHAR 4, 4, 2   '
FOR I1 = 0 TO 255    '
    VISLOC 10, 10    '
    VISPRINT I1      '
    VISDEFTABLE 5, I1, 255-I1
                     'Set table number 5.
NEXT I1              '
VISCAMOUT 1, 5       'Reverses an image (dynamic image) from camera 1 and displays
                     'it on the monitor.
```

VISREFTABLE (Function)

Function

Refers to data on the look-up table.

Format

VISREFTABLE (<Table number>, <Input value>)

Explanation

<Table number> Designates the number of the look-up table (0 to 15).
<Input value> Designates the input value of the table (0 to 255).

Related Terms

VISDEFTABLE

Example

```
VISSCREEN 1, 0, 1               '
VISCLS 0                        '
FOR I1 = 0 TO 255               '
    I2 = VISREFTABLE(1, I1)     'Obtains table number 1 data.
    VISLOC 10, 10               'Sets the position to display.
    VISDEFCHAR 1, 1, 2          'Sets characters to display.
    VISPRINT “Data”;I1;“=”;I2   'Displays the window.
NEXT I1                         '
```

21.4 Window Setting

WINDMAKE (Statement)

Function

Designates an area for image processing.

Format

```
WINDMAKE <Window shape>, <Window number>, <Parameter 1>, <Parameter 2>, …
    Line window (2 point designation):
        WINDMAKE P, <Window number>, <Start point X coordinate>,
                <Start point Y coordinate>, <End point X coordinate>,
                <End point Y coordinate>
    Line window (length and angle designation):
        WINDMAKE L, <Window number>, <Length>[, <Angle>]
    Circle window:
        WINDMAKE C, <Window number>, <Radius>
    Ellipse window:
        WINDMAKE E, <Window number>, <Width>, <Height>
    Sector window:
        WINDMAKE S, <Window number>, <Outer diameter>,
        <Inner diameter>, <Start angle>, <End angle>, <Partition
        angle>[, <Mode>]
    Rectangle window:
        WINDMAKE R, <Window
        number>, <Width>, <Height>[, <Angle>[, <Mode>]]
```

Explanation

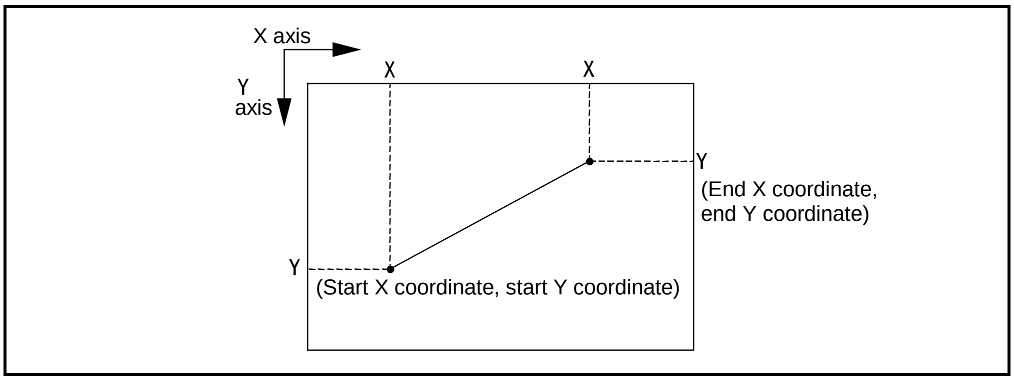
<Window shape> Designates the window shape.

P: Line window Point to Point (2 point designation)
L: Line window Line (Length and angle designation)
C: Circle window Circle
E: Ellipse window Ellipse
S: Sector window Section
R: Rectangle window Rectangle

<Window number> Designates the window number (0 to 511).
<Parameter> Designates the value to set each window shape.

Line window (2 point designation)

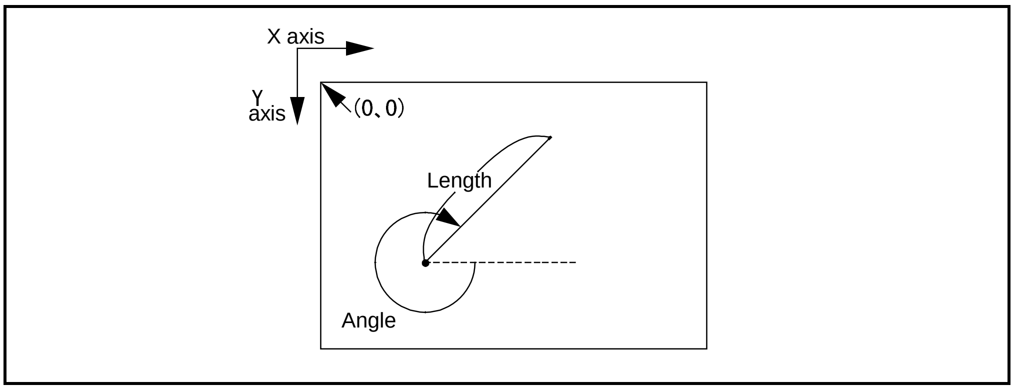
<Start point X coordinate>	Designates the line start point X coordinate (0 to 511).
<Start point Y coordinate>	Designates the line start point Y coordinate (0 to 479).
<End point X coordinate>	Designates the line end point X coordinate (0 to 511).
<End point Y coordinate>	Designates the line start point Y coordinate (0 to 479).


X axis
Y axis
X
X
Y
(End X coordinate, end Y coordinate)
Y
(Start X coordinate, start Y coordinate)

Line window (Length and angle designation):

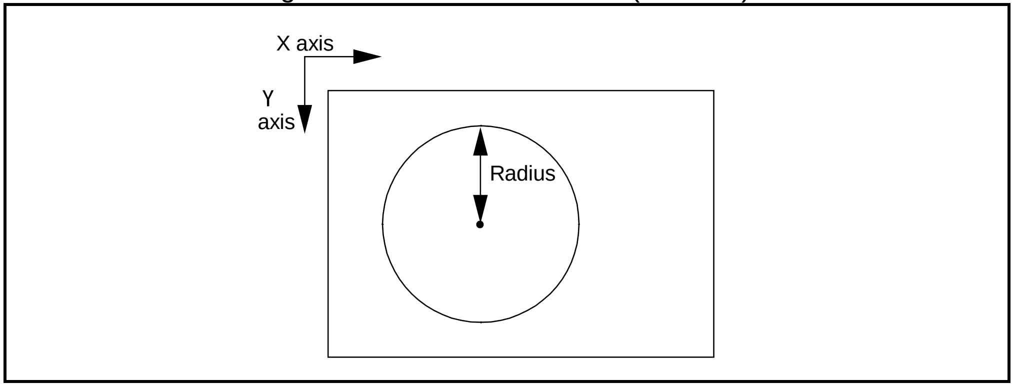
<Length> Designates the line length from 1 to 512.

<angle> Designates the angle of the line. If this is ignored, 0 degrees is set as the default.



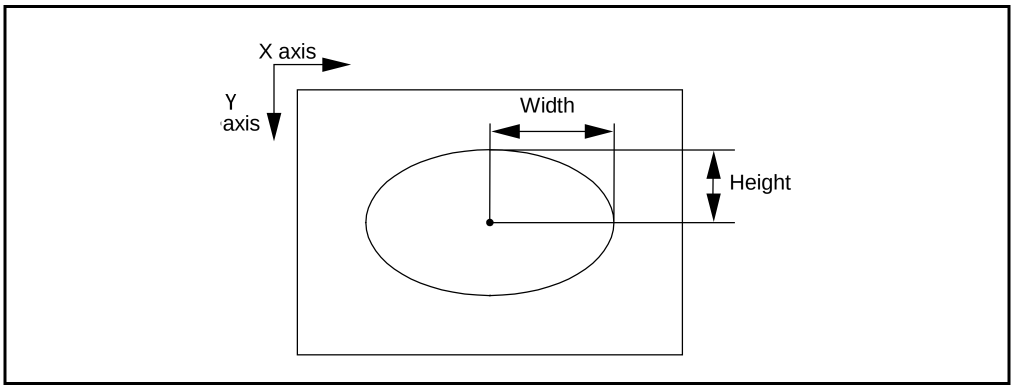
Circle window:

<Radius> Designates the radius of a circle (1 to 240).



Ellipse window:

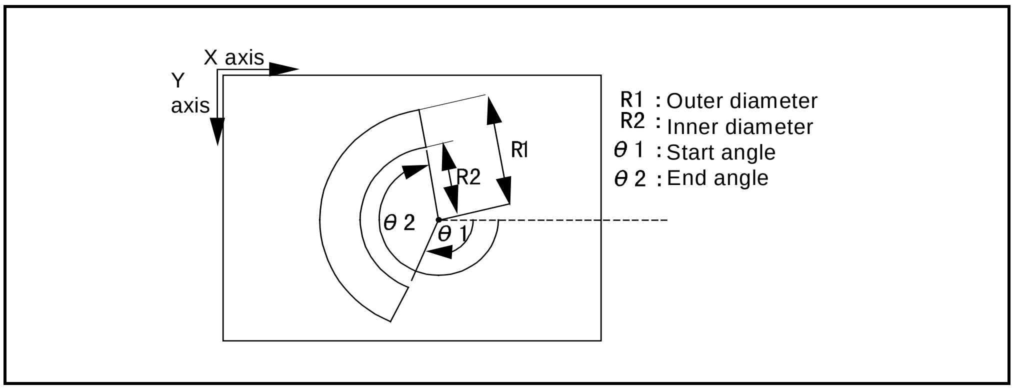
<Width> Designates the width of an ellipse (1 to 256).
<Height> Designates the height of an ellipse (1 to 240).



Sector window:

<Outer diameter> Designates the outer diameter of a sector (outer diameter > inner diameter) (1 to 9999).
<Inner diameter> Designates the inner diameter of a sector (outer diameter > inner diameter) (1 to 9999).
<Start angle> Designates the start angle of a sector (-720 to 720).
<End angle> Designates the end angle of a sector (-720 to 720).
<Partition angle> Designates the resolution for processing (0.1 to 360).
<Mode> Designates the mode to draw (0 to 2).

0: Designates the VISPROJ and VISEDGE scanning direction to the meridian.
1: Designates the VISPROJ and VISEDGE scanning direction to the periphery of a circle.
2: Does not designate the VISPROJ and VISEDGE scanning direction.
If this is ignored, 0 is entered.



Rectangle window:

<Width> Designates the width of a rectangle (1 to 512).

<Height> Designates the height of a rectangle (1 to 480).

<Angle> Designates the angle of the line. If this is ignored, 0 degrees is entered (-720 to 720).

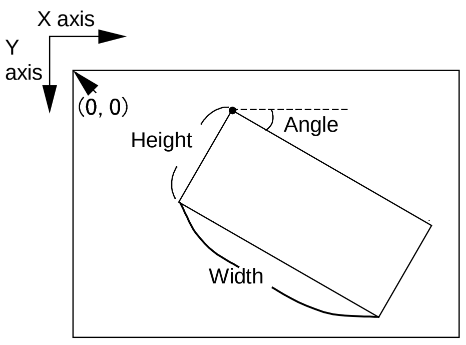
<Mode> Designates the mode to draw (0 to 2).

0: Designates the VISPROJ and VISEDGE scanning direction to the width direction.

1: Designates the VISPROJ and VISEDGE scanning direction to the height direction.

2: Does not designate the VISPROJ and VISEDGE scanning direction.

If this is ignored, 0 is set as the default.



Note (1): This instruction does not change the initial setting. When restarting the system with the power OFF, the initial setting values are restored.

Note (2): If it is necessary to permanently change, delete the data with the WINCAPSII VisManager.

Note (3): To execute this instruction, a µVision board (option) is required.

Related Terms

VISHIST, VISBINA, VISFILTER, VISMASK, VISMEASURE, VISPROJ, VISEDGE, VISREADQR, BLOB, SHMODEL, SHCORNER, SHCIRCLE

Example

```
VISSCREEN 1, 0, 1                   '
VISCLS 0                            '
VISCAMOUT 1                         '
CAMIN 1                             '
VISPLNOUT 0                         '
WINDMAKE P, 1, 50, 100, 100, 150    'Creates a line window (2 point designation).
WINDMAKE L, 2, 100, 45              'Creates a line window (Length and angle
                                    'designation).
WINDMAKE C, 3, 50                   'Creates a circle window.
WINDMAKE E, 4, 50, 100              'Creates an ellipse window.
WINDMAKE S, 5, 100, 80, 90, 300, 1, 2  'Creates a sector window.
WINDMAKE R, 6, 100, 50, 45, 2       'Creates a rectangle window.
VISMEASURE 1, 100, 100, 1, 1, 128   '
WINDDISP                                '
VISMEASURE 2, 150, 150, 1, 1, 128       '
WINDDISP 2                              '
VISMEASURE 3, 200, 200, 1, 1, 128       '
WINDDISP 3                              '
VISMEASURE 4, 250, 250, 1, 1, 128       '
WINDDISP 4                              '
VISMEASURE 5, 300, 300, 1, 1, 128       '
WINDDISP 5                              '
VISMEASURE 6, 350, 350, 1, 1, 128       '
WINDDISP 6                              '
```

WINDCLR (Statement)

Function

Deletes set window information.

Format

WINDCLR <Window number>

Explanation

<Window number> Designates the window number (0 to 511).

Note (1): This instruction does not change the initial setting. When restarting the system with the power OFF, the initial setting values are restored.
Note (2): If it is necessary to permanently delete data, delete if with the WINCAPSII VisManager.
Note (3): To execute this instruction, a μVision board (option) is required.

Related Terms

WINDMAKE

Example

```
VISSCREEN 1, 0, 1                      '
VISCLS 0                               '
VISCAMOUT 1                            '
WINDMAKE R, 1, 50, 100, 0, 2           '
FOR I1 = 0 TO 7                        '
    I2 = WINDREF(1, I1)                'Obtains window number 1 data.
    VISLOC 0, I1                       'Sets the position to display.
    VISPRINT “Data”;I1;“=”;I2          'Displays the window.
NEXT I1                                '
WINDCLR 1                              '
VISLOC 0, 9                            '
VISPRINT “After deletion of window information”
                                       '
FOR I1 = 0 TO 7                        '
    I2 = WINDREF(1, I1)                'Obtains window number 1 data.
    VISLOC 0, 10+I1                    'Sets the position to display.
    VISPRINT “Data”;I1;“=”;I2          'Displays the window.
NEXT I1                                '
```

WINDCOPY (Statement)

Function

Copies window data.

Format

WINDCOPY <Copy source window number>, <Copy destination window number>

Explanation

<Copy source window number>	Designates the window number from which data will be copied (0 to 511).
<Copy destination window number>	Designates the window number to which data will be copied (0 to 511).

Note (1): This instruction does not change the initial setting. When restarting the system with power the OFF, the copied setting is lost.
Note (2): To execute this instruction, a μVision board (option) is required.

Related Terms

WINDMAKE

Example

```
VISSCREEN 1, 0, 1                               '
VISCLS 0                                        '
VISCAMOUT 1                                     '
WINDCLR 2                                       '
WINDMAKE R, 1, 50, 100, 0, 2                    '
VISLOC 0, 0                                     '
VISPRINT “Copy source window information”       '
FOR I1 = 0 TO 7                                 '
    I2 = WINDREF(1, I1)                         'Obtains window number 1 data.
    VISLOC 0, 1+I1                              'Sets the position to display.
    VISPRINT “Data”;I1;“=”;I2                   'Displays the window.
NEXT I1                                         '
VISLOC 0, 9                                     '
VISPRINT “Before window information copy”       '
FOR I1 = 0 TO 7                                 '
    I2 = WINDREF(2, I1)                         'Obtains window number 1 data.
    VISLOC 0, 10+I1                             'Sets the position to display.
    VISPRINT “Data”;I1;“=”;I2                   'Displays the window.
NEXT I1                                         '
WINDCOPY 1, 2                                   '
VISLOC 0, 18                                    '
VISPRINT “After window information copy”        '
FOR I1 = 0 TO 7                                 '
    I2 = WINDREF(2, I1)                         'Obtains window number 1 data.
    VISLOC 0, 19 + I1                           'Sets the position to display.
    VISPRINT “Data”;I1;“=”;I2                   'Displays the window.
NEXT I1                                         '
```

WINDREF (Function)

Function

Obtains window information.

Format

WINDREF (<window number>, <Item>)

Explanation

This statement designates the window number with <Window number>(0 to 511).
Designates the number to obtain the data with <Item>(0 to 7).

Item number 0:	Presence of the window setting	Return value Present = 0 Not present = -1
Item number 1:	Window shape	Return value (Refer to the table below.)
Item number 2:	Window reference point X coordinates	
Item number 3:	Window reference point Y coordinates	
Item number 4~9:	Window's each setting data	Return value for each setting data (Refer to the table below.)

	Item						
Window shape	1	4	5	6	7	8	9
Line (2 Point Designation)	0	Start Point X Coordinate	Start Point Y Coordinate	End Point X Coordinate	End Point Y Coordinate	-1	-1
Line (Length and Angle Designation)	1	Length	Angle	-1	-1	-1	-1
Circle	2	Radius	-1	-1	-1	-1	-1
Ellipse	3	Width	Height	-1	-1	-1	-1
Sector	4	Outer diameter	Inner diameter	Start angle	End angle	Partition angle	Mode
Rectangle	5	Width	Height	Angle	Mode	-1	-1

Note (1): If nothings is set, a return value of -1 is set as the default.
Note (2): Data obtained is not the initially set data but the current set data.
Note (3): To execute this instruction, a μVision board (option) is required.

Related Terms

WINDMAKE

Example

```
VISSCREEN 1, 0, 1               '
VISCLS 0                        '
VISCAMOUT 1                     '
WINDMAKE R, 1, 50, 100, 0, 2    '
FOR I1 = 0 TO 7                 '
    I2 = WINDREF(1, I1)         'Obtains window number 1 data.
    VISLOC 0, I1                'Sets the display position.
    VISPRINT “Data”;I1;“=”;I2   'Displays the window.
NEXT I1                         '
```

WINDDISP (Statement)

Function

Draws a designated window.

Format

WINDDISP <Window number>

Explanation

This statement designates the window number with <Window number> (0 to 511).

Note (1): In window information, there is a reference point to process a window. This data is determined with each image process instruction. Therefore, if you execute this instruction after process instructions are executed, the window will be displayed at a right position.
Note (2): Just after a new window is set, the window reference point is set to X = 0 and Y = 0.
Note (3): A screen to draw becomes the one set with VISSCREEN.
Note (4): To execute this instruction, a μVision board (option) is required.

Related Terms

WINDMAKE, VISSCREEN

Example

```
VISOVERLAY 1                 'Displays draw only screen number 0 on the
                             'monitor.
VISSCREEN 1, 0, 1            'Instantaneously draws on draw screen number 0.
WINDMAKE R, 1, 200, 200, 0, 2  'Creates a rectangular window.
WINDDISP 1                   'Displays the window (with the reference point of
                             'X=0 and Y=0).
VISHIST 1, 100, 100          'Executes histogram processing.
WINDDISP 1                   'Displays the window (with the reference point of
                             'X=100 and Y=100).
```

21.5 Draw

VISSCREEN (Statement)

Function

Designates a drawing screen.

Format

VISSCREEN <Draw object>, <Screen number>[, <Draw mode>]

Explanation

<Draw object>	Designates the storage memory or overlay memory (screen) (0 or 1). 0: Storage memory (Processing screen) 1: Overlay memory (Draw only screen)
<Screen number>	Screen number on each screen Storage memory (Processing screen): 4 screens from 0 to 3 Overlay memory (Draw only screen): 2 screens, 0 and 1.
<Draw mode>	Designates the display drawing method(0 or 1). 0: Instant display OFF 1: Instant display ON If ignored, 1 is the default setting.

Note (1): When you turn ON the power, VISSCREEN 1, 0, 1 are set as the initial setting.

Note (2): When the system executes the draw instruction with instant display ON, the draw result is displayed on the monitor. However, with instant display OFF, the screen is renewed after the execution of instructions corresponding to the draw object of either VISPLNOUT or VISOVERLAY.

Note (3): With instant draw ON, when the draw instruction is executed, it takes about 0.02 seconds for the system to renew. Therefore, if you frequently repeat drawing, requirement time rapidly accumulates. By setting the instant draw to OFF and displaying all objects once, it is possible to save processing time.

Note (4): For this instruction, a μVision board (option) is required.

Related Terms

VISBRIGHT, VISCLS, VISPUTP, VISLINE, VISPTP, VISRECT, VISCIRCLE, VISELLIPSE, VISSECT, VISCROSS, VISLOC, VISDEFCHAR, VISPRINT

Example

```
VISSCREEN 1,0,1             'Instantaneously draws the drawing screen 0.
VISCLS 0                    '
FOR I1 = 100 TO 200 STEP 2  '
    VISRECT I1,I1,200,200   'Draws a rectangle with a width of 200 and a height of 200.
NEXT I1                     '
VISCLS 0                    'Clears the screen.
VISSCREEN 1,0,0             'Draws on drawing only screen 0.
FOR I1 = 100 TO 200 STEP 2  '
    VISRECT I1,I1,200,200   'Draws a rectangle with a width of 200 and a height of 200.
NEXT I1                     '
VISOVERLAY 1                'Displays (Renews) draw only screen 0 on the monitor.
```

VISBRIGHT (Statement)

Function

Designates a drawing brightness value.

Format

VISBRIGHT <Brightness value>

Explanation

<Brightness value> Designates a drawing brightness value (0 to 255).

Note (1): If a drawing object is in the storage memory (Processing screen), it is drawn with a designated brightness. If it is in the overlay memory (draw only memory), the following brightness will be used.

Brightness value 128 to 255	**:**	**255 (White)**
Brightness value 1 to 127	**:**	**0 (Black)**
Brightness value 0	**:**	**Through (Transparent)**

Note (2): When you turn ON the power, VISBRIGHT 255 is set as the default setting.

Note (3): For this instruction, a μVision board (option) is required.

Related Terms

VISSCREEN, VISCLS, VISPUTP, VISLINE, VISPTP, VISRECT, VISCIRCLE, VISELLIPSE, VISSECT, VISCROSS, VISLOC, VISDEFCHAR, VISPRINT

Example

```
VISPLNOUT 0                    'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1                'Instantaneously draws on processing screen 0.
VISCLS 0                       '
FOR I1 = 10 TO 200 STEP 5      '
    VISBRIGHT I1               '
    VISRECT 100+I1,100,200,200 'Draws a rectangle with a width of 200 and a height of 200.
NEXT I1                        '
DELAY 500                      'Stops for 0.5 seconds.
VISCLS 0                       'Clears the screen.
VISSCREEN 1,0,1                'Instantaneously draws on draw only screen 0.
FOR I1 = 10 TO 200 STEP 5      '
    VISBRIGHT I1               '
    VISRECT 100+I1,100,200,200 'Draws a rectangle with a width of 200 and a height of 200.
NEXT I1                                          '
```

VISCLS (Statement)

Function

Fills (clears) a designated screen, set in a mode with a designated brightness.

Format

VISCLS [<Mode>[,<Brightness value>]]

Explanation

<Mode> (0~3) If ignored, 2 is set.

0: Fills the screen set with VISSCREEN instruction with a designated brightness.
1: Fills the entire processing screen with a designated brightness.
2: Fills the entire screen with a designated brightness.
3: Fills all screens with a designated brightness.

<Brightness value> Designates the brightness value for coating (clearing). (0 to 255). If ignored, 0 will be the default setting.

Note (1): If a drawing object is in the storage memory (Processing screen), it is cleared with a designated brightness. If it is in the overlay memory (draw only memory), the following brightness will be used.

Brightness value 128 to 255	**: 255 (White)**
Brightness value 1 to 127	**: 0 (Black)**
Brightness value 0	**: Through (Transparent)**

Note (2): For this instruction, a μVision board (option) is required.

Related Terms

VISSCREEN

Example

```
VISSCREEN 1,0,1             '
VISCLS 0                    '
VISSCREEN 1,1,1             '
VISCLS 0                    '
VISPLNOUT 0                 'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1             'Instantaneously draws on processing screen 0.
FOR I1 = 10 TO 200 STEP 5   '
    VISCLS 0,I1             'Fills the screen with the designated brightness of I1.
NEXT I1                     '
DELAY 500                   'Stops for 0.5 seconds.
VISCLS 0                    'Fills the screen with brightness 0.
VISRECT 200,200,200,200     'Draws a rectangle with a width of 200 and a height of 200.
DELAY 500                   'Stops for 0.5 seconds.
VISCLS 0                    'Fills a rectangle on the drawing screen.
VISCAMOUT 1                 '
VISSCREEN 1,0,1             'Instantaneously draws on draw only screen 0.
VISRECT 100,100,200,200     'Draws a rectangle with a width of 200 and a height of 200.
DELAY 500                   'Stops for 0.5 seconds.
VISCLS 0                    'Fills a rectangle on the draw screen.
VISCLS 0,127                'Fills the drawing screen black.
DELAY 500                   'Stops for 0.5 seconds.
VISCLS 0,255                'Fills the draw screen white.
DELAY 500                   'Stops for 0.5 seconds.
VISCLS 0                    'Sets the drawing screen to transparent.
```

VISPUTP (Statement)

Function

Draws a point on the screen.

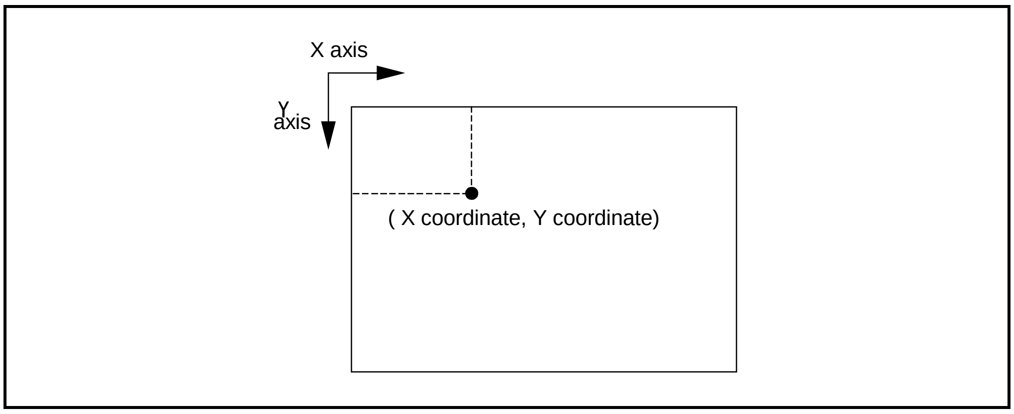
Format

VISPUTP <X coordinate >, <Y coordinate >

Explanation

<X coordinate > Designates the X coordinate in order to draw a point.
<Y coordinate > Designates the Y coordinate in order to draw a point.

Note (1): The values of the X and Y coordinates are not checked. Fven if they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with VISSCREEN.
Note (3): The brightness value for drawing is the brightness designated with VISBRIGHT.
Note (4): For this instruction, a μVision board (option) is required.



Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0                  'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1              'Instantaneously draws on processing screen 0.
VISCLS 0                     'Clears the screen.
VISBRIGHT 255                'Sets the brightness value for drawing.
FOR I1 = 10 TO 200 STEP 5    '
    VISPUTP 100+I1,100       'Draws a point at the coordinates (100+I1,100).
NEXT I1                      '
```

VISLINE (Statement)

Function

Draws a line on the screen.

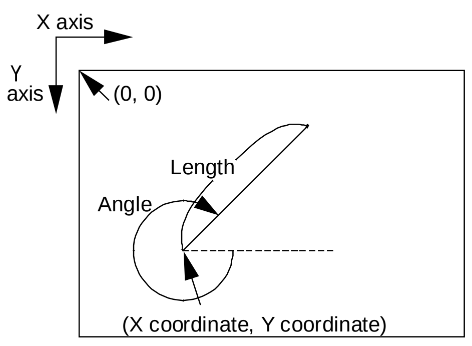
Format

VISLINE<X coordinate >, <Y coordinate >, <Length> [, <Angle>]

Explanation

<X coordinate > Designates the X coordinate in order to draw a line.
<Y coordinate > Designates the Y coordinate in order to draw a line.
<Length> Designates the length of the line to be drawn.
<Angle> Designates the angle of the line to be drawn. If ignored, 0 degrees will be the default setting.

Note (1): The values of the X and Y coordinates, lengths, and angles are not checked. Even if they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with VISSCREEN.
Note (3): The brightness value for drawing is the same as the brightness designated with VISBRIGHT.
Note (4): For this instruction, a μVision board (option) is required.



Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0                    'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1                'Instantaneously draws on processing screen 0.
VISCLS 0                       'Clears the screen.
VISBRIGHT 255                  'Sets the brightness value for drawing.
FOR I1 = 0 TO 360 STEP 5       '
    VISLINE 256,256,100,I1     'Draws a line with a length of 100.
NEXT I1                        '
```

VISPTP (Statement)

Function

Draws a line connecting two points on the screen.

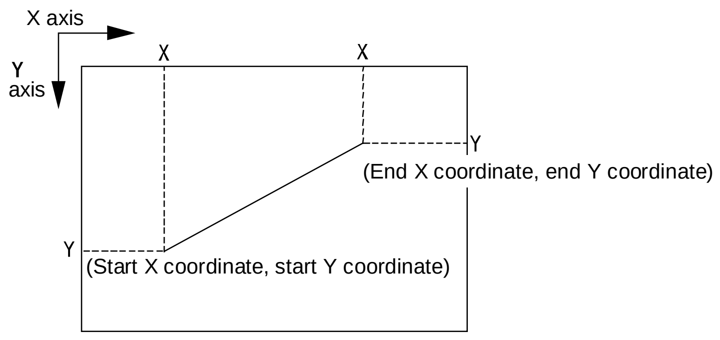
Format

VISPTP <Start point X coordinate >, <Start point Y coordinate >, <End point X coordinate >, <End point Y coordinate >

Explanation

<Start point X coordinate >	Designates the start point of the X coordinate of the line to be drawn.
<Start point Y coordinate >	Designates the start point of the Y coordinate of the line to be drawn.
<End point X coordinate >	Designates the end point of the X coordinate of the line to be drawn.
<End point Y coordinate >	Designates the end point of the Y coordinate of the line to be drawn.

Note (1): The values of the X and Y coordinates are not checked. Even if they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with VISSCREEN.
Note (3): The brightness value for drawing is the same as the brightness designated with VISBRIGHT.
Note (4): For this instruction, a μVision board (option) is required.


X axis
Y axis
X
X
Y
(End X coordinate, end Y coordinate)
Y
(Start X coordinate, start Y coordinate)

Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0                  'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1              'Instantaneously draws on processing screen 0.
VISCLS 0                     'Clears the screen.
VISBRIGHT 255                'Sets the brightness value for drawing.
FOR I1 = 200 TO 300          '
    VISPTP 100,100,200,I1    'Draws a line connecting two points.
NEXT I1                      '
```

VISRECT (Statement)

Function

Draws a rectangle on the screen.

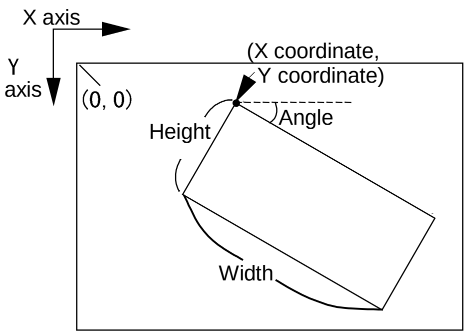
Format

VISRECT <X coordinate >, <Y coordinate >, <Width>, <Height>[, <Mode>[, <Angle>]]

Explanation

<X coordinate > Designates the X coordinate of the rectangle to be drawn.
<Y coordinate > Designates the Y coordinate of the rectangle to be drawn.
<Width> Designates the width of the rectangle to be drawn.
<Height> Designates the height of the rectangle to be drawn.
<Mode> Designates the mode for drawing.
0: Draws only an outline of the rectangle.
1: Draws a whole coated screen.
If ignored, 0 will be the default setting.
<Angle> Designates the angle of the line to be drawn. If ignored, 0 degrees is will be the default setting.

Note (1): Values of X and Y coordinates, lengths and angles are not checked. If they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with VISSCREEN.
Note (3): The brightness value for drawing is the same as the brightness designated with VISBRIGHT.
Note (4): For this instruction, a μVision board (option) is required.



Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0                      'Displays the storage memory 0 (processing screen).
VISSCREEN 0,0,1                  'Instantaneously draws on the processing screen 0.
VISCLS 0                         'Clears the screen.
VISBRIGHT 255                    'Sets the brightness value for the drawing.
FOR I1 = 0 TO 360 STEP 5         '
    VISRECT 256,256,100,100,0,I1 'Draws a rectangle with a height of 100 and width of 100.
NEXT I1                          '
VISRECT 200,200,50,50,1,45       'Draws a coated rectangle with a height of 50 and width of 50.
```

VISCIRCLE (Statement)

Function

Draws a circle on the screen.

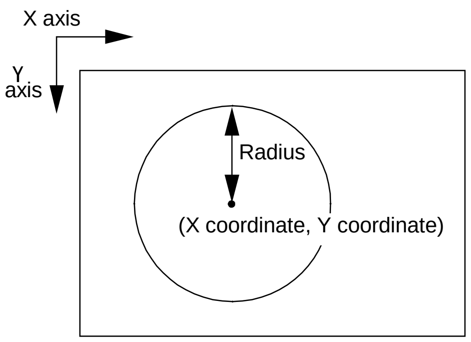
Format

VISCIRCLE <X coordinate >, <Y coordinate >, <Radius> [, <Mode>]

Explanation

<X coordinate > Designates the X coordinate of the circle to be drawn.
<Y coordinate > Designates the Y coordinate of the circle to be drawn.
<Radius> Designates the radius of the circle to be drawn.
<Mode> Designates the mode of drawing.
0: Draws only an outline of a circle
1: Draws a whole filled circle.
If ignored, 0 will be the default setting.

Note (1): The values of the X and Y coordinates and the radius are not checked. Even if they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with V ISSCREEN.
Note (3): The brightness value for drawing is the same as the brightness designated with VISBRIGHT.
Note (4): For this instruction, a µVision board (option) is required.



Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0            'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1        'Instantaneously draws on processing screen 0.
VISCLS 0               'Clears the screen.
VISBRIGHT 255          'Sets the brightness value for drawing.
VISCIRCLE 255,255,100  'Draws a circle with a radius of 100.
VISCIRCLE 200,200,50,1 'Draws a filled circle with a radius 50.
```

VISELLIPSE (Statement)

Function

Draws an ellipse on the screen.

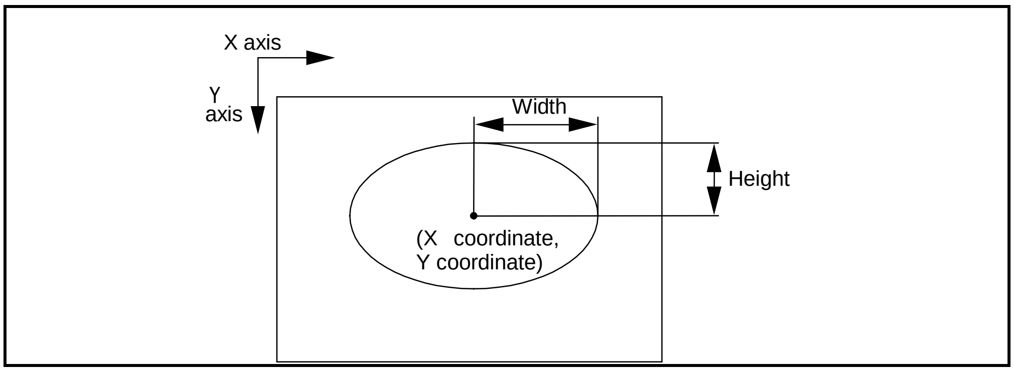
Format

VISELLIPSE <X coordinate >, <Y coordinate >, <Width>, <Height> [, <Mode>]

Explanation

<X coordinate > Designates the X coordinate of the ellipse to be drawn.
<Y coordinate > Designates the Y coordinate of the ellipse to be drawn.
<Width> Designates the width of the ellipse to be drawn.
<Height> Designates the height of the ellipse to be drawn.
<Mode> Designates the mode of drawing.
0: Draws only an outline of an ellipse.
1: Draws a whole filled ellipse.
If ignored, 0 will be the default setting.

Note (1): The values of the X and Y coordinates and the radius are not checked. Even if they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with VISSCREEN.
Note (3): The brightness value for drawing is the same as the brightness designated with VISBRIGHT.
Note (4): For this instruction, a μVision board (option) is required.



Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0                  'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1              'Instantaneously draws on processing screen 0.
VISCLS 0                     'Clears the screen.
VISBRIGHT 255                'Sets the brightness value for drawing.
VISELLIPSE 255,255,100,50    'Draws an ellipse with a width of 50 and a height of 100.
VISELLIPSE 255,255,50,100,1  'Draws a coated ellipse with a width of 50 and a height 100.
```

VISSECT (Statement)

Function

Draws a sector on the screen.

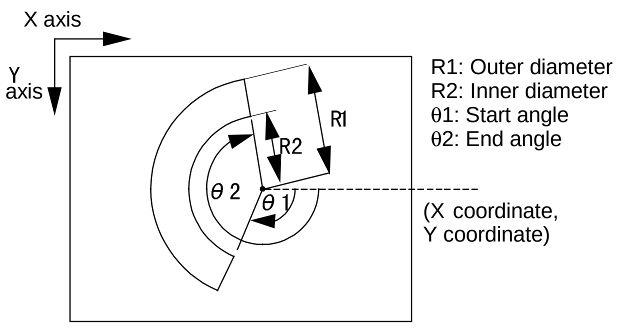
Format

VISSECT <X coordinate>, <Y coordinate>, <Outer diameter>, <Inner diameter>, <Start angle>, <End angle>

Explanation

<X coordinate > Designates the X coordinate of the sector to be drawn.
<Y coordinate > Designates the Y coordinate of the sector to be drawn.
<Outer diameter> Designates the outer diameter of the sector to be drawn.
<Inner diameter> Designates the inner diameter of the sector to be drawn.
<Start angle> Designates the start angle of the sector to be drawn.
<End angle> Designates the end angle of of the sector to be drawn.

Note (1): Designated values are not checked. Even if they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with VISSCREEN.
Note (3): The brightness value for drawing is the same as the brightness designated with VISBRIGHT.
Note (4): For this instruction, a μVision board (option) is required.



Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0                    'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1                'Instantaneously draws on processing screen 0.
VISCLS 0                       'Clears the screen.
VISBRIGHT 255                  'Sets the brightness value for drawing.
VISSECT 255,255,100,50,100,260 'Draws a sector.
```

VISCROSS (Statement)

Function

Draws a cross symbol on the screen.

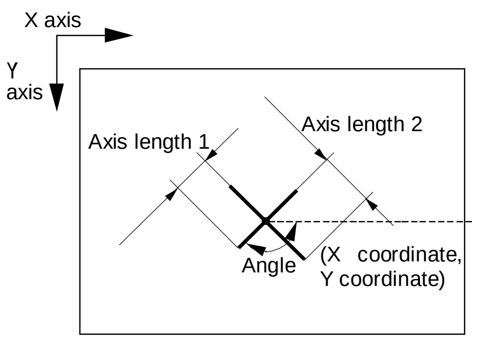
Format

VISCROSS <X coordinate>, <Y coordinate>[, <Axis length 1>[, <Axis length 2> [, <Angle>]]]

Explanation

<X coordinate >	Designates the X coordinate of the cross symbol to be drawn.
<Y coordinate >	Designates the Y coordinate of the cross symbol to be drawn.
<Axis length 1>	Designates the axis length of the cross symbol to be drawn. If ignored, 10 will be the default setting.
<Axis length 2>	Designates the axis length of the cross symbol to be drawn. If ignored, 10 will be the default setting.
<Angle>	Designates the angle of the cross symbol to be drawn. If ignored, 0 degrees will be the default setting.

Note (1): Designated values are not checked. Even if they are out of the permissible drawing range, no error will result.
Note (2): The object screen is the screen set with VISSCREEN.
Note (3): The brightness value for drawing is the same as the brightness designated with VISBRIGHT.
Note (4): For this instruction, a μVision board (option) is required.



Related Terms

VISSCREEN, VISBRIGHT

Example

```
VISPLNOUT 0                'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1            'Instantaneously draws on processing screen 0.
VISCLS 0                   'Clears the screen.
VISBRIGHT 255              'Sets the brightness value for drawing.
VISCROSS 255,255,10,20,45  'Draws a cross symbol.
```

VISLOC (Statement)

Function

Designates the display position of characters.

Format

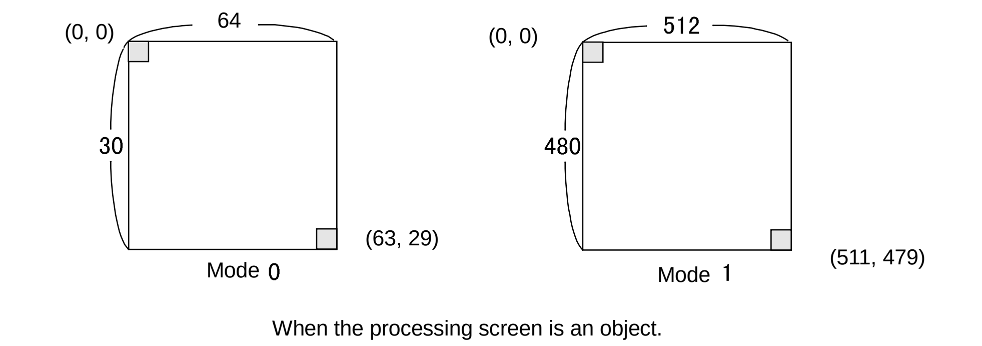
VISLOC <X position>, <Y position>[, <Mode>]

Explanation

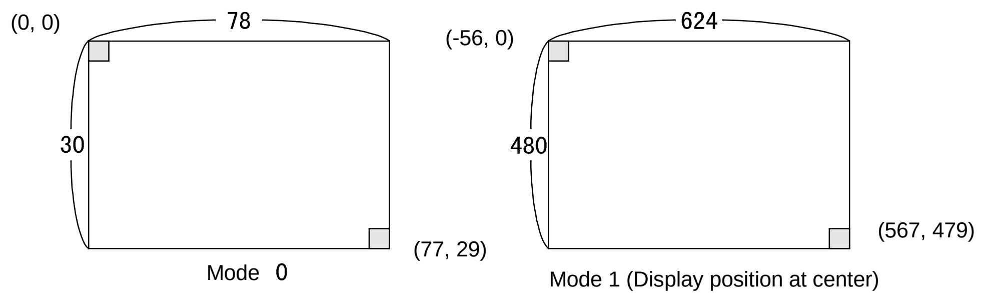
<X coordinate > Designates the X coordinate of the character to be drawn.
<Y coordinate > Designates the Y coordinate of the character to be drawn.
<Mode> Designates the coordinate mode of X and Y position data.
If ignored, 0 will be the default setting.
0: Designates by column and line.
1: Designates with the XY coordinate system.

The values to designate are not checked. Even if they are out of the drawing range, no error will result. Additionally, if they are out of the range, this instruction becomes invalid and the previously set value will be used.

Note (1): When you turn ON the power, VISLOC 0, 0, 0 will be set as the initial setting.
Note (2): If you set the mode to 0, the system will memorize the end position of the characters after they are drawn.
Note (3): If the right of characters exceeds the end of a line, the system automatically feeds more lines.
Note (4): For this instruction, a μVision board (option) is required.



When the processing screen is an object.



When the draw screen is an object.

Related Terms

VISPRINT

Example

```
VISPLNOUT 0                    'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1                'Instantaneously draws on processing screen 0.
VISCLS 0                       'Clears the screen.
VISBRIGHT 255                  'Sets the brightness value for drawing.
VISLOC 10,10                   'Designates the position to display characters.
VISPRINT “Test mode 0”         '
VISLOC 10,10,1                 'Designates the position to display characters.
VISPRINT “Test mode 1”         '
VISPRINT “Continuing Test mode 1”
                               '
VISPRINT “******** Line feed ********”
```

VISDEFCHAR (Statement)

Function

Designates the size of characters and the display method.

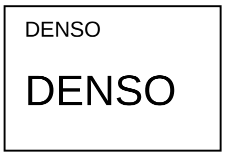
Format

VISDEFCHAR <Lateral size>, <Longitudinal size>, <Display method>

Explanation

<Lateral size> Designates the lateral size of character (1 to 4).
<Longitudinal size> Designates the longitudinal size of characters (1 to 4).
<Display method> Designates the display method of characters (0 to 3).
0: White
1: Black
2: Outline characters on a white background
3: Outline characters on a black background

Note (1): When you turn ON the power, VISDEFCHAR 1, 1, 0 will be set as the initial setting.
Note (2): The standard character size is 16 (longitudinal) x 16 lateral dots a (VISDEFCHAR 1, 1, *).



VISDEFCHAR 1,1,1

VISDEFCHAR 2,2,1

Note (3): If you set white or black, only characters are displayed with the background remaining.
Note (4): For characters on a black background, the background is set to black and characters to white. For characters on a white background, the background is set to white and characters to black. Therefore, characters which are hard to read can be seen clearly.
Note (5): For this instruction, a μVision board (option) is required.

Related Terms

VISPRINT

Example

```
VISPLNOUT 0           'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1       'Instantaneously draws on processing screen 0.
VISCLS 128            'Clears the screen.
VISLOC 10,10          'Sets the display position.
VISDEFCHAR 1,1,0      'Designates the character size and the display method.
VISPRINT “Size 1”     '
VISLOC 10,11          'Sets the display position.
VISDEFCHAR 2,2,1      'Designates the character size and the display method.
VISPRINT “Size 2”     '
VISLOC 10,13          'Sets the display position.
VISDEFCHAR 2,2,2      'Designates the character size and the display method.
VISPRINT “Outline character on white background”
VISDEFCHAR 2,2,3      'Designates the character size and the display method.
VISPRINT “Outline character on black background”
```

VISPRINT (Statement)

Function

Displays characters and figures on the screen.

Format

VISPRINT <Message>[<Separator><Message> …]

Explanation

<Message>	Designates characters, variables and constants specified in “”.
<Separator>	Uses a comma (,) or semicolon (;). Comma: Creates blank spaces between messages. Semicolon: No spaces between messages. If you designate a comma or semicolon at the end of <Message>, no line feed is generated and the next display with VISPRINT continues from that line.

Related Terms

VISSCREEN, VISBRIGHT, VISLOC, VISDEFCHAR

Example

```
VISPLNOUT 0                    'Displays storage memory 0 (processing screen).
VISSCREEN 0,0,1                'Instantaneously draws on processing screen 0.
VISCLS 0                       'Clears the screen.
VISLOC 10,10                   'Sets the display position.
VISDEFCHAR 1,1,0               'Designates the character size and the display method.
I1= 10                         '
F1 = 0.999                     '
VISPRINT “Integer variable I1=”;I1,“Real variable F1=”;F1
```

21.6 Vision Processing

VISWORKPLN (Statement)

Function

Designates the storage memory (process screen) to process.

Format

VISWORKPLN <Storage memory number>

Explanation

<Storage memory number>	Designates the storage memory number to process (0 to 3). If ignored, 0 is set.

Note (1): When you turn ON the power, VISWORKPLN 0 is the initial setting.
Note (2): For this instruction, a μVision board (option) is required.

Related Terms

VISGETP, VISHIST, VISBINA, VISMEASURE, VISPROJ, VISEDGE, VISREADQR, BLOB, SHDEFMODEL, SHMODEL, SHCORNER, SHCIRCLE

Example

```
VISWORKPLN 0            'Designates the processing object to storage memory 0.
```

VISGETP (Function)

Function

Obtains designated coordinate brightness from the storage memory (processing screen).

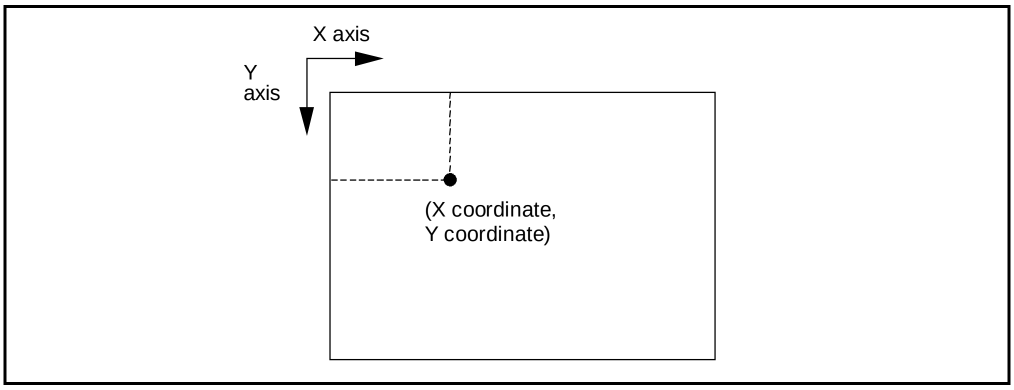
Format

VISGETP (<Coordinate X>, <Coordinate Y>)

Explanation

<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).

Note (1):	**The processing object is the screen designated with VISWORKPLN.**
Note (2):	**For this instruction, a μVision board (option) is required.**



Related Terms

VISWORKPLN

Example

```
VISPLNOUT 0                      'Displays storage memory 0 (process screen).
FOR I1 = 10 TO 200 STEP 5        '
  I2 = VISGET P(100+I1,100)      'Assigns the brightness value of the (100+I1, 100) coordinates to
                                 'I2.
  VISLOC 10,10                   'Sets the display position.
  VISDEFCHAR 1,1,3               'Designates the display character size and the display mode.
  VISPRINT "brightness value =";I2
                                 '
NEXT I1
```

VISHIST (Statement)

Function

Obtains the histogram (brightness distribution) of the screen.

Format

VISHIST <Window number>, <Coordinate X>, <Coordinate Y>

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).

Note (1):	**Designate the process area with a window.**
Note (2):	**If the designated window position is out of screen, the execution will result in an error.**
Note (3):	**The only possible window shape that you may designate is a rectangle with 0 degrees. If another window shape is designated, an error will result.**
Note (4):	**The processing object is the screen designated with VISWORKPLN.**
Note (5):	**It is possible to read the processing result with the VISREFHIST instruction.**
Note (6):	**The memory stores the processing result. It will be kept until this instruction is executed again.**
Note (7):	**For this instruction, a µVision board (option) is required.**

Related Terms

WINDMAKE, VISWORKPLN, VISREFHIST

Example

```
WINDMAKE R,1,100,100,0,2     'Sets window 1 to rectangle.
CAMIN 1                      'Obtains a camera image from the storage memory.
VISWORKPLN 0                 'Sets the processing object screen for storage memory 0.
VISHIST 1,100,100            'Executes the histogram for window 1 with the coordinates
                             '(100, 100) as the home position.
FOR I1 = 0 TO 255            '
    I2 = VISREFHIST(I1)      'Assigns the distribution data of the brightness value I1 to I2.
    VISLOC 10, 10            'Sets the display position.
    VISDEFCHAR 1,1,3         'Designates the display character size and the display mode.
    VISPRINT “Distribution data=”;I2
                             '
NEXT I1
```

VISREFHIST (Function)

Function

Reads histogram results.

Format

VISREFHIST (<Brightness value >)

Explanation

<Brightness value> Designates the brightness value of the histogram to read (0 to 255).

Related Terms

VISHIST

Example

```
WINDMAKE R,1,100,100,0,2     'Sets window 1 to rectangle.
 CAMIN 1                     'Obtains a camera image from the storage memory.
 VISWORKPLN 0                'Sets the processing object screen for storage memory 0.
 VISHIST 1,100,100           'Executes the histogram for window 1 with the coordinates
                             '(100, 100) as the home position.
 FOR I1 = 0 TO 255           '
     I2 = VISREFHIST(I1)     'Assigns the distribution data of the brightness value I1 to I2.
     VISLOC 10, 10           'Sets the display position.
     VISDEFCHAR 1,1,3        'Designates the display character size and the display mode.
     VISPRINT “Distribution data=”;I2
                             '
 NEXT I1
```

VISLEVEL (Function)

Function

Obtains a binarization level based on the histogram result.

Format

VISLEVEL (<Mode>[, <Reference area>[, <Processing object>]])

Explanation

<Mode>	Designates the method of obtaining the binarization level (0 to 2). 0: Mode method 1: Discrimination analysis method 2: P tile method For details, refer to Part 1 “6.1.1.5 Binarization”.
<Reference area>	Designates the value of the area when the system obtains the binarization level by the tiling method P (1 to 245760). If this is ignored, 1 will be the default setting.
<Processing object>	Designates the object (white and black) when the system obtains the binarization level by the tiling method P (0 or 1). If this is ignored, 1 will be the default setting. 0: Black (accumulated from brightness value 0) 1: White(accumulated from brightness value 255)

Note (1):	**<Reference area> and <Processing object> are not used in the mode method and the discrimination analysis method.**
Note (2):	**You should execute VISHIST before executing this function.**
Note (3):	**If the designated data is incorrect, or the process result is an error, the return value will be –1.**
Note (4):	**For this instruction, a μVision board (option) is required.**

Related Terms

VISHIST

Example

```
        VISCLS 0                      '
        WINDMAKE R,1,100,100,0,2      'Sets window 1 to rectangle.
        CAMIN 1                       'Obtains a camera image from the storage memory.
        VISWORKPLN 0                  'Sets the processing object screen to storage memory
                                      '0.
        VISHIST 1,100,100             'Executes the histogram in window 1 with the
                                      'coordinates (100, 100) as the home position.
        WINDDISP 1                    '
        I2 = VISLEVEL(0)              'Obtains the binarization level using the mode
                                      'method.
        VISLOC 10,10                  '
        IF I2 = -1 THEN VISPRINT “Error” ELSE VISPRINT “Binarization levle=”;I2
                                      '
        I2 = VISLEVEL(1)              'Obtains the binarization level using the
                                      'discrimination analysis method.
        VISLOC 10,11                  '
        IF I2 = -1 THEN VISPRINT “Error” ELSE VISPRINT “Binarization level=”;I2
                                      '
        I2 = VISLEVEL(2,100,0)        'Obtains the binarization level using the P tile
method.
        VISLOC 10,12                  '
        IF I2 = -1 THEN VISPRINT “Error” ELSE VISPRINT “Binarization level=”;I2
                                      '
```

VISBINA (Statement)

Function

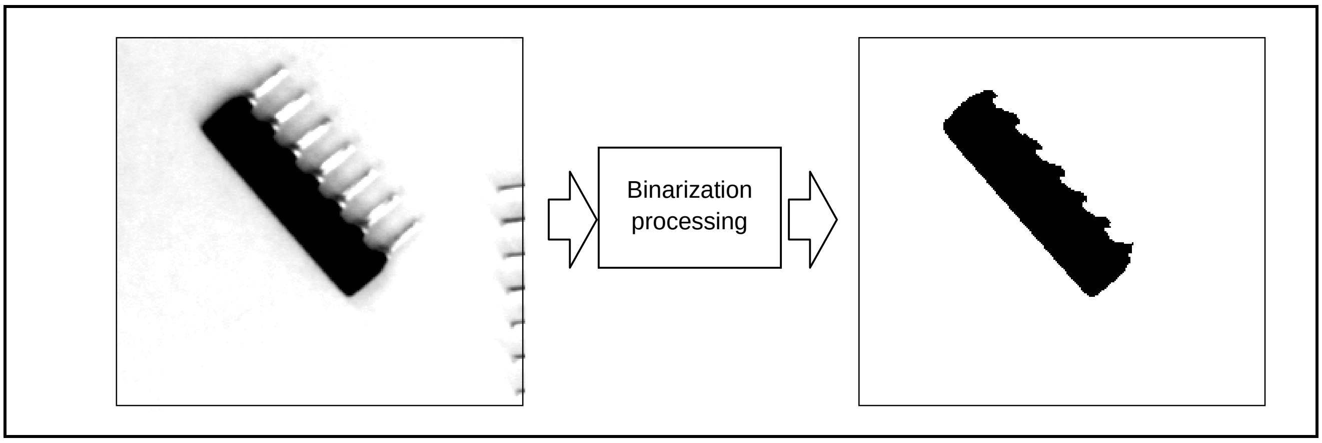
Binarizes the screen.

Format

VISBINA <Window number>, <Coordinate X>, <Coordinate Y>, <Binary lower limit>[, <Binary upper limit>]

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Binary lower limit> Designates the upper level for binarization
(0 to 254 lower limit < upper limit).
<Binary upper limit> Designates the upper level for binarization
(1 to 255 lower limit < upper limit).
If this is ignored, 255 will be the default setting.



Example of binarization

Note (1):	**Designate the process area with a window.**
Note (2):	**If the designated window position is out of screen, the execution will result in an error.**
Note (3):	**The only possible window shape that may be designated is a rectangle with 0 degrees. If another window shape is designated, an error will result.**
Note (4):	**The processing object is the screen designated with VISWORKPLN.**
Note (5):	**For this instruction, a μVision board (option) is required.**

Related Terms

WIMDMAKE, VISWORKPLN

Example

```
        VISSCREEN 1,0,1                 'Instantaneously draws on drawing screen 0.
        WINDMAKE R,1,100,100,0,2        'Sets window 1 to rectangle.
        CAMIN 1                         'Obtains a camera image from the storage memory.
        VISWORKPLN 0                    'Sets the processing object screen to storage memory
 0.
        VISPLNOUT 0                     'Displays storage memory 0 on the monitor.
        VISBINA 1,100,100,128,255       'Binarizes in the window.
        WINDDISP 1                      'Draws the window.
```

VISBINAR (Statement)

Function

Displays a binarized screen.

Format

VISBINAR <Mode>[, <Binary lower limit>[, Binary upper limit]]

Explanation

<Mode> Designates the mode to display the binarized screen (0 or 1).
- 0: Quits binarization display and returns to the original display.
- 1: Executes binarization display.

<Binary lower limit>	Designates the lower level for binarization (0 to 254 lower limit < upper limit).
<Binary upper limit>	Designates the upper level for binarization (1 to 255 lower limit < upper limit). If this is ignored, 255 will be the default setting.

Note (1):	**The whole screen being displayed on the current monitor will be binarized.**
Note (2):	**The contents of the memory do not change even if the storage memory (process screen) is selected and displayed.**
Note (3):	**Binarization display continues unless the mode is set to 0.**
Note (4):	**For this instruction, a µVision board (option) is required.**

Related Terms

VISBINA

Example

```
VISBINAR 1,128,255      'Starts binarization display.
VISCAMOUT 1             'Displays camera 1 on the monitor.
DELAY 5000              'Stops for 5 seconds.
VISPLNOUT 0             'Displays storage memory 0 on the monitor.
DELAY 5000              'Stops for 5 seconds.
VISBINAR 0              'Returns to the previous display.
```

VISFILTER (Statement)

Function

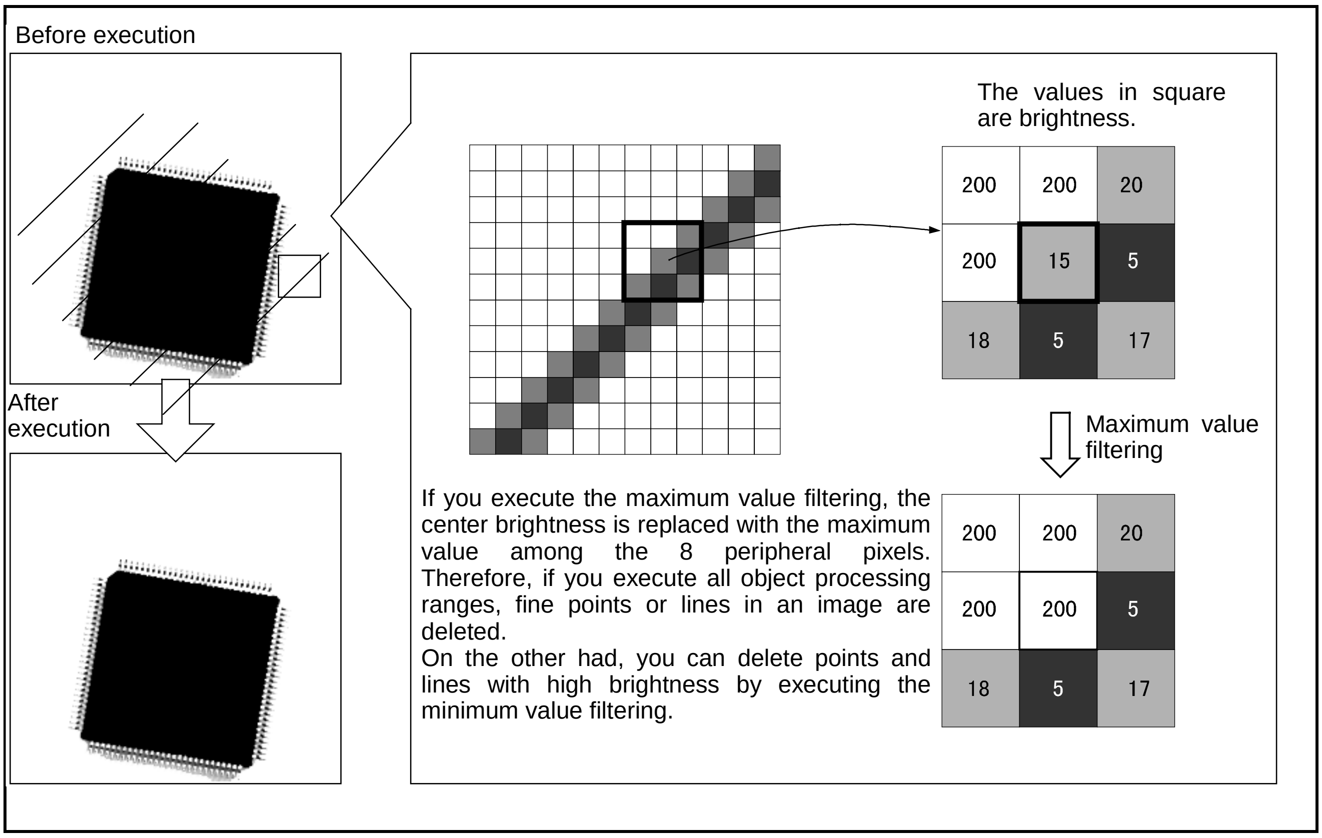
Executes filtering on the screen.

Format

VISFILTER <Window number>, <Coordinate X>, <Coordinate Y>, <Process screen>, <Storage screen>
[, <Mode>]

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<process screen> Designates the storage memory number (0 to 3).
<Storage screen> Designates the storage memory number to store filtering results (0~3).
<Mode> Designates the type of filtering (3 x 3 space filtering).
0: minimum value filtering
1: maximum value filtering
If this is ignored, 0 will be the default setting.



If you execute the maximum value filtering, the center brightness is replaced with the maximum value among the 8 peripheral pixels. Therefore, if you execute all object processing ranges, fine points or lines in an image are deleted.
On the other had, you can delete points and lines with high brightness by executing the minimum value filtering.

Note (1):	**If the process screen and the storage screen have the same number, an error will result.**
Note (2):	**Designate the process area with a window.**
Note (3):	**If the designated window position is out of screen, the execution will result in an error.**
Note (4):	**The only possible window shape that may be designated is a rectangle with 0 degrees. If another window shape is designated, an error will result.**
Note (5):	**For this instruction, a µVision board (option) is required.**

Related Terms

WINDMAKE

Example

```
VISSCREEN 1,0,1                'Instantaneously draws on drawing screen 0.
WINDMAKE R,1,100,100,0,2       'Sets window 1 to rectangle.
CAMIN 1                        'Obtains a camera image from the storage memory.
VISPLNOUT 1                    'Displays storage memory 1 on the monitor.
VISFILTER 1,100,100,0,1,0      '
VISFILTER 1,100,100,1,0,0      '
VISFILTER 1,100,100,0,1,0      '
VISFILTER 1,100,100,1,0,0      '
VISFILTER 1,100,100,0,1,0      '
WINDDISP 1                     'Draws the window.
```

VISMASK (Statement)

Function

Executes calculations between images.

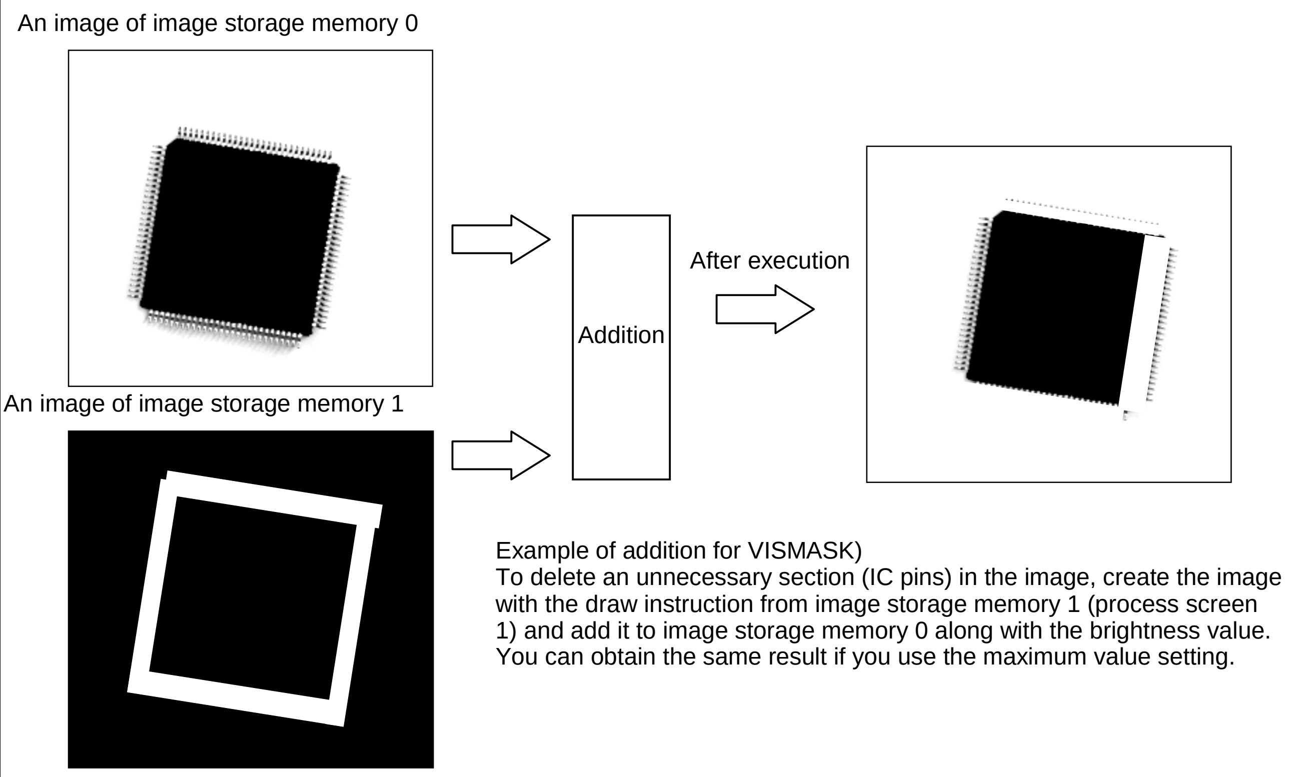
Format

VISMASK <Window number>, <Coordinate X>, <Coordinate Y>,
<Screen 1>,<Screen 2>,
<Mode> [, <Binary lower limit>[, <Binary upper limit>]]

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Screen 1> Designates the storage memory number to calculate (0 to 3).
<screen 2> Designates the storage memory number to calculate. This is the storage destination for a processing result (0 to 3).
<Mode> Designates the type of calculation between images(0 to 10).

0: Binary AND
1: Binary OR
2: Binary XOR
3: AND (Executes AND for each bit after the brightness value is binarized)
4: OR (Executes OR for each bit after the brightness value is binarized.)
5: XOR (Executes XOR for each bit after the brightness value is binarized.)
6: Addition (Sets 255 if the brightness value is 255 or more.)
7: Subtraction (Sets 0 if the brightness value is 0 or less.)
8: Maximum value (Selects a larger brightness value.)
9: Minimum value (Selects a smaller brightness value.)
10: Absolute value (the absolute value of the difference between brightness values.)


An image of image storage memory 0
An image of image storage memory 1
Addition
After execution

Example of addition for VISMASK)
To delete an unnecessary section (IC pins) in the image, create the image with the draw instruction from image storage memory 1 (process screen 1) and add it to image storage memory 0 along with the brightness value. You can obtain the same result if you use the maximum value setting.

Note (1):	**If the process screen and the storage screen have the same number, an error will result.**
Note (2):	**Designate the process area with a window.**
Note (3):	**If the designated window position is out of screen, the execution will result in an error.**
Note (4):	**The only possible window shape that may be designated is a rectangle with 0 degrees. If another window shape is designated, an error will result.**
Note (5):	**In calculation of binarization, screen 1 is also binarized.**
Note (6):	**For this instruction, a μVision board (option) is required.**

Related Terms

VISBINA

Example

```
        VISSCREEN 0,0,1         'Instantaneously draws on storage memory 0.
        WINDMAKE R,1,512,480,0,2
                                'Sets window 1 to rectangle.
        CAMIN 1                 'Obtains a camera image from the storage memory.
        VISCOPY 0,1             'Copies storage memory 0 to 1.
        VISBRIGHT 255           'Sets the drawing brightness to 255.
        VISRECT 100,100,100,100,1
                                'Draws a filled rectangle on the screen.
        VISPLNOUT 1             'Displays storage memory 1 on the monitor.
        VISMASK 1,0,0,0,1,10
                                'Calculates the absolute value of the difference between the
2
                                'screens.
        WINDDISP 1              'Draws the window.
```

VISCOPY (Statement)

Function

Copies the screen.

Format

VISCOPY <Copy source screen>, <Copy destination screen>

Explanation

<Copy source screen>	Designates the storage memory number of the copy source. (0 to 3)
<Copy destination screen>	Designates the storage memory number of the copy destination.(0 to 3)

Note (1): **If the copy source and copy destination numbers are the same, an error will result.**
Note (2): **If the copy destination number has been displayed on the screen, the system follows the designation of VISSCREEN draw mode.**
Note (3): **For this instruction, a μVision board (option) is required.**

Related Terms

VISSCREEN

Example

```
VISSCREEN 1,0,1        'Instantaneously draws on drawing screen 0.
CAMIN 1                'Obtains a camera image from the storage memory.
VISCOPY 0,1            'Copies storage memory 0 to 1.
VISPLNOUT 1            'Displays storage memory 1 on the monitor.
```

VISMEASURE (Statement)

Function

Measures features in the window (area, center of gravity, main axis angle).

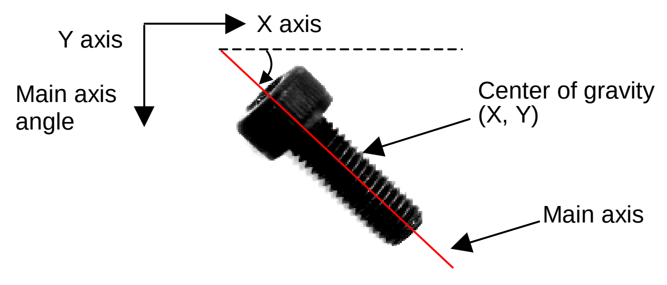
Format

VISMEASURE <Window number>, <Coordinate X>, <Coordinate Y>, <Processing object>, <Mode>, <Binary lower limit>[, <Binary upper limit>]

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Processing object> Designates the object to measure (0 or 1).
0: Black (brightness value < binary lower limit, binary upper limit < brightness value)
1: White (binary lower limit ≤ brightness value ≤ binary upper limit)
<Mode> Designates the feature to measure.
0: Accumulated brightness, area
1: Accumulated brightness, area, center of gravity (primary moment)
2: Accumulated brightness, area, center of gravity (primary moment), main axis angle (secondary moment)

Note (1): The more the features are, the longer the time process takes.
Note (2): When this command is executed, the process screen 3 (VISWORKPLN 3) is used as a work area and data on the process screen 3 are not guaranteed. Also, you cannot use the process screen 3 for processing.
Note (3): For this instruction, a μVision board (option) is required.



<Binary lower limit> Designates the lower level for binarization (0 to 254 lower limit < upper limit).
<Binary upper limit> Designates the upper level for binarization (1 to 255 lower limit < upper limit).
If this is ignored, 255 will be the default setting.

Note (1): **Designate the process area with a window. (Only the sector window cannot measure the main axis angle.)**

		Mode		
	○: Available ×: not available	0	1	2
Line (2-point designation)	Windmake P	○	○	○
Line (Length and angle)	Windmake L	○	○	○
Circle	Windmake C	○	○	○
Ellipse	Windmake E	○	○	○
Sector	Windmake S	○	○	×
Rectangle	Windmake R	○	○	○

Note (2): **If the designated window position is out of screen, the execution will result in an error.**

Note (3): **The following data can be obtained with the processing result obtaining function.**

	VISSTATUS (n)
n	Item
0	Execution result 0= normal -1= abnormal
1	unknown
2	Execution time

	VISGETNUM (a, b)
b	a = 0
0	Area
1	Center of gravity coordinate X value
2	Center of gravity coordinate Y value
3	Main axis angle
4	Accumulated brightness
5	Primary moment X
6	Primary moment Y
7	Secondary moment X
8	Secondary moment Y
9	Secondary moment XY

Note (4): **For this instruction, a μVision board (option) is required.**

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS

Example

```
VISSCREEN 0,0,1                 'Instantaneously draws on storage memory 0.
WINDMAKE R,1,512,480,0,2        'Sets window 1 to rectangle.
CAMIN 1                         'Obtains a camera image from the storage memory.
VISWORKPLN 0                    'Designates the object from storage memory 0.
VISPLNOUT 0                     '
VISMEASURE 1,0,0,1,2,128        'Obtains the accumulated brightness, area, center of
                                'gravity and main axis angle.
IF VISSTATUS(0) = 0.0 THEN      '
    FOR I1 = 0 TO 9             '
        VISLOC 0,I1             '
        VISPRINT “Result”;I1;“=”;VISGETNUM(0,I1)
                                '
    NEXT I1                     '
END IF                          '
```

VISPROJ (Statement)

Function

Measures the projected data in the window.

Format

VISPROJ <Window number>, <Coordinate X>, <Coordinate Y>, <Processing object>, <Binary lower limit>[, <Binary upper limit>]

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Processing object> Designates the object to measure (0 or 1).
0: Black (brightness value < binary lower limit, binary upper limit < brightness value)
1: White (binary lower limit ≤ brightness value ≤ binary upper limit)

<Binary lower limit>	Designates the lower level for binarization (0 to 254 lower limit < upper limit).
<Binary upper limit>	Designates the lower level for binarization (1 to 255 lower limit < upper limit). If this is ignored, 255 will be the default setting.

Note (1): Designate the processing range with a window.

○: Available ×: Not avalilable

Line (2-point designation)	Windmake P	○
Line (length and angle)	Windmake L	○
Circle	Windmake C	×
Ellipse	Windmake E	×
Sector	Windmake S	○
Rectangle	Windmake R	○

Note (2): If the designated window position is out of screen, the execution will result in an error.

Note (3): **The following data can be obtained with the processing result obtaining function.**

	VISSTATUS (n)
n	Item
0	Execution result 0= Normal -1= Abnormal
1	Unknown
2	Execution time

	VISGETNUM (a, b)
b	a = 0~511
0	Area
1	unknown
2	unknown
3	unknown
4	Brightness integration
5	unknown
6	unknown
7	unknown
8	unknown
9	unknown

Note (4): **When this command is executed, the process screen 3 (VISWORKPLN 3) is used as a work area and data on the process screen 3 are not guaranteed. Also, you cannot use the process screen 3 for processing.**

Note (5): **For this instruction, a μVision board (option) is required.**

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS

Example

```
VISSCREEN 0,0,1                 'Instantaneously draws on storage memory 0.
WINDMAKE R,1,100,20,0,1         'Sets window 1 to rectangle.
CAMIN 1                         'Obtains a camera image from the storage memory.
VISWORKPLN 0                    'Designates an object from storage memory 0.
VISPROJ 1,100,100,1,128'Measures the project data.
IF VISSTATUS(0) = 0.0 THEN      '
    FOR I1 = 0 TO 19            '
      VISPRINT VISGETNUM(I1,0)  '
    NEXT I1                     '
END IF                          '
```

VISEDGE (Statement)

Function

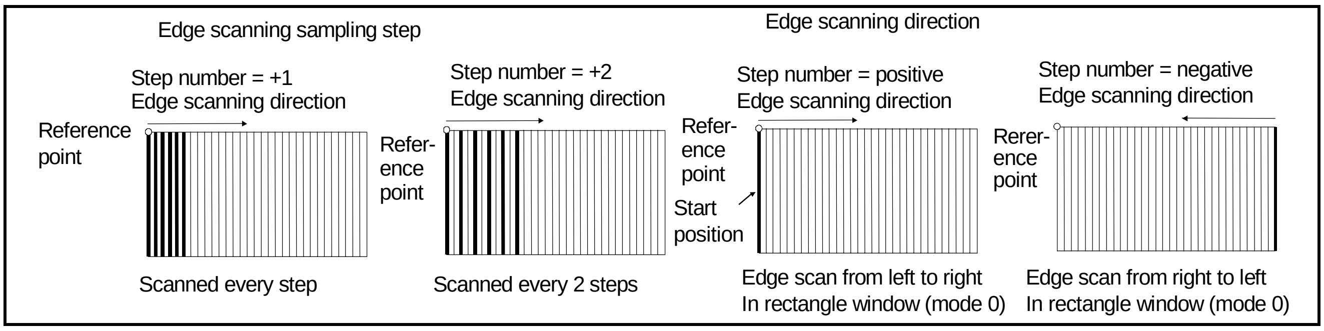
Measures the edge in a window.

Format

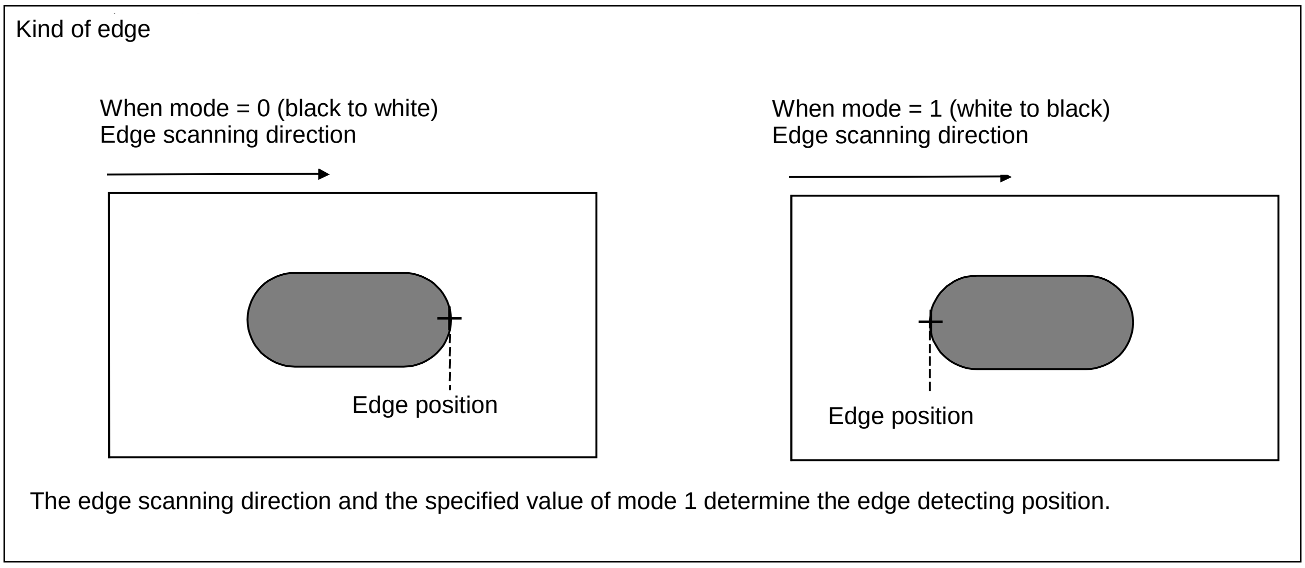
VISEDGE<Window number>,<Coordinate X>,<Coordinate Y>, <Step>, <Processing object>, <Level>[,<Mode>[, <Binary lower limit>[,<Binary upper limit>]]]

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Step> Designates the scanning direction and the sampling rate (-511 to 511).



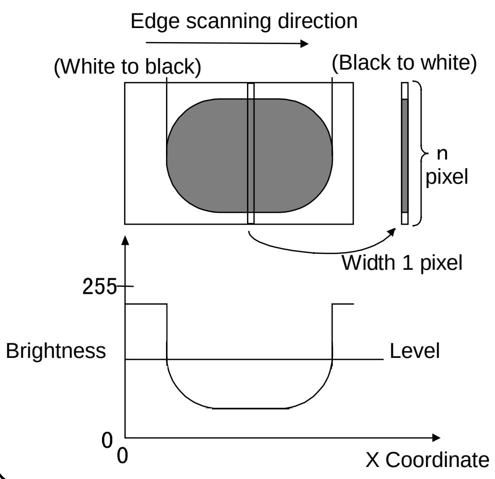
<Processing object> Designates the objects to be measured (0 to 2)
0: Turning point from black to white (edge)
1: Turning point from white to black
2: Turning point (both edges 0 and 1)



Kind of edge
When mode = 0 (black to white)
Edge scanning direction
Edge position
When mode = 1 (white to black)
Edge scanning direction
Edge position
The edge scanning direction and the specified value of mode 1 determine the edge detecting position.

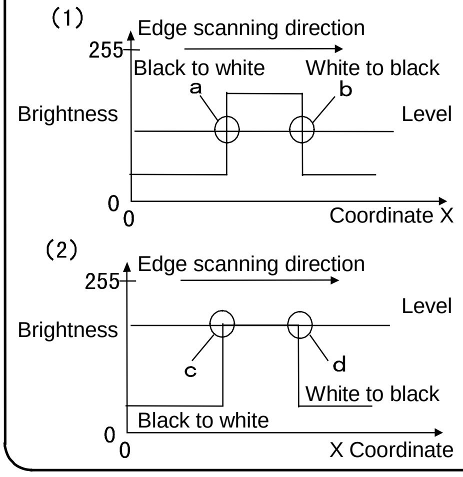
<Level>	Designates the level to detect the edge (0 to 512).
<Mode>	Designates the method for detecting the edge. If this is ignored, 0 will be the default setting. 0: Absolute value of average brightness 1: Difference value of the average brightness 2: Absolute value of the area 3: Difference value of the area

Brightness average value



In this example, the edge is detected from left to right in a rectangle window. The graph shows how the brightness changes with the brightness average.
The window used is divided into units of 1 pixel, in the edge scanning direction. Brightness average value:
An average value of one pixel obtained by dividing the brightness value measured in each divided pixel window by the number of pixels (n pixels) in each window. Specify the level value with the brightness average value (0~255).

Relation between Level and Edge



The graphs show the change in brightness in a window.
The detected edge position is points a and b where the brightness passes a designated level in graph (1).
In graph (2), c is the point where the brightness reaebes the designated level.
If the brightness does not reach the designated level, the edge of black to white is detected.
If the brightness reaches a level higher than the designated level, the edge of white to black is detected.
If the brightness changes from the same level as the designated level to a lower level value, like point d shown in graph (2), it is not detected as an edge.

<Binary lower limit>	Designates the lower level for binarization (0 to 254 lower limit < upper limit). The default is 0.
<Binary upper limit>	Designates the upper level for binarization (1 to 255 lower limit < upper limit) The default is 255.

Note (1): Designate the processing range with a window.

O: Available ×: Not available

Line (2 point specification)	Windmake P	O
Line (Length, angle)	Windmake L	O
Circle	Windmake C	×
Ellipse	Windmake E	×
Sector	Windmake S	O
Rectangle	Windmake R	O

Note (2): If the specified window is larger than the screen, an error will result.

Note (3): The following data can be obtained with the processing result obtaining function.

	VISSTATUS (n)
n	Item
0	Execution result 0= Normal -1= Abnormal
1	Number of edges detected
2	Execution time

	VISGETNUM (a, b)
b	a = 0~511
0	Unknown
1	Coordinate X value
2	Coordinate Y value
3	Angle(Note (4))
4	Unknown
5	Unknown
6	Unknown
7	Unknown
8	Unknown
9	Unknown

Note (4): Gauging results (angle) can be obtained only when the processing range is specified in the sector window (mode=0).

Note (5): The processing screen is the one defined by VISWORKPLN.

Note (6): For this instruction, a µVision board (option) is required.

Note (7): Increasing the number of steps reduces the detection time but lowers the resolving power for detection.

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS

Example

```
VISSCREEN 1,0,1               'Instantaneously draws on drawing screen 0.
VISPLNOUT 0                   '
VISCLS 0                      '
WINDMAKE R,1,300,20,0,0       'Sets window 1 to rectangle.
CAMIN 2                       'Obtains a camera image from the storage memory.
VISWORKPLN 0                  'Designates the object to storage memory 0.
VISPLNOUT 0                   '
VISEDGE 1,100,100,1,0,128     'Measures an edge.
WINDDISP 1                    '
I1 = VISSTATUS(0)             '
IF I1 = 0 THEN                '
    FOR I1 = 0 TO VISSTATUS(1)-1
                              '
        VISCROSS VISPOSX(I1),VISPOSY(I1)
                              '
    NEXT I1                   '
    I1 = VISSTATUS(1)         '
    IF I1 = 0 THEN            '
        VISLOC 10,10          '
        VISPRINT “An edge cannot be found.”
                              '
    END IF                    '
ELSEIF I1 <> 0 THEN           '
    VISLOC 10,10              '
    VISPRINT “Measurement cannot be done.”
                              '
END IF                        '
```

21.7 Code Recognition

VISREADQR (Statement)

Function

Reads the QR code.

Format

VISREADQR <Window number>, <Coordinate X>, <Coordinate Y>,
<Mode> [, <Binary lower limit>[, <Binary upper limit>]]

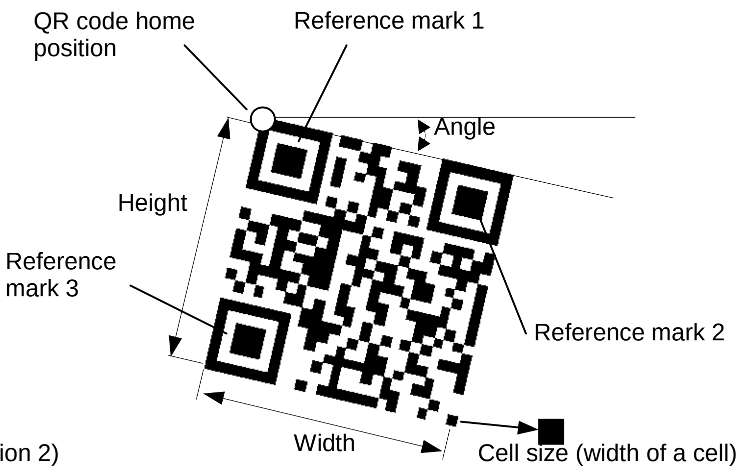
Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Mode> Designate the method for binarization.

0: Automatic binarization (Binarizes the process range with the decision analysis method.)
1: Designated value binarization (Binarizes based on the binarization level in the instructions.)

<Binary lower limit> Designates the lower limit for binarization (0 to 254 lower limit < upper limit).
If ignored, 0 is set.
<Binary upper limit> Designates the upper limit for binarization (1 to 255 lower limit < upper limit).
If ignored, 255 is set.

Example of a QR code (Version 2)



Note (1): Designate the process range with a window.
Note (2): The only window shape that can be designeted is a rectangle with 0 degrees. If another window shape is designated, an error will result.
Note (3): The processing object is the screen designated with VISWORKPLN.
Note (4): The memory board stores the contents of the codes and you can obtain them with VISGETSTR.
Note (5): If the code has an error and it cannot be read, the result of VISSTATUS (0) will be -1.
Note (6): The following data can be obtained with the processing result obtaining function.

	VISSTATUS(n)
n	Item
0	Execution result 0=Normal -1=Abnormal
1	Number of characters (Unit of byte)
2	Execution time

Note (7): For this instruction, a μVision board (option) is required.

	VISGETNUM (a, b)			
b	a = 0	a = 1	a = 2	a = 3
0	Number of characters (Unit of byte)	unknown	unknown	unknown
1	Coordinate X value	Reference mark 1 X coordinate value	Reference mark 2 X coordinate value	Reference mark 3 X coordinate value
2	Coordinate Y value	Reference mark 1 Y coordinate value	Reference mark 2 Y coordinate value	Reference mark 3 Y coordinate value
3	Angle	unknown	unknown	unknown
4	Width	unknown	unknown	unknown
5	Height	unknown	unknown	unknown
6	Version	unknown	unknown	unknown
7	Cell size	unknown	unknown	unknown
8	Model identification [V1.4 or later]	unknown	unknown	unknown
9	unknown	unknown	unknown	unknown

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS, VISGETSTR

Example

```
VISSCREEN 1,0,1                 '
VISCLS                          '
WINDMAKE R,1,512,480,0,2        'Sets window 1 to a rectangle.
CAMIN 1                         'Obtains a camera image from storage memory.
VISPLNOUT 0                     '
VISREADQR 1,0,0,0               'Reads the QR code.
I1 = VISSTATUS(0)               '
VISPRINT I1, VISSTATUS(1)       '
IF I1 = 0 THEN                  '
    VISLOC 10,10                '
    VISPRINT VISGETSTR(1, VISSTATUS(1))
                                '
END IF                          '
VISCAMOUT 1                     '
```

21.8 Labeling

BLOB (Statement)

Function

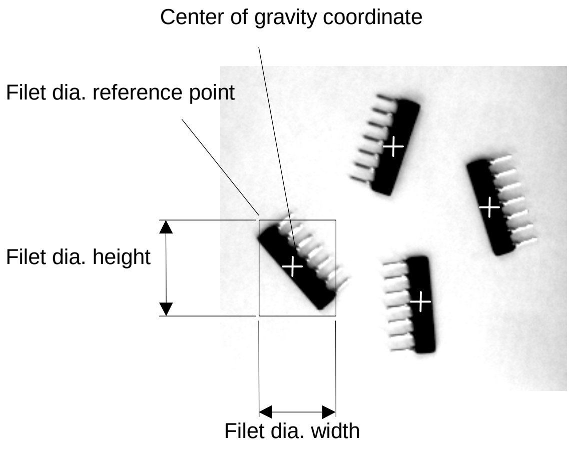
Executes labeling.

Format

BLOB <Widow number>, <Coordinate X>, <Coordinate Y>, <Processing object>, <Binary lower limit>[, <Binary upper limit>[, <Link>[, <Area lower limit>[, <Sort>]]]]

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Processing object> Designates the object to obtain with labeling (0 or 1).
0: Black (brightness value < binary lower limit, binary upper limit < brightness value)
1: White(binary lower limit ≤ brightness value ≤ binary upper limit)
<Binary lower limit> Designates the lower limit for binarization (0 to 254 lower limit < upper limit).
<Binary upper limit> Designates the upper limit for binarization (1 to 255 lower limit < upper limit).
If ignored, 255 is set.
<Link> Designates the condition of the link (0 or 1).
0: Neighbor 4 link (Neighbor pixels at right and left, and top and bottom are checked.)
1: Neighbor 8 link (Neighbor pixels at slant, as well as right and left, and top and bottom are checked.)
<Area lower limit> Designates a lower limit of an area value to be ignored in labeling. (0 to 245760)
<Sort> Designates sorting of numbers obtained with labeling (0 to 2).
0: Obtained order
1: Area value descending
2: Area value ascending



By executing labeling, you can obtain the numbers and positions of multiple objects.
In the example shown on the left, the labeling number is 4.
If you use BLOBMEASURE, you can obtain the indination (direction : main axis angle) and the peripheral length individually.

Example of labeling

Note (1): Designate the process range with a window.
Note (2): If the designated window position is out of screen, the execution will result in an error.
Note (3): The only window shape you are able to designate is a rectangle with 0 degrees. If another window shape is designated, an error will result.
Note (4): The processing object is a screen designated with VISWORKPLN.
Note (5): The following data can be obtained with the process result obtaining function.

	VISSTATUS (n)
n	Item
0	Execution result 0=Normal -1=Abnormal
1	Number of labels
2	Execution time

	VISGETNUM (a, b)
b	a = 0~ max511
0	Area
1	Center of gravity a coordinate X value
2	Center of gravity a coordinate Y value
3	unknown
4	Filet dia. reference point coordinate Y
5	Filet dia. reference point coordinate X
6	Filet dia. width
7	Filet dia. height
8	unknown
9	unknown

Note (6): For this instruction, a μVision board (option) is required.

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS

Example

```
VISSCREEN 1,0,1               'Instantaneously draws on drawing screen 0.
VISCLS 0                      '
WINDMAKE R,1,512,480,0,2      'Sets window 1 to rectangle.
CAMIN 1                       'Obtains a camera image to storage memory 0.
VISPLNOUT 0                   '
VISWORKPLN 0                  'Designates the object to storage memory 0.
BLOB 1,0,0,0,128              'Executes labeling.
I1 = VISSTATUS(0)             '
IF I1 = 0 THEN                '
    I2 = VISSTATUS(1)         '
    VISDEFCHAR 1,1,2          '
    VISLOC 10,10              '
    VISPRINT I1,I2            '
    IF I2 <> 0 THEN           '
        FOR I1 = 0 TO I2 -1   '
            VISLOC 10,11      '
            VISPRINT VISGETNUM(I1,1), VISGETNUM(I1,2)
                              '
            VISCROSS VISGETNUM(I1,1), VISGETNUM(I1,2)
                              '
        NEXT I1
    END IF                    '
END IF                        '
VISCAMOUT 1                   '
```

BLOBMEASURE (Statement)

Function

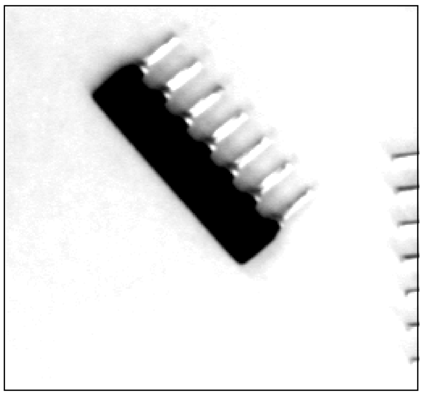
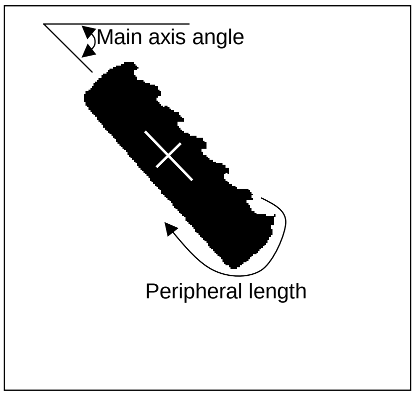
Executes feature measurement of the object label number.

Format

BLOBMEASURE <Label number>, <Feature>

Explanation

<Label number> Designates the label number obtained by labeling. (0 to 511)
<Feature>   Designates the feature to obtain. (0 or 1)
    0: Main axis angle
    1: Periphery length

Binarization is automatically done inside without changing the original image.
You do not need to execute binarization beforehand.

Note (1): Before executing this function, you need to execute labeling with BLOB.
Note (2): When you obtain the periphery length, you need to leave the source image when you executed labeling.
Note (3): The following is an example of the data you can obtain with the processing result obtaining function.

	VISSTATUS (n)
n	Item
0	Execution result 0=Norma -1=Abnormal
1	unknown
2	Execution time

	VISGETNUM (a, b)
b	a = 0~ max511
0	Area
1	Center of gravity a coordinate X value
2	Center of gravity a coordinate Y value
3	Main axis angle
4	Filet dia. Reference point coordinate X
5	Filet dia. Reference point coordinate Y
6	Filet dia. width
7	Filet dia. height
8	Periphery length
9	unknown

Note (4): For this instruction, a μVision board (option) is required.

Related Terms

BLOB

Example

```
VISSCREEN 1,0,1                'Instantaneously draws the drawing screen 0.
WINDMAKE R,1,512,480,0,2       'Sets window 1 to rectangle.
CAMIN 1                        'Obtains a camera image from the storage memory.
BLOB 1,0,0,0,128               'Executes labeling.
IF VISSTATUS(0)=0.0 THEN       '
    IF VISSTATUS(1)<>0.0 THEN  '
        FOR I1 = 0 TO VISSTATUS(1)-1
                               '
            BLOBMEASURE I1,0   'Obtains the main axis angle of label I1.
            VISCROSS VISGETNUM(I1,1), VISGETNUM(I1,2),10,20,VISGETNUM(I1,3)
       NEXT I1                 '
    END IF                     '
END IF                         '
```

BLOBLABEL (Function)

Function

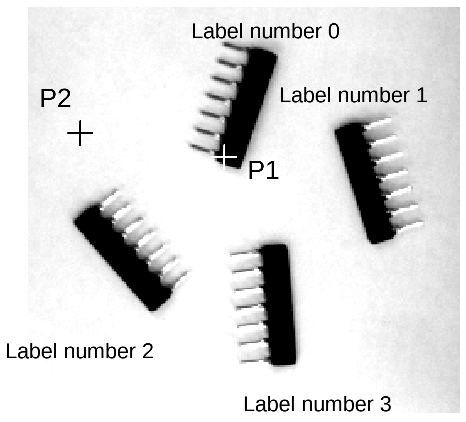
Obtains the label number for designated coordinates.

Format

BLOBLABEL(<Coordinate X>, <Coordinate Y>)

Explanation

<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).



BLOBLABEL checks if the designated coordinates are included in each labeled object.
If you designate the coordinates. of P1 with BLOBLABEL for a measured image when the number of objects to be labeled is 4 and the label number is as shown in the left figure, the return value becomes 0 for the label number.
If you designate P2, the return value becomes -1 because there is no corresponding object.

Example of label number obtaining

Note (1): Before executing this function, you need to execute labeling with BLOB beforehand.
Note (2): Obtain the label number present for the designated coordinates.
Note (3): If there is no label number present, -1 is returned.
Note (4): For this instruction, a μVision board (option) is required.

Related Terms

BLOB

Example

```
VISSCREEN 1,0,1                'Instantaneously draws on drawing screen 0.
WINDMAKE R,1,512,480,0,2       'Sets window 1 to rectangle.
CAMIN 1                        'Obtains a camera image from the storage memory.
BLOB 1,0,0,0,128               'Executes labeling.
IF VISSTATUS(0)=0.0 THEN       '
    IF VISSTATUS(1)<>0.0 THEN  '
        IF BLOBLABEL(100,100)<>-1 THEN
                               '
            VISLOC 100,100,1   '
            VISPRINT “Label number =”;BLOBLABEL(100,100)
                               '
        END IF                 '
    END IF                     '
END IF                         '
```

BLOBCOPY (Statement)

Function

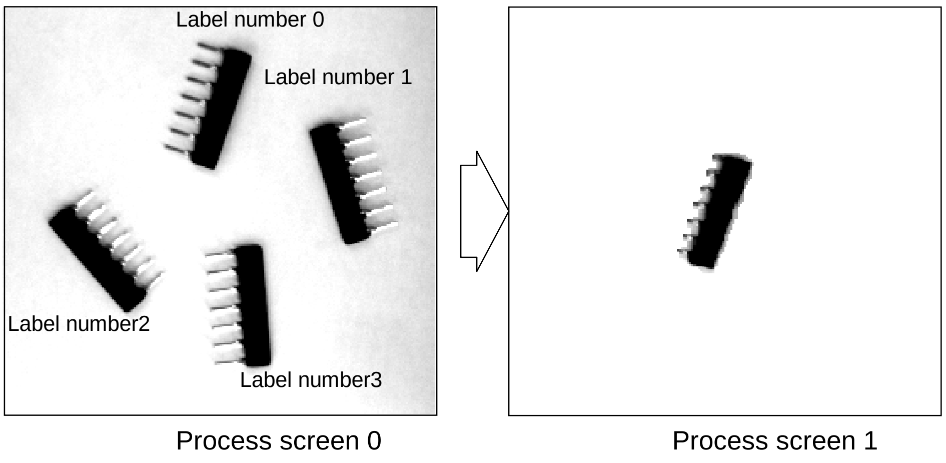
Copies an object label number.

Format

BLOBCOPY <Label number>, <Copy destination screen>, <Coordinate X>, <Coordinate Y>

Explanation

<Label number>	Designates the label number obtained with labeling (0 to 511).
<Copy destination screen>	Designates the storage memory number of the copy destination (0 to 3).
<Coordinate X>	Designates the X coordinate (0 to 511).
<Coordinate Y>	Designates the Y coordinate (0 to 479).



The object image is designated with a label number when copied.
In the above example, label number 0 is copied to process screen 1.

Example of BLOBCOPY

Note (1):	**Before executing this function, you need to execute labeling with BLOB beforehand.**
Note (2):	**Do not change the screen, because the copy source screen (labeling object screen) is referenced when copying.**
Note (3):	**For this instruction, a μVision board (option) is required.**

Related Terms

BLOB

Example

```
VISSCREEN 0,1,                  'Instantaneously draws on storage memory 1.
VISCLS 128                      'Clears the screen.
VISSCREEN 1,0,1                 'Instantaneously draws on drawing screen 0.
VISCLS 0                        '
WINDMAKE R,1,512,480,0,2        'Sets window 1 to rectangle.
CAMIN 1                         'Obtains a camera image for the storage memory.
BLOB 1,0,0,0,128                'Executes labeling.
I1 = VISSTATUS(0)               '
IF I1 = 0 THEN                  '
    I1 = VISSTATUS(1)           '
    IF I1<>0 THEN               '
        BLOBCOPY 0,1,100,100    'Copies label 0 to storage memory 1.
    END IF                      '
END IF                          '
VISPLNOUT 0                     '
DELAY 2000                      '
VISPLNOUT 1                     '
DELAY 2000                      '
VISCAMOU VISCAMOUT 1            '
```

21.9 Search Function

SHDEFMODEL (Statement)

Function

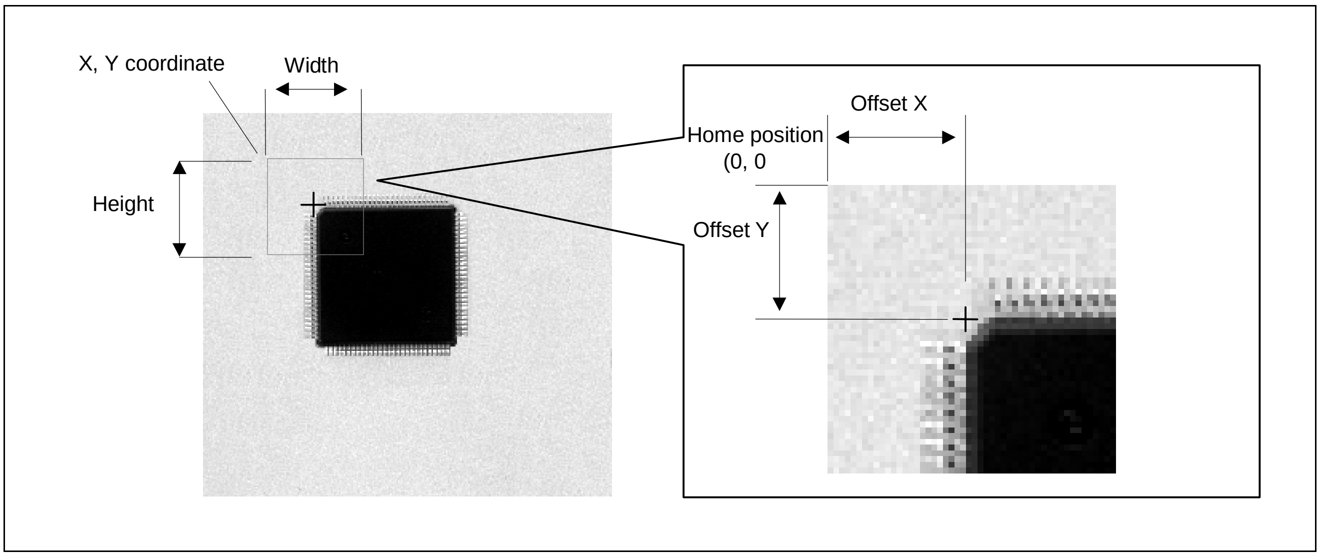
Registers the search model.

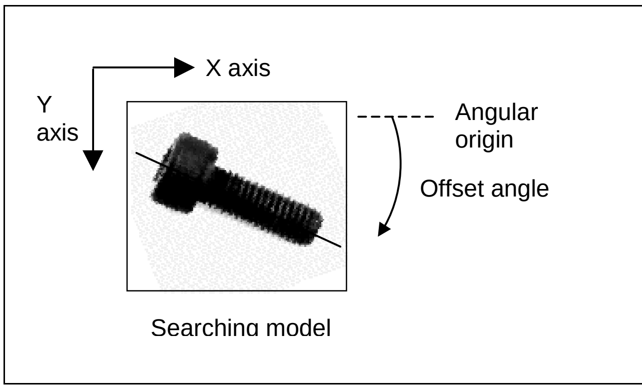
Format

SHDEFMODEL <Model number>, <Coordinate X>, <Coordinate Y>, <Width>, <Height>, <Offset X>, <Offset Y>[, <Offset angle>]

Explanation

<Model number> Designates the model number to register (0 to 99).
<Coordinate X> Designates the home position X coordinate (16 to 485).
<Coordinate Y> Designates the home position Y coordinate (16 to 463).
<Width> Designates the width of the registered model (10 to 256).
<Height> Designates the height of the registered model (10 to 256).
<Offset X> Designates Offset X measured from the origin (-511 to +511)
<Offset Y> Designates Offset Y measured from the origin (-511 to +511)
<Offset angle> Designates Offset angle measured from the angular origin (-360 to 360)
[V1.4 or later]





You specifies an offset value measured from the angular origin to [Offset angle]. When a searching model has an offset angle measured from the angular origin as indicated in the figure, you can specify [Offset angle] to reflect the offset angle to [Angle] in a measured result obtained with [SHMODEL].

Note (1): If the model to be registered is not more than 16 pixels inside from the edge of the screen, it cannot be registered.
Note (2): The reference coordinates are used to designate a point to detect when a model is searched.
Note (3): A registered model requires a certain amount of brightness distribution. If the brightness distribution is too flat or there are many small differences in the model, it cannot be registered.
Note (4): If you designate a number already registered, it overwrites the already registered model.
Note (5): You can find the availability of registration by using VISSTATUS after the instruction is executed.
Note (6): When this command is executed, the process screen 3 (VISWORKPLN 3) is used as a work area and data on the process screen 3 are not guaranteed. Also, you cannot use the process screen 3 for processing.

	VISSTATUS (n)
n	Item
0	Execution Result 0 = Normal -1 = Designated area error -2 = Space full -3 = Uniform model -4 = Complicated 1,2 = Search time long 3,4 = Angle unidentifiable [V1.4 or later]
1	Not Used 0
2	Execution Time

Note (7): For this instruction, a μVision board (option) is required.
Note (8): During execution of this instruction, do not power off the controller. If you do so, the controller will recognize in the next powering-on sequence that it has not been normally terminated, so it will initialize the vision-related information.

Related Terms

SHREFMODEL, SHDISPMODEL, SHCLRMODEL, SHMODEL

Example

```
VISSCREEN 1,0,1             'Instantaneously draws on draw screen No. 0.
VISCLS 0                    '
VISRECT 100,100,100,100     '
CAMIN 1                     'Obtains a camera image from the storage memory.
SHDEFMODEL 1,100,100,100,100,50,50
                            'Registers the model.
I1 = VISSTATUS(0)           '
VISLOC 10,10                '
IF I1 = 0 THEN VISPRINT “Registration completed” ELSE VISPRINT “Cannot register.”
                            '
VISCAMOUT 1                 '
```

SHREFMODEL (Statement)

Function

Refers to registered model data.

Format

SHREFMODEL (<Model number>,<Item>)

Explanation

<Model number> Designates the reference model number (0 to 99).
<Item> Designates the data type of a reference model (0 to 8).

0: Status (Presence of the model registration
   Yes = 0 No = -1)
1: Width of the registered model
2: Height of the registered model
3: Offset X of the registered model
4: Offset Y of the registered model
5: File size of the registered model
6: Registrable file size (Available capacity).
7. Offset angle of the registered model [V1.4 or later]
8: Compatible mode (1: for mode without angle measurement, 2: for mode with angle measurement, 3 for mode with and without angle measurement) [V1.4 or later]

Related Terms

SHDEFMODEL

Example

```
VISSCREEN 1,0,1                     '
VISCLS 0                            '
IF SHREFMODEL(1,0) = 0 THEN         'Confirms the presence of registration.
    VISLOC 10,1                     '
    VISPRINT “Width =”;SHREFMODEL(1,1)  'Displays the width.
    VISLOC 10,2                     '
    VISPRINT “Height =”;SHREFMODEL(1,2) 'Displays the height.
    VISLOC 10,3                     '
    VISPRINT “X=”;SHREFMODEL(1,3)   'Displays the reference X coordinate.
    VISLOC 10,4                     '
    VISPRINT “Y=”;SHREFMODEL(1,4)   'Displays the Y reference coordinate.
    VISLOC 10,5                     '
    VISPRINT “Size =”;SHREFMODEL(1,5)   'Displays the file size.
    VISLOC 10,6                     '
    VISPRINT “Capacity =”;SHREFMODEL(1,6)
                                    'Displays the available capacity.
END IF                              '
```

SHCOPYMODEL (Statement)

Function

Copies a registered model.

Format

SHCOPYMODEL <Copy source model number>,<Copy destination model number>

Explanation

<Copy source model number> Designates the model number to copy (0 to 99).
<Copy destination model number> Designates the new model number (0 to 99).

Note (1): If the copy source number and the copy destination member are the same, an error occurs.
Note (2): If the copy source file is not present or if there is insufficient capacity, copying is not executed.
Note (3): The following data may be obtained with the processing result obtaining function.

	VISSTATUS (n)
n	Item
0	Executed result 0=Normal -1=Abnormal
1	unknown
2	unknown

Note (4): For this instruction, a μVision board (option) is required.
Note (5): During execution of this instruction, do not power off the controller. If you do so, the controller will recognize in the next powering-on sequence that it has not been normally terminated, so it will initialize the vision-related information.

Related Terms

SHDEFMODEL, SHREFMODEL

Example

```
VISSCREEN 1,0,1        '
VISCLS 0               '
SHCOPYMODEL 2,0        'Copies model 2 informetion to model 0.
VISLOC 10,10           '
I1 = VISSTATUS(0)
IF I1 = 0 THEN VISPRINT “Copy completed” ELSE VISPRINT “Copy failed”
                       '
```

SHCLRMODEL (Statement)

Function

Deletes a registered model.

Format

SHCLRMODEL <Model number>

Explanation

<Model number> Designates the model number to delete (0 to 99).

Note (1):	**If the model number designated does not exist, nothing is executed.**
Note (2):	**For this instruction, a μVision board (option) is required.**
Note (3):	**During execution of this instruction, do not power off the controller. If you do so, the controller will recognize in the next powering-on sequence that it has not been normally terminated, so it will initialize the vision-related information.**

Related Terms

SHDEFMODEL, SHREFMODEL

Example

```
VISSCREEN 1,0,1        '
VISCLS 0               '
SHCLRMODEL 1           'Deletes registered model 1.
I1 = SHREFMODEL(1,0)   '
VISLOC 10,10           '
IF I1 = -1 THEN VISPRINT “Deletion completed.” ELSE VISPRINT “Deletion failed.”
                       '
```

SHDISPMODEL (Statement)

Function

Displays a registered model on the screen.

Format

SHDISPMODEL <Model number>, <Displaying screen>, <Coordinate X>, <Coordinate Y>

Explanation

<Model number>	Designates the model number to display (0 to 99).
<Destination screen to display>	Designates the storage memory number for display (0 to 3).
<Coordinate X>	Designates the home position coordinate X of the registered model (0 to 511).
<Coordinate Y>	Designates the home position coordinate Y of the registered model (0 to 479).

Note (1): If the model number designated does not exist, nothing is executed.
Note (2): For this instruction, a μVision board (option) is required.

Related Terms

SHDEFMODEL

Example

```
VISSCREEN 0,0,1                'Instantaneously draws from storage memory 0.
VISPLNOUT 0                    'Displays storage memory 0 on the monitor.
SHDISPMODEL 1,0,100,100        'Displays model 1 on the screen.
```

SHMODEL (Statement)

Function

Searches for a model.

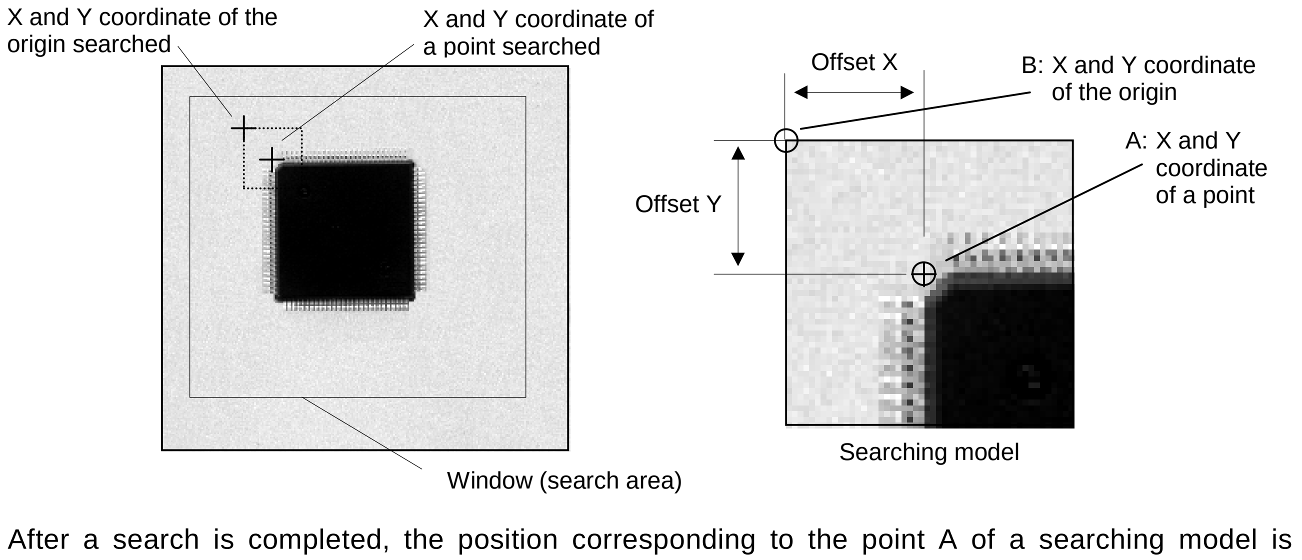
Format

SHMODEL <Window number>, <Coordinate X>, <Coordinate Y>, <Model number>, <Correspondence degree>[, <Mode>[, <Number>[, <Start angle>[, <End angle>]]]]

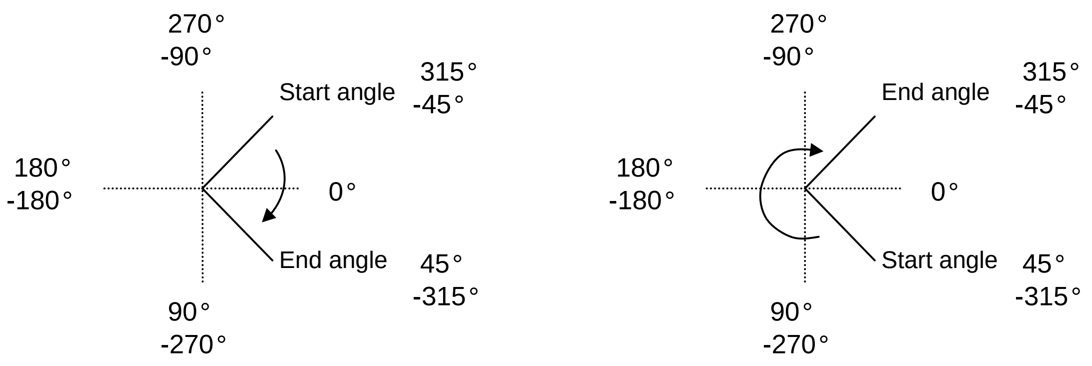
Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Model number> Designates the model number to search for (0 to 99).

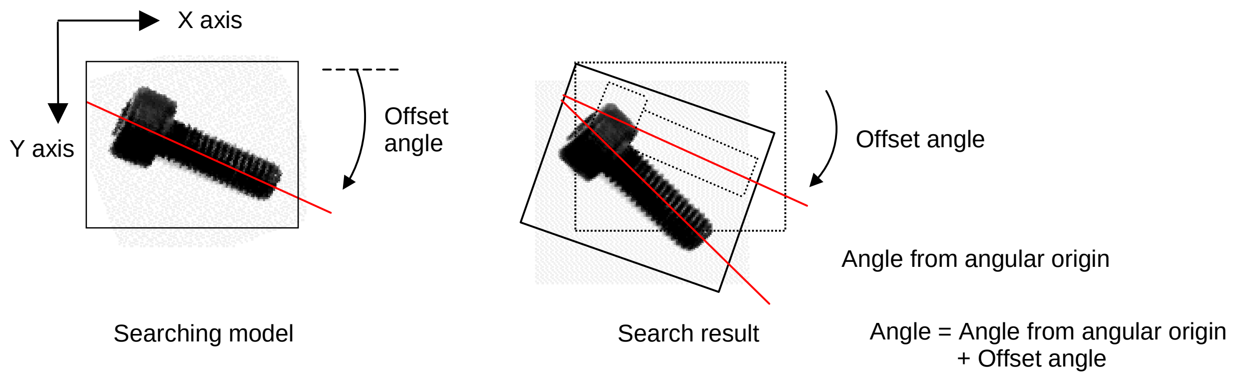
<Correspondence degree>	Designates the correspondence degree of the model to search for (0 to 100).
<Mode>	Designates the mode when searching is executed. 0: Search in pixel units. 1: Search in sub-pixel units. If these are ignored, 0 is set as the default.
<Number>	Designates the number of models to search for at a time (1 to 49). If this is ignored, 1 is set.
<Start angle>	Designates an angular range (start angle) for an object to be searched (-360 to 360). 0 is assumed as the default. [V1.4 or later]
<End angle>	Designates an angular range (end angle) for an object to be searched (-360 to 360). 0 is assumed as the default. [V1.4 or later]


X and Y coordinate of the origin searched
X and Y coordinate of a point searched
Window (search area)
Offset X
Offset Y
B: X and Y coordinate of the origin
A: X and Y coordinate of a point
Searching model

After a search is completed, the position corresponding to the point A of a searching model is stored in [X, Y Coordinate Value] and the position corresponding to the origin B of a searching model is stored in [X, Y Coordinate Value for Origin].



Measures an angle of an object whose angle from the angular origin exists in an area ranging from [Start Angle] to [End Angle]. As shown in the figure, both condition (1) and (2) give the same measuring range.
(1) [Start Angle] = -45°, [End Angle] = 45° (2) [Start Angle] = -45°, [End Angle] = -315°


X axis
Y axis
Offset angle
Searching model
Offset angle
Angle from angular origin
Search result
Angle = Angle from angular origin + Offset angle

An angle deviated from an image registered as a searching model is stored in [Angle from Angular Origin] as a measuring result. The sum of [Offset Angle] registered in a searching model and [Angle form Angular Origin] is stored in [Angle] as a measuring result.

Note (1): Register the model to search for with SHDEFMODEL.
Note (2): When you set two or more numbers and the system cannot find a designated number, an error occurs.
Note (3): A search requires time, and if searching is not finished within a limited time, a timeout error occurs. You can set this on your personal computer. The initial setting is 2 seconds.
Note (4): If the correspondence degree is set to high, searching cannot be performed; therefore, decrease the correspondence degree.
Note (5): Designate the process range with a window.
Note (6): If the position of the designated window is not on the screen, an execution error will result.

Note (7): **The shape of the window available to designate is a rectangle with 0 degrees. If you designate any shape other than this, an error occurs.**
Note (8): **The processing object is the screen designated with VISWORKPLN.**
Note (9): **When this command is executed, the process screen 3 (VISWORKPLN 3) is used as a work area and data on the process screen 3 are not guaranteed. Also, you cannot use the process screen 3 for processing.**
Note (10): **You can obtain data with the processing result obtaining function after executing an instruction.**

	VISSTATUS (n)
n	Item
0	Execution Result 0 = Normal -1 = Model Unregistered -2 = Failure -3 = Timeout
1	Number
2	Execution Time

	VISGETNUM (a, b
b	a = 0~49
0	Number
1	X Coordinate Value
2	Y Coordinate Value
3	Correspondence Degree
4	Angle [V1.4 or later]
5	X Coordinate Value for Origin [V1.4 or later]
6	Y Coordinate Value for Origin [V1.4 or later]
7	Angle from Angular Origin [V1.4 or later]
8	unknown
9	unknown

Note (11): **µVision board (optional) is required for this command.**
Note (12): **If the searching mode size and the widow size coincide, the correspondence degree only at that position is calculated.**
Note (13): **An angles measurement is executed when you set both [Start Angle] and [End Angle] to 0.**
Note (14): **An angle measurement is executed as you set as [Start Angle] = 0 and [End Angle] = 360, if you set both [Start Angle] and [End Angle] to the same value other than 0.**

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS, SHDEFMODEL

Example

```
VISSCREEN 1,0,1               'Instantaneously draws on drawing screen 0.
VISCLS 0                      '
VISPLNOUT 0                   '
WINDMAKE R,1,512,480,0,2      'Sets window 1 to rectangle.
CAMIN 1                       'Obtains a camera image from the storage memory.
VISWORKPLN 0                  'Designates an object to storage memory 0.
SHMODEL 1,0,0,1,80            'Searches for model 1 and the part whose correspondence
                              'degree is 80% on the screen.
I1 = VISSTATUS(0)             '
VISLOC 10,10                  '
VISDEFCHAR 1,1,3              '
VISPRINT I1                   '
IF I1 = 0 THEN                '
    VISPRINT VISGETNUM(0,1),VISGETNUM(0,2)
                              '
    VISCROSS VISPOSX(0),VISPOSY(0)
                              '
END IF                        '
```

SHDEFCORNER (Statement)

Function

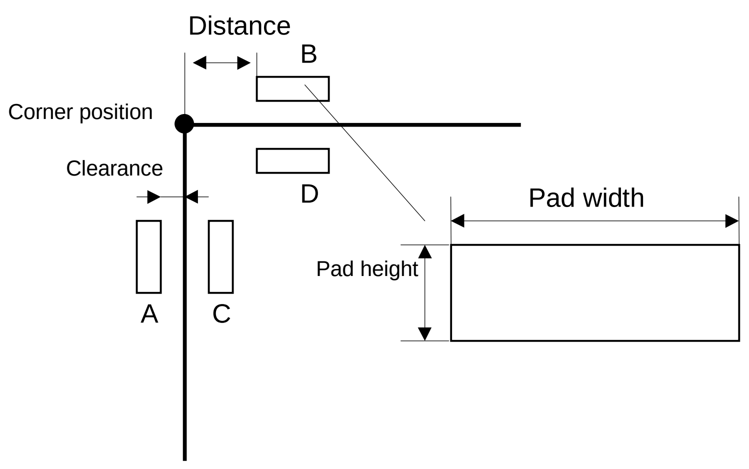
Sets the conditions for a corner search.

Format

SHDEFCORNER <Distance>, <Clearance>, <Width>, <Height>

Explanation

<Distance> Designates the distance from a pad corner in the corner search. (1 to 10)
<Clearance> Designates the space of pads in the corner search (1 to 10).
<Width> Designates the pad width in the corner search (1 to 10).
<Height> Designates the pad height in the corner search (1 to 10).



A corner is detected using the average brightness of 4 pads, as shown in the left figure.
In other words, if SHCORNER is 1, this means that a corner is detected where the difference between the average brightness of A and B and the average brightness of C and D is greater than the difference in the SHCORNER levels.
You can adjust the pad clearance and width with SHDEFCORNER.

Note (1): This instruction is a temporary setting, so the initial value is not permanently changed.
Note (2): For this instruction, a μVision board (option) is required.
Note (3): If the clearance is set to wide, it is unaffected by disturbances in detection but detection becomes inaccurate.
Note (4): The initial values set at the factory prior to shipping are as follows: distance = 4, clearance = 1, width = 3, and height =3.

Related Terms

SHCORNER

Example

```
SHDEFCORNER 4,1,3,3
```

SHCORNER (Statement)

Function

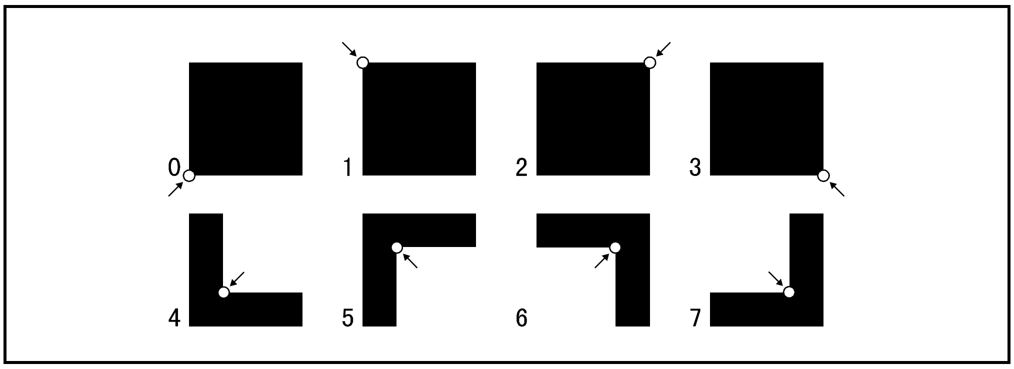
Searches for a corner.

Format

SHCORNER <Window number>, <Coordinate X>, <Coordinate Y>, <Level difference>, <Mode>

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Level difference> Designates the detection level in the corner search (0 to 255).
<Mode> Designates an object in the corner search (0 to 7).



Note (1): Designate the process range with a window.
Note (2): If the designated window is not positioned on the screen, an execution error will result.
Note (3): Only rectangular windows with an angle of 0 degrees can be designated. If you designate any shape other than this, an error occurs.
Note (4): The processing object is the screen designated with VISWORKPLN.
Note (5): When this command is executed, the process screen 3 (VISWORKPLN 3) is used as a work area and data on the process screen 3 are not guaranteed. Also, you cannot use the process screen 3 for processing.
Note (6): The following data can be obtained with the processing results obtaining function.

	VISSTATUS (n)
n	Item
0	Execution result 0 = Normal -1 = Abnormal
1	Number
2	Execution Time

	VISGETNUM (a, b)
b	a = 0~511
0	Number
1	X Coordinate Value
2	Y Coordinate Value
3	unknown
4	Level
5	unknown
6	unknown
7	unknown
8	unknown
9	unknown

Note (7): For this instruction, a µVision board (option) is required.

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS, SHDEFCORNER

Example

```
VISSCREEN 1,0,1            'Instantaneously draws on drawing screen 0.
VISCLS 0                   '
WINDMAKE R,1,512,480,0,2   'Sets window 1 to rectangular parallelepiped.
CAMIN 1                    'Obtains a camera image from the storage memory.
VISWORKPLN 0               'Designates an object to storage memory 0.
SHCORNER 1,0,0,180,0       'Searches for a black corner in the left lower section.
I1 = VISSTATUS(0)          '
IF I1 = 0 THEN             '
    I2 = VISSTATUS(1)      '
    IF I2 <> 0 THEN        '
        FOR I1 = 0 TO I2-1 '
            VISCROSS VISGETNUM(I1,1),VISGETNUM(I1,2)
                           '
        NEXT I1            '
    END IF                 '
END IF                     '
```

SHDEFCIRCLE (Statement)

Function

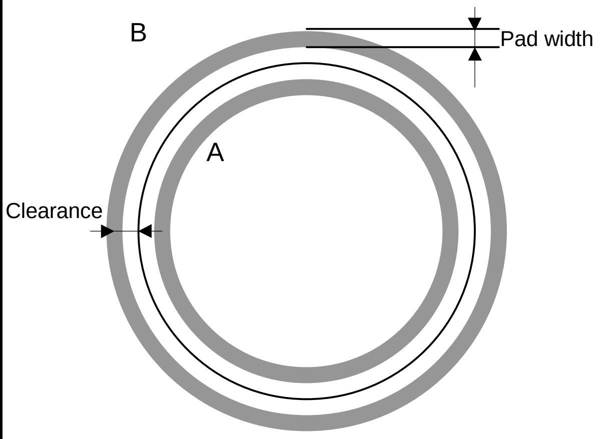
Sets the condition for searching a circle.

Format

SHDEFCIRCLE <Clearance>, <Width>

Explanation

<Clearance> Designates the clearance between pads for the circle search (1 to 10).
<Width> Designates the pad width for the circle search (1 to 10).



A circle is detected with an average brightness of 2 pads, as shown in the left figure.
In other words, if SHCIRCLE is 0, a circle is detected when the difference between the average brightness of A and that of B is larger than the difference in SHDEFCIRCLE.
You can adjust the pad clearance and width with SHDEFCIRCLE.

Note (1): This instruction is a temporary setting, so the initial value is not permanently changed.
Note (2) : For this instruction, a μVision board (option) is required.
Note (3) : If a large clearance is set, it is only slightly affected by disturbances in detection but detection accuracy lowers.
Note (4) : The initial values set at the factory prior to shipping are as follows: clearance = 1 and width = 3

Related Terms

SHCIRCLE

Example

```
SHDEFCIRCLE 1,3
```

SHCIRCLE (Statement)

Function

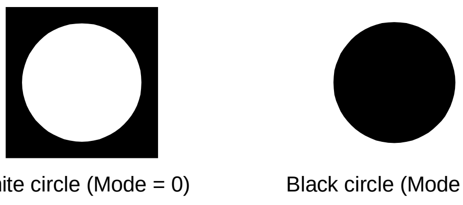
Searches for a circle.

Format

SHCIRCLE <Window number>, <Coordinate X>, <Coordinate Y>, <Radius>, <Level difference>, <Mode>

Explanation

<Window number> Designates the window number (0 to 511).
<Coordinate X> Designates the X coordinate (0 to 511).
<Coordinate Y> Designates the Y coordinate (0 to 479).
<Radius> Designates the radius of the circle to search for (3 to 240).
<Level difference> Designates the detection level for the circle search (0 to 255).
<Mode> Designates the object for the circle search (0 or 1).



Note (1): Designate the process range with the window.
Note (2): If the position of the designated window is not on the screen, an execution error will result.
Note (3): The shape of the window available to designate is a rectangle with 0 degrees. If you designate any shape other than this, an error occurs.
Note (4): The processing object is the screen designated with VISWORKPLN.
Note (5): When this command is executed, the process screen 3 (VISWORKPLN 3) is used as a work area and data on the process screen 3 are not guaranteed. Also, you cannot use the process screen 3 for processing.
Note (6): The following data can be obtained with the processing result obtaining function.

	VISSTATUS (n)
n	Item
0	Execution Result 0 = Normal -1 = Abnormal
1	Number
2	Execution Time

	VISGETNUM a, b
b	a = 0~511
0	Number
1	X Coordinate Value
2	Y Coordinate Value
3	unknown
4	Level
5	unknown
6	unknown
7	unknown
8	unknown
9	unknown

Note (7): For this instruction, a μVision board (option) is required.
Note (8): If the search range of a designated window is wide and the radius is small, the processing time increases and a timeout error may occur.

Related Terms

WINDMAKE, VISWORKPLN, VISGETNUM, VISSTATUS, SHDEFCIRCLE

Example

```
VISSCREEN 1,0,1               'Instantaneously draws on drawing screen 0.
VISCLS 0                      '
WINDMAKE R,1,512,480,0,2      'Sets window 1 to rectangle.
CAMIN 1                       'Obtains a camera image from the storage memory.
VISWORKPLN 0                  'Designates an object to storage memory 0.
SHCIRCLE 1,0,0,30,128,1       'Searches for a black circle.
I1 = VISSTATUS(0)             '
VISLOC 10,10                  '
VISPRINT I1                   '
IF I1 = 0 THEN                '
    I2 = VISSTATUS(1)          '
    IF I2 <> 0 THEN            '
        FOR I1 = 0 TO I2-1     '
            VISCROSS VISGETNUM(I1,1), VISGETNUM(I1,2)
                               '
        NEXT I1                '
    END IF                     '
END IF                         '
```

21.10 Obtaining Results

VISGETNUM (Function)

Function

Obtains an image process result from the storage memory.

Format

VISGETNUM(<Parameter 1>, <Parameter 2>)

Explanation

<Parameter 1>	Designates the number of the process result to obtain (0 to 511).
<Parameter 2>	Designates the type of the process result to obtain (0 to 9).

Note (1): The result contents stored change depending on an image process instruction executed in advance. Refer to the image process instructions.
Note (2) : The result is kept until the next image process instruction is executed; therefore, you can obtain the result as whenever you want.
Note (3) : The value becomes unknown if you designate an unknown storage with the image process instruction in advance.
Note (4) : For this instruction, a μVision board (option) is required.

Related Terms

VISMEASURE, VISPROJ, VISEDGE, VISREADQR, BLOB, BLOBMEASURE, SHMODEL, SHCORNER, SHCIRCLE, VISPOSX, VISPOSY

Example

```
VISSCREEN 1,0,1                 'Instantaneously draws on drawing screen 0.
VISCLS 0                        '
WINDMAKE R,1,512,480,0,2        'Sets window 1 to rectangle.
CAMIN 1                         'Obtains a camera image from the storage memory.
VISPLNOUT 0                     '
VISWORKPLN 0                    'Designates an object to storage memory 0.
BLOB 1,0,0,0,128                'Executes labeling.
I1 = VISSTATUS(0)               '
IF I1 = 0 THEN                  '
    I2 = VISSTATUS(1)           '
    IF I2 <> 0 THEN             '
        FOR I1 = 0 TO 15        '
            VISDEFCHAR 1,1,0    '
            VISLOC 10,10+I1     '
            VISPRINT “X=”;VISGETNUM(I1,1), VISGETNUM(I1,2)
                                '
        NEXT I1                 '
    END IF                      '
END IF                          '
```

VISGETSTR (Function)

Function

Obtains code recognition result.

Format

VISGETSTR(<Leading character number>, <Number of characters>)

Explanation

<Leading character number>	Designates the leading character number to obtain (1 to 611).
<Number of characters>	Designates the number of characters to obtain (1 to 240).

Note (1): If the number of characters to obtain is unknown, refer to a the process result for each instruction,
Note (2): For this instruction, a μVision board (option) is required.

Related Terms

VISREADQR, VISGETNUM

Example

```
VISSCREEN 1,0,1               '
VISCLS 0                      '
WINDMAKE R,1,512,480,0,2      'Sets window 1 to rectangle.
CAMIN 1                       'Obtains a camera image from the storage memory.
VISPLNOUT 0                   '
VISREADQR 1,0,0,0             'Reading the QR code.
I1 = VISSTATUS(0)             '
VISPRINT I1, VISSTATUS(1)     '
IF I1 = 0 THEN                '
    VISLOC 10,10              '
    VISPRINT VISGETSTR(1, VISSTATUS(1))
                              '
END IF                        '
VISCAMOUT 1                   '
```

VISPOSX (Function)

Function

Obtains an image process result (Coordinate X) from the storage memory.

Format

VISPOSX (<Parameter>)

Explanation

<Parameter> Designates the number of the process result (Coordinate X) to obtain (0 to 511).

Note (1): This is the same as when the VISGETNUM parameter is set to 1.
VISGETNUM (n, 2) = VISPOSY (n)
Note (2) : The process results are different from the results stored with previous image processing instructions. Refer to the image processing instructions.
Note (3) : You can repeatedly obtain results because they are kept until the next image process instruction is executed,
Note (4) : If the previous image processing instruction designated an unexpected storage location, the value becomes an unknown number.
Note (5) : For this instruction, a μVision board (option) is required.

Related Terms

VISMEASURE, VISPROJ, VISEDGE, VISREADQR, BLOB, BLOBMEASURE, SHMODEL, SHCORNER, SHCIRCLE, VISGETNUM, VISPOSY

Example

```
VISSCREEN 1,0,1               'Instantaneously draws on drawing screen 0.
VISCLS 0                      '
WINDMAKE R,1,512,480,0,2      'Sets window 1 to rectangle.
CAMIN 1                       'Obtains a camera image from the storage memory.
VISPLNOUT 0                   '
VISWORKPLN 0                  'Designates an object to storage memory 0.
BLOB 1,0,0,0,128              'Executes labeling.
I1 = VISSTATUS(0)             '
IF I1 = 0 THEN                '
    I2 = VISSTATUS(1)         '
    IF I2 <> 0 THEN           '
        FOR I1 = 0 TO 15      '
            VISDEFCHAR 1,1,0  '
            VISLOC 10,10+I1   '
            VISPRINT “X=”;VISPOSX(I1), “Y=”;VISPOSY(I1)
                              '
            VISCROSS VISPOSX(I1), VISPOSY(I1)
                              '
         NEXT I1              '
    END IF                    '
END IF                        '
VISCAMOUT 1                   '
```

VISPOSY (Function)

Function

Obtains an image process result (Coordinate Y) from the storage memory.

Format

VISPOSY (<Parameter>)

Explanation

<Parameter> Designates the number for the processing result (Coordinate Y) to obtain (0 to 511). An obtained value is represented as a single precision real type constant (F type).

Note (1): This is the same as when parameter 1 of VISGETNUM is designated to 2.
VISGETNUM (n, 2) = VISPOSY (n)
Note (2): The process results are different from the results stored with previous image processing instructions. Refer to the image processing instructions.
Note (3): You can repeatedly obtain results because they are kept until the next image process instruction is executed.
Note (4): If the previous image processing instruction designates an unexpected storage location, the value becomes an unknown number.
Note (5): For this instruction, a μVision board (option) is required.

Related Terms

VISMEASURE, VISPROJ, VISEDGE, VISREADQR, BLOB, BLOBMEASURE, SHMODEL, SHCORNER, SHCIRCLE, VISGETNUM, VISPOSX

Example

```
VISSCREEN 1,0,1                'Instantaneously draws on drawing screen 0.
VISCLS 0                       '
WINDMAKE R,1,512,480,0,2       'Sets window 1 to rectangle.
CAMIN 1                        'Obtains a camera image from the storage memory.
VISPLNOUT 0                    '
VISWORKPLN 0                   'Designates an object to storage memory 0.
BLOB 1,0,0,0,128               'Executes labeling.
I1 = VISSTATUS(0)              '
IF I1 = 0 THEN                 '
    I2 = VISSTATUS(1)          '
    IF I2 <> 0 THEN            '
        FOR I1 = 0 TO 15       '
            VISDEFCHAR 1,1,0   '
            VISLOC 10,10+I1    '
            VISPRINT “X=”;VISPOSX(I1), “Y=”;VISPOSY(I1)
                               '
            VISCROSS VISPOSX(I1), VISPOSY(I1)
                               '
         NEXT I1               '
    END IF                     '
END IF                         '
VISCAMOUT 1                    '
```

VISSTATUS (Function)

Function

Monitors the process result of each instruction.

Format

VISSTATUS (<Parameter>)

Explanation

<Parameter> Designates the data to obtain (0 to 2).
0: Execution result status
1: Auxiliary data
2: Processing time

An obtained value is represented as a single precision real type constant (F type).

Note (1): The obtained data varies depending on the instructions previously executed. Refer to the explanation of each instruction.
Note (2): All processing times for instructions become objects. You can obtain the processing times of previously executed instructions.
Note (3): For this instruction, a μVision board (option) is required.

Related Terms

VISMEASURE, VISPROJ, VISEDGE, VISREADQR, BLOB, BLOBMEASURE, SHMODEL, SHCORNER, SHCIRCLE

Example

```
VISSCREEN 1,0,1               'Instantaneously draws on drawing screen 0.
VISCLS 0                      '
WINDMAKE R,1,512,480,0,2      'Sets window 1 to rectangle.
CAMIN 1                       'Obtains a camera image from the storage memory.
VISPLNOUT 0                   '
VISWORKPLN 0                  'Designates an object to storage memory 0.
BLOB 1,0,0,0,128              'Execute labeling.
I1 = VISSTATUS(0)             '
I2 = VISSTATUS(1)             '
F1 = VISSTATUS(2)             '
VISLOC 10,9                   '
VISPRINT “Execution result =”;I1;“Labeling number =”;I2, “Execution time
(second)=”;F1                 '
IF I1 = 0 THEN                '
    IF I2 <> 0 THEN           '
        FOR I1 = 0 TO I2 -1   '
            VISCROSS VISGETNUM(I1,1), VISGETNUM(I1,2)
                              '
        NEXT I1               '
    END IF                    '
END IF                        '
VISCAMOUT 1                   '
```

VISREFCAL (Function)

Function

Obtains calibration data (Vision-robot coordinate transformation).

Format

VISREFCAL (<Set number>, <Data number>)

Explanation

<Set number>	Designates the number of the calibration data group to use (0 to 31).
<Data number>	Designates the number of the calibration data (0 to 11).

Note (1): The system can store up to 32 sets of calibration data groups.
Note (2): Use a personal computer to set calibration data.
Note (3): For this instruction, a μVision board (option) is required.

Example

```
VISSCREEN 1,0,1                       'Instantaneously draws on storage memory
                                      '0.
VISCLS 0                              '
FOR I1 = 0 TO 11                      '
    VISLOC 10,10+I1                   '
    VISPRINT “Data”;I1;“=”;VISREFCAL(0,I1)
                                      '
NEXT I1
```

Chapter 22

Appendices

22.1 Character Code Table

Table 1. Character Code Table

	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+A	+B	+C	+D	+E	+F
00																
10																
20		!	″	#	$	~	&	′	(	)	*	+	,	-	.	/
30	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
40	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
60	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
70	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	
80																
90																
A0																
B0																
C0																
D0																
E0																
F0																

22.2 Figures of the Shoulder, Elbow, and Wrist

[1] Available 32 Figures

A 6-axis robot can take different figures for its shoulder, elbow, wrist, 6th axis, and 4th axis for a single point and attitude (X, Y, Z, RX, RY, and RZ) at the end of the end-effector.

Figures 1 through 5 show how the robot can take different figures for its shoulder, elbow, wrist, 6th axis, and 4th axis, respectively.

Combining these different figures allows the robot to take 32 different figures for its single position and attitude, as listed in Table 2.

Figure 6 shows examples of eight possible combinations of the shoulder, elbow, and wrist figures in the VS-D series robot.

Table 2. Available Figures

Value	4th-Axis Figure	6th-Axis Figure	Wrist Figure	Elbow Figure	Shoulder Figure
0	SINGLE 4	SINGLE	FLIP	ABOVE	RIGHTY
1	SINGLE 4	SINGLE	FLIP	ABOVE	LEFTY
2	SINGLE 4	SINGLE	FLIP	BELOW	RIGHTY
3	SINGLE 4	SINGLE	FLIP	BELOW	LEFTY
4	SINGLE 4	SINGLE	NONFLIP	ABOVE	RIGHTY
5	SINGLE 4	SINGLE	NONFLIP	ABOVE	LEFTY
6	SINGLE 4	SINGLE	NONFLIP	BELOW	RIGHTY
7	SINGLE 4	SINGLE	NONFLIP	BELOW	LEFTY
8	SINGLE 4	DOUBLE	FLIP	ABOVE	RIGHTY
9	SINGLE 4	DOUBLE	FLIP	ABOVE	LEFTY
10	SINGLE 4	DOUBLE	FLIP	BELOW	RIGHTY
11	SINGLE 4	DOUBLE	FLIP	BELOW	LEFTY
12	SINGLE 4	DOUBLE	NONFLIP	ABOVE	RIGHTY
13	SINGLE 4	DOUBLE	NONFLIP	ABOVE	LEFTY
14	SINGLE 4	DOUBLE	NONFLIP	BELOW	RIGHTY
15	SINGLE 4	DOUBLE	NONFLIP	BELOW	LEFTY
16	DOUBLE 4	SINGLE	FLIP	ABOVE	RIGHTY
17	DOUBLE 4	SINGLE	FLIP	ABOVE	LEFTY
18	DOUBLE 4	SINGLE	FLIP	BELOW	RIGHTY
19	DOUBLE 4	SINGLE	FLIP	BELOW	LEFTY
20	DOUBLE 4	SINGLE	NONFLIP	ABOVE	RIGHTY
21	DOUBLE 4	SINGLE	NONFLIP	ABOVE	LEFTY
22	DOUBLE 4	SINGLE	NONFLIP	BELOW	RIGHTY
23	DOUBLE 4	SINGLE	NONFLIP	BELOW	LEFTY
24	DOUBLE 4	DOUBLE	FLIP	ABOVE	RIGHTY
25	DOUBLE 4	DOUBLE	FLIP	ABOVE	LEFTY
26	DOUBLE 4	DOUBLE	FLIP	BELOW	RIGHTY
27	DOUBLE 4	DOUBLE	FLIP	BELOW	LEFTY
28	DOUBLE 4	DOUBLE	NONFLIP	ABOVE	RIGHTY
29	DOUBLE 4	DOUBLE	NONFLIP	ABOVE	LEFTY
30	DOUBLE 4	DOUBLE	NONFLIP	BELOW	RIGHTY
31	DOUBLE 4	DOUBLE	NONFLIP	BELOW	LEFTY

(1) Shoulder figure

A shoulder figure is defined by a set of the values of the 1st-, 2nd-, and 3rd-axis components.

The robot can take two different shoulder figures--Left-handed (LEFTY) and Right-handed (RIGHTY). (J1 to J6 denote Joint 1 to Joint 6.)

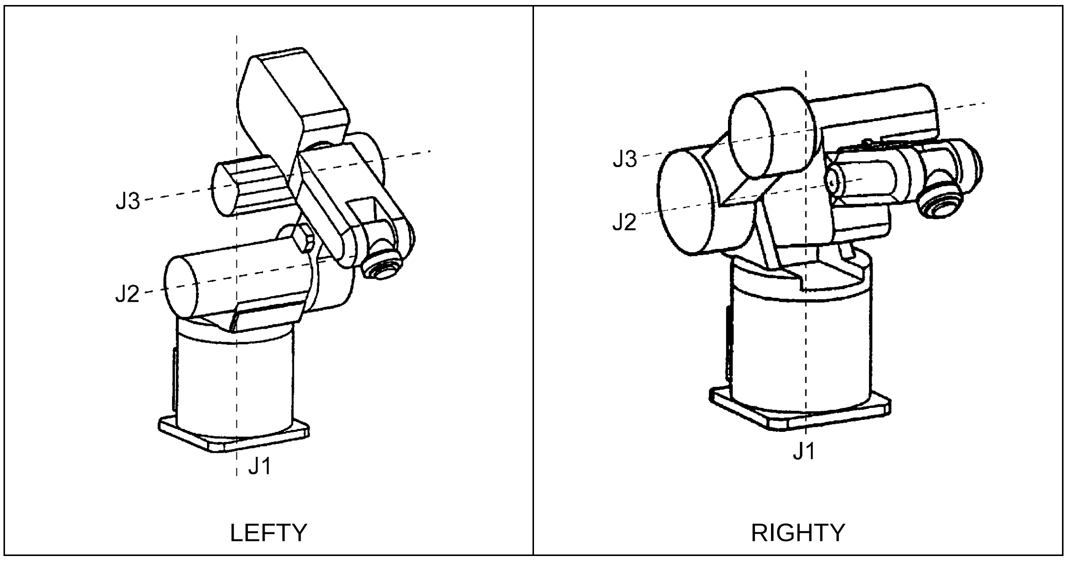


Figure 1. Shoulder Figure

(2) Elbow figure

An elbow figure is defined by a set of the values of the 2nd- and 3rd-axis components.

The robot can take two different elbow figures--Over-handed (ABOVE) and Under-handed (BELOW). (J1 to J6 denote Joint 1 to Joint 6.)

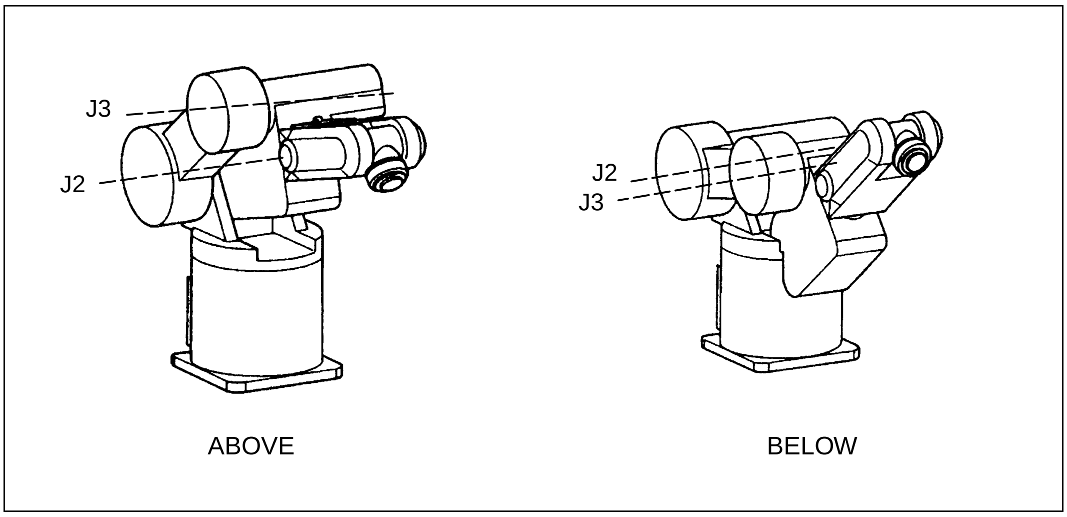


Figure 2. Elbow Figure

(3) Wrist figure

A wrist figure is defined by a set of the values of the 4th- and 5th-axis components.

The robot can take two different shoulder figures--Normal (NONFLIP) and Reversed (FLIP). The NONFLIP figure refers to a figure of the robot whose 4th axis is turned by 180 degrees without changing the wrist figure. (J1 to J6 denote Joint 1 to Joint 6.)

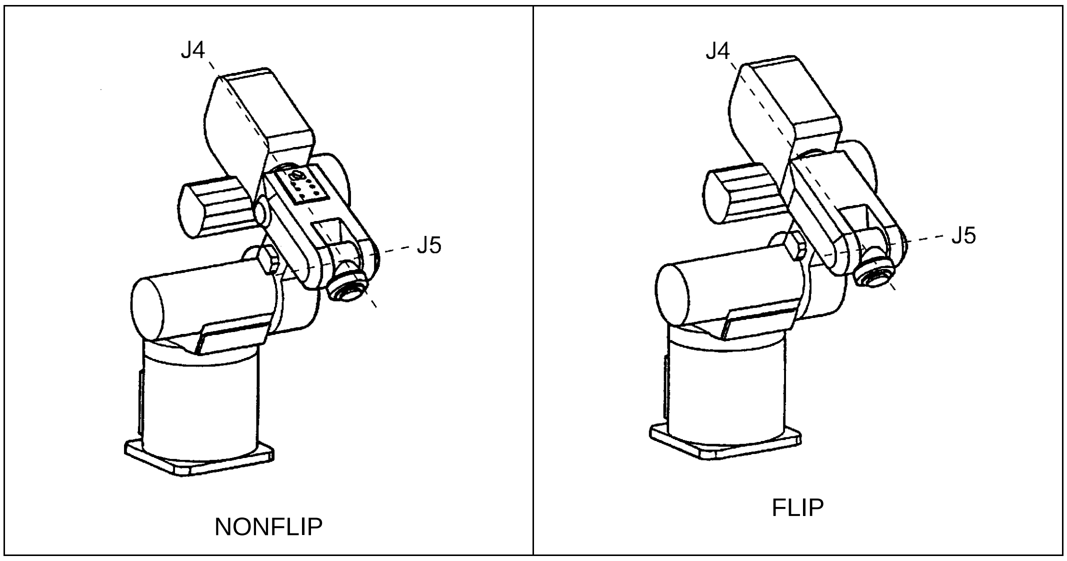


Figure 3. Wrist Figure

(4) 6th-axis figure

A 6th-axis figure is defined by the value of the 6th-axis component.

The robot can take two different 6th-axis figures--SINGLE and DOUBLE. If the 6th axis rotates by $-180° < \theta_6 \leq 180°$ in mechanical interface coordinates, the figure is SINGLE; if it rotates by $180° < \theta_6 \leq 360°$ or $-360° < \theta_6 \leq -180°$, the figure is DOUBLE.

The robot takes quite different figures when θ_6 is 180° or 181°. Take special care when changing any position data fort the 6th-axis figure. For example, supposing that you want to change the 6th-axis figure at θ_6=181°, the robot will take the 6th-axis figure at θ_6=-179° if you make no figure modification.

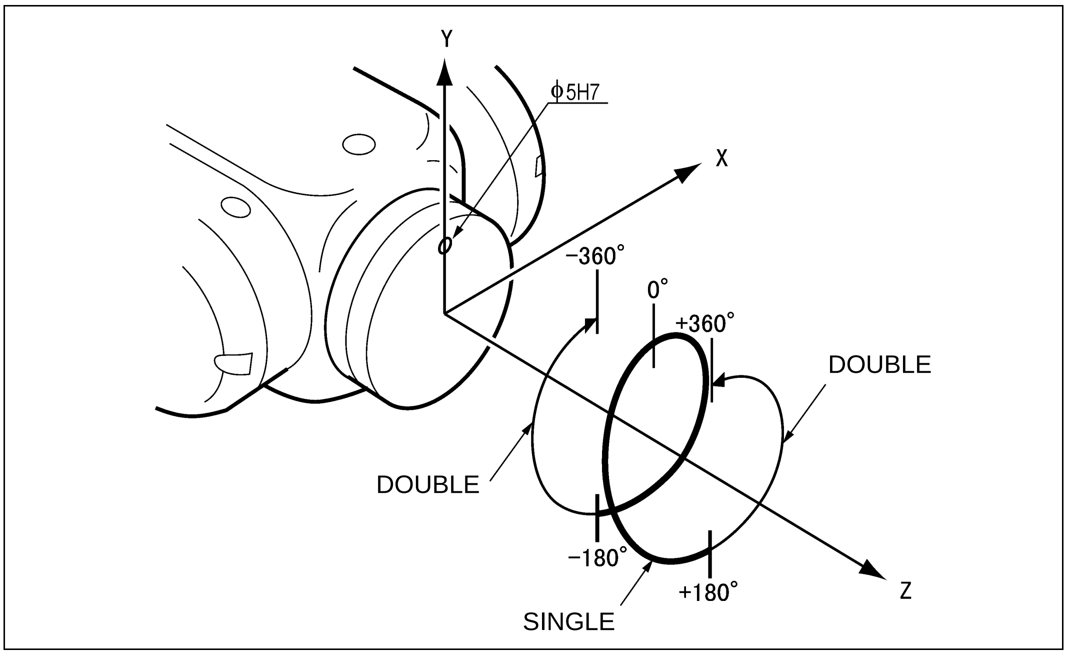


Figure 4. 6th-Axis Figure

(5) 4th-axis figure

The 4th-axis figure is defined by a value of the 4th-axis component.

The robot can take two different 4th-axis figures--SINGLE 4 and DOUBLE 4. If the 4th axis rotates by -180°<θ_4≤180° in mechanical interface coordinates, the figure is SINGLE 4; if it rotates by 180°<θ_4≤185° or -185°<θ_4≤-180°, the figure is DOUBLE 4.

The robot takes quite different figures when θ_4 is 180° or 181°. Take special care when changing any position data fort the 6th-axis figure. For example, supposing that you want to change the 4th-axis figure at θ_4=181°, the robot will take the 4th-axis figure at θ_4=-179° if you make no figure modification.

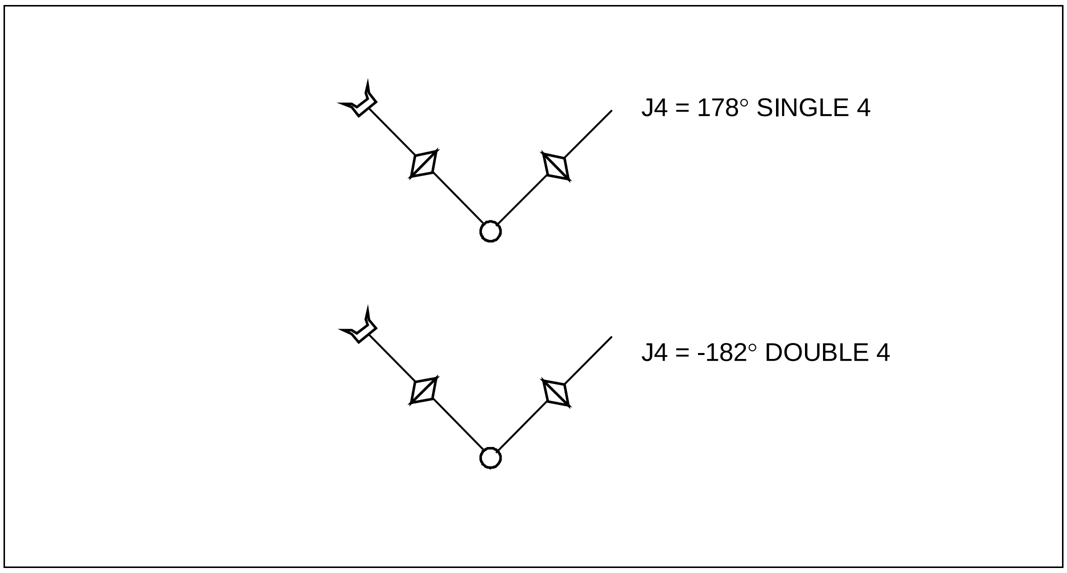


Figure 5. 4th-Axis Figure

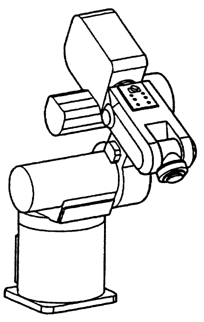
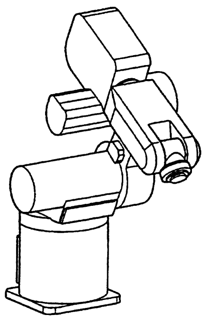
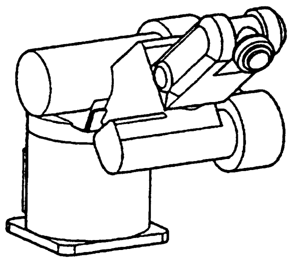
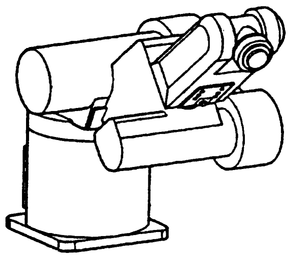
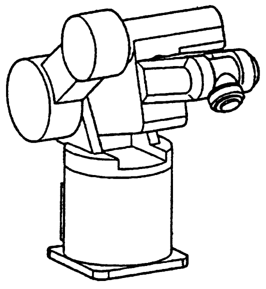
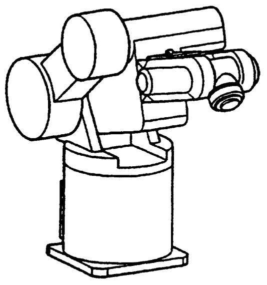
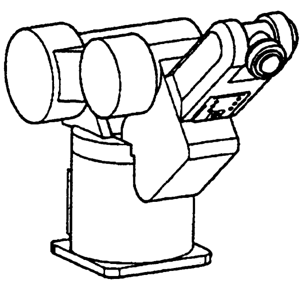
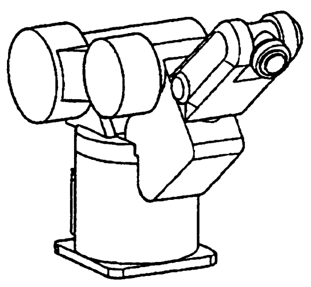
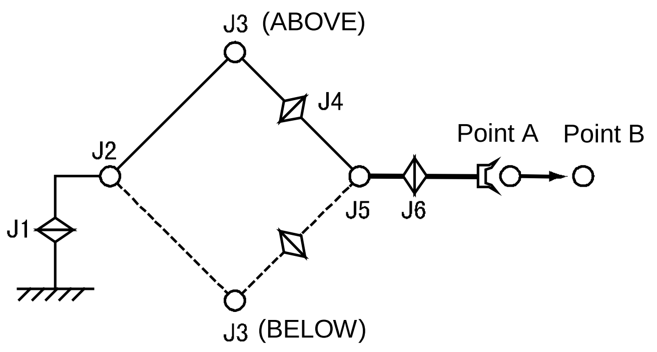
Figure-1 LEFTY, ABOVE, and NONFLIP 	Figure-2 LEFTY, ABOVE, and FLIP 
Figure-3 LEFTY, BELOW, and NONFLIP 	Figure-4 LEFTY, BELOW, and FLIP 
Figure-5 RIGHTY, ABOVE, and NONFLIP 	Figure-6 RIGHTY, ABOVE, and FLIP 
Figure-7 RIGHTY, BELOW, and NONFLIP 	Figure-8 RIGHTY, BELOW, and FLIP 

Figure 6. Possible Combinations of Robot Shoulder, Elbow, and Wrist Figures

⚠**CAUTION**: When carrying out a command with CP control, if the robot figures at the start point differ from those saved in programming or teaching, be sure to check beforehand that no part of the robot will not interfere with the surrounding equipment or facilities. This is because each joint of the robot will take currently suitable motions depending upon the current figures to make the tip of the end-effector reach an object point even if the robot position and attitude at the start point are the same as those in programming or teaching. However, the path of the end-effector is virtually the same although the figures may be different.



CAUTION: All of the 32 different figures may not be applicable to every position and attitude of the robot due to the robot structure. In some cases, only the LEFTY/ABOVE/NONFLIP figure may be applicable depending upon point and attitude. (In almost of all practical cases, the robot may not take all of the logically possible figures, but only two figures are possible--LEFTY/ABOVE/NONFLIP and LEFTY/ABOVE/FLIP. For the 4th-axis figure, the robot will take SINGLE 4.)

[2] Boundaries of Robot Figures

This section describes the boundary of each of the robot shoulder, elbow, wrist, and 6th-axis figures.

When judging the boundaries of the robot shoulder, elbow, and wrist, the system uses intersection point Pw of the two rotary axes of the 5th and 6th axes, as illustrated in Figure 7.

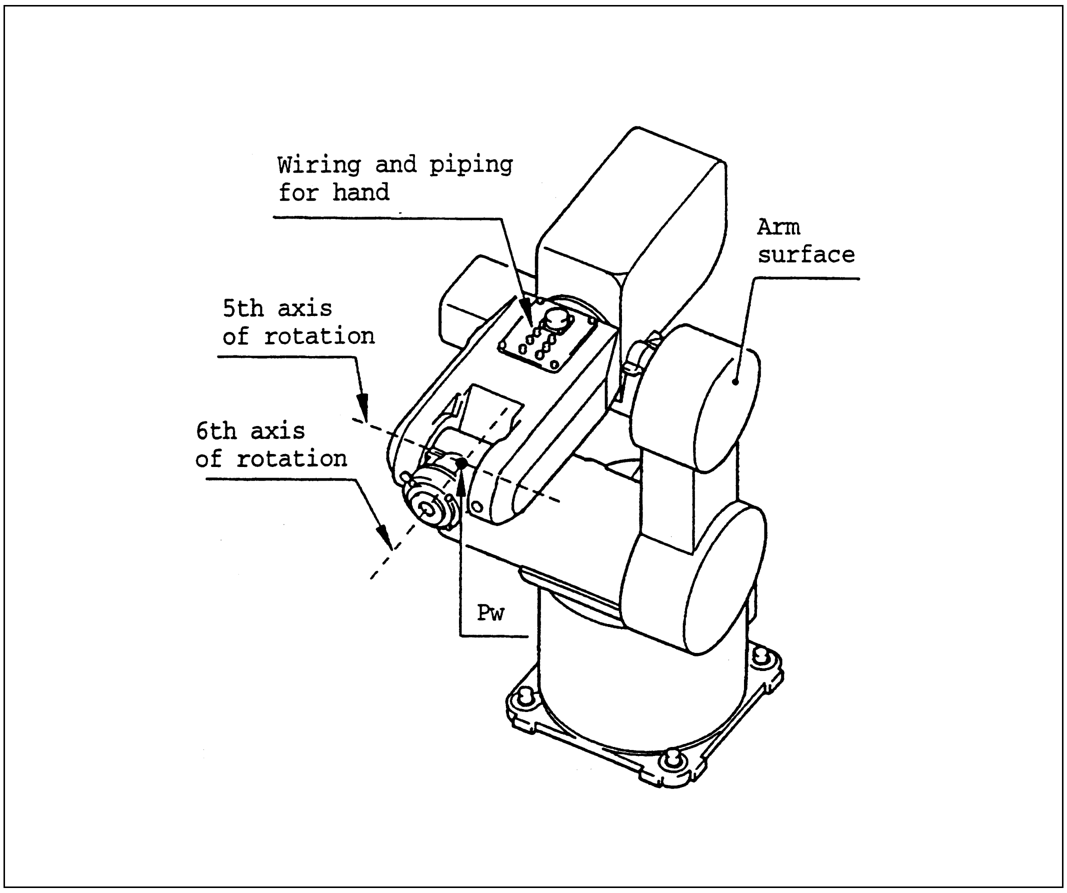


Figure 7. Location of Pw

A boundary point in figures is called a singular point.

Any path defined by commands with CP control (e.g., MOVE, APPROACH, and DEPART) should not run through the vicinity of the singular point. Refer to PART 1, Section 4.3. If the path runs through the vicinity of the singular point, the robot will issue ERROR6080s (Over speed) or ERROR6070s (Over software motion limit) and then stop.

(1) LEFTY/RIGHTY (Shoulder figure)

The rotary axis of the 1st axis is defined as the boundary between LEFTY and RIGHTY.

When viewed from the normal line on the side of the arm link, if point Pw exists in the left-hand side of the rotary axis of the 1st axis, the figure is LEFTY; if point Pw exists in the right-hand side, it is RIGHTY. In Figure 8, the boundary is drawn with alternate long and short dash lines.

NOTE: If point Pw exists on the rotary axis of the 1st axis, that is, on the boundary between LEFTY and RIGHTY, then it is called a singular point.

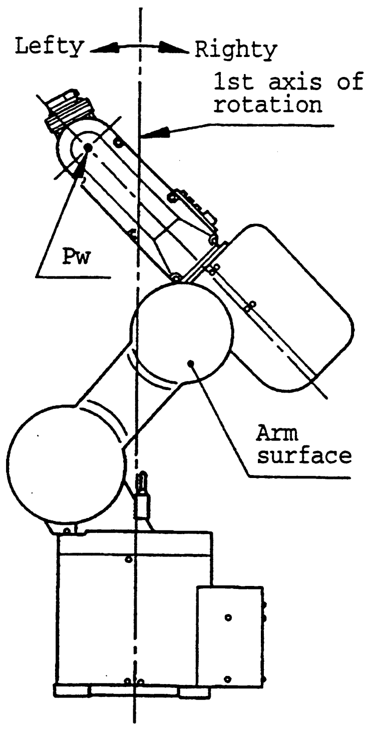


Figure 8. Boundary between LEFTY and RIGHTY

(2) ABOVE/BELOW (Elbow figure)

The centerline of the arm link (connecting the shoulder with elbow) is defined as the boundary between ABOVE and BELOW.

If point Pw exists in the + side of the centerline, the figure is ABOVE; if point Pw exists in the -side, it is BELOW. In Figures 9 and 10, the boundary is drawn with alternate long and short dash lines.

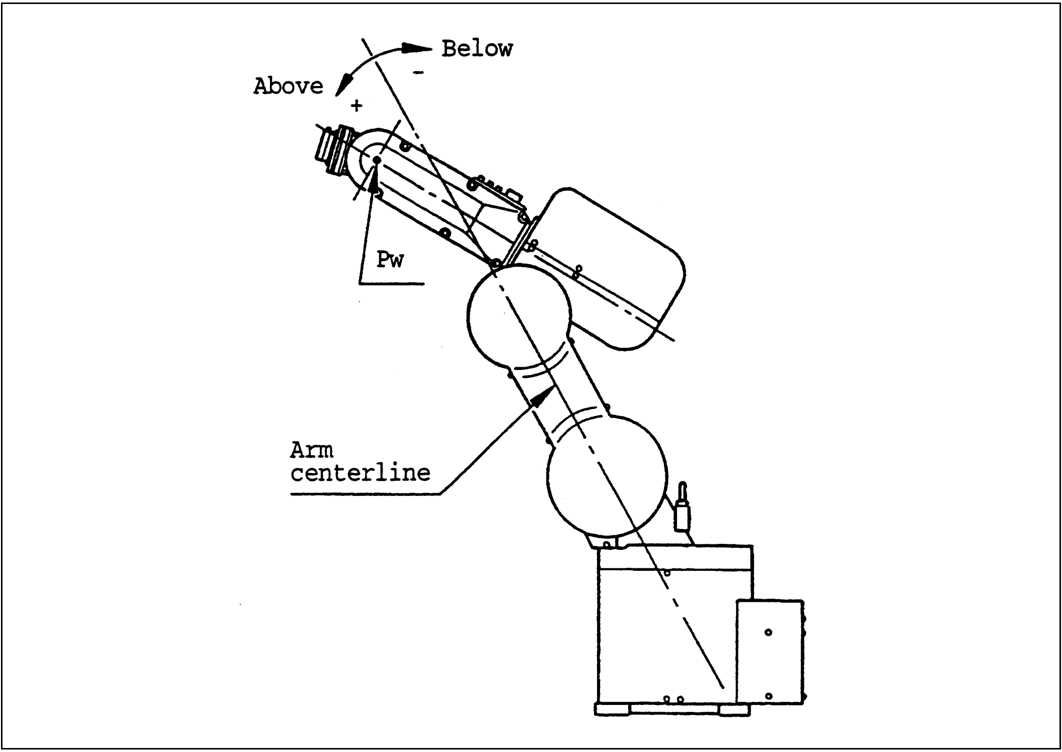


Figure 9. Boundary between ABOVE and BELOW for LEFTY

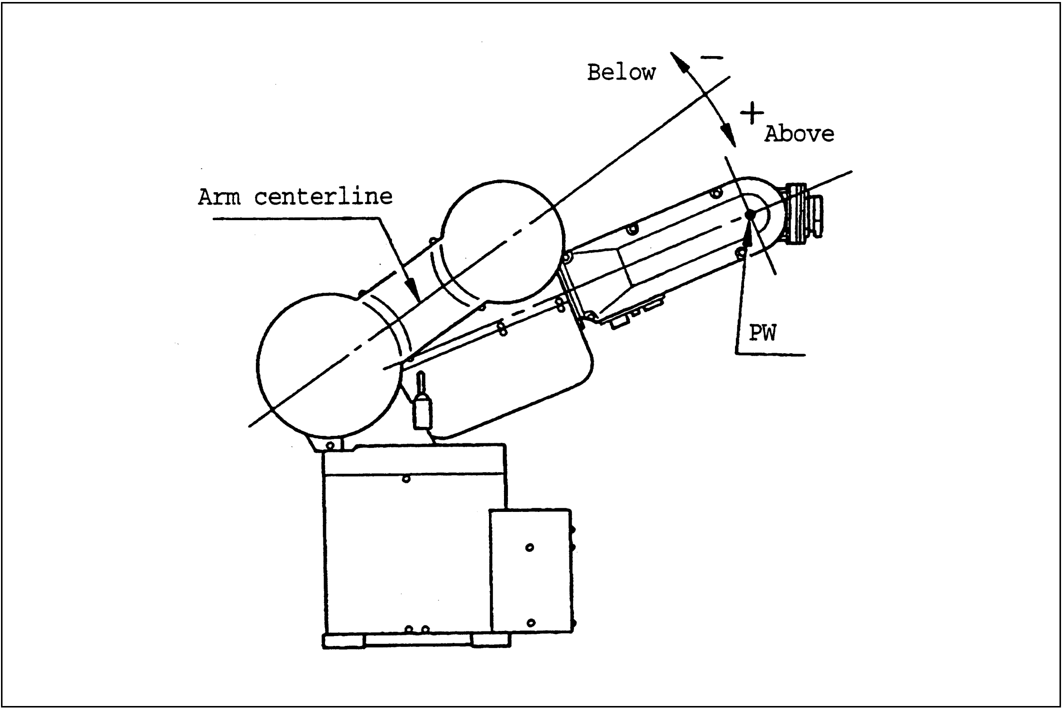


Figure 10. Boundary between ABOVE and BELOW for RIGHTY

(3) FLIP/NONFLIP (Wrist figure)

The rotary axis of the 4th axis is defined as the boundary between FLIP and NONFLIP.

If the normal line on the flange surface tilts up the rotary axis of the 4th axis, the figure is FLIP; if it tilts down the rotary axis, it is NONFLIP. In Figures 11 and 12, the boundary is drawn with alternate long and short dash lines.

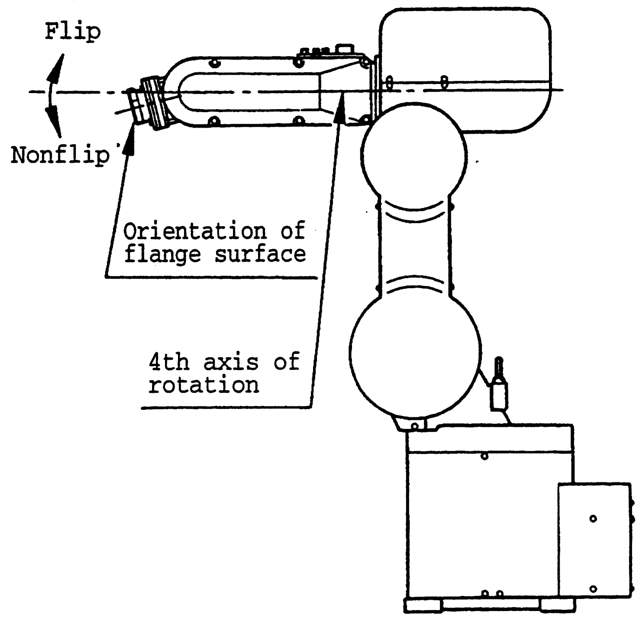


Figure 11. Boundary between FLIP and NONFLIP for LEFTY

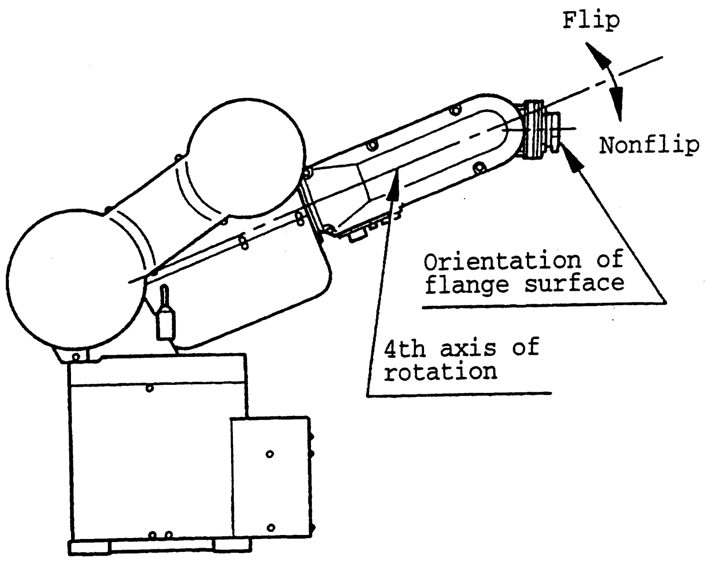


Figure 12. Boundary between FLIP and NONFLIP for RIGHTY

(4) SINGLE/DOUBLE (6th-axis figure)

If the rotation angle (θ6) of the 6th axis is within the range of -180°<θ6≤180° around the Z axis in mechanical interface coordinates, the figure is SINGLE; if it is within the range of 180°<θ6≤360° or -360°<θ6≤-180°, the figure is DOUBLE. Boundaries exist at -180° and +180°.

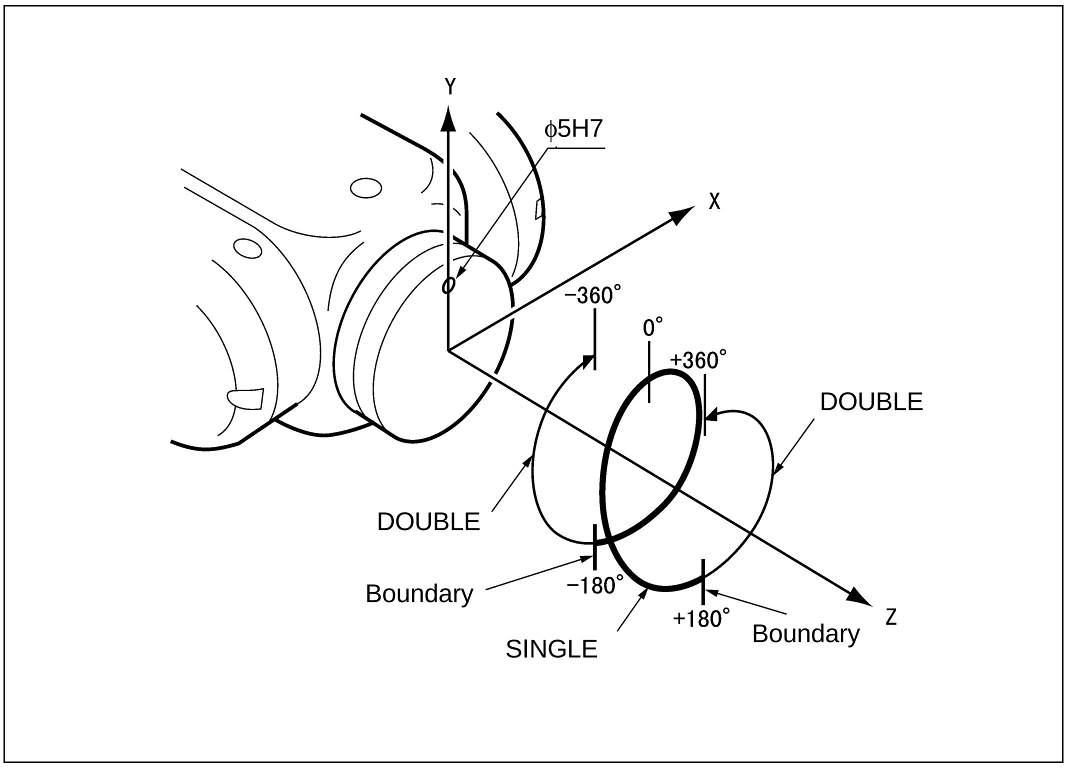


Figure 13. Boundary between SINGLE and DOUBLE

22.3 Environment Setting Values

Table number	Macro name	Description	WINCAPSII
1	cnfSYS	System parameter table	—
2	cnfARM	Path creation parameter table	Arm manager
3	cnfVIS	Vision parameter table	Vision manager
4	cnfPAC	PAC parameter table	PACmanager
5	cnfSRV	Servo parameter table	Arm manager
6	cnfSPD	Using condition parameter table	Arm manager
7	cnfITP	Interpreter parameter table	PACmanager
8	cnfDIO	DIO parameter table	DIOmanager
9	cnfCOM	Communication parameter table	—

Remark (1): Macro names are defined in <pacman.h>. If you use a macro name with the GETENV and LETENV commands, include the file in the following manner.

```
#INCLUDE        <pacman.h>
```

Remark (2): You can create a macro name of an element number in an arbitrary table with each manager of WINCAPSII. Refer to the Owners Manual (WINCAPSII) for the creating procedure. For example, if you create a macro definition file for path creation parameter table in the arm manager, include the file in the following manner.

```
#INCLUDE        "arm_cnf.h"
```

22.4 Configuration List

The table below lists the items displayed in the User Preferences window of the teach pendant (Access: [F2 Arm]—[F6 Aux.]—[F7 Config.]) or in the Config. tab of the Options window in WINCAPSII (Access: [Arm Manager]—[Tools Menu]—[Options]—[Configuration]).

No.	Items	Factory default	Powering-on default	Description	Comments
7	Control set of motion optimization	0	0	0: OFF 1: PTP movement only 2: CP movement only 3: Both PTP and CP movement (Refer to the PROGRAMMER'S MANUAL, Section 4.6, "Control Sets of Motion Optimization.")	Can be set with aspChange ().
8	Floor-mount, Overhead-mount or Wall-hanging setting	0	Last value at powering-off	0: Floor-mount 1: Overhead-mount 2: Wall-hanging (Ver. 1.6 or later)	
9	Mass of payload (g)	Differs depend-ing upon models.	Last value at powering-off	Mass of end-effector and object to be mounted at the end of the robot arm.	Can be set with aspACLD.
10	Payload center of gravity X (mm)	0	Last value at powering-off	X component of payload center of gravity (consisting of end-effector and object) (Refer to the PROGRAMMER'S MANUAL, Section 4.6, "Control Sets of Motion Optimization.")	Can be set with aspACLD.
11	Payload center of gravity Y (mm)	80	Last value at powering-off	Y component of payload center of gravity (consisting of end-effector and object) (Refer to the PROGRAMMER'S MANUAL, Section 4.6, "Control Sets of Motion Optimization.")	
12	Payload center of gravity Z (mm) For 4-axes robot in Ver.1.9 or later: inertia of payload (kgcm^2)	100	Last value at powering-off	Z component of payload center of gravity (consisting of end-effector and object) (Refer to the PROGRAMMER'S MANUAL, Section 4.6, "Control Sets of Motion Optimization.")	
13 to 20	Encoder pulse count for positioning allowance (J1 to J8)	20	20	Convergence accuracy for specified axis (one of J1 to J8) at execution of a motion command with @E option	Can be set with mvSetPulseWidth ().
21	Positioning completion timeout (ms)	5600	5600	At execution of a motion command with @E option, if positioning is not completed within this specified time, a timeout will occur.	Can be set with mvSetTimeOut ().
22	Control log mode	1	Last value at powering-off	No. of control logs to be stored. Entry range: 1 to 3 (1250 x Set value) = No. of control logs	If many programs and/or variables are used, setting many control logs may cause an error at powering-on time. If such occurs, decrease the number of control logs.

No.	Items	Factory default	Powering-on default	Description	Comments
23	Control log sampling intervals	8	Last value at powering-off	Sampling intervals of control log. Entry range: 8, 16, 24, or 32 ms	If a value other than a multiple of 8 is set, the controller automatically modifies it to a multiple of 8.
24	Efficiency of gravity effect (For 6-axis robot)	0	Last value at powering-off	0: Gravity compensation feature disabled 1: Gravity compensation feature enabled	Can be set with SetGravity or ResetGravity.
25	Curlmt function cancellation switch	0	Last value at powering-off	If lowest bit is 0: Resets the current limit setting when the motor is turned on If 2nd lowest bit is 0: Unlocks the servo loop when the motor is turned on If 3rd lowest bit is 0: Resets the cancellation of the PWM switching when the motor is turned on	The release of the servo lock and cancellation of the PWM switching are exclusively designed for 4-axis robots.
26	Servo-lock configuration (For 4-axis robot)	0	Last value at powering-off	1: Servo lock released	Can be set with OffSrvLock or OnSrvLock.
27	Control method (For HM/HS-D series)	0	Last value at powering-off	1: P-control	Make sure that the "Changing accel mode" is set to 0.
28	High-inertia configuration (For HM/HS-D series)	0	Last value at powering-off	1: Loop gain set to high-inertia	Make sure that the "Changing accel mode" is set to 0 and the "Mass of payload (g)" is 10000.
29	Changing accel mode	0 or 1	Last value at powering-off	0: Gain change function enabled 1: Gain change function disabled	The initial setting is 0 or 1 for 4-axis or 6-axis robots, respectively. Do not change the initial setting.
34	Motor power holding function	1	Last value at powering-off	Sets the motor power state when the Auto Enable switch is switched. 0: Turns the motor power OFF if it was ON 1: Keeps the current state of the motor power	
35	Cycloid motion setting	0	Last value at powering-off	0: Cycloid motion disabled 1: Cycloid motion enabled	Can be set with Setcycloid or Resetcycloid.

No.	Items	Factory default	Powering-on default	Description	Comments
53 to 60	Gain reduce rate (J1 to J8)	Value proper to each robot	Last value at powering-off	Gain reduction rate for one of J1 to J8	Takes effect when the "Changing accel mode," "Control method" and "High-inertia configuration" are set to 0. <u>Do not change the initial value.</u>
61 to 68	High-inertia load operation gain reduce rate (J1 to J8) (For HM/HS-D series)	0	Last value at powering-off	Gain reduction rate for one of J1 to J8 when the high-inertia load operation is selected	Takes effect when the "Changing accel mode" and "Control method" are set to 0 and "High-inertia configuration" is set to 1. <u>Do not change the initial value.</u>
69	New type robot or old type robot (For 4-axis robot)	0	Last value at powering-off	0: New type (D series) 1: Old type (C series)	If you purchase the controller alone to connect it to the HM/HS/HC-C series, set this item to 1.
70	Pass motion setting	0	Last value at powering-off	When restarted after any stop operation during pass motion, the robot will make motion towards: 0: Target position specified after the pass motion (Default) 1: Target position specified before the pass motion	
71	Positioning allowance of pass end	5	Last value at powering-off	Condition for preventing the robot from taking motion towards the target position specified before pass motion, when the robot is restarted The condition should be set as a distance from the target position.	The condition refers to a distance from the target position at the command level, not the actual distance from the current robot end position.
78	Damper setting rate (X) (For 6-axis robot)	10000	10000	Damping ratio along the X-axis under compliance control	Can be set with SetDampRate or ResetDampRate. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
79	Damper setting rate (Y) (For 6-axis robot)	10000	10000	Damping ratio along the Y-axis under compliance control	
80	Damper setting rate (Z) (For 6-axis robot)	10000	10000	Damping ratio along the Z-axis under compliance control	

No.	Items	Factory default	Powering-on default	Description	Comments
81	Damper setting rate (RX) (For 6-axis robot)	10000	10000	Damping ratio around the X-axis under compliance control	Can be set with SetDampRate or ResetDampRate. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
82	Damper setting rate (RY) (For 6-axis robot)	10000	10000	Damping ratio around the Y-axis under compliance control	
83	Damper setting rate (RZ) (For 6-axis robot)	10000	10000	Damping ratio around the Z-axis under compliance control	
84	Compliance control mode (For 6-axis robot)	1	1	If lowest bit is 0: Compliance speed control mode If 2nd lowest bit is 1: Disables the gravity compensation feature under compliance control	Can be set with SetCompVMode, ResetCompV Mode, SetCompControl, or SetCompF Control. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
86	Antivibration setting (For 6-axis robot)	0	Last value at powering-off	1: Residual vibration reduction control mode	Can be set with SetVibControl or ResetVibControl.
87	Compliance control ON/OFF (For 6-axis robot)	0	0	1: Under compliance control	Can be set with SetCompControl, SetCompF Control, or ResetComp Control. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
88	Coordinates for compliance control (For 6-axis robot)	0	0	0: Base coordinates 1: Tool coordinates 2: Work coordinates	Can be set with SetFrcCoord. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
89	Force limit rate (+X) (For 6-axis robot)	10000	10000	Force control rate along the +X axis under compliance control	Can be set with SetFrcCoord. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
90	Force limit rate (+Y) (For 6-axis robot)	10000	10000	Force control rate along the +Y axis under compliance control	
91	Force limit rate (+Z) (For 6-axis robot)	10000	10000	Force control rate along the +Z axis under compliance control	

No.	Items	Factory default	Powering-on default	Description	Comments
92	Force limit rate (+RX) (For 6-axis robot)	10000	10000	Force control rate around the +X axis under compliance control	Can be set with SetFrcCoord. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
93	Force limit rate (+RY) (For 6-axis robot)	10000	10000	Force control rate around the +Y axis under compliance control	
94	Force limit rate (+RZ) (For 6-axis robot)	10000	10000	Force control rate around the +Z axis under compliance control	
95	Force limit rate (-X) (For 6-axis robot)	10000	10000	Force control rate along the -X axis under compliance control	Can be set with SetFrcCoord. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
96	Force limit rate (-Y) (For 6-axis robot)	10000	10000	Force control rate along the -Y axis under compliance control	
97	Force limit rate (-Z) (For 6-axis robot)	10000	10000	Force control rate along the -Z axis under compliance control	
98	Force limit rate (-RX) (For 6-axis robot)	10000	10000	Force control rate around the -X axis under compliance control	Can be set with SetFrcCoord. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
99	Force limit rate (-RY) (For 6-axis robot)	10000	10000	Force control rate around the -Y axis under compliance control	
100	Force limit rate (-RZ) (For 6-axis robot)	10000	10000	Force control rate around the -Z axis under compliance control	
101	Compliance setting rate (X) (For 6-axis robot)	10000	10000	Compliance rate along the X-axis under compliance control	Can be set with SetCompRate. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
102	Compliance setting rate (Y) (For 6-axis robot)	10000	10000	Compliance rate along the Y-axis under compliance control	
103	Compliance setting rate (Z) (For 6-axis robot)	10000	10000	Compliance rate along the Z-axis under compliance control	
104	Compliance setting rate (RX) (For 6-axis robot)	10000	10000	Compliance rate around the X-axis under compliance control	Can be set with SetCompRate. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
105	Compliance setting rate (RY) (For 6-axis robot)	10000	10000	Compliance rate around the Y-axis under compliance control	
106	Compliance setting rate (RZ) (For 6-axis robot)	10000	10000	Compliance rate around the Z-axis under compliance control	
107	Compliance/positional error allowance (X) (For 6-axis robot)	100	100	Allowable deviation along the X-axis under compliance control	Can be set with SetCompEralw. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
108	Compliance/positional error allowance (Y) (For 6-axis robot)	100	100	Allowable deviation along the Y-axis under compliance control	
109	Compliance/positional error allowance (Z) (For 6-axis robot)	100	100	Allowable deviation along the Z-axis under compliance control	

No.	Items	Factory default	Powering-on default	Description	Comments
110	Compliance/positional error allowance (RX) (For 6-axis robot)	300	300	Allowable deviation around the X-axis under compliance control	Can be set with SetCompEralw. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
111	Compliance/positional error allowance (RY) (For 6-axis robot)	300	300	Allowable deviation around the Y-axis under compliance control	
112	Compliance/positional error allowance (RZ) (For 6-axis robot)	300	300	Allowable deviation around the Z-axis under compliance control	
113	Force offset (X) (For 6-axis robot)	0	0	Force offset along the X-axis under compliance control	Can be set with SetFrcAssist. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
114	Force offset (Y) (For 6-axis robot)	0	0	Force offset along the Y-axis under compliance control	
115	Force offset (Z) (For 6-axis robot)	0	0	Force offset along the Z-axis under compliance control	
116	Force offset (RX) (For 6-axis robot)	0	0	Offset moment around the X-axis under compliance control	Can be set with SetFrcAssist. Cannot be modified with the teach pendant. (Ver. 1.4 or later)
117	Force offset (RY) (For 6-axis robot)	0	0	Offset moment around the Y-axis under compliance control	
118	Force offset (RZ) (For 6-axis robot)	0	0	Offset moment around the Z-axis under compliance control	
120	Optimization initialize	0	Last value at powering-off	0: Will reset the control set of motion optimization to 0 when the power is turned OFF and ON (Default) 1: Will not reset the control set of motion optimization when the power is turned OFF and ON	(Ver. 1.4 or later)
121 to 128	Torque limit for compliance control (J1 to J8) (For 6-axis robot)	0	0	Current limit value for one of J1 to J8 under compliance control	Can be set with SetCompJLimit or ResetCompJ Limit. Cannot be modified with the teach pendant. (Ver. 1.4 or later)

196	J4 brake lock setting (For VM-6083D/ VM-60B1D and VS-E series)	0	0	If the J4 overrides its software motion limit when the brake is released: 0: Will lock the J4 brake 1: Will not lock the J4 brake	(Ver. 1.7 or later)
197	Setting of TCP speed pattern **(Note 1)**	0	Last value at powering-off	0: Conventional speed control 1: Constant TCP speed (Tool end speed in CP motion)	(Ver. 1.8 or later)
198	Restoration of TOOL/WORK data **(Note 2)**	0	Last value at powering-off	0: No resume 1: Resume	(Ver. 1.8 or later)
199	Arc interpolation approved value of easy teaching	100	100	Positional error allowance for arc motion in easy teaching	Do not change this setting if not necessary. (Ver. 1.8 or later)

Note 1: If you specify a CP motion involving the rotation of the robot hand, then the system will automatically decrease the TCP speed (Tool end speed in CP motion) according to the rotation angle by default. This causes some problems that the robot does not run in the specified speed or at constant speed.

In Version 1.8 or later, it is possible to keep the TCP speed constant by setting Parameter No. 197 to 1. If you specify such a motion that will exceed the rotation speed limit, then the system will issue a warning message and run the robot while increasing/decreasing the TCP speed.

Note 2: In earlier versions, the system will not retain TOOL/WORK coordinates declared or defined in programs if the power is turned off. Accordingly, to make a same job, you need to set up the same operation environments every time when restarting the robot.

Setting Parameter No. 198 to 1 will make the system retain those operation environments. When the power is on, they will be resumed.

22.5 Reserved Word List

You cannot use these reserved words as variable names or label names.

A	ABOVE ABS ACCEL ACOS ADDCOMLOG ADDERRLOG ALL AND APPROACH AREA AREAPOS AREASIZE ARRIVE AS ASC ASIN ATN ATN2 AVEC
B	B BELOW BIN BIT BLOB BLOBCOPY BLOBLABEL BLOBMEASURE BREAK BUZZER BYTE
C	C CALCWORKPOS CALL CAMASPECT CAMIN CAMLEVEL CAMMODE CAMTIN CAMTOFF CAMTON CASE CHANGE_BCAP CHANGE_PCAP CHANGECOORD CHANGETOOL CHANGEWORK CHGEXTMODE CHGINTMODE CHR CLEARLOG CLOSECOMLOG CLOSEERRLOG CLRERR CODE COM_DISCOM COM_ENCOM COM_STATE CONTINUERUN CONT COS CREATESEM CURACC CURDEC CUREJNT CUREXJ CUREXTACC CUREXTDEC CUREXTSPD CURFIG CURJACC CURJDEC CURJNT CURJSPD CUROPTMODE CURPOS CURSPD CURTOOL CURTRACKPOS CURTRACKPOSEX CURTRACKSPD CURTRN CURWORK CYCLE
D	D DATE DECEL DEF DEFDBL DEFEND DEFINT DEFIO DEFJNT DEFPOS DEFSNG DEFSTR DEFTRN DEFVEC DEG DEGRAD DELAY DELETESEM DEPART DESTEXJ DESTJNT DESTPOS DESTTRN DETECT DIM DISP_PAGE DIST DO DOUBLE DRAW DRIVE DRIVEA
E	E EJ ELSE ELSEIF EMGSTOP END ENDIF EQJ EQP EQS EQT EQU EQV ERL ERR ERRMSG ERROR EX EXA EXECAL EXIT EXP EXTSPEED
F	F FALSE FIG FIGAPRL FIGAPRP FLIP FLOAT FLUSH FLUSHSEM FOR FORMAT FREE
G	GETCOMLOG GETENV GETERR GETERRLOG GETERRLVL GETJNTDATA GETSRVDATA GETSRVSTATE GIVEARM GIVEARMNOWAIT GIVESEM GIVEVIS GO GOHOME GOSUB GOTO GRASP
H	H HALT HAND HEX HMOVE HOLD HOME
I	I IF IN INIT INPUT INPUTB INPUTB$ INT INTEGER INTERRUPT IO IOBLOCK IS
J	J J2P J2T JOINT JSPEED JACCEL JDECEL
K	KEEP KILL KILLALL
L	L LEFT LEFTY LEN LET LETA LETENV LETF LETJ LETJ1 LETJ2 LETJ3 LETJ4 LETJ5 LETJ6 LETO LETP LETR LETRX LETRY LETRZ LETT LETX LETY LETZ LINEINPUT LINPUTB LOG LOG10 LOOP LPRINTB
M	MAGNITUDE MAX MID MIN MIRROR MOD MOTOR MOVE MPS
N	NEJ NEP NEQ NES NET NEV NEXT NONFLIP NORMTRN NOT
O	OFF ON OR ORD OUT OVEC
P	P P2J P2T PI POSCLR POSE POSITION POSRX POSRY POSRZ POST POSX POSY POSZ POW PRINT PRINTB PRINTDBG PRINTLBL PRINTMSG PRIORITY PROGRAM PTP PVEC
R	R RAD RADDEG RELEASE REM REPEAT RESET RESETAREA RESETVALVE RESULT RESUME RETURN RIGHT RIGHTY RND ROB ROBOT ROTATE ROTATEH RUN RVEC

S	S SEC SELECT SENDKEY SET SETAREA SETVALVE SGN SHADDGROUP SHCIRCLE SHCLRGROUP SHCLRMODEL SHCOPYMODEL SHCORNER SHDEFCIRCLE SHDEFCORNER SHDEFMODEL SHDISPMODEL SHDROPGROUP SHGROUP SHLOADMODEL SHMODEL SHREFGROUP SHREFMODEL SHSAVEMODEL SIN SINGLE SPEED SPRINTF SQR SQRT ST_ASPACLD ST_ASPCHANGE ST_OFFSRVLOCK ST_ONSRVLOCK ST_RESETCOMPCONTROL ST_RESETCOMPERALW ST_RESETCOMPJLIMIT ST_RESETCOMPRATE ST_RESETCOMPVMODE ST_RESETCURLMT ST_RESETDAMPRATE ST_RESETERALW ST_RESETFRCASSIST ST_RESETFRCLIMIT ST_RESETGRAVITY ST_RESETGRVOFFSET ST_RESETZBALANCE ST_SETCOMPCONTROL ST_SETCOMPERALW ST_SETCOMPFCONTROL ST_SETCOMPJLIMIT ST_SETCOMPRATE ST_SETCOMPVMODE ST_SETCURLMT ST_SETDAMPRATE ST_SETERALW ST_SETFRCASSIST ST_SETFRCCOORD ST_SETFRCLIMIT ST_SETGRAVITY ST_SETGRVOFFSET ST_SETZBALANCE STARTDATA STARTLOG STATUS STEP STOP STOPEND STOPLOG STARTTRI STR STRING STRPOS SUB SUSPEND SUSPENDALL SYSSTATE
T	T T2J T2P TACCEL TAKEARM TAKESEM TAKEVIS TAN TDECEL THEN TIME TIMER TINV TLSPEED TO TOOL TOOLPOS TRACKDATAGET TRACKDATAINFO TRACKDATAINITIALIZE TRACKDATANUM TRACKDATASET TRADIUS TRANS TRAVELD TRAVELG TRNS TRUE TS TSMOVE TSPEED TSPIN TSRSTATE TTURN
U	UNTIL
V	V VAL VECTOR VER VISBINA VISBINAR VISBRIGHT VISCAL VISCAMOUT VISCIRCLE VISCLS VISCOPY VISCROSS VISDEFCHAR VISDEFTABLE VISEDGE VISELLIPSE VISFILTER VISGETNUM VISGETP VISGETSTR VISHIST VISLEVEL VISLINE VISLOC VISMASK VISMEASURE VISOVERLAY VISPLNOUT VISPOSX VISPOSY VISPRINT VISPROJ VISPTP VISPUTP VISREADBAR VISREADQR VISRECT VISREFCAL VISREFHIST VISREFTABLE VISSCREEN VISSECT VISSTATUS VISWORKPLN
W	WAIT WAITTRACKMOVE WAITTRACKMOVEEX WEND WHILE WINDCLR WINDCOPY WINDDISP WINDMAKE WINDREF WORD WORK WORKPOS WRITE
X	X XOR XY XYH
Y	YZ YZH
Z	ZX ZXH

22.6 Conventional Language Command Correspondence Table (VS)

■ Motion Command Correspondence Table

Conventional language command	PAC COMMAND	MOVE Macro
MVE J*n*	MOVE P, J*n*	——
MVP J*n*	MOVE P, @P J*n*	——
MVSE P*n*	MOVE L, T*n*	——
MVSP P*n*	MOVE L, @P T*n*	——
DRVE (*j1 j2 j3 j4 j5 j6*)	DRIVE (1*j1*),…	*Jn* = *Jc* + (*j1 j2 j3 j4 j5 j6*) MOVE P, *Jn*
DRVE J*n*	DRIVE (1, JOINT (1, J*n*)),…	*jj* = *Jc* + (JOINT (1, J*n*)),…, JOINT (6, J*n*) MOVE P, @P J*n*
DRVP (*j1 j2 j3 j4 j5 j6*)	DRIVE @P (1 *j1*),…	*Jn* = *Jc* + (*j1 j2 j3 j4 j5 j6*) MOVE P, @P J*n*
DRVP J*n*	DRIVE @P (1, JOINT (1*j1*)),…	*jj* = *Jc* + (JOINT (1, J*n*)),…, JOINT (6, J*n*) MOVE P, @P *jj*
DRWE (*x, y, z*)	DRAW L, (*x, y, z*)	MOVE L, *Pc* + (*x, y, z*)
DRWE Pn	DRAW L, PVEC (T*n*)	MOVE L, *Pc* + (POSX (P*n*), POSY (P*n*), POSZ (Pn))
DRWP (*x, y, z*)	DRAW L, @P (*x, y, z*)	MOVE L, @P *Pc* + (*x, y, z*)
DRWP P*n*	DRAW L, @P PVEC (T*n*)	MOVE L, @P *Pc* + (POSX (P*n*), POSY (P*n*), POSZ (P*n*))
DEPE *n*	DEPART L, *n*	MOVE L, *Pc* + (0, 0, -*n*) H
DEPP *n*	DEPART L, @P *n*	MOVE L, @P *Pc* + (0, 0, -*n*) H
APRE *n*	APPROACH L, *Px*, *n*	MOVE L, *Px* + (0, 0, -*n*) H
APRP *n*	APPROACH L, @P *Px*, *n*	MOVE L, @P *Px* + (0, 0, -*n*) H
APRJE *n*	APPROACH P, *Px*, *n*	MOVE P, *Px* + (0, 0, -*n*) H
APRJP *n*	APPROACH P, @P *Px*, *n*	MOVE P, @P *Px* + (0, 0, -*n*) H
ROTE *n*	ROTATEH *n*	MOVE L, *Pc* + (*0, 0, 0, 0, 0, n*) H
ROTP *n*	ROTATEH @P *n*	MOVE L, @P *Pc* + (*0, 0, 0, 0, 0, n*) H
MVRE P*n2*, P*n3*	MOVE C, T*n2*, T*n3*	——
MVPR P*n2*, P*n3*	MOVE C, T*n2*, @P T*n3*	——

(!) *Pc/Jc* is a current position, and *Px/Jx* is a destination position.
(!) Add DRVE to an argument in the DRIVE Library specification is under consideration.
(!) *jj* is a temporary local variable.

■ Speed Designation Command Correspondence Table

Conventional language command	PAC COMMAND	Remark
ISP *n*	SPEED *n*	
ACC *n*	ACCEL *n, n*	
AACC *n*	ACCEL *n*	
RACC *n*	DECEL *n*	

■ Jump Command Correspondence Table

Conventional language command	PAC COMMAND	Remark
JI *m-n*	IF IO [m]=1 THEN *label*n*	
JZ *m-n*	IF IO [m]=0 THEN *label*n*	
JMP *n*	GOTO *label*n*	
CMP *l s m*	IF *l s m* THEN *label*n*	*s* is a comparison symbol.

Conventional language command	PAC COMMAND	Remark
LABL *n*	*label*n.*	
LABL *n*	*label*n.*	
IPCLR *n*	CALL pltResetAll (*n*)	
INTRPT	INTERRUPT ON	After the next command, this changes to INTERRUPT OFF.
REM	REM|’	

ON *n*
ON *n-m*
	SET IO [*n*]
	SET IO [*n* TO *m*]	

OFF *n* OFF *n-m*	RESET IO [*n*] RESET IO [*n* TO *m*]	
ONT *n-m* TIME=*t*	SET IO [*n* TO *m*], t*10	The unit is msec. (Note) In case of PAC, a control does not proceed to the next process.

VON *n*
VON *n-m*
	SET IO [*n*]
	SET IO [*n* TO *m*]	

VOFF *n* VOFF *n-m*	RESET IO [*n*] RESET IO [*n* TO *m*]	
ON PLT1END	SET IO [*n*]	Refer to the DIO assignment table.
OFF PLT1END	RESET IO [*n*]	Refer to the DIO assignment table.
ON PLTEND	SET IO [*n*]	Refer to the DIO assignment table.
OFF PLTEND	RESET IO [*n*]	Refer to the DIO assignment table.
INB *L m-n*	CALL ndInb (*L, m, n*)	Library call
ONB *L m-n*	CALL ndOnb (*L, m, n*)	Library call
ONB I*x m-n*	CALL ndOnbI (*x, m, n*)	Library call

■ Stop Command Correspondence Table

Conventional language command	PAC COMMAND	Remark
END	END	
STOP	HOLD	
STOPEND	STOPEND	
TIM *n*	DELAY *n** 10	

■ SETI Command Correspondence Table

Conventional language command	PAC COMMAND	Remark
Variable 6 axes P*n*	T [*n*]	
Indirect reference I*n*. P	P [*n*]	
$	CURPOS|*	
\	CURJNT|*	
ISP	CURSPD	
AACC	CURACC	
RACC	CURDEC	
SETI I*x* = N_*n*	CALL pltGetN (*n, x*)	Library call
SETI I*x* = M_*n*	CALL pltGetM (*n, x*)	Library call
SETI I*x* = K_*n*	CALL pltGetK (*n, x*)	Library call
SETI I*x* = N1_*n*	CALL pltGetN1 (*n, x*)	Library call
SETI I*x* = M1_*n*	CALL pltGetM1 (*n, x*)	Library call
SETI I*x* = K1_*n*	CALL pltGetK1 (*n, x*)	Library call

■ Operation Command Correspondence Table

Conventional language command	PAC COMMAND	Remark
+	+	Addition
-	-	Subtraction
*	*	Multiplication
/	/	Division
%	MOD	Remainder
.	*	Inner product (for vectors)
x	x	Outer product (for vectors)
ABS (*n*)	ABS (*n*)	
SIN (*n*)	SIN (*n*)	
COS (*n*)	COS (*n*)	
TAN (*n*)	TAN (*n*)	
ATAN (*n*)	ATAN (*n*)	
ATN2 (*y*, *x*)	ATN2 (*y*, *x*)	
SQRT (*n*)	SQRT (*n*)	
FWRD (J*n*)	J2P (J [*n*])	
REV2 (P*n*)	P2J (P [*n*])	
TRNS (P*m*, J*k*)	P*m* + ($x, y, z, \alpha, \beta, \gamma$) H	Refer to the next page.
TINV (P*n*)	TINV (T*n*)	
DATE	CALL ndDate	Library specification is under consideration.
TIME (0)	CALL ndTime	Library specification is under consideration.
TIME (1)	TIMER	

■ Communication Command Correspondence Table

Conventional language command	PAC COMMAND	Remark
VIS *n*	CALL ndVis (*n*)	Library call
JF *n-m*	CALL ndJf (*n, k*) IF I [*k*] = 0 THEN *label	Library call
VSET *n*	CALL ndVset ()	Library call
VDT	CALL ndVdt	Library call
VPUT $ VPUT P*n*	CALL ndVput ()	Library call
VRST	CALL ndVrst	Library call

■ Defined Command Correspondence Table

Conventional language command	PAC COMMAND	Remark
SUB *n*	CALL SUB*n*	SUB*n* is a program name.
PALT *n*	CALL pltMove (*n*)	Library call
TOOL *n*	CHANGETOOL *n*	

Functions to move the coordinate system

Although the PAC language does not support coordinate system moving functions (TRANS command) of conventional language commands, you can move the coordinate system with the position operation. For details refer to Part 1 Chapter 1, subsection 1.9.7 “Position Operation”.
For the coordinate system, there are methods to use Type P variables and Type T variables, and they can change the work coordinate references and the tool coordinate system references.
If you move the coordinate system to the Type J variable, it is converted to a Type P or a Type T variable with JP2 or J2T.

(1) If Type P variables are used

1. Designate the relative movement distance with the work coordinate system as the reference.

   ```
   Pn = Pm + ( X, Y, Z, Rx, Ry, Rz)
   ```

   Obtain the position Pn: from the reference position Pm, the position moves in millimeters (mm) by X, Y, and Z in the directions of the X, Y and Z axes of the respective work coordinate systems. The posture rotates in degrees of Rx, Ry, and Rz around the X, Y and Z axes of the respective work coordinates. The robot assumes the Pm figure.

2. Designate the relative movement distance with the tool coordinate system as the reference.

   ```
   Pn = Pm + ( X, Y, Z, Rx, Ry, Rz) H
   ```

   Obtain the position Pn: from the reference position Pm, the position moves in millimeters (mm) by X, Y, and Z in the directions of the X (normal vector), Y (orient vector) and Z (approach vector) axes of the respective work coordinate systems. The posture rotates in degrees of Rx, Ry, and Rz around the X (normal vector), Y (orient vector) and Z (approach vector) axes of the respective work coordinates. The robot assumes the Pm figure.

(2) If Type T variables are used

1. Designate the relative movement distance with the work coordinate system as the reference.

   ```
   DEFTRN LT1, LT2
   DEFPOS LP1
   LP1= (0, 0, 0, Rx, Ry, Rz)
   LT1=P2T(LP1)
   LT2=Tm
   LETP LT2 = (0, 0, 0)
   Tn=LT1*LT2
   LETP Tn = PVEC(Tm) + (X, Y, Z)
   LETF Tn = FIG(Tm)
   ```

   Obtain a position Tn: from the reference position Pm, the position moves in millimeters (mm) by X, Y, and Z in the directions of the X, Y and Z axes of the respective work coordinate systems. The posture rotates in degrees of Rx, Ry, and Rz around the X, Y and Z axes of the respective work coordinates. The robot becomes the Tm figure.

2. Designate the relative movement distance with the tool coordinate system as the reference.

   ```
   DEFTRN LT1
   DEFPOS LP1
   LP1=(X, Y, Z, Rx, Ry, Rz)
   LT1=P2T(LP1)
   Tn=LT1*LT2
   LETF Tn=FIG(Tm)
   ```

   Obtain the position Pn: from the reference position Pm, the position moves in millimeters (mm) by X, Y, and Z in the directions of the X (normal vector), Y (orient vector) and Z (approach vector) axes of the respective work coordinate systems. The posture rotates in degrees of Rx, Ry, and Rz around the X (normal vector), Y (orient vector) and Z (approach vector) axes of the respective work coordinates. The robot becomes the Tm figure.

(Note) The TRANS command is a coordinate system movement command which uses the tool coordinate system as the reference; however, the posture rotation method is different from the tool coordinate system movement command for Type P variable and a Type T variable as follows.

	Posture rotation method of the coordinate system

Js = (X, Y, Z, Rx, Ry, Rz)
Pn = TRANS (Pm, Js)
	From the posture at the reference position Pm, it rotates by Rx (degrees) around the X axis (normal vector) of the tool coordinate system, and rotates by Ry (degrees) around the Y axis of the rotated tool axis. It also rotates by Rz (degrees) around the Z axis of the rotated tool coordinate system.

Pn=Pm + (X, Y, Z, Rx, Ry, Rz) H	From the posture at the reference position Pm, it rotates by Rx (degrees) around the X axis (normal vector) of the tool coordinate system, and rotates by Ry (degree) around the Y axis of the tool axis before rotation. It also rotates by Rz (degrees) around the Z axis of the tool coordinate system prior to rotation.

For posture rotation similar to the TRANS command of conventional language, designate as follows.

(1) If Type P variables are used

```
Pn = Pm + (X, Y, Z, 0, 0, 0) H
Pn = Pn + (0, 0, 0, Rx, 0, 0) H
Pn = Pn + (0, 0, 0, 0, Ry, 0) H
Pn = Pn + (0, 0, 0, 0, 0, Rz) H
```

(2) If Type T variables are used

```
DEFTRN LT
DEFPOS LP
LP = (X, Y, Z, 0, 0, 0)
LT = P2T (LP)
Tn = Tm*LT
LP = (0, 0, 0, Rx, 0, 0)
LT = P2T (LP)
Tn = Tn*LT
LP = (0, 0, 0, 0, Ry, 0)
LT = P2T (LP)
Tn = Tn*LT
LP = (0, 0, 0, 0, 0, Rz)
LT = P2T (LP)
Tn = Tn*LT
LETF Tn = FIG (Tm)
```

22.7 Version Correspondence Table

Expression values used with the VER$ function and the corresponding modules are listed on the table below.
For the VER$ function, refer to Part 2 Chapter 12, subsection “12.1.3 VER$ (Function)”.

Expression value	Module name
0	ROM
1	Main board
2	DIO board
3	Vision board
4	Device net board
5	Teach pendant
6	Operation panel
7	PAC language process module
8	Intermediate code process module
9	Path process module
10	Servo process module
11	Communication process module
12	Pendant process module
13	Vision process module
14	Vision communication process module
15	Device net process module
16	PAC language specification
17	Intermediate code specification
18	Servo communication specification
19	Vision communication specification
20	ROBO Talk communication specification
21	Pendant communication specification
22	Device Net communication specification

22.8 Setting Parameter Table

■ Pac Manager - Program

Parameter name	Macro name	Description
Number of Type I variables	PC_NO_INT	The number of numbered long integer type variables.
Number of Type F variables	PC_NO_SNG	The number of numbered single precision real type variables.
Number of Type D variables	PC_NO_DBL	The number of numbered double precision real type variables.
Number of Type V variables	PC_NO_VEC	The number of numbered vector type variables.
Number of Type P variables	PC_NO_POS	The number of numbered position type variables.
Number of Type J variables	PC_NO_JNT	The number of numbered joint type variables.
Number of Type T variables	PC_NO_TRN	The number of numbered homogeneous transformation type variables.
Number of Type S variables	PC_NO_STR	The number of numbered character string type variables.
Approximation comparison precision (*10^6)	PC_EPSILON	Approximation comparison operator (=) permissible deviation amount (×1000000)
Trace code deletion	PC_NO_TRACE	Deletes the debug code from the compile code. (0: do not delete. 2: delete all.)
Cycle time calculation code deletion	PC_NO_CYC_TIME	Deletes cycle time calculation code from the compile code (0: do not delete, 1: partly delete, 2: delete all)
Array range check code deletion	PC_NO_CHK_INDEX	Deletes array range check code from the compile code. (0: do not delete, 1: partly delete, 2: delete all)
Error interruption process code deletion	PC_NO_ERR_TRAP	Deletes interruption process code from the compile code. (0: do not delete, 1: delete)

■ Dio Manager - Hardware

Parameter name	Macro name	Description
Assignment mode (0: compatible, 1: standard)	IO_ASSIGN	I/O assignment mode setting (0: compatible mode, 1: standard mode)
Parity bit (0: invalid, 1: valid)	IO_PARITY	Setting of program No. selection parity in program start Parity bit (0: invalid, 1: valid)
Hand IO. Interruption setting (0: invalid, 1: valid)	IO_HD_ENABLED	--
DeviceNet. Input slot number	IO_DN_IN_SLOT	--
DeviceNet. Output slot number	IO_DN_OUT_SLOT	--
DeviceNet. Preparation failure detection (0: invalid, 1: valid)	IO_DN_EXERRCHK	--
Dedicated I/O Output Mode (0: invalid, 1: valid)	IO_DEDICTDIO	--
M-Dnet Error Indication (0: Every time, 1: First time)	IO_MDN_ERRDISP	--
PROFIBUS node address (1 to 125)	IO_SPRFI_ADRS	--
PROFIBUS Input Setting (0:8, 1:12, 2:16, 3:20, 4:32)	IO_SPRFI_INTYPE	PROFIBUS input setting 0: 8 bytes Output con 1: 12 bytes Output con 2: 16 bytes Output con 3: 20 bytes Output con 4: 32 bytes Output con
PROFIBUS Output Setting (0:8, 1:12, 2:16, 3:20, 4:32)	IO_SPRFI_OUTTYPE	PROFIBUS output setting 0: 8 bytes Input con 1: 12 bytes Input con 2: 16 bytes Input con 3: 20 bytes Input con 4: 32 bytes Input con

■ Arm Manager - Path creation

Parameter name	Macro name	Description
Positive direction software motion limit (J1,deg*10^3)	AM_JPRM_PLIM1	1st axis positive direction software motion limit (×1000, unit: degree)
Positive direction software motion limit (J2,deg*10^3)	AM_JPRM_PLIM2	2nd axis positive direction software motion limit (×1000, unit: degree)
Positive direction software motion limit (J3,deg*10^3)	AM_JPRM_PLIM3	3rd axis positive direction software motion limit (×1000, unit: degree)
Positive direction software motion limit (J4,deg*10^3)	AM_JPRM_PLIM4	4th axis positive direction software motion limit (×1000, unit: degree)
Positive direction software motion limit (J5,deg*10^3)	AM_JPRM_PLIM5	5th axis positive direction software motion limit (×1000, unit: degree)
Positive direction software motion limit (J6,deg*10^3)	AM_JPRM_PLIM6	6th axis positive direction software motion limit (×1000, unit: degree)
Positive direction software motion limit (J7,deg*10^3)	AM_JPRM_PLIM7	7th axis positive direction software motion limit (×1000, unit: degree)
Positive direction software motion limit (J8,deg*10^3)	AM_JPRM_PLIM8	8th axis positive direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J1,deg*10^3)	AM_JPRM_NLIM1	1st axis negative direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J2,deg*10^3)	AM_JPRM_NLIM2	2nd axis negative direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J3,deg*10^3)	AM_JPRM_NLIM3	3rd axis negative direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J4,deg*10^3)	AM_JPRM_NLIM4	4th axis negative direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J5,deg*10^3)	AM_JPRM_NLIM5	5th axis negative direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J6,deg*10^3)	AM_JPRM_NLIM6	6th axis negative direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J7,deg*10^3)	AM_JPRM_NLIM7	7th axis negative direction software motion limit (×1000, unit: degree)
Negative direction software motion limit (J8,deg*10^3)	AM_JPRM_NLIM8	8 axis negative direction software motion limit (×1000, unit: degree)
RANG (J1,deg*10^5)	AM_JPRM_RANG1	1st axis RANG value (×100000, unit: degree)

■ Arm Manager - Using Condition

Parameter name	Macro name	Description
Control set of motion optimization	CND_ASPACC	Control set of motion optimization (0: normal, 1: only PTP is valid, 2: only CP is valid, 3: both PTP and CP are valid)
Floor, ceiling, or wall-hanging setting	CND_SPACE	Floor-, ceiling-, or wall-hanging setting (0: Floor, 1: Ceiling, 2: Wall)
Mass of payload (g)	CND_LOAD	Mass of payload (unit: g)
Payload center of gravity X6 (mm)	CND_LDPOSGX	Component X of payload center of gravity (unit : mm)
Payload center of gravity Y6 (mm)	CND_LDPOSGY	Component Y of payload center of gravity (unit : mm)
Payload center of gravity Z6 (mm)	CND_LDPOSGZ	Component Z of payload center of gravity (unit : mm)
Permissible pulse width in stop (J1)	CND_PLSWDTH1	1st axis permissible pulse width in stop (unit: pulse)
Permissible pulse width in stop (J2)	CND_PLSWDTH2	2nd axis permissible pulse width in stop (unit: pulse)
Permissible pulse width in stop (J3)	CND_PLSWDTH3	3rd axis permissible pulse width in stop (unit: pulse)
Permissible pulse width in stop (J4)	CND_PLSWDTH4	4th axis permissible pulse width in stop (unit: pulse)
Permissible pulse width in stop (J5)	CND_PLSWDTH5	5th axis permissible pulse width in stop (unit: pulse)
Permissible pulse width in stop (J6)	CND_PLSWDTH6	6th axis permissible pulse width in stop (unit: pulse)
Permissible pulse width in stop (J7)	CND_PLSWDTH7	7th axis permissible pulse width in stop (unit: pulse)
Permissible pulse width in stop (J8)	CND_PLSWDTH8	8th axis permissible pulse width in stop (unit: pulse)
Motion finish timeout (msec)	CND_MVTIMOUT	Motion finish timeout time when @E is designated (unit: msec)

■ Vision Manager - General Setting

Parameter name	Macro name	Description
Camera 1 - shutter system	CA_SHUT1	Camera 1 shutter system (0: field, 1: frame)
Camera 1 - input lower limit level	CA_LEVEL_L1	Camera 1 input lower limit level
Camera 1 - input upper limit level	CA_LEVEL_H1	Camera 1 input upper limit level
Camera 1 - Camera availability	CA_CONNECT1	Camera 1 availability to use (0: avaialble to use, 1: not connected, 2: option, 3: none)
Camera 2 - shutter system	CA_SHUT2	Camera 2 shutter system (0: field, 1: frame)
Camera 2 - input lower limit level	CA_LEVEL_L2	Camera 2 input lower limit level
Camera 2 - input upper limit level	CA_LEVEL_H2	Camera 2 input upper limit level
Camera 2 - Camera availability	CA_CONNECT2	Camera 2 availability to use (0: avaialble to use, 1: not connected, 2: option, 3: none)
Camera synchronization system	CA_SYNC	Camera synchronization system (0: camera internal synchronization, 1: camera external synchronization)
ShCorn - distance	SH_CORN_DIST1	ShCorner command measurement condition (distance between pad and corner) 1 to 10
ShCorn - pitch	SH_CORN_DIST2	ShCorner command measurement condition (Pitch between two pads) 1 to 10
ShCorn - width	SH_CORN_WIDTH	ShCorner command measurement condition (Pad width) 1 to 10
ShCorn - height	SH_CORN_HEIGHT	ShCorner command measurement condition (Pad height) 1 to 10
ShCirc - pitch	SH_CIRC_DIST	ShCircle command measurement condition (Pitch between two pads) 1 to 10
ShCirc - width	SH_CIRC_WIDTH	ShCircle command measurement condition (Pad width) 1 to 10
Search timeout time (ms)	SH_TIMEOUT	Search measurement timeout time
Vision monitor display position	VS_DISP_LOC	A position to display the process screen on the vision monitor (0: center, 1: left, 2: right)

■ Log Manager - Communication Specification

Parameter name	Macro name	Description
Timeout time (msec)	COM_RTK_TOUT	Timeout time in communication (unit: msec)
The number of retries when atimeout occurs.	COM_RTK_TRETRY	The number of retry when communication timeout occurs.
The number of retries when an NAK occurs.	COM_RTK_RETRY	The number of retry when NAK (packet failure) occurs.

Parameter name	Macro name	Description
RS232C(2). Communication priority	COM_RS2_ACCESS	Communication priority setting of RS232C channel 2 of the controller (0: not available, 1: only reading, 2: read/write available)
RS232C(2). Baud rate	COM_RS2_SPEED	Baud rate setting of RS232C channel 2 of the controller (unit: bps)
RS232C(2). Parity (0: even, 1: non, 2: odd)	COM_RS2_PARITY	Parity setting of RS232C channel 2 of the controller (0: even, 1: non, 2: odd)
RS232C(2). Data length	COM_RS2_DATELEN	Data length setting of RS232C channel 2 of the controller (unit: bit)
RS232C(2). Stop bit (0: 1bit, 1: 1.5bit, 2: 2bit)	COM_RS2_STOPBIT	Stop bit setting of RS232C channel 2 of the controller (0: 1bit, 1: 1.5bit, 2: 2bit)
RS232C(2). Delimiter (0: CR, 1: CR + LF)	COM_RS2_DELIMITER	Delimiter setting of RS232C channel 2 of the controller (0: CR, 1: CR + LF)
RS232C(3). Communication priority	COM_RS3_ACCESS	Communication priority setting of RS232C channel 3 of the controller (0: not available, 1: only reading, 2: read/write available)
RS232C(3). Baud rate	COM_RS3_SPEED	Baud rate setting of RS232C channel 3 of the controller (unit: bps)
RS232C(3). Parity (0: even, 1: non, 2: odd)	COM_RS3_PARITY	Parity setting of RS232C channel 3 of the controller (0: even, 1: non, 2: odd)
RS232C(3). Data length	COM_RS3_DATELEN	Data length setting of RS232C channel 3 of the controller (unit: bit)
RS232C(3). Stop bit (0: 1bit, 2: 1.5bit, 3: 2bit)	COM_RS3_STOPBIT	Stop bit setting of RS232C channel 3 of the controller (0: 1bit, 1: 1.5bit, 2: 2bit)
RS232C(3). Delimiter (0: CR, 1: CR + LF)	COM_RS3_DELIMITER	Delimiter setting of RS232C channel 3 of the controller (0: CR, 1: CR + LF)
RS232C(4). Communication priority	COM_RS4_ACCESS	Communication priority setting of RS232C channel 4 of the controller (0: not available, 1: only reading, 2: read/write available)
RS232C(4). Baud rate	COM_RS4_SPEED	Baud rate setting of RS232C channel 4 of the controller (unit: bps)
RS232C(4). Parity (0: even, 1: non, 2: odd)	COM_RS4_PARITY	Parity setting of RS232C channel 4 of the controller (0: even, 1: non, 2: odd)
RS232C(4). Data length	COM_RS4_DATELEN	Data length setting of RS232C channel 4 of the controller (unit: bit)
RS232C(4). Stop bit (0: 1bit, 1: 1.5bit, 2: 2bit)	COM_RS4_STOPBIT	Stop bit setting of RS232C channel 4 of the controller (0: 1bit, 1: 1.5bit, 2: 2bit)
RS232C(4). Delimiter (0: CR, 1: CR + LF)	COM_RS4_DELIMITER	Delimiter setting of RS232C channel 4 of the controller (0: CR, 1: CR + LF)
Ethernet. Communication priority	COM_ET_ACCESS	Controller Ethernet communication setting (0: not available, 1: only reading, 2: read/write available)
Ethernet. IP address	COM_ET_IP_ADDR	Controller Ethernet IP address setting
Ethernet. Sub net mask	COM_ET_SUBNET_MASK	Controller Ethernet sub net mask setting
Ethernet. connection destination 1. local port	COM_ET_LPORT1	Connection destination of the controller Ethernet 1.local port setting
Ethernet. connection destination 2. local port	COM_ET_LPORT2	Connection destination of the controller Ethernet 2.local port setting
Ethernet. connection destination 3. local port	COM_ET_LPORT3	Connection destination of the controller Ethernet 3.local port setting
Ethernet. connection destination 4. local port	COM_ET_LPORT4	Connection destination of the controller Ethernet 4.local port setting
Ethernet. connection destination 5. local port	COM_ET_LPORT5	Connection destination of the controller Ethernet 5.local port setting

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