

# **FANUC Robotics SYSTEM R-J3iB Controller KAREL Reference Manual**

**MARAIKLF06031E REV A**

Applies to Version 6.31 and later

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# About This Manual

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## Conventions

This manual includes information essential to the safety of personnel, equipment, software, and data. This information is indicated by headings and boxes in the text.

### Warning



**Information appearing under WARNING concerns the protection of personnel. It is boxed and in bold type to set it apart from other text.**

### Caution



**Information appearing under CAUTION concerns the protection of equipment, software, and data. It is boxed to set it apart from other text.**

**Note** Information appearing next to **NOTE** concerns related information or useful hints.

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# Safety

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FANUC Robotics is not and does not represent itself as an expert in safety systems, safety equipment, or the specific safety aspects of your company and/or its work force. It is the responsibility of the owner, employer, or user to take all necessary steps to guarantee the safety of all personnel in the workplace.

The appropriate level of safety for your application and installation can best be determined by safety system professionals. FANUC Robotics therefore, recommends that each customer consult with such professionals in order to provide a workplace that allows for the safe application, use, and operation of FANUC Robotic systems.

According to the industry standard ANSI/RIA R15-06, the owner or user is advised to consult the standards to ensure compliance with its requests for Robotics System design, usability, operation, maintenance, and service. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for the training of the operator of a robot system to recognize and respond to known hazards associated with your robotic system and to be aware of the recommended operating procedures for your particular application and robot installation.

FANUC Robotics therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC Robotics training course and become familiar with the proper operation of the system. Persons responsible for programming the system-including the design, implementation, and debugging of application programs-must be familiar with the recommended programming procedures for your application and robot installation.

The following guidelines are provided to emphasize the importance of safety in the workplace.

## CONSIDERING SAFETY FOR YOUR ROBOT INSTALLATION

Safety is essential whenever robots are used. Keep in mind the following factors with regard to safety:

- The safety of people and equipment
- Use of safety enhancing devices
- Techniques for safe teaching and manual operation of the robot(s)
- Techniques for safe automatic operation of the robot(s)
- Regular scheduled inspection of the robot and workcell
- Proper maintenance of the robot

## Keeping People and Equipment Safe

The safety of people is always of primary importance in any situation. However, equipment must be kept safe, too. When prioritizing how to apply safety to your robotic system, consider the following:

- People
- External devices
- Robot(s)
- Tooling
- Workpiece

## Using Safety Enhancing Devices

Always give appropriate attention to the work area that surrounds the robot. The safety of the work area can be enhanced by the installation of some or all of the following devices:

- Safety fences, barriers, or chains
- Light curtains
- Interlocks
- Pressure mats
- Floor markings
- Warning lights
- Mechanical stops
- EMERGENCY STOP buttons
- DEADMAN switches

## Setting Up a Safe Workcell

A safe workcell is essential to protect people and equipment. Observe the following guidelines to ensure that the workcell is set up safely. These suggestions are intended to supplement and **not** replace existing federal, state, and local laws, regulations, and guidelines that pertain to safety.

- Sponsor your personnel for training in approved FANUC Robotics training course(s) related to your application. Never permit untrained personnel to operate the robots.
- Install a lockout device that uses an access code to prevent unauthorized persons from operating the robot.
- Use anti-tie-down logic to prevent the operator from bypassing safety measures.
- Arrange the workcell so the operator faces the workcell and can see what is going on inside the cell.

- Clearly identify the work envelope of each robot in the system with floor markings, signs, and special barriers. The work envelope is the area defined by the maximum motion range of the robot, including any tooling attached to the wrist flange that extend this range.
- Position all controllers outside the robot work envelope.
- Never rely on software as the primary safety element.
- Mount an adequate number of EMERGENCY STOP buttons or switches within easy reach of the operator and at critical points inside and around the outside of the workcell.
- Install flashing lights and/or audible warning devices that activate whenever the robot is operating, that is, whenever power is applied to the servo drive system. Audible warning devices shall exceed the ambient noise level at the end-use application.
- Wherever possible, install safety fences to protect against unauthorized entry by personnel into the work envelope.
- Install special guarding that prevents the operator from reaching into restricted areas of the work envelope.
- Use interlocks.
- Use presence or proximity sensing devices such as light curtains, mats, and capacitance and vision systems to enhance safety.
- Periodically check the safety joints or safety clutches that can be optionally installed between the robot wrist flange and tooling. If the tooling strikes an object, these devices dislodge, remove power from the system, and help to minimize damage to the tooling and robot.
- Make sure all external devices are properly filtered, grounded, shielded, and suppressed to prevent hazardous motion due to the effects of electro-magnetic interference (EMI), radio frequency interference (RFI), and electro-static discharge (ESD).
- Make provisions for power lockout/tagout at the controller.
- Eliminate *pinch points*. Pinch points are areas where personnel could get trapped between a moving robot and other equipment.
- Provide enough room inside the workcell to permit personnel to teach the robot and perform maintenance safely.
- Program the robot to load and unload material safely.
- If high voltage electrostatics are present, be sure to provide appropriate interlocks, warning, and beacons.
- If materials are being applied at dangerously high pressure, provide electrical interlocks for lockout of material flow and pressure.

## **Staying Safe While Teaching or Manually Operating the Robot**

Advise all personnel who must teach the robot or otherwise manually operate the robot to observe the following rules:

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Know whether or not you are using an intrinsically safe teach pendant if you are working in a hazardous environment.
- Before teaching, visually inspect the robot and *work envelope* to make sure that no potentially hazardous conditions exist. The work envelope is the area defined by the maximum motion range of the robot. These include tooling attached to the wrist flange that extends this range.
- The area near the robot must be clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.
- FANUC Robotics recommends that no one enter the work envelope of a robot that is on, except for robot teaching operations. However, if you must enter the work envelope, be sure all safeguards are in place, check the teach pendant DEADMAN switch for proper operation, and place the robot in teach mode. Take the teach pendant with you, turn it on, and be prepared to release the DEADMAN switch. Only the person with the teach pendant should be in the work envelope.

**Warning**

**Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.**

- Know the path that can be used to escape from a moving robot; make sure the escape path is never blocked.
- Isolate the robot from all remote control signals that can cause motion while data is being taught.
- Test any program being run for the first time in the following manner:

**Warning**

**Stay outside the robot work envelope whenever a program is being run. Failure to do so can result in injury.**

- Using a low motion speed, single step the program for at least one full cycle.
- Using a low motion speed, test run the program continuously for at least one full cycle.
- Using the programmed speed, test run the program continuously for at least one full cycle.
- Make sure all personnel are outside the work envelope before running production.

## Staying Safe During Automatic Operation

Advise all personnel who operate the robot during production to observe the following rules:

- Make sure all safety provisions are present and active.
- Know the entire workcell area. The workcell includes the robot and its work envelope, plus the area occupied by all external devices and other equipment with which the robot interacts.
- Understand the complete task the robot is programmed to perform before initiating automatic operation.
- Make sure all personnel are outside the work envelope before operating the robot.
- Never enter or allow others to enter the work envelope during automatic operation of the robot.
- Know the location and status of all switches, sensors, and control signals that could cause the robot to move.
- Know where the EMERGENCY STOP buttons are located on both the robot control and external control devices. Be prepared to press these buttons in an emergency.
- Never assume that a program is complete if the robot is not moving. The robot could be waiting for an input signal that will permit it to continue activity.
- If the robot is running in a pattern, do not assume it will continue to run in the same pattern.
- Never try to stop the robot, or break its motion, with your body. The only way to stop robot motion immediately is to press an EMERGENCY STOP button located on the controller panel, teach pendant, or emergency stop stations around the workcell.

## **Staying Safe During Inspection**

When inspecting the robot, be sure to

- Turn off power at the controller.
- Lock out and tag out the power source at the controller according to the policies of your plant.
- Turn off the compressed air source and relieve the air pressure.
- If robot motion is not needed for inspecting the electrical circuits, press the EMERGENCY STOP button on the operator panel.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- If power is needed to check the robot motion or electrical circuits, be prepared to press the EMERGENCY STOP button, in an emergency.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

## Staying Safe During Maintenance

When performing maintenance on your robot system, observe the following rules:

- Never enter the work envelope while the robot or a program is in operation.
- Before entering the work envelope, visually inspect the workcell to make sure no potentially hazardous conditions exist.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Consider all or any overlapping work envelopes of adjoining robots when standing in a work envelope.
- Test the teach pendant for proper operation before entering the work envelope.
- If it is necessary for you to enter the robot work envelope while power is turned on, you must be sure that you are in control of the robot. Be sure to take the teach pendant with you, press the DEADMAN switch, and turn the teach pendant on. Be prepared to release the DEADMAN switch to turn off servo power to the robot immediately.
- Whenever possible, perform maintenance with the power turned off. Before you open the controller front panel or enter the work envelope, turn off and lock out the 3-phase power source at the controller.
- Be aware that an applicator bell cup can continue to spin at a very high speed even if the robot is idle. Use protective gloves or disable bearing air and turbine air before servicing these items.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.



### Warning

**Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock. HIGH VOLTAGE IS PRESENT at the input side whenever the controller is connected to a power source. Turning the disconnect or circuit breaker to the OFF position removes power from the output side of the device only.**

- Release or block all stored energy. Before working on the pneumatic system, shut off the system air supply and purge the air lines.
- Isolate the robot from all remote control signals. If maintenance must be done when the power is on, make sure the person inside the work envelope has sole control of the robot. The teach pendant must be held by this person.

- Make sure personnel cannot get trapped between the moving robot and other equipment. Know the path that can be used to escape from a moving robot. Make sure the escape route is never blocked.
- Use blocks, mechanical stops, and pins to prevent hazardous movement by the robot. Make sure that such devices do not create pinch points that could trap personnel.

**Warning**

**Do not try to remove any mechanical component from the robot before thoroughly reading and understanding the procedures in the appropriate manual. Doing so can result in serious personal injury and component destruction.**

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- When replacing or installing components, make sure dirt and debris do not enter the system.
- Use only specified parts for replacement. To avoid fires and damage to parts in the controller, never use nonspecified fuses.
- Before restarting a robot, make sure no one is inside the work envelope; be sure that the robot and all external devices are operating normally.

## KEEPING MACHINE TOOLS AND EXTERNAL DEVICES SAFE

Certain programming and mechanical measures are useful in keeping the machine tools and other external devices safe. Some of these measures are outlined below. Make sure you know all associated measures for safe use of such devices.

### Programming Safety Precautions

Implement the following programming safety measures to prevent damage to machine tools and other external devices.

- Back-check limit switches in the workcell to make sure they do not fail.
- Implement “failure routines” in programs that will provide appropriate robot actions if an external device or another robot in the workcell fails.
- Use *handshaking* protocol to synchronize robot and external device operations.
- Program the robot to check the condition of all external devices during an operating cycle.

## Mechanical Safety Precautions

Implement the following mechanical safety measures to prevent damage to machine tools and other external devices.

- Make sure the workcell is clean and free of oil, water, and debris.
- Use software limits, limit switches, and mechanical hardstops to prevent undesired movement of the robot into the work area of machine tools and external devices.

## KEEPING THE ROBOT SAFE

Observe the following operating and programming guidelines to prevent damage to the robot.

### Operating Safety Precautions

The following measures are designed to prevent damage to the robot during operation.

- Use a low override speed to increase your control over the robot when jogging the robot.
- Visualize the movement the robot will make before you press the jog keys on the teach pendant.
- Make sure the work envelope is clean and free of oil, water, or debris.
- Use circuit breakers to guard against electrical overload.

### Programming Safety Precautions

The following safety measures are designed to prevent damage to the robot during programming:

- Establish *interference zones* to prevent collisions when two or more robots share a work area.
- Make sure that the program ends with the robot near or at the home position.
- Be aware of signals or other operations that could trigger operation of tooling resulting in personal injury or equipment damage.
- In dispensing applications, be aware of all safety guidelines with respect to the dispensing materials.

**Note** Any deviation from the methods and safety practices described in this manual must conform to the approved standards of your company. If you have questions, see your supervisor.

## **ADDITIONAL SAFETY CONSIDERATIONS FOR PAINT ROBOT INSTALLATIONS**

Process technicians are sometimes required to enter the paint booth, for example, during daily or routine calibration or while teaching new paths to a robot. Maintenance personal also must work inside the paint booth periodically.

Whenever personnel are working inside the paint booth, ventilation equipment must be used. Instruction on the proper use of ventilating equipment usually is provided by the paint shop supervisor.

Although paint booth hazards have been minimized, potential dangers still exist. Therefore, today's highly automated paint booth requires that process and maintenance personnel have full awareness of the system and its capabilities. They must understand the interaction that occurs between the vehicle moving along the conveyor and the robot(s), hood/deck and door opening devices, and high-voltage electrostatic tools.

Paint robots are operated in three modes:

- Teach or manual mode
- Automatic mode, including automatic and exercise operation
- Diagnostic mode

During both teach and automatic modes, the robots in the paint booth will follow a predetermined pattern of movements. In teach mode, the process technician teaches (programs) paint paths using the teach pendant.

In automatic mode, robot operation is initiated at the System Operator Console (SOC) or Manual Control Panel (MCP), if available, and can be monitored from outside the paint booth. All personnel must remain outside of the booth or in a designated safe area within the booth whenever automatic mode is initiated at the SOC or MCP.

In automatic mode, the robots will execute the path movements they were taught during teach mode, but generally at production speeds.

When process and maintenance personnel run diagnostic routines that require them to remain in the paint booth, they must stay in a designated safe area.

## **Paint System Safety Features**

Process technicians and maintenance personnel must become totally familiar with the equipment and its capabilities. To minimize the risk of injury when working near robots and related equipment, personnel must comply strictly with the procedures in the manuals.

This section provides information about the safety features that are included in the paint system and also explains the way the robot interacts with other equipment in the system.

The paint system includes the following safety features:

- Most paint booths have red warning beacons that illuminate when the robots are armed and ready to paint. Your booth might have other kinds of indicators. Learn what these are.
- Some paint booths have a blue beacon that, when illuminated, indicates that the electrostatic devices are enabled. Your booth might have other kinds of indicators. Learn what these are.
- EMERGENCY STOP buttons are located on the robot controller and teach pendant. Become familiar with the locations of all E-STOP buttons.
- An intrinsically safe teach pendant is used when teaching in hazardous paint atmospheres.
- A DEADMAN switch is located on each teach pendant. When this switch is held in, and the teach pendant is on, power is applied to the robot servo system. If the engaged DEADMAN switch is released during robot operation, power is removed from the servo system, all axis brakes are applied, and the robot comes to an EMERGENCY STOP. Safety interlocks within the system might also E-STOP other robots.

**Warning**

**An EMERGENCY STOP will occur if the DEADMAN switch is released on a bypassed robot.**

- Overtravel by robot axes is prevented by software limits. All of the major and minor axes are governed by software limits. Limit switches and hardstops also limit travel by the major axes.
- EMERGENCY STOP limit switches and photoelectric eyes might be part of your system. Limit switches, located on the entrance/exit doors of each booth, will EMERGENCY STOP all equipment in the booth if a door is opened while the system is operating in automatic or manual mode. For some systems, signals to these switches are inactive when the switch on the SCC is in teach mode. When present, photoelectric eyes are sometimes used to monitor unauthorized intrusion through the entrance/exit silhouette openings.
- System status is monitored by computer. Severe conditions result in automatic system shutdown.

## **Staying Safe While Operating the Paint Robot**

When you work in or near the paint booth, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.

**Warning**

**Observe all safety rules and guidelines to avoid injury.**

**Warning**

**Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.**

- Know the work area of the entire paint station (workcell).
- Know the work envelope of the robot and hood/deck and door opening devices.
- Be aware of overlapping work envelopes of adjacent robots.
- Know where all red, mushroom-shaped EMERGENCY STOP buttons are located.
- Know the location and status of all switches, sensors, and/or control signals that might cause the robot, conveyor, and opening devices to move.
- Make sure that the work area near the robot is clean and free of water, oil, and debris. Report unsafe conditions to your supervisor.
- Become familiar with the complete task the robot will perform BEFORE starting automatic mode.
- Make sure all personnel are outside the paint booth before you turn on power to the robot servo system.
- Never enter the work envelope or paint booth before you turn off power to the robot servo system.
- Never enter the work envelope during automatic operation unless a safe area has been designated.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Remove all metallic objects, such as rings, watches, and belts, before entering a booth when the electrostatic devices are enabled.
- Stay out of areas where you might get trapped between a moving robot, conveyor, or opening device and another object.
- Be aware of signals and/or operations that could result in the triggering of guns or bells.
- Be aware of all safety precautions when dispensing of paint is required.
- Follow the procedures described in this manual.

## **Staying Safe While Operating Paint Application Equipment**

When you work with paint application equipment, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.

**Warning**

**When working with electrostatic paint equipment, follow all national and local codes as well as all safety guidelines within your organization.**

**Also reference the following standards: NFPA 33 Standards for Spray Application Using Flammable or Combustible Materials, and NFPA 70 National Electrical Code.**

- **Grounding:** All electrically conductive objects in the spray area must be grounded. This includes the spray booth, robots, conveyors, workstations, part carriers, hooks, paint pressure pots, as well as solvent containers. Grounding is defined as the object or objects shall be electrically connected to ground with a resistance of not more than 1 megohms.
- **High Voltage:** High voltage should only be on during actual spray operations. Voltage should be off when the painting process is completed. Never leave high voltage on during a cap cleaning process.
- Avoid any accumulation of combustible vapors or coating matter.
- Follow all manufacturer recommended cleaning procedures.
- Make sure all interlocks are operational.
- No smoking.
- Post all warning signs regarding the electrostatic equipment and operation of electrostatic equipment according to NFPA 33 Standard for Spray Application Using Flammable or Combustible Material.
- Disable all air and paint pressure to bell.
- Verify that the lines are not under pressure.

## Staying Safe During Maintenance

When you perform maintenance on the painter system, observe the following rules, and all other maintenance safety rules that apply to all robot installations. Only qualified, trained service or maintenance personnel should perform repair work on a robot.

- Paint robots operate in a potentially explosive environment. Use caution when working with electric tools.
- When a maintenance technician is repairing or adjusting a robot, the work area is under the control of that technician. All personnel not participating in the maintenance must stay out of the area.
- For some maintenance procedures, station a second person at the control panel within reach of the EMERGENCY STOP button. This person must understand the robot and associated potential hazards.
- Be sure all covers and inspection plates are in good repair and in place.
- Always return the robot to the “home” position before you disarm it.

- Never use machine power to aid in removing any component from the robot.
- During robot operations, be aware of the robot's movements. Excess vibration, unusual sounds, and so forth, can alert you to potential problems.
- Whenever possible, turn off the main electrical disconnect before you clean the robot.
- When using vinyl resin observe the following:
  - Wear eye protection and protective gloves during application and removal
  - Adequate ventilation is required. Overexposure could cause drowsiness or skin and eye irritation.
  - If there is contact with the skin, wash with water.
- When using paint remover observe the following:
  - Eye protection, protective rubber gloves, boots, and apron are required during booth cleaning.
  - Adequate ventilation is required. Overexposure could cause drowsiness.
  - If there is contact with the skin or eyes, rinse with water for at least 15 minutes. Then, seek medical attention as soon as possible.



# Chapter 1

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## KAREL LANGUAGE OVERVIEW

### Contents

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## **1.1 OVERVIEW**

FANUC Robotics' KAREL system consists of a robot, a controller, and system software. It accomplishes industrial tasks using programs written in the KAREL programming language. KAREL can direct robot motion, control and communicate with related equipment, and interact with an operator.

The SYSTEM R-J3iB controller with KAREL works with a wide range of robot models to handle a variety of applications. This means common operating, programming, and troubleshooting procedures, as well as fewer spare parts. KAREL systems expand to include a full line of support products such as integral vision, off-line programming, and application-specific software packages.

The KAREL programming language is a practical blend of the logical, English-like features of high-level languages, such as Pascal and PL/1, and the proven factory-floor effectiveness of machine control languages. KAREL incorporates structures and conventions common to high-level languages as well as features developed especially for robotics applications. These KAREL features include

- Simple and structured data types
- Arithmetic, relational, and Boolean operators
- Control structures for loops and selections
- Condition handlers
- Procedure and function routines
- Motion control statements
- Input and output operations
- Multi-programming and concurrent motion support

This chapter summarizes the KAREL programming language, and describes the KAREL system software and the R-J3iB controller.

## **1.2 KAREL PROGRAMMING LANGUAGE**

### **1.2.1 Overview**

A KAREL program is made up of declarations and executable statements stored in a source code file. The variable data values associated with a program are stored in a variable file.

KAREL programs are created and edited on the *Cathode Ray Tube/Keyboard (CRT/KB)*. They can be created using the KAREL full screen editor. The editor will create a new program if one does not already exist or it will open a previously created file for editing.

The KAREL language translator turns the source code into an internal format called p-code and generates a p-code file. Programs translated from inside the KAREL editor will be loaded automatically. Programs can also be loaded using the *KAREL Command Language (KCL)* or the FILE menu.

During loading, the system will create any required variables that are not in RAM and set them uninitialized. When you run the program, the KAREL interpreter executes the loaded p-code instructions.

A KAREL program is composed of the program logic and the program data. Program logic defines a sequence of steps to be taken to perform a specific task. Program data is the task-related information that the program logic uses. In KAREL the program logic is separate from the program data.

Program logic is defined by KAREL executable statements between the BEGIN and the END statements in a KAREL program. Program data includes variables that are identified in the VAR declaration section of a KAREL program by name, data type and storage area in RAM.

Values for program data can be taught using the teach pendant to jog the robot, computed by the program, read from data files, set from within the CRT/KB or teach pendant menu structure, or accepted as input to the program during execution. The data values can change from one execution to the next, but the same program logic is used to manipulate the data.

Program logic and program data are separate in a KAREL program for the following reasons:

- To allow a single taught position to be referenced from several places in the same program
- To allow more than one program to reference or share the same data
- To allow a program to use alternative data
- To facilitate the building of data files by an off-line computer-aided design (CAD) system

The executable section of the program contains the motion statements, I/O statements, and routine calls.

The program development cycle is described briefly in the following list. [Section 1.2.2 - Section 1.2.6](#) that follow provide details on each phase.

- Enter a program into *random access memory (RAM)* and save it to a file on a file device.
- Translate the program file.
- Load the program logic and data into RAM.
- Execute the program from RAM.
- Maintain the execute history of the program.

A log or history of programs that have been executed is maintained by the controller and can be viewed.

### **1.2.2 Entering a Program**

You can enter a program into the KAREL system with the KAREL full screen editor or copy the complete program from an off-line storage device or a communication link from another computer.

When you have finished editing a program, you can save it to a file device. You can also invoke the translator from the editor.

The program is stored in a file on a file device. This file, containing KAREL statements, is called the *source file* or *source code*.

**See Also:** [Chapter 11 FULL SCREEN EDITOR](#)

### **1.2.3 Translating a Program**

KAREL source files must be translated into internal code, called *p-code*, before they are executed. The KAREL language translator performs this function and also checks for errors in the source code.

The KAREL language translator starts at the first line of the source code and continues until it encounters an error or translates the program successfully. If an error is encountered, the translator tries to continue checking the program, but no p-code will be generated.

You can invoke the translator from the editor, and the source code you were editing will be translated. After a successful translation, the translator displays a successful translation message and creates a p-code file. This p-code file is stored on the default file device specified by the \$DEVICE system variable, using the program name for the file name and a .PC file type. This file contains an internal representation of the source code and information the system needs to link the program to variable data and routines. If you are translating from the KAREL editor, the translator will load the program into RAM.

If the translator detects any errors, it displays the error messages and the source lines that were being translated. After you have corrected the errors, you can translate the program again.

From KCL, the LIST option on the TRANSLATE command will create a *listing file* on the default file device. The listing file contains the source code lines, numbered consecutively as they are displayed during translation, and any errors that were encountered.

### **1.2.4 Loading Program Logic and Data**

The p-code for a program must be loaded from a file device into RAM before the program can be executed. This is done automatically when the program is translated from inside the KAREL editor. Variable data can be loaded from KCL or the FILE menu. Subsequent changes to variable data must be saved using the teach pendant or the CRT/KB.

When a program is loaded, a variable data table, containing all the static variables in the program, is created in RAM. The variable data table contains the program identifier, all of the variable identifiers, and the name of the storage area in RAM where the variables are located.

Loading a program also establishes the links between statements and variables. If the variable file does not get loaded, the values in the variable data table will be uninitialized. If the variable file is loaded successfully, the values of any variables will be stored in the variable data storage area (CMOS, DRAM, IMAGE, VISION).

Multiple programs are often used to break a large application or problem into smaller pieces that can be developed and tested separately. The KAREL system permits loading of multiple programs into RAM from a file device. Each program that is loaded has its own p-code structure.

Variable data can be shared among multiple programs. In this case, the KAREL language FROM clause must be specified in the VAR declaration so that the system can perform the link when the program is loaded. This saves the storage required to include multiple copies of the data.

The following limits apply to the number and size of KAREL programs that can be loaded:

- Number of programs is limited to 2704 or available RAM.
- Number of variables per program is limited to 2704 or available RAM.

**See Also:** [Section 1.2](#)

## **1.2.5 Executing a Program**

After you have selected a program from the program list and the p-code and variable files are loaded into RAM, test and debug the program to make sure that the robot moves the way it should.

Program execution begins at the first executable line. A stack of 300 words is allocated unless you specify a stack size. The stack is allocated from available user RAM. Stack usage is described in [Section 5.1.6](#).

## **1.2.6 Execution History**

Each time a program is executed, a log of the nested routines and the line numbers that have been executed can be displayed from KCL with the SHOW HISTORY command.

This is useful when a program has paused or been aborted unexpectedly. Execution history displays the sequence of events that led to the disruption.

## 1.2.7 Program Structure

A KAREL program is composed of declaration and executable sections made up of KAREL language statements, as shown in [Structure of a KAREL Program](#).

### Structure of a KAREL Program

```
PROGRAM prog_name
    Translator Directives
    CONST, TYPE, and/or VAR Declarations
    ROUTINE Declarations
BEGIN
    Executable Statements
END prog_name
ROUTINE Declarations
```

In [Structure of a KAREL Program](#), the words shown in uppercase letters are KAREL reserved words, which have dedicated meanings. PROGRAM, CONST, TYPE, VAR, and ROUTINE indicate declaration sections of the program. BEGIN and END mark the executable section. Reserved words are described in [Section 2.1.3](#).

The PROGRAM statement, which identifies the program, must be the first statement in any KAREL program. The PROGRAM statement consists of the reserved word PROGRAM and an identifier of your choice (prog\_name in [Structure of a KAREL Program](#)). Identifiers are described in [Section 2.1.4](#).

**Note** Your program must reside in a file. The file can, but does not have to, have the same name as the program. This distinction is important because you invoke the translator and load programs with the name of the file containing your program, but you initiate execution of the program and clear the program with the program name.

For example, if a program named **mover** was contained in a file named **transfer**, you would reference the file by **transfer** to translate it, but would use the program name **mover** to execute the program. If both the program and the file were named **mover**, you could use mover to translate the file and also to execute the program.

A task is created to execute the program and the task name is the name of the program you initiate. The program can call a routine in another program, but the task name does not change.

The identifier used to name the program cannot be used in the program for any other purpose, such as to identify a variable or constant.

The CONST (constant), TYPE (type), and VAR (variable) declaration sections come after the PROGRAM statement. A program can contain any number of CONST, TYPE, and VAR sections. Each section can also contain any number of individual declaration statements. Also, multiple CONST, TYPE, and VAR sections can appear in any order. The number of CONST, TYPE, and VAR sections, and declaration statements are limited only by the amount of memory available.

ROUTINE declarations can follow the CONST, TYPE, and VAR sections. Each routine begins with the reserved word ROUTINE and is similar in syntax to a program. ROUTINE declarations can also follow the executable section of the main program after the END statement.

The executable section must be marked by BEGIN at the beginning and END, followed by the program identifier (prog\_name in [Structure of a KAREL Program](#)), at the end. The same program identifier must be used in the END statement as in the PROGRAM statement. The executable section can contain any number of executable statements, limited only by the amount of memory available.

**See Also:** [Chapter 2 LANGUAGE ELEMENTS](#) , [Chapter 3 USE OF OPERATORS](#) , and [Chapter 5 ROUTINES](#) .

## **1.3 SYSTEM SOFTWARE**

The KAREL system includes a robot and controller electronics. KAREL hardware interfaces and system software support programming, daily operation, maintenance, and troubleshooting.

This section provides an overview of the supported system software and robot models.

Hardware topics are covered in greater detail in the Maintenance Manual specific for your robot and controller model.

### **1.3.1 Software Components**

KAREL system software is the FANUC Robotics-supplied software that is executed by the controller CPU, which allows you to operate the KAREL system. You use the system software to develop programs, as well as to perform daily operations, maintenance, and troubleshooting.

The components of the system software include:

- **Motion Control** - movement of the tool center point (TCP) from an initial position to a desired destination position
- **File System** - storage of data on the RAM disk or peripheral storage devices
- **Full Screen Editor** - means of editing new or existing KAREL or other files
- **System Variables** - permanently defined variables declared as part of the KAREL system software
- **CRT/KB or Teach Pendant Screens** - screens that facilitate operation of the KAREL system
- **KCL** - KAREL Command Language
- **KAREL Translator** - translates KAREL source files into internal code
- **KAREL Interpreter** - executes KAREL programs

**See Also:** *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual* for detailed operation procedures using the CRT/KB and teach pendant screens.

### **1.3.2 Supported Robots**

The robot, using the appropriate tooling, performs application tasks directed by the system software and controller. The KAREL system supports a variety of robots, each designed for a specific type of application.

For a current list of supported robot models, consult your FANUC Robotics technical representative.

**See Also:** The Maintenance Manual for your specific robot type, for more information on your robot.

## **1.4 CONTROLLERS**

The KAREL controller contains the electronic circuitry and memory required to operate the KAREL system. The electronic circuitry, supported by the system software, directs the operation and motion of the robot and allows communication with peripheral devices.

Controller electronics includes a central processing unit (CPU), several types of memory, an *input/output (I/O)* system, and user interface devices. A cabinet houses the controller electronics and the ports to which remote user interface devices and other peripheral devices are connected.

### **1.4.1 Memory**

Controller memory consists of three types of memory.

- Dynamic random access memory (DRAM)

DRAM memory is volatile. Memory contents do not retain their stored values when power is removed. DRAM memory is also referred to as temporary memory (TEMP).

- A limited amount of battery-backed static/random access memory (SRAM).

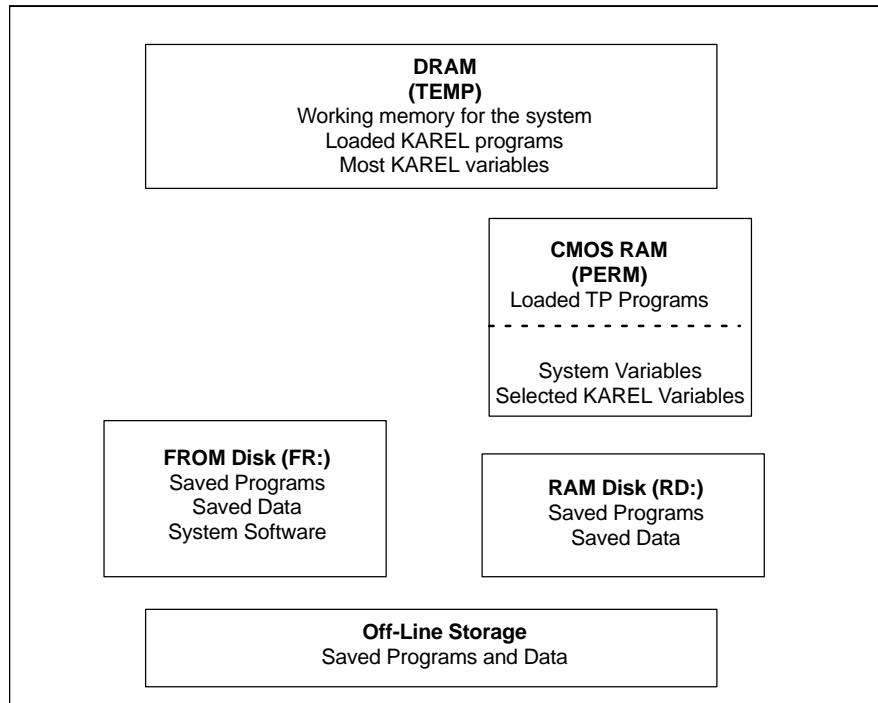
SRAM memory is nonvolatile. Older KAREL controllers used a CMOS implementation of SRAM. The KAREL programming language has many lexical references to CMOS, but the current technology used is non-CMOS SRAM. SRAM memory is also referred to as permanent memory (PERM). The TPP memory pool (used for TP programs) is allocated from PERM. A portion of permanent memory is set aside as a storage device called the memory file device (MF:). Since permanent memory can be set aside on SRAM, the controller further distinguishes SRAM memory as the RAM disk (RD:).

- Flash memory (FROM)

FROM memory is nonvolatile. A portion of permanent memory is set aside as a storage device called the memory file device (MF:). Since permanent memory can also be set aside on FROM, the controller further distinguishes FROM memory as the FROM disk (FR:).

Additional off-line storage for archiving programs and data is also available as an optional feature.

**Figure 1–1. Controller Memory**



A *bootstrap ROM* (or *BootROM*) is a piece of ROM-based software that is executed immediately when the power to the controller is turned on.

### Storage

- **KAREL System Software** is stored in FROM and is automatically loaded to DRAM on power up for execution.
- **System and Application Programs** use DRAM as working memory. A KAREL program and its variable data must be loaded in DRAM before the program can be executed. Any KAREL variables that are not in SRAM (called CMOS in older platforms) will be uninitialized when power is removed. Therefore, it is important to save recorded positional data before powering down. KAREL variables can also be created in SRAM.
- **Teach Pendant Programs** are stored in SRAM memory and DRAM memory.

- **Memory File or Virtual Devices**, FR: and RD:, provide storage for programs and data when they are not being used. You can read data from and write data to the memory file devices. Files on these devices should be copied to an off-line device for backup purposes. Files on RD: will be cleared when an INIT start of the controller is performed. Files on FR: will be cleared when a clear of FROM is performed from the BootROM.
- **Optional Disk Drive Units**, the PS-100, PS-110 and PS-200, can provide off-line storage on 3½" or 5¼" MS-DOS formatted diskettes. The optional KAREL Off-Line programming package (OLPC) can also be used for off-line storage on an IBM personal computer or compatible.
- **Memory Card**, MC:, can be formatted and used as an MS-DOS file system. It can be read from and written to on the controller and a personal computer equipped with the proper hardware and software.

See Also: [Chapter 9 FILE SYSTEM](#)

#### **1.4.2 Input/Output System**

The R-J3iB controller can support a modular I/O structure, allowing you to add I/O boards as required by your application. Both digital and analog input and output modules are supported. In addition, you can add optional process I/O boards for additional I/O. The type and number of I/O signals you have depends on the requirements of your application.

See Also: [Chapter 14 INPUT/OUTPUT SYSTEM](#), for more information

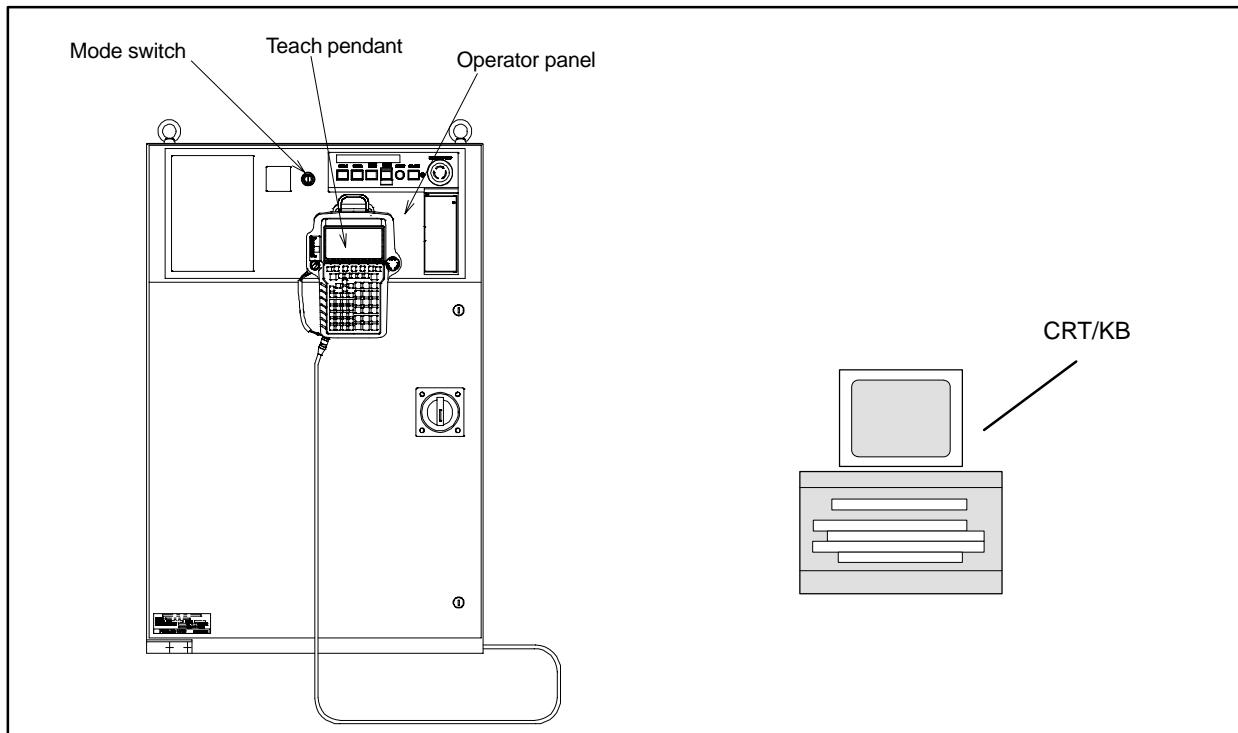
#### **1.4.3 User Interface Devices**

The user interface devices enable you to program and operate the KAREL system. The common user interface devices supported by KAREL include the operator panel, Cathode Ray Tube/Keyboard (CRT/KB), and teach pendant.

[Figure 1–2](#) illustrates these user interface devices. The operator panel and teach pendant have the same basic functions for all models; however, different configurations are also available.

The operator panel, located on the front of the controller cabinet, provides buttons for performing daily operations such as powering up, running a program, and powering down. *Light emitting diodes (LEDs)* on the operator panel indicate operating conditions such as when the power is on and when the robot is in cycle.

The KAREL system also supports I/O signals for a *user operator panel (UOP)*, which is a user-supplied device such as a custom control panel, a programmable controller, or a host computer. Refer to [Chapter 13 KAREL COMMAND LANGUAGE \(KCL\)](#).

**Figure 1–2.** R-J3iB Controller

The CRT/KB resembles a standard computer terminal. It consists of a 24-line by 80-character display and is available as a remote, stand-alone unit.

The CRT/KB is used for developing application programs. In addition, CRT/KB display screens provide access to a variety of information such as the current position of the robot, output from application programs, and on-line diagnostics.

The teach pendant consists of an 16-line by 40-character LCD display, menu-driven function keys, keypad keys, and status LEDs. It is connected to the controller cabinet via a cable, allowing you to perform operations away from the controller.

Internally, the teach pendant connects to the controller's Main CPU board. It is used to jog the robot, teach program data, test and debug programs, and adjust variables. It can also be used to monitor and control I/O, to control end-of-arm tooling, and to display information such as the current position of the robot or the status of an application program.

The *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual* provides descriptions of each of the user interface devices, as well as procedures for operating each device.



# Chapter 2

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## LANGUAGE ELEMENTS

### Contents

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The KAREL language provides the elements necessary for programming effective robotics applications. This chapter lists and describes each of the components of the KAREL language, the available translator directives and the available data types.

## **2.1 LANGUAGE COMPONENTS**

This section describes the following basic components of the KAREL language:

- Character set
- Operators
- Reserved words
- User-defined Identifiers
- Labels
- Predefined Identifiers
- System Variables
- Comments

### **2.1.1 Character Set**

The ASCII character set is available in the KAREL language. [Table 2–1](#) lists the elements in the ASCII character set. Three character sets are available in the KAREL language:

- ASCII Character Set
- Multinational Character Set
- Graphics Character Set

All of the characters recognized by the KAREL language are listed in [Table 2–1](#), [Table 2–2](#), and [Table 2–3](#). The default character set is ASCII. The multinational and graphics character sets are permitted only in literals, data, and comments.

**See Also:** CHR Built-In Procedure, [Appendix A](#).

**Table 2–1.** ASCII Character Set

<b>Letters</b>	a b c d e f g h i j k l m n o p q r s t u v w x y z A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
<b>Digits</b>	0 1 2 3 4 5 6 7 8 9
<b>Symbols</b>	@ < > = / * + - _ , ; : . # \$ ' [ ] ( ) & % { }
<b>Special Characters</b>	blank or space  form feed (treated as new line)  tab (treated as a blank space)

The following rules are applicable for the ASCII character set:

- Blanks or spaces are:
  - Required to separate reserved words and identifiers. For example, the statement **PROGRAM prog\_name** must include a blank between **PROGRAM** and **prog\_name**.
  - Allowed but are not required within expressions between symbolic operators and their operands. For example, the statement **a = b** is equivalent to **a=b**.
  - Used to indent lines in a program.
- Carriage return or a semi-colon (;) separate statements. Carriage returns can also appear in other places.

Table 2-2. Multinational Character Set

Symbols	i	¢	£	¥	§	¤
©	<u>a</u>	«	°	±	²	
³	µ	¶	•	¹	º	
»	¼	½	¿			
Special Characters	À	Á	Â	Ã	Ä	Å
	Æ	Ç	È	É	Ê	Ë
	Ì	Í	Î	Ï	Ñ	Ò
	Ó	Ô	Õ	Ö	Œ	Ø
	Ù	Ú	Û	Ü	Ý	Þ
	à	á	â	ã	ä	å
	æ	ç	è	é	ê	ë
	ì	í	î	ï	ç	ñ
	ò	ó	ô	õ	ö	œ
	ø	ù	ú	û	ü	ÿ

**Table 2-3.** Graphics Character Set

<b>Letters</b>	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
<b>Digits</b>	0	1	2	3	4	5	6	7	8	9																
<b>Symbols</b>	@	<	>	=	/	*	+	-	,	:	.	#	\$	'	\	[	]	(	)	&	%	!	"	^		
<b>Special Characters</b>	♦				H	F	C	R	L	F	O	±	N	L	V	T	J	Ј	Ћ	Ѓ	Ќ	Љ	Џ	Ћ		
	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	≠	£	.																							

See Also: [Appendix D](#) for a listing of the character codes for each character set

## 2.1.2 Operators

KAREL provides operators for standard arithmetic operations, relational operations, and Boolean (logical) operations. KAREL also includes special operators that can be used with positional and VECTOR data types as operands.

[Table 2-4](#) lists all of the operators available for use with KAREL.

**Table 2-4.** KAREL Operators

<b>Arithmetic</b>	+	-	*	/	DIV	MOD
<b>Relational</b>	<	< =	=	< >	> =	>
<b>Boolean</b>	AND	OR	NOT			
<b>Special</b>	> = <	:	#	@		

The precedence rules for these operators are as follows:

- Expressions within parentheses are evaluated first.

- Within a given level of parentheses, operations are performed starting with those of highest precedence and proceeding to those of lowest precedence.
- Within the same level of parentheses and operator precedence, operations are performed from left to right.

[Table 2–5](#) lists the precedence levels for the KAREL operators.

**Table 2–5. KAREL Operator Precedence**

OPERATOR	PRECEDENCE LEVEL
NOT	High
: , @, #	↓
* , /, AND, DIV, MOD	↓
Unary + and -, OR, +, -	↓
<, >, =, < >, < =, > =, > = <	Low

**See Also:** [Chapter 3 USE OF OPERATORS](#) , for descriptions of functions operators perform

### **2.1.3 Reserved Words**

Reserved words have a dedicated meaning in KAREL. They can be used only in their prescribed contexts. All KAREL reserved words are listed in [Table 2–6](#) .

**Table 2–6. Reserved Word List**

ABORT	CONST	GET_VAR	NOPAUSE	STOP
ABOUT	CONTINUE	GO	NOT	STRING
ABS	COORDINATED	GOTO	NOWAIT	STRUCTURE
AFTER	CR	GROUP	OF	THEN
ALONG	DELAY	GROUP_ASSOC	OPEN	TIME

**Table 2–6.** Reserved Word List (Cont'd)

ALSO	DISABLE	HAND	OR	TIMER
AND	DISCONNECT	HOLD	PATH	TO
ARRAY	DIV	IF	PATHHEADER	TPENABLE
ARRAY_LEN	DO	IN	PAUSE	TYPE
AT	DOWNTO	INDEPENDENT	POSITION	UNHOLD
ATTACH	DRAM	INTEGER	POWERUP	UNINIT
AWAY	ELSE	JOINTPOS	PROGRAM	UNPAUSE
AXIS	ENABLE	JOINTPOS1	PULSE	UNTIL
BEFORE	END	JOINTPOS2	PURGE	USING
BEGIN	ENDCONDITION	JOINTPOS3	READ	VAR
BOOLEAN	ENDFOR	JOINTPOS4	REAL	VECTOR
BY	ENDIF	JOINTPOS5	RELATIVE	VIA
BYNAME	ENDMOVE	JOINTPOS6	RELAX	VIS_PROCESS
BYTE	ENDSELECT	JOINTPOS7	RELEASE	WAIT
CAM_SETUP	ENDSTRUCTURE	JOINTPOS8	REPEAT	WHEN
CANCEL	ENDUSING	JOINTPOS9	RESTORE	WHILE
CASE	ENDWHILE	MOD	RESUME	WITH
CLOSE	ERROR	MODEL	RETURN	WRITE
CMOS	EVAL	MOVE	ROUTINE	XZWPR

**Table 2–6.** Reserved Word List (Cont'd)

COMMAND	EVENT	NEAR	SELECT	XYZWPREXT
COMMON_ASSOC	END	NOABORT	SEMAPHORE	
CONDITION	FILE	NODE	SET_VAR	
CONFIG	FOR	NODEDATA	SHORT	
CONNECT	FROM	NOMESSAGE	SIGNAL	

**See Also:** Index for references to descriptions of KAREL reserved words

## **2.1.4 User-Defined Identifiers**

User-defined identifiers represent constants, data types, statement labels, variables, routine names, and program names. Identifiers

- Start with a letter
- Can include letters, digits, and underscores
- Can have a maximum of 12 characters
- Can have only one meaning within a particular scope. Refer to [Section 5.1.4](#).
- Cannot be reserved words
- Must be defined before they can be used.

For example, the program excerpt in [Declaring Identifiers](#) shows how to declare program, variable, and constant identifiers.

### **Declaring Identifiers**

```
PROGRAM mover --program identifier (mover)
    VAR
        original      : POSITION --variable identifier (original)
    CONST
        no_of_parts = 10 --constant identifier (no_of_parts)
```

## 2.1.5 Labels

Labels are special identifiers that mark places in the program to which program control can be transferred using the GOTO Statement.

- Are immediately followed by two colons (::). Executable statements are permitted on the same line and subsequent lines following the two colons.
- Cannot be used to transfer control into or out of a routine.

In [Using Labels](#), **weld:** : denotes the section of the program in which a part is welded. When the statement **go to weld** is executed, program control is transferred to the **weld** section.

### Using Labels

```
weld:: --label
      .   --additional program statements
      .
GOTO weld
```

## 2.1.6 Predefined Identifiers

Predefined identifiers within the KAREL language have a predefined meaning. These can be constants, types, variables, or built-in routine names. [Table 2–7](#) and [Table 2–8](#) list the predefined identifiers along with their corresponding values. Either the identifier or the value can be specified in the program statement. For example, \$MOTYPE = 7 is the same as \$MOTYPE = LINEAR. However, the predefined identifier MININT is an exception to this rule. This identifier must always be used in place of its value, -2147483648. The value or number itself can not be used.

**Table 2–7. Predefined Identifier and Value Summary**

Predefined Identifier	Type	Value
TRUE	BOOLEAN	ON
FALSE		OFF
ON	BOOLEAN	ON
OFF		OFF

**Table 2-7.** Predefined Identifier and Value Summary (Cont'd)

Predefined Identifier	Type	Value
MAXINT	INTEGER	+2147483647
MININT		-2147483648
RSWORLD	Orientation Type: \$ORIENT_TYPE	1 2 3
AESWORLD		
WRISTJOINT		
JOINT	Motion Type: \$MOTYPE	6 7 8
LINEAR (or STRAIGHT)		
CIRCULAR		
FINE	Termination Types: \$TERMTYPE and \$SEGTERMTYPE	1 2 3 4 5
COARSE		
NOSETTLE		
NODECEL		
VARDECCEL		

**Table 2-8.** Port and File Predefined Identifier Summary

Predefined Identifier	Type
DIN (Digital input)	Boolean port array
DOUT (Digital output)	

**Table 2–8. Port and File Predefined Identifier Summary (Cont'd)**

Predefined Identifier	Type
GIN (Group input)	Integer port array
GOUT (Group output)	
AIN (Analog output)	
AOUT (Analog output)	

**Table 2–8. Port and File Predefined Identifier Summary (Cont'd)**

Predefined Identifier	Type
TPIN (Teach pendant input) TPOUT (Teach pendant output) RDI (Robot digital input) RDO (Robot digital output) OPIN (Operator panel input) OPOUT (Operator panel output) WDI (Weld input) WDOUT (Weld output)	Boolean port array
TPDISPLAY (Teach pendant KAREL display)* TPERROR (Teach pendant message line) TPPROMPT (Teach pendant function key line)* TPFUNC (Teach pendant function key line)* TPSTATUS (Teach pendant status line)* INPUT (CRT/KB KAREL keyboard)* OUTPUT (CRT/KB KAREL screen)* CRTERROR (CRT/KB message line) CRTFUNC (CRT function key line)* CRTSTATUS (CRT status line)* CRTPROMPT (CRT prompt line)* VIS_MONITOR (Vision Monitor Screen)	File

\*Input and output occurs on the USER menu of the teach pendant or CRT/KB.

### **2.1.7 System Variables**

System variables are variables that are declared as part of the KAREL system software. They have permanently defined variable names, that begin with a dollar sign (\$). Many are robot specific, meaning their values depend on the type of robot that is attached to the system.

Some system variables are not accessible to KAREL programs. Access rights govern whether or not a KAREL program can read from or write to system variables.

**See Also:** *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for a complete list and description of all available system variables

### **2.1.8 Comments**

Comments are lines of text within a program used to make the program easier for you or another programmer to understand. For example, [Comments From Within a Program](#) contains some comments from [%INCLUDE Directive in a KAREL Program](#) and [Include File mover\\_decs for a KAREL Program](#).

#### **Comments From Within a Program**

```
--This program, called mover, picks up 10 objects  
--from an original POSITION and puts them down  
--at a destination POSITION.  
  
original : POSITION    --POSITION of objects  
destination : POSITION   --Destination of objects  
count    : INTEGER      --Number of objects moved
```

A comment is marked by a pair of consecutive hyphens (- -). On a program line, anything to the right of these hyphens is treated as a comment.

Comments can be inserted on lines by themselves or at the ends of lines containing any program statement. They are ignored by the translator and have absolutely no effect on a running program.

## **2.2 TRANSLATOR DIRECTIVES**

Translator directives provide a mechanism for directing the translation of a KAREL program. Translator directives are special statements used within a KAREL program to

- Include other files into a program at translation time
- Specify program and task attributes

All directives except %INCLUDE must be after the program statement but before any other statements. [Table 2–9](#) lists and briefly describes each translator directive. Refer to [Appendix A](#) for a complete description of each translator directive.

**Table 2–9.** Translator Directives

Directive	Description
%ALPHABETIZE	Specifies that variables will be created in alphabetical order when p-code is loaded.
%CMOSVARS	Specifies the default storage for KAREL variables is CMOS RAM.
%COMMENT = 'comment'	Specifies a comment of up to 16 characters. During load time, the comment is stored as a program attribute and can be displayed on the SELECT screen of the teach pendant or CRT/KB.
%CRTDEVICE	Specifies that the CRT/KB user window will be the default in the READ and WRITE statements instead of the TPDISPLAY window.
%DEFGROUP = n	Specifies the default motion group to be used by the translator.
%DELAY	Specifies the amount of time the program will be delayed out of every 250 milliseconds.
%ENVIRONMENT filename	Used by the off-line translator to specify that a particular environment file should be loaded.
%INCLUDE filename	Specifies files to insert into a program at translation time.
%LOCKGROUP =n,n	Specifies the motion group(s) locked by this task.
%NOABORT = option	Specifies a set of conditions which will be prevented from aborting the program.
%NOBUSYLAMP	Specifies that the busy lamp will be OFF during execution.
%NOLOCKGROUP	Specifies that no motion groups will be locked by this task.
%NOPAUSE = option	Specifies a set of conditions which will be prevented from pausing the program.

**Table 2–9.** Translator Directives (Cont'd)

Directive	Description
%NOPAUSESHFT	Specifies that the task is not paused if the teach pendant shift key is released.
%PRIORITY = n	Specifies the task priority.
%STACKSIZE = n	Specifies the stack size in long words.
%TIMESLICE = n	Supports round-robin type time slicing for tasks with the same priority.
%TPMOTION	Specifies that task motion is enabled only when the teach pendant is enabled.

[%INCLUDE Directive in a KAREL Program](#) illustrates the %INCLUDE directive. [Include File mover\\_decs for a KAREL Program](#) shows the included file.

#### %INCLUDE Directive in a KAREL Program

```

PROGRAM mover
-- This program, called mover, picks up 10 objects
-- from an original POSITION and puts them down
-- at a destination POSITION.

%INCLUDE mover_decs
-- Uses %INCLUDE directive to include the file
-- called mover_decs containing declarations

BEGIN
    $SPEED = 200.0
    $MOTYPE = LINEAR
    OPEN HAND gripper

    -- Loop to move total number of objects
    FOR count = 1 TO num_of_parts DO
        MOVE TO original
        CLOSE HAND gripper
        MOVE TO destination
        OPEN HAND gripper
    ENDFOR           -- End of loop

END mover

```

**Include File mover\_decs for a KAREL Program**

```
-- Declarations for program mover in file mover_decs

VAR
    original : POSITION      --POSITION of objects
    destination : POSITION    --Destination of objects
    count : INTEGER          --Number of objects moved

CONST
    gripper = 1      -- Hand number 1
    num_of_parts = 10     -- Number of objects to move
```

## **2.3 DATA TYPES**

Three forms of data types are provided by KAREL to define data items in a program:

- Simple type data items
  - Can be assigned constants or variables in a KAREL program
  - Can be assigned actual (literal) values in a KAREL program
  - Can assume only single values
- Structured type data items
  - Are defined as data items that permit or require more than a single value
  - Are composites of simple data and structured data
- User-defined type data items
  - Are defined in terms of existing data types including other user-defined types
  - Can be defined as structures consisting of several KAREL variable data types
  - Cannot include itself

[Table 2–10](#) lists the simple and structured data types available in KAREL. User-defined data types are described in [Section 2.4](#).

**Table 2–10.** Simple and Structured Data Types

<b>Simple</b>	<b>Structured</b>	
BOOLEAN	ARRAY OF BYTE	JOINTPOS7
FILE	CAM_SETUP	JOINTPOS8
INTEGER	COMMON_ASSOC	JOINTPOS9
REAL	CONFIG	MODEL
STRING	GROUP_ASSOC	PATH
	JOINTPOS	POSITION
	JOINTPOS1	QUEUE_TYPE
	JOINTPOS2	ARRAY OF SHORT
	JOINTPOS3	VECTOR
	JOINTPOS4	VIS_PROCESS
	JOINTPOS5	XYZWPR
	JOINTPOS6	XYZWPREXT

See Also: [Appendix A](#) for a detailed description of each data type.

## **2.4 USER-DEFINED DATA TYPES AND STRUCTURES**

User-defined data types are data types you define in terms of existing data types. User-defined data structures are data structures in which you define a new data type as a structure consisting of several KAREL variable data types, including previously defined user data types.

## **2.4.1 User-Defined Data Types**

User-defined data types are data types you define in terms of existing data types. With user-defined data types, you

- Include their declarations in the TYPE sections of a KAREL program.
- Define a KAREL name to represent a new data type, described in terms of other data types.
- Can use predefined data types required for specific applications.

User-defined data types can be defined as structures, consisting of several KAREL variable data types.

The continuation character, "&", can be used to continue a declaration on a new line.

[User-Defined Data Type Example](#) shows an example of user-defined data type usage and continuation character usage.

### **User-Defined Data Type Example**

```
CONST
    n_pages = 20
    n_lines = 40
    std_str_lng = 8

TYPE
    std_string_t = STRING [std_str_lng]
    std_table_t = ARRAY [n_pages]&                      --continuation character
                  OF ARRAY [n_lines] OF std_string_t

    path_hdr_t FROM main_prog = STRUCTURE      --user defined data type
        ph_uframe: POSITION
        ph_utool: POSITION
    ENDSTRUCTURE

    node_data_t FROM main_prog = STRUCTURE
        gun_on: BOOLEAN
        air_flow: INTEGER
    ENDSTRUCTURE

    std_path_t FROM main_prog =
        PATH PATHDATA = path_hdr_t NODEDATA = node_data_t

VAR
    msg_table_1: std_table_t
    msg_table_2: std_table_t
    temp_string: std_string_t
    seam_1_path: std_path_t
```

### Usage

User-defined type data can be

- Assigned to other variables of the same type
- Passed as a parameter
- Returned as a function

Assignment between variables of different user-defined data types, even if identically declared, is not permitted. In addition, the system provides the ability to load and save variables of user-defined data types, checking consistency during the load with the current declaration of the data type.

### Restrictions

A user-defined data type cannot

- Include itself
- Include any type that includes it, either directly or indirectly
- Be declared within a routine

## 2.4.2 User-Defined Data Structures

A structure is used to store a collection of information that is generally used together. User-defined data structures are data structures in which you define a new data type as a structure consisting of several KAREL variable data types.

When a program containing variables of user-defined data types is loaded, the definitions of these types are checked against a previously created definition. If a previously created definition does not exist, a new one is created.

With user-defined data structures, you

- Define a data type as a structure consisting of a list of component fields, each of which can be a standard data type or another, previously defined, user data type. See [Defining a Data Type as a User-Defined Structure](#) .

### Defining a Data Type as a User-Defined Structure

```
new_type_name = STRUCTURE
    field_name_1:  type_name_1
    field_name_2:  type_name_2
    .
ENDSTRUCTURE
```

- Access elements of a data type defined as a structure in a KAREL program. The continuation character, "&", can be used to continue access of the structure elements. See [Accessing Elements of a User-Defined Structure in a KAREL Program](#) .

### Accessing Elements of a User-Defined Structure in a KAREL Program

```
var_name = new_type_name.field_name_1
new_type_name.field_name_2 = expression
outer_struct_name.inner_struct_name&
    .field_name = expression
```

- Access elements of a data type defined as a structure from the CRT/KB and at the teach pendant.
- Define a range of executable statements in which fields of a STRUCTURE type variable can be accessed without repeating the name of the variable. See [Defining a Range of Executable Statements](#) .

### Defining a Range of Executable Statements

```
USING struct_var, struct_var2 DO
    statements
    ..
ENDUSING
```

In the above example, struct\_var and struct\_var2 are the names of structure type variables.

**Note** If the same name is both a field name and a variable name, the field name is assumed. If the same field name appears in more than one variable, the right-most variable in the USING statement is used.

### Restrictions

User-defined data structures have the following restrictions:

- The following data types are **not valid** as part of a data structure:
  - STRUCTURE definitions; types that are declared structures are permitted. See [Valid STRUCTURE Definitions](#) .

### Valid STRUCTURE Definitions

The following is valid:

```
TYPE
    sub_struct = STRUCTURE
        subs_field_1: INTEGER
        subs_field_2: BOOLEAN
    ENDSTRUCTURE
```

```

big_struct = STRUCTURE
    bigs_field_1: INTEGER
    bigs_field_2: sub_struct
ENDSTRUCTURE

```

The following is not valid:

```

big_struct = STRUCTURE
    bigs_field_1: INTEGER
    bigs_field_2: STRUCTURE
        subs_field_1: INTEGER
        subs_field_2: BOOLEAN
    ENDSTRUCTURE
ENDSTRUCTURE

```

- PATH types
- FILE types
- VISION types
- Variable length arrays
- The data structure itself, or any type that includes it, either directly or indirectly
- Any structure not previously defined.
- A variable can not be defined as a structure, but can be defined as a data type previously defined as a structure. See [Defining a Variable as a Type Previously Defined as a Structure](#).

### **Defining a Variable as a Type Previously Defined as a Structure**

The following is valid:

```

TYPE
    struct_t = STRUCTURE
        st_1: BOOLEAN
        st_2: REAL
    ENDSTRUCTURE
VAR
    var_name: struct_t

```

The following is not valid:

```

VAR
    var_name: STRUCTURE
        vn_1: BOOLEAN
        vn_2: REAL
    ENDSTRUCTURE

```

## 2.5 ARRAYS

You can declare arrays of any data type except PATH.

You can access elements of these arrays in a KAREL program, from the CRT/KB, and from the teach pendant.

In addition, you can define two types of arrays:

- Multi-dimensional arrays
- Variable-sized arrays

### 2.5.1 Multi-Dimensional Arrays

Multi-dimensional arrays are arrays of elements with two or three dimensions. These arrays allow you to identify an element using two or three subscripts.

Multi-dimensional arrays allow you to

- Declare variables as arrays with two or three (but not more) dimensions. See [Declaring Variables as Arrays with Two or Three Dimensions](#).

#### Declaring Variables as Arrays with Two or Three Dimensions

VAR

    name: ARRAY [size\_1] OF ARRAY [size\_2] ... , OF element\_type

OR

VAR

    name: ARRAY [size\_1, size\_2,...] OF element\_type

- Access elements of these arrays in KAREL statements. See [Accessing Elements of Multi-Dimensional Arrays in KAREL Statements](#).

#### Accessing Elements of Multi-Dimensional Arrays in KAREL Statements

    name [subscript\_1, subscript\_2,...] = value

    value = name [subscript\_1, subscript\_2,...]

- Declare routine parameters as multi-dimensional arrays. See [Declaring Routine Parameters as Multi-Dimensional Arrays](#).

### Declaring Routine Parameters as Multi-Dimensional Arrays

Routine expects 2-dimensional array of INTEGER.

```
ROUTINE array_user (array_param:ARRAY [*,*] OF INTEGER)
```

The following are equivalent:

```
ROUTINE rtn_name(array_param: ARRAY[*] OF INTEGER)
```

and

```
ROUTINE rtn_name(array_param: ARRAY OF INTEGER)
```

- Access elements with KCL commands and the teach pendant.
- Save and load multi-dimensional arrays to and from variable files.

### Restrictions

The following restrictions apply to multi-dimensional arrays:

- A subarray can be passed as a parameter or assigned to another array by omitting one or more of the right-most subscripts only if it was defined as a separate type. See [Using a Subarray](#).

### Using a Subarray

```
TYPE
    array_30 = ARRAY[30] OF INTEGER
    array_20_30 = ARRAY[20] OF array_30

VAR
    array_1: array_30
    array_2: array_20_30
    array_3: ARRAY[10] OF array_20_30

ROUTINE array_user(array_data: ARRAY OF INTEGER
                  FROM other-prog

BEGIN
    array_2 = array_3[10]                      -- assigns elements array_3[10,1,1]
                                                -- through array_3[10,20,30] to
    array_2
    array_2[2] = array_1                         -- assigns elements array_1[1] through
                                                -- array_1 [30] to elements array_2[2,1]
                                                -- through array_2[2,30]
    array_user(array_3[5,3])                     -- passes elements array_3[5,3,1]
                                                -- through array_3[5,3,30] to array_user
```

- The element type cannot be any of the following:
  - Array (but it can be a user-defined type that is an array)
  - Path

## **2.5.2 Variable-Sized Arrays**

Variable-sized arrays are arrays whose actual size is not known, and that differ from one use of the program to another. Variable-sized arrays allow you to write KAREL programs without establishing dimensions of the array variables. In all cases, the dimension of the variable must be established before the .PC file is loaded.

Variable-sized arrays allow you to

- Declare an array size as “to-be-determined” (\*). See [Indicates that the Size of an Array is "To-Be-Determined"](#).

### **Indicates that the Size of an Array is "To-Be-Determined"**

```
VAR
    one_d_array: ARRAY[*] OF type
    two_d_array: ARRAY[*,*] OF type
```

- Determine an array size from that in a variable file or from a KCL CREATE VAR command rather than from the KAREL source code.

The actual size of a variable-sized array will be determined by the actual size of the array if it already exists, the size of the array in a variable file if it is loaded first, or the size specified in a KCL CREATE VAR command executed before the program is loaded. Dimensions explicitly specified in a program must agree with those specified from the .VR file or specified in the KCL CREATE VAR command.

### **Restrictions**

Variable-sized arrays have the following restrictions:

- The variable must be loaded or created in memory (in a .VR file or using KCL), with a known length, before it can be used.
- When the .PC file is loaded, it uses the established dimension, otherwise it uses 0.
- Variable-sized arrays are only allowed in the VAR section and not the TYPE section of a program.
- Variable-sized arrays are only allowed for static variables.

# Chapter 3

---

## USE OF OPERATORS

### Contents

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This chapter describes how operators are used with other language elements to perform operations within a KAREL application program. Expressions and assignments, which are program statements that include operators and operands, are explained first. Next, the kinds of operations that can be performed using each available KAREL operator are discussed.

## **3.1 EXPRESSIONS AND ASSIGNMENTS**

Expressions are values defined by a series of operands, connected by operators and cause desired computations to be made. For example, **4 + 8** is an expression in which **4** and **8** are the *operands* and the plus symbol (+) is the *operator*.

*Assignments* are statements that set the value of variables to the result of an evaluated expression.

### **3.1.1 Rule for Expressions and Assignments**

The following rules apply to expressions and assignments:

- Each operand of an expression has a data type determined by the nature of the operator.
- Each KAREL operator requires a particular operand type and causes a computation that produces a particular result type.
- Both operands in an expression must be of the same data type. For example, the AND operator requires that both its operands are INTEGER values or that both are BOOLEAN values. The expression **i AND b**, where **i** is an INTEGER and **b** is a BOOLEAN, is invalid.
- Five special cases in which the operands can be mixed provide an exception to this rule. These five cases include the following:
  - INTEGER and REAL operands to produce a REAL result
  - INTEGER and REAL operands to produce a BOOLEAN result
  - INTEGER and VECTOR operands to produce a VECTOR
  - REAL and VECTOR operands to produce a VECTOR
  - POSITION and VECTOR operands to produce a VECTOR
- Any positional data type can be substituted for the POSITION data type.

### **3.1.2 Evaluation of Expressions and Assignments**

[Table 3–1](#) summarizes the data types of the values that result from the evaluation of expressions containing KAREL operators and operands.

Table 3-1. Summary of Operation Result Types

Operator	+	-	*	/	DIV MOD	< >, >= <=, <, >, =	>= <	AND OR NOT	#	@	:
<b>Types of Operators</b>											
INTEGER	I	I	I	R	I	B	-	I	-	-	-
REAL	R	R	R	R	-	B	-	-	-	-	-
Mixed**	R	R	R	R	-	B	-	-	-	-	-
INTEGER- REAL											
BOOLEAN	-	-	-	-	-	B	-	B	-	-	-
STRING	S	-	-	-	-	B	-	-	-	-	-
Mixed**	-	-	V	V	-	-	-	-	-	-	-
INTEGER- VECTOR											
Mixed** REAL- VECTOR	-	-	V	V	-	-	-	-	-	-	-
VECTOR	V	V	-	-	-	B***	-	-	V	R	-
POSITION	-	-	-	-	-	-	B	-	-	-	P
Mixed** POSITION- VECTOR	-	-	-	-	-	-	-	-	-	-	V

\*\*Mixed means one operand of each type

\*\*\*VECTOR values can be compared using = < > only

–Operation not allowed

I INTEGER

R REAL

B BOOLEAN

V VECTOR

P POSITION

### **3.1.3 Variables and Expressions**

Assignment statements contain variables and expressions. The variables can be any user-defined variable, a system variable with write access, or an output port array with write access. The expression can be any valid KAREL expression. The following examples are acceptable assignments:

**\$SPEED = 200.00** -- assigns a REAL value to a system variable

**count = count + 1** -- assigns an INTEGER value to an INTEGER variable

The data types of **variable** and **expression** must match with three exceptions:

- INTEGER variables can be assigned to REAL variables. In this case, the INTEGER is treated as a REAL number during evaluation of the expression. However, a REAL number cannot be used where an INTEGER value is expected.
- If required, a REAL number can be converted to an INTEGER using the ROUND or TRUNC built-in functions.
- INTEGER, BYTE, and SHORT types can be assigned to each other, although a run-time error will occur if the assigned value is out of range.
- Any positional type can be assigned to any other positional type. A run-time error will result if a JOINTPOS from a group without kinematics is assigned to an XYZWPR.

**See Also:** Relational Operations, ROUND and TRUNC built-in functions, Appendix A, “KAREL Language Alphabetical Description”

## **3.2 OPERATIONS**

Operations include the manipulation of variables, constants, and literals to compute values using the available KAREL operators. The following operations are discussed:

- Arithmetic Operations

- Relational Operations
- Boolean Operations
- Special Operations

[Table 3–2](#) lists all of the operators available for use with KAREL.

**Table 3–2. KAREL Operators**

Operation	Operator					
<b>Arithmetic</b>	+	-	*	/	DIV	MOD
<b>Relational</b>	<	< =	=	< >	> =	>
<b>Boolean</b>	AND	OR	NOT			
<b>Special</b>	> = <	:	#	@		

### **3.2.1 Arithmetic Operations**

The addition (+), subtraction (-), and multiplication (\*) operators, along with the DIV and MOD operators, can be used to compute values within arithmetic expressions. Refer to [Table 3–3](#).

**Table 3–3. Arithmetic Operations Using +, -, and \* Operators**

EXPRESSION	RESULT
3 + 2	5
3 - 2	1
3 * 2	6

- The DIV and MOD operators are used to perform INTEGER division. Refer to [Table 3–4](#).

**Table 3–4.** Arithmetic Operations Examples

EXPRESSION	RESULT
11 DIV 2	5
11 MOD 2	1

- The DIV operator truncates the result of an equation if it is not a whole number.
- The MOD operator returns the remainder of an equation that results from dividing the left-side operand by the right-side operand.
- If the right-side operand of a MOD equation is a negative number, the result is also negative.
- If the divisor in a DIV equation or the right-side operand of a MOD equation is zero, the KAREL program is aborted with the “Divide by zero” error.
- The INTEGER bitwise operators, AND, OR, and NOT, produce the result of a binary AND, OR, or NOT operation on two INTEGER values. Refer to [Table 3–5](#).

**Table 3–5.** Arithmetic Operations Using Bitwise Operands

EXPRESSION	BINARY EQUIVALENT	RESULT
5 AND 8	0101 AND 1000	0000 = 0
5 OR 8	0101 OR 1000	1101 = 13
-4 AND 8	1100 AND 1000	1000 = 8
-4 OR 8	1100 OR 1000	1100 = -4
NOT 5	NOT 0101	1010 = -6*
NOT -15	NOT 110001	1110 = 14*

\*Because negative INTEGER values are represented in the two's complement form, NOT i is not the same as -i.

- If an INTEGER or REAL equation results in a value exceeding the limit for INTEGER or REAL variables, the program is aborted with an error. If the result is too small to represent, it is set to zero.

[Table 3–6](#) lists the precedence levels for the KAREL operators.

**Table 3–6.** KAREL Operator Precedence

OPERATOR	PRECEDENCE LEVEL
NOT	High
: , @, #	↓
* , /, AND, DIV, MOD	↓
Unary + and -, OR, +, -	↓
<, >, =, < >, <=, >=, > <	Low

### **3.2.2 Relational Operations**

Relational operators ( $<>$ ,  $=$ ,  $>$ ,  $<$ ,  $<=$ ,  $>=$ ) produce a BOOLEAN (TRUE/FALSE) result corresponding to whether or not the values of the operands are in the relation specified. In a relational expression, both operands must be of the same simple data type. Two exceptions to this rule exist:

- REAL and INTEGER expressions can be mixed where the INTEGER operand is converted to a REAL number.

For example, in the expression **1 > .56** , the number **1** is converted to **1.0** and the result is TRUE.

- VECTOR operands, which are a structured data type, can be compared in a relational expression but only by using the equality (=) or inequality ( $\neq$ ) operators.

The relational operators function with INTEGER and REAL operands to evaluate standard mathematical equations. Refer to [Table 3–7](#) .

**Note** Performing equality (=) or inequality ( $\neq$ ) tests between REAL values might not yield the results you expect. Because of the way REAL values are stored and manipulated, two values that would appear to be equal might not be exactly equal. This is also true of VECTOR values which are composed of REAL values. Use  $\geq$  or  $\leq$  where appropriate instead of =.

Relational operators can also have STRING values as operands. STRING values are compared lexically character by character from left to right until one of the following occurs. Refer to [Table 3–7](#) .

- The character code for a character in one STRING is greater than the character code for the corresponding character in the other STRING. The result in this case is that the first string is greater. For example, the ASCII code for A is 65 and for a is 97. Therefore,  $a > A$  = TRUE.

- One STRING is exhausted while characters remain in the other STRING. The result is that the first STRING is less than the other STRING.
- Both STRING expressions are exhausted without finding a mismatch. The result is that the STRINGs are equal.

**Table 3–7. Relational Operation Examples**

EXPRESSION	RESULT
'A' < 'AA'	TRUE
'A' = 'a'	FALSE
4 > 2	TRUE
17.3< > 5.6	TRUE
(3 *4) < > (4* 3)	FALSE

With BOOLEAN operands, TRUE > FALSE is defined as a true statement. Thus the expression FALSE >= TRUE is a false statement. The statements FALSE >= FALSE and TRUE >= FALSE are also true statements.

### **3.2.3 Boolean Operations**

The Boolean operators AND, OR, and NOT, with BOOLEAN operands, can be used to perform standard mathematical evaluations. [Table 3–8](#) summarizes the results of evaluating Boolean expressions, and some examples are listed in [Table 3–9](#).

**Table 3–8.** BOOLEAN Operation Summary

OPERATOR	OPERAND 1	OPERAND 2	RESULT
NOT	TRUE	-	FALSE
	FALSE	-	TRUE
OR	TRUE	TRUE	TRUE
		FALSE	
	FALSE	TRUE	
		FALSE	FALSE
AND	TRUE	TRUE	TRUE
		FALSE	FALSE
	FALSE	TRUE	
		FALSE	

**Table 3–9.** BOOLEAN Operations Using AND, OR, and NOT Operators

EXPRESSION	RESULT
DIN[1] AND DIN[2]	TRUE if DIN[1] and DIN[2] are both TRUE; otherwise FALSE
DIN[1] AND NOT DIN[2]	TRUE if DIN[1] is TRUE and DIN[2] is FALSE; otherwise FALSE
(x < y) OR (y > z)	TRUE if $x < y$ or if $y > z$ ; otherwise FALSE
(i = 2) OR (i = 753)	TRUE if $i = 2$ or if $i = 753$ ; otherwise FALSE

### 3.2.4 Special Operations

The KAREL language provides special operators to perform functions such as testing the value of approximately equal POSITION variables, relative POSITION variables, VECTOR variables, and STRING variables. This section describes their operations and gives examples of their usage.

The following rules apply to approximately equal operations:

- The relational operator ( $\geq\leq$ ) determines if two POSITION operands are approximately equal and produces a BOOLEAN result. The comparison is similar to the equality (=) relation except that the operands compared need not be identical. Extended axis values are not considered.
- Approximately equal operations must be used in conjunction with the system variables, \$LOCTOL, \$ORIENTTOL, and \$CHECKCONFIG to determine how close two positions must be. Refer to the *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for a description of these variables.
- The relational operator ( $\geq\leq$ ) is allowed only in normal program use and cannot be used as a condition handler statement.

In the following example the relational operator ( $\geq\leq$ ) is used to determine if the current robot position (determined by using the CURPOS built-in procedure) is near the designated perch position:

#### Relational Operator

```
IF perch >=< CURPOS ( 0 , 0 ) THEN MOVE TO perch
ELSE
    ABORT
ENDIF
```

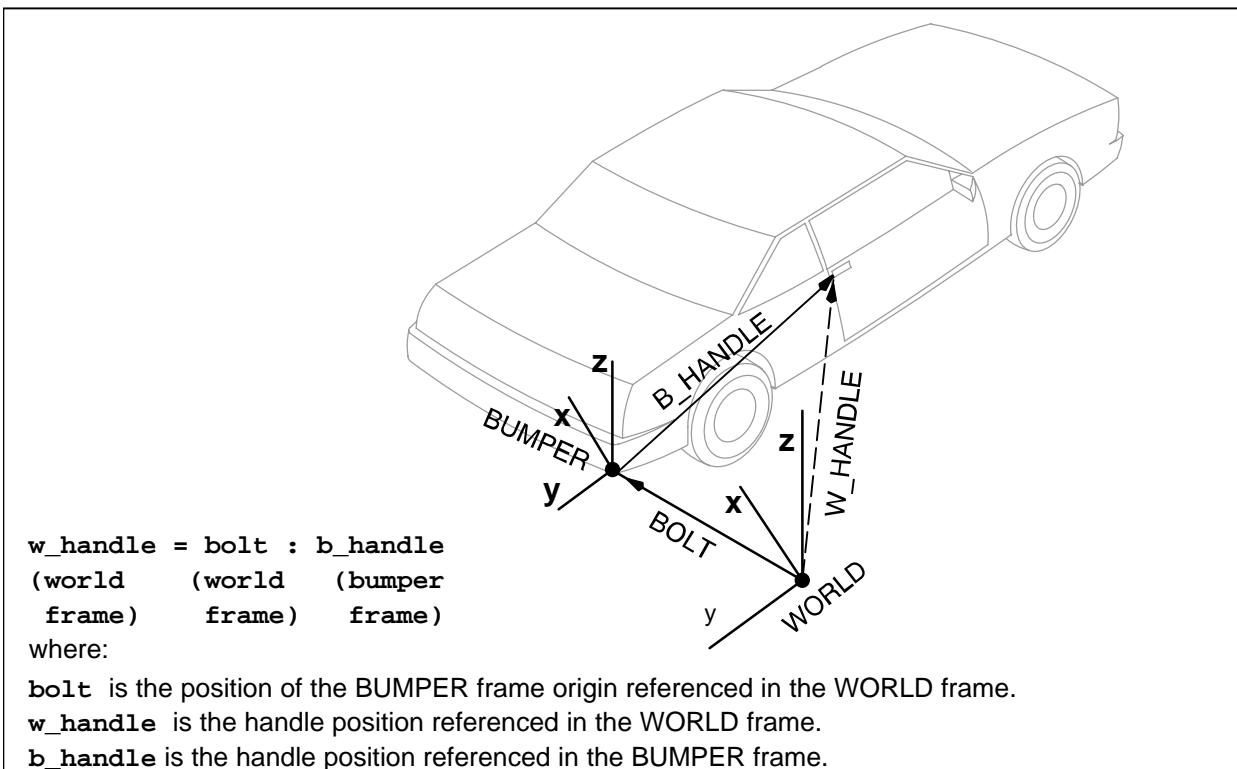
#### Relative Position Operations

To locate a position in space, you must reference it to a specific coordinate frame. In KAREL, reference frames have the POSITION data type. The relative position operator (:) allows you to reference a position or vector with respect to the coordinate frame of another position (that is, the coordinate frame that has the other position as its origin point).

The relative position operator (:) is used to transform a position from one reference frame to another frame.

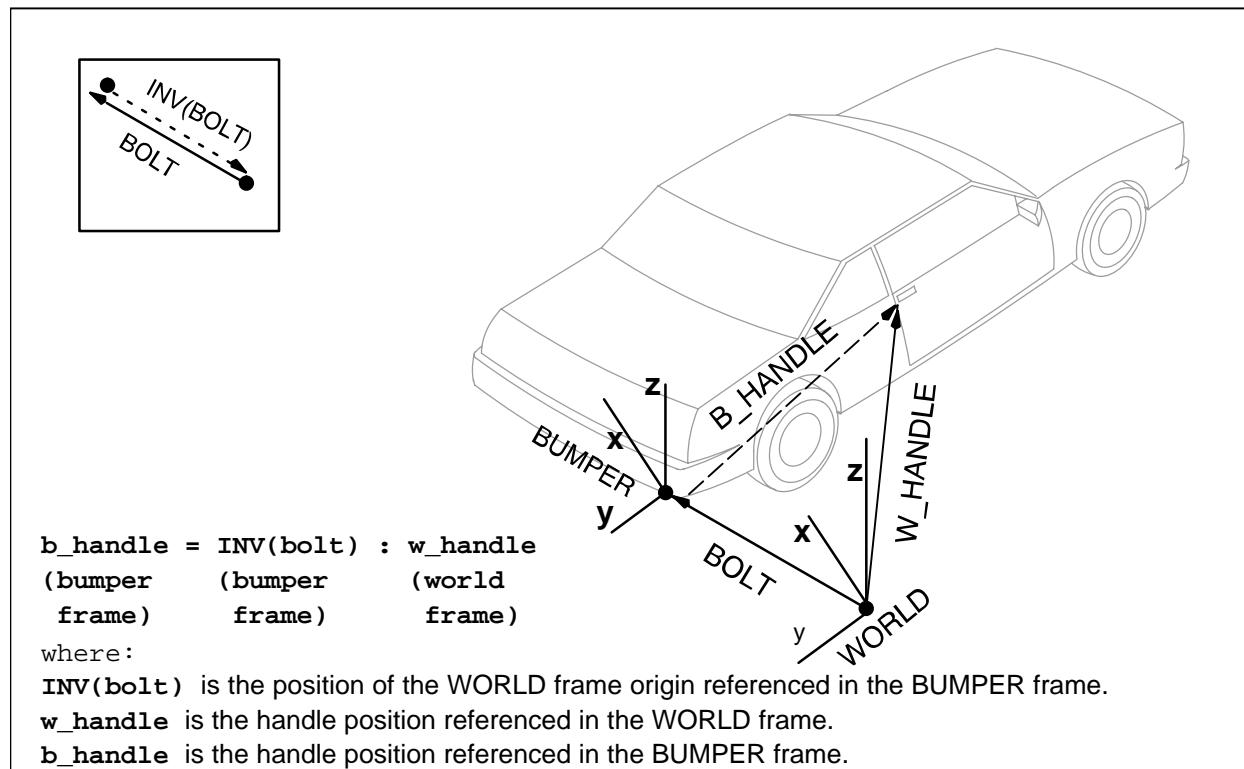
In the example shown in [Figure 3–1](#), a vision system is used to locate a target on a car such as a bolt head on a bumper. The relative position operator is used to calculate the position of the door handle based on data from the car drawings. The equation shown in [Figure 3–1](#) is used to calculate the position of **w\_handle** in the WORLD frame.

**Figure 3–1.** Determining w\_handle Relative to WORLD Frame



The KAREL INV Built-In Function reverses the direction of the reference.

For example, to determine the position of the door handle target (**b\_handle**) relative to the position of the **bolt**, use the equation shown in [Figure 3–2](#).

**Figure 3–2.** Determining b\_handle Relative to BUMPER Frame

**Note** The order of the relative operator (:) is important where:  $b\_handle = bolt : w\_handle$  is NOT the same as  $b\_handle = w\_handle : bolt$

See Also: [Chapter 8 MOTION](#), INV Built-In Function, [Appendix A](#).

### Vector Operations

The following rules apply to VECTOR operations:

- A VECTOR expression can perform addition (+) and subtraction (-) equations on VECTOR operands. The result is a VECTOR whose components are the sum or difference of the corresponding components of the operands. For example, the components of the VECTOR vect\_3 will equal (5, 10, 9) as a result of the following program statements:

### Vector Operations

```
vect_1.x = 4; vect_1.y = 8; vect_1.z = 5
vect_2.x = 1; vect_2.y = 2; vect_2.z = 4
vect_3 = vect_1 + vect_2
```

- The multiplication (\*) and division (/) operators can be used with either

- A VECTOR and an INTEGER operand
- A VECTOR and a REAL operand

The product of a VECTOR and an INTEGER or a VECTOR and a REAL is a scaled version of the VECTOR. Each component of the VECTOR is multiplied by the INTEGER (treated as a REAL number) or the REAL.

For example, the VECTOR (8, 16, 10) is produced as a result of the following operation:

$$(4, 8, 5) * 2$$

VECTOR components can be on the left or right side of the operator.

- A VECTOR divided by an INTEGER or a REAL causes each component of the VECTOR to be divided by the INTEGER (treated as a REAL number) or REAL. For example,  $(4, 8, 5) / 2$  results in (2, 4, 2.5).

If the divisor is zero, the program is aborted with the “Divide by zero” error.

- An INTEGER or REAL divided by a VECTOR causes the INTEGER (treated as a REAL number) or REAL to be multiplied by the reciprocal of each element of the VECTOR, thus producing a new VECTOR. For example,  $3.5 / \text{VEC}(7.0, 8.0, 9.0)$  results in (0.5, 0.4375, 0.38889).

If any of the elements of the VECTOR are zero, the program is aborted with the “Divide by zero” error.

- The cross product operator (#) produces a VECTOR that is normal to the two operands in the direction indicated by the right hand rule and with a magnitude equal to the product of the magnitudes of the two vectors and  $\sin(\Theta)$ , where  $\Theta$  is the angle between the two vectors. For example,  $\text{VEC}(3.0, 4.0, 5.0) \# \text{VEC}(6.0, 7.0, 8.0)$  results in (-3.0, 6.0, -3.0).

If either vector is zero, or the vectors are exactly parallel, an error occurs.

- The inner product operator (@) results in a REAL number that is the sum of the products of the corresponding elements of the two vectors. For example,  $\text{VEC}(3.0, 4.0, 5.0) @ \text{VEC}(6.0, 7.0, 8.0)$  results in 86.0.
- If the result of any of the above operations is a component of a VECTOR with a magnitude too large for a KAREL REAL number, the program is aborted with the “Real overflow” error.

[Table 3–10](#) lists additional examples of vector operations.

**Table 3–10. Examples of Vector Operations**

EXPRESSION	RESULT
$\text{VEC}(3.0, 7.0, 6.0) + \text{VEC}(12.6, 3.2, 7.5)$	(15.6, 10.2, 13.5)
$\text{VEC}(7.6, 9.0, 7.0) - \text{VEC}(14.0, 3.5, 17.0)$	(-6.4, 5.5, -10)

**Table 3–10.** Examples of Vector Operations (Cont'd)

EXPRESSION	RESULT
$4.5 * \text{VEC}(3.2, 7.6, 4.0)$	(14.4, 34.2, 18.0)
$\text{VEC}(12.7, 2.0, 8.3) * 7.6$	(96.52, 15.2, 63.08)
$\text{VEC}(17.3, 1.5, 0.23) / 2$	(8.65, 0.75, 0.115)

### String Operations

The following rules apply to STRING operations:

- You can specify that a KAREL routine returns a STRING as its value. See [Specifying a KAREL Routine to Return a STRING Value](#).

#### Specifying a KAREL Routine to Return a STRING Value

```
ROUTINE name(parameter_list): STRING
    declares name as returning a STRING value
```

- An operator can be used between strings to indicate the concatenation of the strings. See [Using an Operator to Concatenate Strings](#).

#### Using an Operator to Concatenate Strings

```
string_1 = string_2 + string_3 + 'ABC' + 'DEF'
```

- STRING expressions can be used in WRITE statements. See [Using a STRING Expression in a WRITE Statement](#).

#### Using a STRING Expression in a WRITE Statement

```
WRITE(CHR(13) + string_1 + string_2)
```

writes a single string consisting of a return character followed by string\_1 and string\_2

- During STRING assignment, the string will be truncated if the target string is not large enough to hold the same string.

- You can compare or extract a character from a string. For example if *string\_1* = ‘ABCDE’ . Your output would be ‘D’ . See [String Comparison](#) .

### String Comparison

```
IF SUB_STR(string_1, 4, 1) = 'D' THEN
```

- You can build a string from another string. See [Building a String from Another String](#) .

### Building a String from Another String

```
ROUTINE toupper(p_char: INTEGER): STRING
BEGIN
    IF (p_char > 96) AND (p_char < 123) THEN
        p_char = p_char - 32
    ENDIF
    RETURN (CHR(p_char))
END toupper

BEGIN
    WRITE OUTPUT ('Enter string: ')
    READ INPUT (string_1)
    string_2 = ''
    FOR idx = 1 TO STR_LEN(string_1) DO
        string_2 = string_2 + toupper(ORD(string_1, idx))
    ENDFOR
```



# Chapter 4

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## MOTION AND PROGRAM CONTROL

### Contents

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The KAREL language provides several motion control statements that direct the movement of the tool center point or the auxiliary axes. Optional clauses used in conjunction with the motion control statements specify motion characteristics, intermediate positions, and conditions to be monitored.

Program control structures define the flow of execution within a program or routine and include alternation, looping, and unconditional branching as well as execution control.

## **4.1 MOTION CONTROL STATEMENTS**

In robotic applications, motion is the movement of the tool center point (TCP) from an initial position to a desired destination position. Some applications also involve the movement of other objects, such as auxiliary axes. Auxiliary axes can be set up either in the same group as robot axes or a separate group. If auxiliary axes are set up in the robot group, they are called extended axes.

The MOVE statement directs the motion of the TCP, as well as any auxiliary axes, in a KAREL program. A MOVE statement specifies the object and the destination of that object.

This chapter briefly lists the MOVE statements that are available in KAREL. For a detailed description of each statement, action, or clause listed in this section, refer to [Appendix A](#). A more in-depth view of the motion environment is provided in [Chapter 8 MOTION](#).

The following MOVE statements are available in KAREL:

- **MOVE TO** - specifies the destination of the move when the destination is TO a particular position or individual path node. Auxiliary axes can be the object of the move if the destination position is specified as the extended position type, “XYZWPREXT.”
- **MOVE ALONG** - causes motion along the nodes defined for a PATH variable. The object being moved (TCP and/or AUX) depends on the data stored in each path node or a subset can be specified in the MOVE statement.
- **MOVE NEAR** - allows you to specify a destination that is NEAR a position value, using a REAL value for the offset distance. The specified offset is measured in millimeters along the negative z-axis of the specified POSITION.
- **MOVE RELATIVE** - allows you to specify a destination that is RELATIVE to the current location of the group of axes using a VECTOR value for the offset distance. The (x, y, z) components of the offset VECTOR value are in the user coordinate system (\$UFRAME).
- **MOVE AWAY** - allows you to specify a destination that is AWAY from the current position of the group of axes, using a REAL value for the offset distance. The specified offset is measured in millimeters along the negative z-axis of the tool coordinate system.
- **MOVE ABOUT** - allows you to specify a destination that is an angular distance about a specified vector from the current position of a group of axes. The angular distance of the destination of a group of axes is measured from the current position of a group of axes ABOUT the specified VECTOR value in tool coordinates by the specified angle (in degrees).

- **MOVE AXIS** - allows you to specify a particular robot or auxiliary axis as the object being moved BY a distance that is specified as a REAL value.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, personnel could be injured, and equipment could be damaged.**

Optional clauses included in a MOVE statement can specify motion characteristics for a single move, intermediate positions for circular moves, and conditions to be monitored during a move. KAREL provides the following clauses to be used for these purposes:

- **WITH Clause** - allows you to specify a temporary value for a system variable. This temporary value is used by the motion environment while executing the move in which the WITH clause is used. It remains in effect until the move statement, containing the WITH clause, is done executing. At that time, the temporary value ceases to exist.
- **VIA Clause** - specifies a VIA position for moves that use circular interpolation. The VIA position is used to define the circular arc between the initial position and the destination of a MOVE TO motion.
- **NOWAIT Clause** - allows the interpreter to continue program execution beyond the current motion statement while the motion environment carries out the motion.
- **Local Condition Handler Clause** - specifies local condition handlers to be defined at the end of a MOVE statement. Each local condition handler takes effect when the motion starts and is purged either when the conditions are satisfied and the actions have been taken or when the motion interval is complete.

The following KAREL statements and condition handler actions terminate the motion but have no effect on program execution.

- **CANCEL** - causes any motion in progress and any pending motion to be canceled.
- **STOP** - causes the robot and auxiliary axes to decelerate smoothly to a stop but the remainder of the motion command is not lost. Instead, a record of the motion is saved and the motion command can be resumed.
- **HOLD** - causes all robot and auxiliary axes to decelerate to a stop. HOLD also prevents motion from being started or resumed by any KAREL motion statement or condition handler action other than UNHOLD.

**See Also:** [Appendix A](#) for more detailed information on each motion instruction, [Chapter 6 CONDITION HANDLERS](#), for more information on local condition handlers, [Chapter 8 MOTION](#)

#### **4.1.1 Extended Axis Motion**

Auxiliary axes can be set up either in the same group as the robot axes or in a separate group. If the auxiliary axes are set up as part of the robot axes group, they are called extended axes. If the auxiliary axes are separate from the robot axes group, the motion becomes group motion. [Section 4.1.2](#) contains more information about group motion.

Since extended axes are in the same group as robot axes, a kinematics relationship needs to be established. Three types of kinematics relationships can be specified for any extended axis: integrated rail, swing rotary axis, and no kinematics. Because extended axis are in the same group as the robot axis, they are usually moved, started, and stopped at the same time as the robot axis. To control extended axis motion in KAREL, the “XYZWPREXT” position type is used. All MOVE statements described in [Section 4.1](#) are supported for extended axes.

#### **4.1.2 Group Motion**

Group motion refers to the ability of moving several groups of axes at the same time in an overlapping manner. Group motion has the following characteristics:

- A **group** is referred to as a mutually exclusive collection of axes.
- Up to a maximum of three groups can be defined. Group numbers will be designated as 1, 2, and 3. Each group can support up to nine axes. The total number of axes per controller cannot exceed 16.
- Group definitions are set by the user only during a controlled start.
- Within a group, the motion of all axes will start and stop at the same time.
- Among groups, motions are independent of each other.



##### **Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, personnel could be injured, and equipment could be damaged.**

- A group is *kinematic* if there is a correspondence between the position in Cartesian space and the joint angles.

**Caution**

If you add a second motion group to a system, and there are KAREL programs currently loaded that reference the \$xxx\_GRP system variables, all of these programs must be reloaded to reference these variables properly.

## **4.2 PROGRAM CONTROL STRUCTURES**

Program control structures can be used to define the flow of execution within a program or routine. By default, execution starts with the first statement following the BEGIN statement and proceeds sequentially until the END statement (or a RETURN statement) is encountered. The following control structures are available in KAREL:

- Alternation
- Looping
- Unconditional Branching
- Execution Control
- Condition Handlers

For detailed information on each type of control structure, refer to Appendix A, “KAREL Language Alphabetical Description.”

### **4.2.1 Alternation Control Structures**

An alternation control structure allows you to include alternative sequences of statements in a program or routine. Each alternative can consist of several statements.

During program execution, an alternative is selected based on the value of one or more data items. Program execution then proceeds through the selected sequence of statements.

Two types of alternation control structures can be used:

- **IF Statement** - provides a means of specifying one of two alternatives based on the value of a BOOLEAN expression.
- **SELECT Statement** - used when a choice is to be made between several alternatives. An alternative is chosen depending on the value of the specified INTEGER expression.

**See Also:** IF...THEN Statement, [Appendix A](#), SELECT Statement, [Appendix A](#).

## 4.2.2 Looping Control Statements

A looping control structure allows you to specify that a set of statements be repeated an arbitrary number of times, based on the value of data items in the program. KAREL supports three looping control structures:

- The **FOR statement** - used when a set of statements is to be executed a specified number of times. The number of times is determined by INTEGER data items in the FOR statement. At the beginning of the FOR loop, the initial value in the range is assigned to an INTEGER counter variable. Each time the cycle is repeated, the counter is reevaluated.
- The **REPEAT statement** - allows execution of a sequence of statements to continue as long as some BOOLEAN expression remains FALSE. The sequence of executable statements within the REPEAT statement will always be executed once.
- The **WHILE statement** - used when an action is to be executed as long as a BOOLEAN expression remains TRUE. The boolean expression is tested at the start of each iteration, so it is possible for the action to be executed zero times.

**See Also:** FOR Statement, [Appendix A](#), REPEAT Statement, [Appendix A](#), WHILE Statement, [Appendix A](#)

## 4.2.3 Unconditional Branch Statement

Unconditional branching allows you to use a GO TO Statement to transfer control from one place in a program to a specified label in another area of the program, without being dependent upon a condition or BOOLEAN expression.



### Warning

**Never include a GO TO Statement into or out of a FOR loop. The program might be aborted with a "Run time stack overflow" error.**

**See Also:** GO TO Statement, [Appendix A](#).

## 4.2.4 Execution Control Statements

The KAREL language provides the following program control statements, which are used to terminate or suspend program execution:

- **ABORT** - causes the execution of the program, including any motion in progress, to be terminated. The program cannot be continued after being aborted.
- **DELAY** - causes execution to be suspended for a specified time, expressed in milliseconds.

- **PAUSE** - causes execution to be suspended until a CONTINUE operation is executed.
- **WAIT FOR** - causes execution to be suspended until a specified condition or list of conditions is satisfied.

**See Also:** ABORT Statement, DELAY Statement, PAUSE Statement, WAIT FOR Statement, all in [Appendix A, Chapter 6 \*CONDITION HANDLERS\*](#)

#### **4.2.5 Condition Handlers**

A condition handler defines a series of actions which are to be performed whenever a specified condition is satisfied. Once defined, a condition handler can be ENABLED or DISABLED.



# Chapter 5

---

## ROUTINES

## Contents

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Routines, similar in structure to a program, provide a method of modularizing KAREL programs. Routines can include VAR and/or CONST declarations and executable statements. Unlike programs, however, a routine must be declared within an upper case program, and cannot include other routine declarations.

KAREL supports two types of routines:

- Procedure Routines - do not return a value
- Function Routines - return a value

KAREL routines can be predefined routines called built-in routines or they can be user-defined.

The following rules apply to all KAREL routines:

- Parameters can be included in the declaration of a routine. This allows you to pass data to the routine at the time it is called, and return the results to the calling program.
- Routines can be called or invoked:
  - By the program in which they are declared
  - By any routine contained in that program
  - With declarations by another program, refer to [Section 5.1.1](#)

## **5.1 ROUTINE EXECUTION**

---

This section explains the execution of procedure and function routines:

- Declaring routines
- Invoking routines
- Returning from routines
- Scope of variables
- Parameters and Arguments

### **5.1.1 Declaring Routines**

The following rules apply to routine declarations:

- A routine cannot be declared in another routine.
- The ROUTINE statement is used to declare both procedure and function routines.
- Both procedure and function routines must be declared before they are called.

- Routines that are local to the program are completely defined in the program. Declarations of local routines include:
  - The ROUTINE statement
  - Any VAR and/or CONST declarations for the routine
  - The executable statements of the routine
- While the VAR and CONST sections in a routine are identical in syntax to those in a program, the following restrictions apply:
  - PATH, FILE, and vision data types cannot be specified.
  - FROM clauses are not allowed.
  - IN clauses are not allowed.
- Routines that are local to the program can be defined after the executable section if the routine is declared using a FROM clause with the same program name. The parameters should only be defined once. See [Defining Local Routines Using a FROM Clause](#).

### Defining Local Routines Using a FROM Clause

```

PROGRAM funct_lib
  ROUTINE done_yet(x: REAL; s1, s2: STRING): BOOLEAN FROM funct_lib
  BEGIN
    IF done_yet(3.2, 'T', '')
    --
  END funct_lib
  ROUTINE done_yet
  BEGIN
  --
END done_yet

```

- Routines that are external to the program are declared in one program but defined in another.
  - Declarations of external routines include only the ROUTINE statement and a FROM clause.
  - The FROM clause identifies the name of the program in which the routine is defined.
  - The routine must be defined local to the program named in the FROM clause.
- You can include a list of parameters in the declaration of a routine. A parameter list is an optional part of the ROUTINE statement.
- If a routine is external to the program, the names in the parameter list are of no significance but must be included to specify the parameters. If there are no parameters, the parentheses used to enclose the list must be omitted for both external and local routines.

The examples in [Local and External Procedure Declarations](#) illustrate local and external procedure routine declarations.

## Local and External Procedure Declarations

```

PROGRAM procs_lib

ROUTINE wait_a_bit
--local procedure, no parameters
BEGIN
  DELAY 20
END wait_a_bit

ROUTINE move_there(p: POSITION)
--local procedure, one parameter
BEGIN
  MOVE TO p      --reference to parameter p
END move_there

ROUTINE calc_dist(p1,p2: POSITION; dist: REAL)
FROM math_lib
--external procedure defined in math_lib.kL

```

The example in [Function Declarations](#) illustrate local and external function routine declarations.

## Function Declarations

```

PROGRAM funct_lib
  ROUTINE done_yet(x: REAL; s1, s2 :STRING): BOOLEAN
    FROM bool_lib
  --external function routine defined in bool_lib.kl
  --returns a BOOLEAN value

  ROUTINE xy_dist(x1,y1,x2,y2: REAL): REAL
    -local function, returns a REAL value
    VAR
      sum_square: REAL  --dynamic local variable
      dx,dy: REAL       --dynamic local variables
    BEGIN
      dx = x2-x1    --references parameters x2 and x1
      dy = y2-y1    --references parameters y2 and y1
      sum_square = dx * dx + dy * dy
      RETURN(SQRT(sum_square))  --SQRT is a built-in
    END xy_dist

    BEGIN
  END funct_lib

```

**See Also:** FROM Clause, [Appendix A](#), ROUTINE Statement, [Appendix A](#).

## **5.1.2 Invoking Routines**

Routines that are declared in a program can be called within the executable section of the program, or within the executable section of any routine contained in the program. Calling a routine causes the routine to be invoked. A routine is invoked according to the following procedure:

- When a routine is invoked, control of execution passes to the routine.
- After execution of a procedure is finished, control returns to the next statement after the point where the procedure was called.
- After execution of a function is finished, control returns to the assignment statement where the function was called.

The following rules apply when invoking procedure and function routines:

- Procedure and function routines are both called with the routine name followed by an argument for each parameter that has been declared for the routine.
- The argument list is enclosed in parentheses.
- Routines without parameters are called with only the routine name.
- A procedure is invoked as though it were a statement. Consequently, a procedure call constitutes a complete executable statement.

[Procedure Calls](#) shows the declarations for two procedures followed by the procedure calls to invoke them.

### **Procedure Calls**

```
ROUTINE wait_a_bit FROM proc_lib
    --external procedure with no parameters

ROUTINE calc_dist(p1,p2: POSITION; dist: REAL)&
FROM math_lib
    --external procedure with three parameters
BEGIN
    ...
    wait_a_bit      --invokes wait_a_bit procedure
    calc_dist (start_pos, end_pos, distance)
        --invokes calc_dist using three arguments for
        --the three declared parameters
```

- Because a function returns a value, a function call must appear as part or all of an expression.
- When control returns to the calling program or routine, execution of the statement containing the function call is resumed using the returned value.

[Function Calls](#) shows the declarations for two functions followed by the function calls to invoke them.

## Function Calls

```

ROUTINE error_check : BOOLEAN FROM error_prog
    --external function with no parameters returns a BOOLEAN value

ROUTINE distance(p1, p2: POSITION) : REAL &
FROM funct_lib
    --external function with two parameters returns a REAL value
BEGIN  --Main program
    --the function error_check is invoked and returns a BOOLEAN
    --expression in the IF statement
    IF error_check THEN
        ...
    ENDIF
    travel_time = distance(prev_pos, next_pos)/current_spd
    --the function distance is invoked as part of an expression in
    --an assignment statement

```

- Routines can call other routines as long as the other routine is declared in the program containing the initial routine. For example, if a program named **master\_prog** contains a routine named **call\_proc**, that routine can call any routine that is declared in the program, **master\_prog**.
- A routine that calls itself is said to be recursive and is allowed in KAREL. For example, the routine **factorial**, shown in [Recursive Function](#), calls itself to calculate a factorial value.

## Recursive Function

```

ROUTINE factorial(n: INTEGER) : INTEGER
    --calculates the factorial value of the integer n
BEGIN
    IF n = 0 THEN RETURN (1)
    ELSE RETURN (n * factorial(n-1))
    --recursive call to factorial
    ENDIF
END factorial

```

- The only constraint on the depth of routine calling is the use of the KAREL *stack*, an area used for storage of temporary and local variables and for parameters. Routine calls cause information to be placed in memory on the stack. When the RETURN or END statement is executed in the routine, this information is taken off of the stack. If too many routine calls are made without this information being removed from the stack, the program will run out of stack space.

**See Also:** [Section 5.1.6](#) for information on how much space is used on the stack for routine calls

### **5.1.3 Returning from Routines**

The RETURN statement is used in a routine to restore execution control from a routine to the calling routine or program.

The following rules apply when returning from a routine:

- In a procedure, the RETURN statement cannot include a value.
- If no RETURN statement is executed, the END statement restores control to the calling program or routine.

[Procedure RETURN Statements](#) illustrates some examples of using the RETURN statement in a procedure.

#### **Procedure RETURN Statements**

```
ROUTINE gun_on (error_flag: INTEGER)
  --performs some operation while a "gun" is turned on
  --returns from different statements depending on what,
  --if any, error occurs.

  VAR gun: INTEGER
  BEGIN
    IF error_flag = 1 THEN RETURN
    --abnormal exit from routine, returns before
    --executing WHILE loop
    ENDIF
    WHILE DIN[gun] DO
    --continues until gun is off
    ...
    IF error_flag = 2 THEN RETURN
    --abnormal exit from routine, returns from
    --within WHILE loop
    ENDIF
  ENDWHILE  --gun is off
END gun_on  --normal exit from routine
```

- In a function, the RETURN statement must specify a value to be passed back when control is restored to the calling routine or program.
- The function routine can return any data type except
  - FILE
  - PATH
  - Vision types
- If the return type is an ARRAY, you cannot specify a size. This allows an ARRAY of any length to be returned by the function. The returned ARRAY, from an ARRAY valued function, can be used only in a direct assignment statement. ARRAY valued functions cannot be used as

parameters to other routines. Refer to [Correct Passage of an ARRAY](#), for an example of an ARRAY passed between two function routines.

- If no value is provided in the RETURN statement of a function, a translator error is generated.
- If no RETURN statement is executed in a function, execution of the function terminates when the END statement is reached. No value can be passed back to the calling routine or program, so the program aborts with an error.

[Function RETURN Statements](#) illustrates some examples using the RETURN statement in function routines.

### Function RETURN Statements

```

ROUTINE index_value (table: ARRAY of INTEGER;
    table_size: INTEGER): INTEGER
    --Returns index value of FOR loop (i) depending on
    --condition of IF statement. Returns 0 in cases where
    --IF condition is not satisfied.
    VAR i: INTEGER
    BEGIN
        FOR i = 1 TO table_size DO
            IF table[i] = 0 THEN RETURN (i)    --returns index
        ENDIF
        ENDFOR
        RETURN (0)    --returns 0
    END index_value

ROUTINE compare (test_var_1: INTEGER;
    test_var_2: INTEGER): BOOLEAN
    --Returns TRUE value in cases where IF test is
    --satisfied. Otherwise, returns FALSE value.
    BEGIN
        IF test_var_1 = test_var_2 THEN
            RETURN (TRUE)    --returns TRUE
        ELSE
            RETURN (FALSE)    --returns FALSE
        ENDIF
    END compare

```

**See Also:** ROUTINE Statement, [Appendix A](#).

#### 5.1.4 Scope of Variables

The scope of a variable declaration can be

- Global

- Local

### Global Declarations and Definitions

The following rules apply to global declarations and definitions:

- Global declarations are recognized throughout a program.
- Global declarations are referred to as *static* because they are given a memory location that does not change during program execution, even if the program is cleared or reloaded (unless the variables themselves are cleared.)
- Declarations made in the main program, as well as predefined identifiers, are global.
- The scope rules for predefined and user-defined routines, types, variables, constants, and labels are as follows:
  - All predefined identifiers are recognized throughout the entire program.
  - Routines, types, variables, and constants declared in the declaration section of a program are recognized throughout the entire program, including routines that are in the program.

### Local Declarations and Definitions

The following rules apply to local declarations and definitions:

- Local declarations are recognized only within the routines where they are declared.
- Local data is created when a routine is invoked. Local data is destroyed when the routine finishes executing and returns.
- The scope rules for predefined and user-defined routines, variables, constants, and labels are as follows:
  - Variables and constants, declared in the declaration section of a routine, and parameters, declared in the routine parameter list, are recognized only in that routine.
  - Labels defined in a program (not in a routine of the program) are local to the body of the program and are not recognized within any routines of the program.
  - Labels defined in a routine are local to the routine and are recognized only in that routine.
- Types cannot be declared in a routine, so are never local.

#### 5.1.5 Parameters and Arguments

Identifiers that are used in the parameter list of a routine declaration are referred to as parameters. A parameter declared in a routine can be referenced throughout the routine. Parameters are used to pass data between the calling program and the routine. The data supplied in a call, referred to as arguments, can affect the way in which the routine is executed.

The following rules apply to the parameter list of a routine call:

- As part of the routine call, you must supply a data item, referred to as an argument, for each parameter in the routine declaration.
- An argument can be a variable, constant, or expression. There must be one argument corresponding to each parameter.
- Arguments must be of the same data type as the parameters to which they correspond, with three exceptions:
  - An INTEGER argument can be passed to a REAL parameter. In this case, the INTEGER value is treated as type REAL, and the REAL equivalent of the INTEGER is passed by value to the routine.
  - A BYTE or SHORT argument can be passed by value to an INTEGER or REAL parameter.
  - Any positional types can be passed to any other positional type. If they are being passed to a user-defined routine, the argument positional type is converted and passed by value to the parameter type.
  - ARRAY or STRING arguments of any length can be passed to parameters of the same data type.

[Corresponding Parameters and Arguments](#) shows an example of a routine declaration and three calls to that routine.

### Corresponding Parameters and Arguments

```
PROGRAM params
  VAR
    long_string: STRING[10]; short_string: STRING[5]
    exact_dist: REAL; rough_dist: INTEGER
  ROUTINE label_dist (strg: STRING; dist: REAL) &
    FROM procs_lib
  BEGIN
    ...
    label_dist(long_string, exact_dist)
      --long_string corresponds to strg;
      --exact_dist corresponds to dist
    label_dist(short_string, rough_dist)
      --short_string, of a different length,
      --corresponds to strg; rough_dist, an
      --INTEGER, corresponds to REAL dist
    label_dist('new distance', (exact_dist * .75))
      --literal constant and REAL expression
      --arguments correspond to the parameters
  END params
```

- When the routine is invoked, the argument used in the routine call is passed to the corresponding parameter. Two methods are used for passing arguments to parameters:
  - **Passing Arguments By Reference**

If an argument is passed by reference, the corresponding parameter shares the same memory location as the argument. Therefore, changing the value of the parameter changes the value of the corresponding argument.

#### — Passing Arguments By Value

If an argument is passed by value, a temporary copy of the argument is passed to the routine. The corresponding parameter uses this temporary copy. Changing the parameter does not affect the original argument.

- Constant and expression arguments are always passed to the routine by value. Variables are normally passed by reference. The following variable arguments, however, are passed by value:
  - Port array variables
  - INTEGER variables passed to REAL parameters
  - BYTE and SHORT arguments passed to INTEGER or REAL parameters
  - System variables with read only (RO) access
  - Positional parameters that need to be converted
- While variable arguments are normally passed by reference, you can pass them by value by enclosing the variable identifier in parentheses. The parentheses, in effect, turn the variable into an expression.
- PATH, FILE, and vision variables can not be passed by value. ARRAY elements (indexed form of an ARRAY variable) can be passed by value, but entire ARRAY variables cannot.

[Passing Variable Arguments](#) shows a routine that affects the argument being passed to it differently depending on how the variable argument is passed.

### Passing Variable Arguments

```

PROGRAM reference
  VAR arg : INTEGER
  ROUTINE test(param : INTEGER)
  BEGIN
    param = param * 3
    WRITE ('value of param:', param, CR)
  END test
  BEGIN
    arg = 5
    test((arg))    --arg passed to param by value
    WRITE('value of arg:', arg, CR)
    test(arg)      --arg passed to param by reference
    WRITE('value of arg:', arg, CR)
  END reference

```

The output from the program in [Passing Variable Arguments](#) is as follows:

```

value of param: 15
value of arg: 5

```

```
value of param: 15
value of arg: 15
```

If the routine calls from [Passing Variable Arguments](#) were made in reverse order, first passing **arg** by reference using "**test(arg)**" and then passing it by value using "**test ((arg))**," the output would be affected as follows:

```
value of param: 15
value of arg: 15
value of param: 45
value of arg: 15
```

- To pass a variable as a parameter to a KAREL routine you can use one of two methods:
  - You can specify the name of the variable in the parameter list. For example, **other\_rtn(param\_var)** passes the variable **param\_var** to the routine **other\_rtn**. To write this statement, you have to know the name of the variable to be passed.
  - You can use BYNAME. The BYNAME feature allows a program to pass as a parameter to a routine a variable whose name is contained in a string. For example, if the string variables **prog\_name** and **var\_name** contain the name of a program and variable the operator has entered, this variable is passed to a routine using this syntax:

**other\_rtn(BYNAME(prog\_name,var\_name, entry))**

Refer to Appendix A for more information about BYNAME.

- If a function routine returns an ARRAY, a call to this function cannot be used as an argument to another routine. If an incorrect pass is attempted, a translation error is detected.

[Correct Passage of an ARRAY](#) shows the correct use of an ARRAY passed between two function routines.

### Correct Passage of an ARRAY

```
PROGRAM correct
  VAR a : ARRAY[8] of INTEGER

  ROUTINE rtn_ary : ARRAY of INTEGER FROM util_prog

  ROUTINE print_ary(arg : ARRAY of INTEGER)
    VAR i : INTEGER
    BEGIN
      FOR i = 1 to ARRAY_LEN(arg) DO
        WRITE(arg[i],cr)
      ENDFOR
    END print_ary
  BEGIN
    a = rtn_ary
    print_ary(a)
  END correct
```

Incorrect Passage of an ARRAY shows the incorrect use of an ARRAY passed between two function routines.

### Incorrect Passage of an ARRAY

PROGRAM wrong

```

ROUTINE rtn_ary : ARRAY of INTEGER FROM util_prog

ROUTINE print_ary(arg : ARRAY of INTEGER)
  VAR i : INTEGER
  BEGIN
    FOR i = 1 to ARRAY_LEN(arg) DO
      WRITE(arg[i],cr)
    ENDFOR
  END print_ary
  BEGIN
    print_ary(rtn_ary)
  END wrong

```

**See Also:** ARRAY\_LEN Built-In Function, [Appendix A](#), STR\_LEN Built-In Function, [Appendix A](#), [Appendix E](#), "Syntax Diagrams

### 5.1.6 Stack Usage

When a program is executed, a stack of 300 words is allocated unless you specify a stack size. The stack is allocated from available user RAM.

Stack usage can be calculated as follows:

- Each call (or function reference) uses at least five words of stack.
- In addition, for each parameter and local variable in the routine, additional space on the stack is used, depending on the variable or parameter type as shown in [Table 5–1](#).

**Table 5–1. Stack Usage**

Type	Parameter Passed by Reference	Parameter Passed by Value	Local Variable
BOOLEAN	1	2	1
ARRAY OF BOOLEAN		not allowed	1 + array size
ARRAY OF BYTE	1	not allowed	1 + (array size)/4

Table 5-1. Stack Usage (Cont'd)

Type	Parameter Passed by Reference	Parameter Passed by Value	Local Variable
CAM_SETUP	1	not allowed	not allowed
ARRAY OF CAM_SETUP		not allowed	not allowed
COMMON_ASSOC	1	2	1
ARRAY OF COMMON_ASSOC		not allowed	1 + array size
CONFIG	1	2	1
ARRAY OF CONFIG		not allowed	1 + array size
GROUP_ASSOC	1	2	1
ARRAY OF GROUP_ASSOC		not allowed	1 + array size
INTEGER	1	2	1
ARRAY OF INTEGER		not allowed	1 + array size
FILE	1	not allowed	not allowed
ARRAY OF FILE		not allowed	not allowed
JOINTPOS	2	12	10
ARRAY OF JOINTPOS	1	not allowed	1 + 10 * array size
JOINTPOS1	2	4	2
ARRAY OF JOINTPOS1	1	not allowed	1 + 2 * array size
JOINTPOS2	2	5	3
ARRAY OF JOINTPOS2	1	not allowed	1 + 3 * array size

Table 5-1. Stack Usage (Cont'd)

Type	Parameter Passed by Reference	Parameter Passed by Value	Local Variable
JOINTPOS3	2	6	4
ARRAY OF JOINTPOS3	1	not allowed	$1 + 4 * \text{array size}$
JOINTPOS4	2	7	5
ARRAY OF JOINTPOS4	1	not allowed	$1 + 5 * \text{array size}$
JOINTPOS5	2	8	6
ARRAY OF JOINTPOS5	1	not allowed	$1 + 6 * \text{array size}$
JOINTPOS6	2	9	7
ARRAY OF JOINTPOS6	1	not allowed	$1 + 7 * \text{array size}$
JOINTPOS7	2	10	8
ARRAY OF JOINTPOS7	1	not allowed	$1 + 8 * \text{array size}$
JOINTPOS8	2	11	9
ARRAY OF JOINTPOS8	1	not allowed	$1 + 9 * \text{array size}$
JOINTPOS9	2	12	10
ARRAY OF JOINTPOS9	1	not allowed	$1 + 10 * \text{array size}$
MODEL	1	not allowed	not allowed
ARRAY OF MODEL	1	not allowed	not allowed
PATH	2	not allowed	not allowed
POSITION	2	16	14
ARRAY OF POSITION	1	not allowed	$1 + 14 * \text{array size}$

**Table 5–1. Stack Usage (Cont'd)**

Type	Parameter Passed by Reference	Parameter Passed by Value	Local Variable
REAL	1	2	1
ARRAY OF REAL	1	not allowed	1 + array size
ARRAY OF SHORT	1	not allowed	1 + (array size)/2
STRING	2	2 + (string length+2)/4	(string length+2)/4
ARRAY OF STRING	1	not allowed	1+((string length+2)*array size)/4
VECTOR	1	4	3
ARRAY OF VECTOR	1	not allowed	1 + 3 * array size
VIS_PROCESS	1	not allowed	not allowed
ARRAY OF VIS_PROCESS	1	not allowed	not allowed
XYZWPR	2	10	8
ARRAY OF XYZWPR	1	not allowed	1 + 8 * array size
XYZWPREXT	2	13	11
ARRAY OF XYZWPREX	1	not allowed	1 + 11 * array size
ARRAY [m,n] OF some_type	1	not allowed	m(ele size/4 * n + 1)+1
ARRAY [l,m,n] OF some_type	1	not allowed	l(m(ele size/4 * n + 1)+1)+1

## **5.2 BUILT- IN ROUTINES**

The KAREL language includes predefined routines referred to as KAREL built-in routines, or built-ins. Predefined routines can be either procedure or function built-ins. They are provided as a programming convenience and perform commonly needed services.

Many of the built-ins return a status parameter that signifies an error if not equal to 0. The error returned can be any of the error codes defined in the *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual*. These errors can be posted to the error log and displayed on the error line by calling the POST\_ERR built-in routine with the returned status parameter.

**Table 5–2** is a summary list of all the predefined built-in routines included in the KAREL language. A detailed description of all the KAREL built-in routines is provided in [Appendix A](#).

**See Also:** [Appendix A](#), which lists optional KAREL built-ins and where they are documented.

**Table 5–2. KAREL Built-In Routine Summary**

Group	Identifier		
Byname (BYNAM)	CALL_PROG CALL_PROGLIN	CURR_PROG FILE_LIST	PROG_LIST VAR_INFO VAR_LIST
Error Code Handling (ERRS)	ERR_DATA	POST_ERR	
File and Device Operation (FDEV)	COPY_FILE DELETE_FILE DISMOUNT_DEV	FORMAT_DEV MOUNT_DEV MOVE_FILE	PRINT_FILE PURGE_DEV RENAME_FILE
Serial I/O, File Usage (FLBT)	BYTES_AHEAD BYTES_LEFT CLR_IO_STAT GET_FILE_POS	GET_PORT_ATR IO_STATUS SET_FILE_ATR SET_FILE_POS	SET_PORT_ATR VOL_SPACE
Process I/O Setup (IOSETUP)	CLR_PORT_SIM GET_PORT_ASG GET_PORT_MOD	GET_PORT_SIM IO_MOD_TYPE SET_PORT_ASG	SET_PORT_MOD SET_PORT_SIM
KCL Operation (KCLOP)	KCL	KCL_NO_WAIT	KCL_STATUS

**Table 5–2.** KAREL Built-In Routine Summary (Cont'd)

Group	Identifier		
Memory Operation (MEMO)	CLEAR	LOAD_STATUS	RENAME_VARS
	CREATE_VAR	RENAME_VAR	SAVE
	LOAD		SAVE_DRAM
MIRROR (MIR)	MIRROR		
Motion and Program Control (MOTN)	CNCL_STP_MTN	MOTION_CTL	RESET
Multi-programming (MULTI)	ABORT_TASK	PAUSE_TASK	SET_TSK_ATTR
	CLEAR_SEMA	PEND_SEMA	SET_TSK_NAME
	CONT_TASK	POST_SEMA	UNLOCK_GROUP
	GET_TSK_INFO	RUN_TASK	
	LOCK_GROUP	SEMA_COUNT	
Path Operation (PATHOP)	APPEND_NODE	INSERT_NODE	PATH_LEN
	COPY_PATH	NODE_SIZE	
	DELETE_NODE		
Personal Computer Communications (PC)	ADD_BYNAME	ADD_STRINGPC	
	PCADD_INT	SEND_DATAPC	
	PCADD_REALPC	SEND_EVENTPC	
Queue Manager (PBQMGR)	APPEND_QUEUE	GET_QUEUE	MODIFY_QUEUE
	COPY_QUEUE	INIT_QUEUE	
	DELETE_QUEUE	INSERT_QUEUE	

**Table 5–2.** KAREL Built-In Routine Summary (Cont'd)

Group	Identifier		
Register Operation (REGOPE)	CLR_POS_REG	GET_REG_CMT	SET_POS_REG
	GET_JPOS_REG	GET_REG	SET_PREG_CMT
	GET_POS_REG	SET_INT_REG	SET_REAL_REG
	GET_PREG_CMT	SET_JPOS_REG	SET_REG_CMT
String Operation (STRNG)	CNV_CONF_STR	CNV_REAL_STR	CNV_STR_INT
	CNV_INT_STR	CNV_STR_CONF	CNV_STR_REAL
System (SYSTEM)	ABS	CURPOS	ROUND
	ACOS	EXP	SET_PERCH
	ARRAY_LEN	FRAME	SET_VAR
	ASIN	GET_VAR	SIN
	ATAN2	IN_RANGE	SQRT
	BYNAME	INDEX	STR_LEN
	CHR	INV	SUB_STR
	CNV_JPOS_REL	J_IN_RANGE	TAN
	CNV_REL_JPOS	LN	TRUNC
	COS	ORD	UNINIT
Time-of-Day Operation (TIM)	CURJPOS	POS	UNPOS
	CNV_STR_TIME	GET_TIME	
	CNV_TIME_STR	SET_TIME	

**Table 5–2.** KAREL Built-In Routine Summary (Cont'd)

Group	Identifier		
TPE Program (TPE)	AVL_POS_NUME	GET_JPOS_TPE	SET_EPOS_TPE
	CLOSE_TPE	GET_POS_TPE	SET_JPOS_TPE
	COPY_TPE	GET_POS_TYP	SET_POS_TPE
	CREATE_TP	OPEN_TPE	
	DEL_INST_TPE	SELECT_TPE	
	GET_ATTR_PRG	SET_ATTR_PRG	
Translate (TRANS)	TRANSLATE		
User Interface (UIF)	ACT_SCREEN	DEF_WINDOW	PUSH_KEY_RD
	ADD_DICT	DET_WINDOW	READ_DICT
	ATT_WINDOW_D	DISCTRL_ALPH	READ_DICT_V
	ATT_WINDOW_S	DISCTRL_LIST	READ_KB
	CHECK_DICT	FORCE_SPMENU	REMOVE_DICT
	CNC_DYN_DISB	INI_DYN_DISB	SET_CURSOR
	CNC_DYN_DISE	INI_DYN_DISE	SET_LANG
	CNC_DYN_DISI	INI_DYN_DISI	WRITE_DICT
	CNC_DYN_DISP	INI_DYN_DISP	WRITE_DICT_V
	CNC_DYN_DISR	INI_DYN_DISR	
	CNC_DYN_DISS	INI_DYN_DISS	
	DEF_SCREEN	POP_KEY_RD	
Vector (VECTR)	APPROACH	ORIENT	

# Chapter 6

---

## CONDITION HANDLERS

### Contents

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The condition handler feature of the KAREL language allows a program to respond to external conditions more efficiently than conventional program control structures allow. Two kinds of condition handlers are available in KAREL:

- Global - used to monitor and act on conditions throughout an entire program.
- Local - defined as part of a move statement and are in effect only while the motion is in progress.

These condition handlers allow specified conditions to be monitored in parallel with normal program execution and, if the conditions occur, corresponding actions to be taken in response.

For a condition handler to be monitored, it must be defined first and then enabled. Disabling a condition handler removes it from the group being scanned. Purging condition handlers deletes their definition.

[Table 6–1](#) lists the conditions that can be monitored by condition handlers.

**Table 6–1. Conditions**

GLOBAL OR LOCAL CONDITIONS		LOCAL CONDITIONS
port_id[n]	ERROR[n]	AT NODE[n]
NOT port_id[n]	EVENT[n]	TIME t BEFORE NODE[n]
port_id[n]+	ABORT	TIME t AFTER NODE[n]
port_id[n]-	PAUSE	
operand = operand	CONTINUE	
operand <> operand	SEMAPHORE[n]	
operand < operand		
operand <= operand		
operand > operand		
operand >= operand		

[Table 6–2](#) lists the actions that can be taken.

**Table 6–2.** Actions

variable = expression	NOABORT
port_id[n] = expression	NOMESSAGE
STOP	NOPAUSE
CANCEL	ENABLE CONDITION[n]
RESUME	DISABLE CONDITION[n]
HOLD	PULSE DOUT[n] FOR t
UNHOLD	UNPAUSE
routine_name	ABORT
SIGNAL EVENT[n]	CONTINUE
	PAUSE
	SIGNAL SEMAPHORE[n]

## **6.1 CONDITION HANDLER OPERATIONS**

Global condition handler operations differ from those of local condition handlers. [Table 6–3](#) summarizes condition handler operations.

**Table 6–3.** Condition Handler Operations

OPERATION	GLOBAL CONDITION HANDLER	LOCAL CONDITION HANDLER
Define	CONDITION[n]:<WITH \$SCAN_TIME = n> WHENconds DO actions ENDCONDITION	MOVE ... , WHENconds DO actions UNTILconds UNTILconds THEN actions ENDMOVE
Enable	ENABLE CONDITION[n] (statement or action)	Motion start, RESUME or UNHOLD
Disable	DISABLE CONDITION[n] (statement or action) or conditions satisfied	Motion STOP or HOLD
Purge	PURGE CONDITION[n] (statement), program terminated	Motion completed or canceled, program terminated, or conditions satisfied

### **6.1.1 Global Condition Handlers**

Global condition handlers are defined by executing a CONDITION statement in the executable section of a program. The definition specifies conditions/actions pairs. The following rules apply to global condition handlers.

- Each global condition handler is referenced throughout the program by a specified number, from 1 to 1000. If a condition handler with the specified number was previously defined, it must be purged before it is replaced by the new one.
- The conditions/actions pairs of a global condition handler are specified in the WHEN clauses of a CONDITION statement. All WHEN clauses for a condition handler are enabled, disabled, and purged together.
- The condition list represents a list of conditions to be monitored when the condition handler is scanned.
- By default, each global condition handler is scanned at a rate based on the value of \$SCR.\$cond\_time. If the “WITH \$SCAN\_TIME = n” clause is used in a CONDITION statement, the condition will be scanned roughly every “n” milliseconds. The actual interval between the scans is determined as shown in [Table 6–4](#).

**Table 6–4.** Interval Between Global Condition Handler Scans

"n"	Interval Between Scans
$n \leq \$COND\_TIME$	$\$COND\_TIME$
$\$COND\_TIME < n \leq (2 * \$COND\_TIME)$	$(2 * \$COND\_TIME)$
$(2 * \$COND\_TIME) < n \leq (4 * \$COND\_TIME)$	$(4 * \$COND\_TIME)$
$(4 * \$COND\_TIME) < n \leq (8 * \$COND\_TIME)$	$(8 * \$COND\_TIME)$
$(8 * \$COND\_TIME) < n \leq (16 * \$COND\_TIME)$	$(16 * \$COND\_TIME)$
$(16 * \$COND\_TIME) < n \leq (32 * \$COND\_TIME)$	$(32 * \$COND\_TIME)$
$(32 * \$COND\_TIME) < n \leq (64 * \$COND\_TIME)$	$(64 * \$COND\_TIME)$
$(64 * \$COND\_TIME) < n \leq (128 * \$COND\_TIME)$	$(128 * \$COND\_TIME)$
$(128 * \$COND\_TIME) < n \leq (256 * \$COND\_TIME)$	$(256 * \$COND\_TIME)$
$(256 * \$COND\_TIME) < n$	$(512 * \$COND\_TIME)$

- Multiple conditions must all be separated by the AND operator or the OR operator. Mixing of AND and OR is not allowed.
- If AND is used, all of the conditions of a single WHEN clause must be satisfied simultaneously for the condition handler to be triggered.
- If OR is used, the actions are triggered when any of the conditions are TRUE.
- The action list represents a list of actions to be taken when the corresponding conditions of the WHEN clause are simultaneously satisfied.
- Multiple actions must be separated by a comma or a new line.

[Global Condition Handler Definitions](#) shows three examples of defining global condition handlers.

**See Also:** \$SCR.\$cond\_time System Variable, *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* \$SCAN\_TIME Condition Handler Qualifier, *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual*

### Global Condition Handler Definitions

CONDITION[1]: --defines condition handler number

```

1
WHEN DIN[1] DO DOUT[1] = TRUE          --triggered if any one
WHEN DIN[2] DO DOUT[2] = TRUE          --of the WHEN clauses
WHEN DIN[3] DO DOUT[3] = TRUE          --is satisfied
ENDCONDITION

CONDITION[2]:   --defines condition handler number 2
    WHEN PAUSE DO                      --one condition triggers
        AOUT[speed_out] = 0             --multiple actions
        DOUT[pause_light] = TRUE
    ENABLE CONDITION [2]              --enables this condition
ENDCONDITION                         --handler again

CONDITION[3]:
    WHEN DIN[1] AND DIN[2] AND DIN[3] DO --multiple
        DOUT[1] = TRUE                --conditions separated by AND;
        DOUT[2] = TRUE                --all three conditions must be
        DOUT[3] = TRUE                --satisfied at the same time
ENDCONDITION

```

- You can enable, disable, and purge global condition handlers as needed throughout the program. Whenever a condition handler is triggered, it is automatically disabled, unless an ENABLE action is included in the action list. (See condition handler 2 in [Global Condition Handler Definitions](#).)
- The ENABLE statement or action enables the specified condition handler. The condition handler will be scanned during the next scan operation and will continue to be scanned until it is disabled.
- The DISABLE statement or action removes the specified condition handler from the group of scanned condition handlers. The condition handler remains defined and can be enabled again with the ENABLE statement or action.
- The PURGE statement deletes the definition of the specified condition handler.
- ENABLE, DISABLE, and PURGE have no effect if the specified condition handler is not defined. If the specified condition handler is already enabled, ENABLE has no effect; if it is already disabled, DISABLE has no effect.

[Using Global Condition Handlers](#) shows examples of enabling, disabling, and purging global condition handlers.

### Using Global Condition Handlers

```

CONDITION[1]:   --defines condition handler number 1
    WHEN line_stop = TRUE DO DOUT[1] = FALSE
ENDCONDITION

CONDITION[2]:   --defines condition handler number 2
    WHEN line_go = TRUE DO
        DOUT[1] = TRUE, ENABLE CONDITION [1]

```

```

ENDCONDITION

ENABLE CONDITION[2] --condition handler 2 is enabled
. . .

IF ready THEN line_go = TRUE; ENDIF
--If ready is TRUE condition handler 2 is triggered (and
--disabled) and condition handler 1 is enabled.

--Otherwise, condition handler 2 is not triggered (and is
--still enabled), condition handler 1 is not yet enabled,
--and the next two statements will have no effect.
DISABLE CONDITION[1]
ENABLE CONDITION[2]
. . .
ENABLE CONDITION[1] --condition handler 1 is enabled
. . .
line_stop = TRUE --triggers (and disables) condition handler 1
. . .
PURGE CONDITION[2] --definition of condition handler 2 deleted
ENABLE CONDITION[2] --no longer has any effect
line_go = TRUE      --no longer a monitored condition

```

### **6.1.2 Local Condition Handlers**

A local condition handler is defined at the end of a MOVE statement and includes one or more conditions/actions pairs in conjunction with the WHEN or UNTIL clauses. The following rules apply to local condition handlers:

- They are defined only during execution of a particular motion statement and are automatically enabled when the motion starts, and purged when the motion completes or is cancelled.
- A comma (,) separates the condition handler definition from the rest of the MOVE statement.
- The reserved word ENDMOVE, which must be on a new line, ends a MOVE statement that contains condition handler definitions.
- The conditions/actions pairs of a local condition handler can be specified in WHEN clauses or UNTIL clauses.
- WHEN clauses and UNTIL clauses can be used in any order and combination; each must begin on a separate line.
  - The WHEN clause specifies conditions to be monitored and actions to be taken when the conditions are satisfied.
  - The UNTIL clause specifies that the motion is to be canceled if the conditions are satisfied.

The optional THEN portion of the UNTIL clause can be used to specify other actions (in addition to canceling the motion) to be taken when the conditions are satisfied.

- The condition list represents a list of conditions to be monitored when the condition handler is scanned. Each condition handler is scanned at a rate based on the value of the \$SCR.\$COND\_TIME system variable.
  - Multiple conditions must all be separated by the AND operator or the OR operator. Mixing of AND and OR is not allowed.
  - When AND is used, all of the conditions in a single WHEN or UNTIL clause must be satisfied simultaneously for the condition handler to be triggered.
  - When OR is used, the condition handler is triggered when any of the conditions are satisfied.
- The action list represents a list of actions to be taken when the corresponding conditions in the WHEN or UNTIL clause are simultaneously satisfied. Multiple actions must be separated by a comma or a new line.
- A local condition handler is automatically enabled when the physical motion starts. It is automatically purged when the condition handler is triggered, when the motion is completed, or when the motion is canceled. Unlike global condition handlers, each WHEN block in a MOVE is a separate condition handler. If one WHEN block triggers, only that WHEN block is disabled.
- The time delay between executing the MOVE statement and enabling a condition handler might be long for MOVE statements following incomplete NOWAIT moves.
- Local condition handlers automatically are disabled when the motion is held or stopped and are re-enabled when the motion starts again due to execution of an UNHOLD or RESUME statement or action.

[Local Condition Handler Examples](#) shows an example of local condition handlers in MOVE statements with both WHEN and UNTIL clauses.

**See Also:** \$SCR.\$cond\_time System Variable, *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual*

### Local Condition Handler Examples

```
--local condition handler at end of move statement
WITH $SPEED = 200, $MOTYPE = CIRCULAR
MOVE ALONG paint_path NOWAIT,           --comma
      --start of local condition handler
      WHEN TIME 100 BEFORE NODE[2] DO DOUT[2] = TRUE
ENDMOVE      --end of local condition handler

MOVE TO posn,
      WHEN AT NODE[3] AND DIN[1] DO  --multiple conditions
          CANCEL
ENDMOVE

MOVE ALONG weld_pth,      --multiple cond/action pairs
      UNTIL ERROR[stop_error] THEN
```

```

SIGNAL EVENT[shut_off]           --multiple actions
    clean_up --call interrupt routine
WHEN PAUSE DO
    tmp_clean_up --call interrupt routine
WHEN TIME 100 BEFORE NODE[last_node] DO
    clean_up --call interrupt routine
ENDMOVE

```

## **6.2 CONDITIONS**

One or more conditions are specified in the condition list of a WHEN or UNTIL clause, defining the conditions portion of a conditions/actions pair. Conditions can be

- States - which remain satisfied as long as the state exists. Examples of states are DIN[1] and (VAR1 > VAR2).
- Events - which are satisfied only at the instant the event occurs. Examples of events are ERROR[n], DIN[n]+, and PAUSE.

The following rules apply to system and program event conditions:

- After a condition handler is enabled, the specified conditions are monitored.
  - If all of the conditions of an AND, WHEN, or UNTIL clause are simultaneously satisfied, the condition handler is triggered and corresponding actions are performed.
  - If all of the conditions of an OR, WHEN, or UNTIL clause are satisfied, the condition handler is triggered and corresponding actions are performed.
- Event conditions very rarely occur simultaneously. Therefore, you should never use AND between two event conditions in a single WHEN or UNTIL clause because, both conditions will not be satisfied simultaneously.
- While many conditions are similar in form to BOOLEAN expressions in KAREL, and are similar in meaning, only the forms listed in this section, not general BOOLEAN expressions, are permitted.
- Expressions are permitted within an EVAL clause. More general expressions may be used on the right side of comparison conditions, by enclosing the expression in an EVAL clause: EVAL (expression). However, expressions in an EVAL clause are evaluated when the condition handler is defined. They are not evaluated dynamically.
- The value of an EVAL clause expression must be INTEGER, REAL, or BOOLEAN.

**See Also:** EVAL Clause, [Appendix A](#).

## **6.2.1 Port\_Id Conditions**

Port\_id conditions are used to monitor digital port signals. Port\_id must be one of the predefined BOOLEAN port array identifiers (DIN, DOUT, OPIN, OPOUT, TPIN, TPOUT, RDI, RDO, WDI, or WDO). The value of n specifies the port array signal to be monitored. [Table 6–5](#) lists the available port\_id conditions.

**Table 6–5. Port\_Id Conditions**

CONDITION	SATISFIED (TRUE) WHEN
port_id[n]	Digital port n is TRUE. (state)
NOT port_id[n]	Digital port n is FALSE. (state)
port_id[n]+	Digital port n changes from FALSE to TRUE. (event)
port_id[n]-	Digital port n changes from TRUE to FALSE. (event)

- For the state conditions, **port\_id[n]** and **NOT port\_id[n]**, the port is tested during every scan. The following conditions would be satisfied if, during a scan, DIN[1] was TRUE and DIN[2] was FALSE:

```
WHEN DIN[1] AND NOT DIN[2] DO . . .
```

Note that an input signal should remain ON or OFF for the minimum scan time to ensure that its state is detected.

- For the event condition **port\_id[n]+**, the initial port value is tested when the condition handler is enabled. Each scan tests for the specified change in the signal. The change must occur while the condition handler is enabled.

The following condition would only be satisfied if, while the condition handler was enabled, DIN[1] changed from TRUE to FALSE since the last scan.

```
WHEN DIN[1]- DO . . .
```

## **6.2.2 Relational Conditions**

Relational conditions are used to test the relationship between two operands. They are satisfied when the specified relationship is TRUE. Relational conditions are state conditions, meaning the relationship is tested during every scan. [Table 6–6](#) lists the relational conditions.

**Table 6–6.** Relational Conditions

CONDITION	SATISFIED (TRUE) WHEN
operand = operand	Relationship specified is TRUE. Operands on the left can be a port array element, referenced as port_id[n], or a variable. Operands on the right can be a variable, a constant, or an EVAL clause. (state)
operand < > operand	
operand < operand	
operand < = operand	
operand > operand	
operand > = operand	

The following rules apply to relational conditions:

- Both operands must be of the same data type and can only be of type INTEGER, REAL, or BOOLEAN. (As in other situations, INTEGER constants can be used where REAL values are required, and will be treated as REAL values.)
- The operand on the left side of the condition can be any of the port array signals, a user-defined variable, a static variable, or a system variable that can be read by a KAREL program.
- The operand on the right side of the condition can be a user-defined variable, a static variable, a system variable that can be read by a KAREL program, any constant, or an EVAL clause. For example:

```

WHEN DIN[1] = ON DO . . .      --port_id and constant
WHEN flag = TRUE DO . . .     --variable and constant
WHEN AIN[1] >= temp DO . . .   --port_id and variable
WHEN flag_1 <> flag_2 DO . . .  --variable and variable
WHEN AIN[1] <= EVAL(temp * scale) DO . . .
    --port_id and EVAL clause
WHEN dif > EVAL(max_count - count) DO . . .
    --variable and EVAL clause

```

- The EVAL clause allows you to include expressions in relational conditions. However, it is evaluated only when the condition handler is defined. The expression in the EVAL clause cannot include any routine calls.

**See Also:** EVAL Clause, [Appendix A](#).

### **6.2.3 System and Program Event Conditions**

System and program event conditions are used to monitor system and program generated events. The specified condition is satisfied only if the event occurs when the condition handler is enabled.

Enabled condition handlers containing ERROR, EVENT, PAUSE, ABORT, POWERUP, or CONTINUE conditions are scanned only if the specified type of event occurs. For example, an enabled condition handler containing an ERROR condition will be scanned only when an error occurs. [Table 6–7](#) lists the available system and program event conditions.

**Table 6–7. System and Program Event Conditions**

CONDITION	SATISFIED (TRUE) WHEN
ERROR [n]	The error specified by n is reached or, if n = *, any error occurs. (event)
EVENT[n]	The event specified by n is signaled. (event)
ABORT	The program is aborted. (event)
PAUSE	The program is paused. (event)
CONTINUE	The program is continued. (event)
POWERUP	The program is continued. (event)
SEMAPHORE[n]	The value of the semaphore specified by n is posted.

The following rules apply to these conditions:

#### **ERROR Condition**

- The ERROR condition can be used to monitor the occurrence of a particular error by specifying the error code for that error. For example, ERROR[15018] monitors the occurrence of the error represented by the error code 15018.

The error codes are listed in the following format:  
ffccc (decimal)

where

ff represents the facility code of the error

ccc represents the error code within the specified facility

For example, 15018 is MOTN-018, which is "Position not reachable." The facility code is 15 and the error code is 018. The error facility codes are listed in [Table 6–8](#). Refer to the *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual* for a complete listing of error codes.

**Table 6–8. Error Facility Codes**

Facility Name	Facility Code (Decimal)	Description
SRIO	1	Serial driver
FILE	2	File system
PROG	3	Interpreter
COND	4	Condition handler
ELOG	5	Error logger
MCTL	6	Motion control manager
MEMO	7	Memory manager
OPIF	8	Operator interface
TPIF	9	Teach pendant user interface
FLPY	10	Serial floppy disk system
SRVO	11	FLTR&SERVO in motion sub-system
INTP	12	Interpreter errors
PRI0	13	Digital I/O subsystem
TPAX	14	Aux task/subsystem
MOTN	15	Motion subsystem

**Table 6–8.** Error Facility Codes (Cont'd)

<b>Facility Name</b>	<b>Facility Code (Decimal)</b>	<b>Description</b>
VARS	16	Variable manager subsystem
ROUT	17	Interpreter built-ins
WNDW	18	Window I/O manager
JOG	19	Manual jog task
APPL	20	Application manager
LANG	21	Language utility
SPOT	23	Spot application
SYST	24	Facility code of system
SCIO	25	Syntax checking routine for teach pendant programs
PALT	26	Pallet
UAPL	27	UAMR
VISN	32	Vision system
DICT	33	Dictionary processor
TRAN	35	Translator
TKSP	36	Translator/KCL scanner/parser
KT	37	KAREL tools
APSH	38	Application shell

**Table 6–8. Error Facility Codes (Cont'd)**

<b>Facility Name</b>	<b>Facility Code (Decimal)</b>	<b>Description</b>
CMND	42	Command processor
RPSM	43	Root pass memorization
LNTK	44	Line tracking
WEAV	45	Weaving
TCPP	46	TCP speed prediction
TAST	47	Through-arc seam tracking
MUPS	48	Multi-pass motion
MIGE	49	MIG-Eye tracking
LSW	50	Laser welding
SEAL	51	Sealing
PAIN	52	Paint application errors
ARC	53	Arc welding
TRAK	54	TRACK softpart
CMCC	55	CMC softpart
SP	56	Softparts utility loader
MACR	57	MACRO option
SENS	58	Sensor interface
COMP	59	Computer interface

**Table 6–8. Error Facility Codes (Cont'd)**

Facility Name	Facility Code (Decimal)	Description
THSR	60	Touch sensing
DJOG	64	Detached jog
OPTN	65	Option installation

- The ERROR condition can also be used to monitor the occurrence of any error by specifying an asterisk (\*), the wildcard character, in place of a specific error code. For example, ERROR[\*] monitors the occurrence of any error.
- The ERROR condition is satisfied only for the scan performed when the error was detected. The error is not remembered in subsequent scans.

### **EVENT Condition**

- The EVENT condition monitors the occurrence of the specified program event. The SIGNAL statement or action in a program indicates that an event has occurred.
- The EVENT condition is satisfied only for the scan performed when the event was signaled. The event is not remembered in subsequent scans.

### **ABORT Condition**

- The ABORT condition monitors the aborting of program execution. If an ABORT occurs, the corresponding actions are performed. However, if one of the actions is a routine call, the routine will not be executed because program execution has been aborted.

If an ABORT condition is used in a condition handler all actions, except routine calls, will be performed even though the program has aborted.

### **PAUSE Condition**

- The PAUSE condition monitors the pausing of program execution. If one of the corresponding actions is a routine call, it is also necessary to specify a NOPAUSE or UNPAUSE action.

### **CONTINUE Condition**

- The CONTINUE condition monitors the resumption of program execution. If program execution is paused, the CONTINUE action, the KCL> CONTINUE command, a CYCLE START from the operator panel, or the teach pendant FWD key will continue program execution and satisfy the CONTINUE condition.

**POWERUP Condition**

- The POWERUP condition monitors the resumption of program execution after a power failure recovery. The controller must be able to recover successfully from a power failure before the program can be resumed.

**SEMAPHORE Condition**

- The SEMAPHORE condition monitors the specified semaphore. The CLEAR\_SEMA built-in can be used to set the semaphore value to 0. The POST\_SEMA built-in or the SIGNAL SEMAPHORE action can be used to increment the semaphore value and satisfy the SEMAPHORE condition.

**See Also:** In [Appendix A](#):

ABORT Condition

CONTINUE Condition

ERROR Condition

EVENT Condition

PAUSE Condition

POWERUP Condition

SEMAPHORE Condition

*FANUC Robotics SYSTEM R-J3iB Controller Application-Specific Setup and Operations Manual* for error codes. *FANUC Robotics SYSTEM R-J3iB Controller Error Code Manual*.

#### **6.2.4 Local Conditions**

The conditions that can be monitored only by local condition handlers are listed in [Table 6–9](#).

**Table 6–9. Local Conditions**

CONDITION	SATISFIED (TRUE) WHEN
AT NODE[ n ]	The node specified by n is reached or, in n = * , any node is reached. (event)

**Table 6–9.** Local Conditions (Cont'd)

TIME $t$ BEFORE NODE[ $n$ ]	It is specified time $t$ before the specified node $n$ (or any node if $n = *$ ) will be reached during a move. (event)
TIME $t$ AFTER NODE[ $n$ ]	It is specified time $t$ after the specified node $n$ (or any node if $n = *$ ) was reached during a move. (event)

These are used for monitoring the progress of a move to a position or along a PATH.

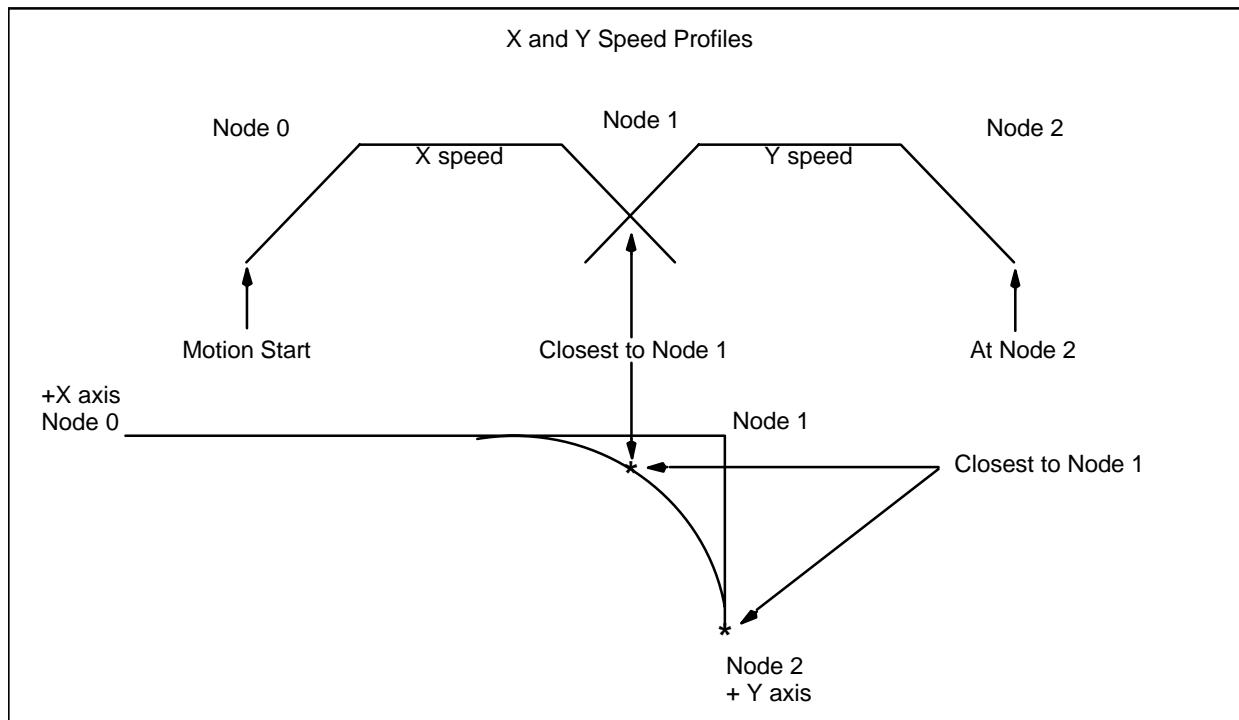
The following rules apply to local conditions:

- $n$  is an INTEGER that indicates the path node or a position AT which, BEFORE which, or AFTER which the condition is satisfied. The wildcard character (\*) can be specified for  $n$ , indicating every path node.
- TIME  $t$  is an INTEGER expression specifying a time interval in milliseconds.
- If the motion segment preceding NODE[ $n$ ] is less than  $t$  milliseconds long for a TIME  $t$  BEFORE condition, the condition is considered satisfied at the start of the segment.
- If the motion completes or is canceled before  $t$  milliseconds after NODE[  $n$  ] (or any node if  $n = *$  ) is reached for a TIME  $t$  AFTER condition, the condition is never satisfied.
- NODE[ 0 ] represents the start of the move.
- For non-path moves such as MOVE TO position, MOVE AWAY, and MOVE NEAR, NODE[1] represents the destination of the move.
- The TIME  $t$  BEFORE condition will not be satisfied before NODE[0]. The TIME  $t$  AFTER condition will not be satisfied after the last node.

### **6.2.5 Synchronization of Local Condition Handlers**

The triggering of local conditions depends on the motion segment termination type. The timing associated with interval and segment termination is shown in [Figure 6–1](#).

This figure shows a two-node PATH in Cartesian coordinates. The first segment is a motion along the x-axis in the negative direction followed by a segment with motion parallel to the y-axis in the positive direction. The PATH is the xy\_path used in the examples that follow.

**Figure 6–1.** Timing of BEFORE, AT and AFTER Conditions

The following MOVE statement, which moves the tool center point (TCP) along the PATH in [Figure 6–1](#), is used in the remainder of this section to clarify the timing associated with the motion and the triggering of conditions. The numbers in parentheses to the left of the WHEN clauses are used to refer to specific clauses in the discussion that follows.

```

WITH $TERMTYPE = COARSE

MOVE ALONG xy_path,
(1) WHEN AT NODE[0] DO DOUT[1] = TRUE
(2) WHEN TIME 100 AFTER NODE[0] DO DOUT[2] = TRUE
(3) WHEN TIME 100 BEFORE NODE[1] DO DOUT[3] = TRUE
(4) WHEN AT NODE[1] DO DOUT[4] = TRUE
(5) WHEN TIME 100 AFTER NODE[1] DO DOUT[5] = TRUE
(6) WHEN AT NODE[2] DO DOUT[6] = TRUE
(7) WHEN TIME 100 AFTER NODE[2] DO DOUT[7] = TRUE

```

### ENDMOVE

First, note the numbering used for nodes. Node[0] is used to denote the starting position of the motion. If the motion were a single segment motion (MOVE TO posn), then Node[0] would refer to the start of the motion and Node[1] to the end of the motion, even though a PATH is not actually used.

Clause 1 asks for a digital output to be turned on at the start of the motion. In this case, since the node specified is Node[0], “AT” means the time when motion first begins (labeled “Motion Start” in [Figure 6–1](#)).

In Clause 2, the time is measured from the start of motion. That is, the digital output would be set 100 ms after the point marked “Motion Start” in [Figure 6–1](#).

In Clause 3, the time is measured back from the point when the TCP would come closest to the taught node in the path.

Clause 6 uses the end of the motion as the basis for timing because NODE[2] is the final node in the PATH.

The entire deceleration time is included in the segment time whenever anything but NODECEL or VARDECCEL is used for the termination type for the last node in the path. If NODECEL is used, then the timing for the last node would include half the deceleration time.

Clause 7 is an example of a condition handler that will never be triggered. All local condition handlers are deleted when the interval for which they are defined terminates. Therefore, actions **after** the last node cannot be performed.

**See Also:** Program Synchronization, [Chapter 8 MOTION](#)

”User-Defined Associated Data, [Chapter 8 MOTION](#)

AT NODE and TIME Conditions, [Appendix A](#).

'\$USETIMESHFT optional System Variable in *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual*

## **6.3 ACTIONS**

Actions are specified in the action list of a WHEN or UNTIL clause. Actions can be

- Specially defined KAREL actions that are executed in parallel with the program
- A routine call, which will interrupt program execution

When the conditions of a condition handler are satisfied, the condition handler is triggered. The actions corresponding to the satisfied conditions are performed in the sequence in which they appear

in the condition handler definition, except for routine calls. Routines are executed after all of the other actions have been performed.

Note that, although many of the actions are similar in form to KAREL statements and the effects are similar to corresponding KAREL statements, the actions are not executable statements. Only the forms indicated in this section are permitted.

**See Also:** Actions and Statements, [Appendix A](#).

### 6.3.1 Assignment Actions

The available assignment actions are given in [Table 6–10](#).

**Table 6–10. Assignment Actions**

ACTION	RESULT
variable = expression	The value of the expression is assigned to the variable. The expression can be a variable, a constant, a port array element, or an EVAL clause.
port_id[n] = expression	The value of the expression is assigned to the port array element referenced by n. The expression can be a variable, a constant, or an EVAL clause.

The following rules apply to assignment actions:

- The assignment actions, “variable = expression” and “port\_id[n] = expression” can be used to assign values to variables and port array elements.
  - The variable must be either a user-defined variable, a static variable, or a system variable without a minimum/maximum range and that can be written to by a KAREL program.
  - The port array, if on the left, must be an output port array that can be set by a KAREL program.
  - The expression can be a user-defined variable, a static variable, a system variable that can be read by a KAREL program, any constant, or an EVAL clause.
- If a variable is on the left side of the assignment, the expression can also be a port array element. However, you cannot assign a port array element to a port array element directly. For example, the first assignment shown is invalid, but the next two are valid:

```
DOUT[1] = DOUT[2] --invalid action
    port_var = DOUT[2] --valid action, where port_var is a variable
    DOUT[1] = port_var --another valid action, which if executed
                        --after port_var = DOUT[2], would in effect
                        --assign DOUT[2] to DOUT[1]
```

- If the expression is a variable, it must be a global variable. The value used is the current value of the variable at the time the action is taken, not when the condition handler is defined. If the expression is an EVAL clause, it is evaluated when the condition handler is defined and that value is assigned when the action is taken.
- Both sides of the assignment action must be of the same data type. An INTEGER or EVAL clause is permitted on the right side of the assignment with an INTEGER, REAL, or BOOLEAN on the left.

### **6.3.2 Motion Related Actions**

Motion related actions affect the current motion and might affect subsequent motions. They are given in [Table 6–11](#).

**Table 6–11. Motion Related Actions**

ACTION	RESULT
STOP	Current motion is stopped.
RESUME	The last stopped motion is resumed.
CANCEL	Current motion is canceled.
HOLD	Current motion is held. Subsequent motions are not started.
UNHOLD	Held motion is released.

The following rules apply to motion related actions:

- If a STOP is issued, the current motion and any queued motions are pushed as a set on a stopped motion stack. If no motion is in progress, an empty entry is pushed on the stack.
- If a RESUME is issued, the newest stopped motion set on the stopped motion stack is queued for execution.
- If a CANCEL is issued, the motion currently in progress is canceled. If no motion is in progress, the action has no effect.

**Note** The CANCEL action in a local condition handler differs from the same action in a global condition handler and the CANCEL statement. In a local condition handler, a CANCEL action cancels only the motion in progress, permitting any queued behind it to start. For a CANCEL action in a global condition handler or a CANCEL statement, any motions queued to the same group behind the current motion are also canceled.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, personnel could be injured, and equipment could be damaged.**

- If a HOLD is issued, the current motion is held and subsequent motions are prevented from starting. The UNHOLD action releases held motion.

**See Also:** [Chapter 8 MOTION](#), for more information on stopping and starting motions.

### **6.3.3 Routine Call Actions**

Routine call actions, or interrupt routines, are specified by

<WITH \$PRIORITY = n> routine\_name

The following restrictions apply to routine call actions or interrupt routines:

- The interrupt routine cannot have parameters and must be a procedure (not a function).
- If the interrupted program is using READ statements, the interrupt routine cannot read from the same file variable. If an interrupted program is reading and the interrupt routine attempts a read from the same file variable, the program is aborted.
- When an interrupt routine is started, the interrupted KAREL program is suspended until the routine returns.
- Interrupt routines, like KAREL programs, can be interrupted by other routines. The maximum depth of interruption is limited only by stack memory size.
- Routines are started in the sequence in which they appear in the condition handler definition, but since they interrupt each other, they will actually execute in reverse order.
- Interrupts can be prioritized so that certain interrupt routines cannot be interrupted by others. The \$PRIORITY condition handler qualifier can be used to set the priority of execution for an indicated routine action. \$PRIORITY values must be 0-255 where the lower value represents a lower priority. If a low priority routine is called while a routine with a higher priority is running, it will be executed only when the higher priority routine has completed. If \$PRIORITY is not specified, the routine's priority will default to the current value of the \$PRIORITY system variable.

**See Also:** WITH Clause, Appendix A, "KAREL Language Alphabetical Description," for more information on \$PRIORITY

### **6.3.4 Miscellaneous Actions**

[Table 6–12](#) describes other allowable actions.

**Table 6–12. Miscellaneous Actions**

ACTION	RESULT
SIGNAL EVENT[n]	The event specified by n is signaled.
NOMESSAGE	The error message that otherwise would have been generated is not displayed or logged.
NOPAUSE	Program execution is resumed if the program was paused, or is prevented from pausing.
NOABORT	Program execution is resumed if the program was aborted, or is prevented from aborting.
ABORT	Program execution is aborted.
CONTINUE	Program execution is continued.
PAUSE	Program execution is paused.
SIGNAL SEMAPHORE[n]	Specified semaphore is signaled.
ENABLE CONDITION[n]	Condition handler n is enabled.
DISABLE CONDITION[n]	Condition handler n is disabled.
PULSE DOUT[n] FOR t	Specified port n is pulsed for the time interval t (in milliseconds).
UNPAUSE	If a routine_name is specified as an action, but program execution is paused, execution is resumed only for the duration of the routine and then is paused again.

**See Also:** [Appendix A](#) for more information on each miscellaneous action.

# Chapter 7

---

## FILE INPUT/OUTPUT OPERATIONS

### Contents

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The KAREL language facilities allow you to perform the following serial input/output (I/O) operations:

- Open data files and serial communication ports using the OPEN FILE Statement
- Close data files and serial communication ports using the CLOSE FILE Statement
- Read from files, communication ports, and user interface devices using the READ Statement
- Write to files, communication ports, and user interface devices using the WRITE Statement
- Cancel read or write operations

*File variables* are used to indicate the file, communication port, or device on which a serial I/O operation is to be performed.

*Buffers* are used to hold data that has not yet been transmitted. The use of data items in READ and WRITE statements and their format specifiers depend on whether the data is text (ASCII) or binary, and on the data type.

## **7.1 FILE VARIABLES**

A KAREL program can perform serial I/O operations on the following:

- Data files residing in the KAREL file system
- Serial communication ports associated with connectors on the KAREL controller
- User interface devices including the CRT/KB and teach pendant

A file variable is used to indicate the file, communication port, or device on which you want to perform a particular serial I/O operation.

**Table 7–1** lists the predefined file variables for user interface devices. These file variables are already opened and can be used in the READ or WRITE statements.

**Table 7–1. Predefined File Variables**

IDENTIFIER	DEVICE	OPERATIONS
CRTFUNC*	CRT/KB function key line	Both
INPUT	CRT/KB keyboard	Read
OUTPUT*	CRT/KB KAREL screen	Write
CRTPROMPT*	CRT/KB prompt line	Both

**Table 7–1.** Predefined File Variables (Cont'd)

CRTERROR	CRT/KB message line	Write
CRTSTATUS*	CRT/KB status line	Write
TPFUNC*	Teach pendant function key line	Both
TPDISPLAY*	Teach pendant KAREL display	Both
TPPROMPT*	Teach pendant prompt line	Both
TPERROR	Teach pendant message line	Write
TPSTATUS*	Teach pendant status line	Write
VIS_MONITOR	Vision Monitor Screen	Write

\* Only displayed when teach pendant or CRT is in the user menu.

A file variable can be specified in a KAREL statement as a FILE variable. [Using FILE in a KAREL Program](#) shows an example of declaring a FILE variable and of using FILE in the executable section of a program.

### Using FILE in a KAREL Program

```
PROGRAM lun_prog
  VAR
    curnt_file : FILE
  ROUTINE input_data(file_spec:FILE) FROM util_prog

  BEGIN
    OPEN FILE curnt_file ('RW','text.dt') --variable FILE
    input_data(curnt_file) --file variable argument
    WRITE TPERROR ('Error has occurred')

  END lun_prog
```

Sharing FILE variables between programs is allowed as long as a single task is executing the programs. Sharing file variables between tasks is not allowed.

## **7.2 OPEN FILE STATEMENT**

The OPEN FILE statement associates the file variable with a particular data file or communication port.

The association remains in effect until the file is closed, either explicitly by a CLOSE FILE statement or implicitly when program execution terminates or is aborted.

The OPEN FILE statement specifies how the file is to be used (usage string), and which file or port (file string) is used.

### **7.2.1 Setting File and Port Attributes**

Attributes specify the details of operation of a serial port, or KAREL FILE variable. The SET\_PORT\_ATR and SET\_FILE\_ATR built-ins are used to set these attributes. SET\_FILE\_ATR must be called before the FILE is opened. SET\_PORT\_ATR can be called before or after the FILE that is using a serial port, is opened.

[Table 7–2](#) lists each attribute type, its function and whether the attribute is intended for use with teach pendant and CRT/KB devices, serial ports, data files, or pipes. Refer to Appendix A, "KAREL Language Alphabetical Descriptions" for more information.

**Table 7–2. Predefined Attribute Types**

ATTRIBUTE TYPE	FUNCTION	SET_PORT_ATR OR SET_FILE_ATR	TP/ CRT	SERIAL PORTS	DATA FILES	PIPES	SOCKET MESSAGING
ATR_BAUD	Baud rate	SET_PORT_ATR	not used	valid	not used	not used	not used
ATR_DBITS	Data length	SET_PORT_ATR	not used	valid	not used	not used	not used
ATR_EOL	End of line	SET_FILE_ATR	not used	valid	not used	valid	valid
ATR_FIELD	Field	SET_FILE_ATR	valid	valid	valid	valid	valid
ATR_IA	Interactively write	SET_FILE_ATR	valid	valid	valid	valid	valid

Table 7–2. Predefined Attribute Types (Cont'd)

ATTRIBUTE TYPE	FUNCTION	SET_PORT_ATR OR SET_FILE_ATR	TP/ CRT	SERIAL PORTS	DATA FILES	PIPES	SOCKET MESSAGING
ATR_MODEM	Modem line	SET_PORT_ATR	not used	valid	not used	not used	not used
ATR_PARITY	Parity	SET_PORT_ATR	not used	valid	not used	not used	not used
ATR_PASSALL	Passall	SET_FILE_ATR	valid	valid	not used	valid	valid
ATR_READAHD	Read ahead buffer	SET_PORT_ATR	not used	valid	not used	not used	not used
ATR_REVERSE	Reverse transfer	SET_FILE_ATR	not used	valid	valid	valid	valid
ATR_SBITS	Stop bits	SET_PORT_ATR	not used	valid	not used	not used	not used
ATR_TIMEOUT	Timeout	SET_FILE_ATR	valid	valid	not used	valid	valid
ATR_UF	Unformatted transfer	SET_FILE_ATR	not used	valid	valid	valid	valid
ATR_XONOFF	XON/XOFF	SET_PORT_ATR	not used	valid	not used	not used	not used
ATR_PIPOVADV	Pipe Overflow	SET_FILE_ATR	not used	not used	not used	valid	valid
ATR_PIPWAIT	Wait for data	SET_FILE_ATR	not used	not used	not used	valid	valid

[Table 7–3](#) contains detailed explanations of each attribute.

Table 7-3. Attribute Values

Attribute Type	Description	Valid Device	Usage Mode	Valid Values	Default Value
ATR_BAUD Baud rate	The baud rate of a serial port can be changed to one of the valid attribute values.	PORT	Read/ Write	BAUD_9600: 9600 baud  BAUD_4800: 4800 baud  BAUD_2400: 2400 baud  BAUD_1200: 1200 baud	BAUD_9600
ATR_DBITS Data length	If specified, the data length for a serial port is changed to the specified attribute values.	PORT	Read/ Write	DBITS_5: 5 bits  DBITS_6: 6 bits  DBITS_7: 7 bits  DBITS_8: 8 bits	DBITS_8
ATR_EOL End of line	If specified, the serial port is changed to terminate read when the specified attribute value. Refer to <a href="#">Appendix D</a> , for a listing of valid attribute values.	PORT	Read/ Write	Any ASCII character code	13 (carriage return)

Table 7-3. Attribute Values (Cont'd)

Attribute Type	Description	Valid Device	Usage Mode	Valid Values	Default Value
ATR_FIELD Field	If specified, the amount of data read depends on the format specifier in the READ statement, or the default value of the data type being read. If not specified, the data is read until the terminator character (EOL) appears.	TP/CRT, PORT, FILE	Read only	Ignored	Read data until terminator character (EOL) appears
ATR_IA Interactively write	If specified, the contents of the buffer are output when each write operation to the buffer is complete. (Interactive)  If not specified, the contents of the buffer are output only when the buffer becomes full or when CR is specified. The size of the output buffer is 256 bytes. (Not interactive)	TP/CRT, PORT, FILE	Write only	Ignored	TP/CRT is interactive, PORT, FILE are not interactive
ATR_MODEM Modem line	Refer to "Modem Line" section that follows for information.				
ATR_PARITY Parity	The parity for a serial port can be changed to one of the valid attribute values.	PORT	Read/ Write	PARITY_NONE: No parity  PARITY_ODD: Odd parity  PARITY_EVEN: Even parity	PARITY_NONE

Table 7-3. Attribute Values (Cont'd)

Attribute Type	Description	Valid Device	Usage Mode	Valid Values	Default Value
ATR_PASSALL Passall	If specified, input is read without interpretation or transaction. Since the terminator character (EOL) will not terminate the read, the field attribute automatically assumes the "field" option.	TP/CRT, PORT	Read only	Ignored	Read only the displayable keys until enter key is pressed
ATR_PIPOVADV	Configures the behavior of the read when an overflow occurs. By default the behavior is to signal an end of file (EOF) when the overflow occurs.	PIPE	Read	The value must be between 0 and the total number of bytes in the pipe. The value will be rounded up to the nearest binary record.	The value parameter is either OVF_EOF (sets the default behavior) or the number of bytes to advance when an overflow occurs.
ATR_PIPWAIT	The read operation waits for data to arrive in the pipe.	PIPE	Read	WAIT_USED or WAIT_NOTUSED	The default is snapshot which means that the system returns an EOF when all the data in the pipe has been read.
ATR_READAHD Read Ahead Buffer	The attribute value is specified in units of 128 bytes, and allocates a read ahead buffer of the indicated size.	PORT	Read/ Write	any positive integer 1=128 bytes 2=256 bytes 0=disable bytes	1 (128 byte buffer)

Table 7–3. Attribute Values (Cont'd)

Attribute Type	Description	Valid Device	Usage Mode	Valid Values	Default Value
ATR_REVERSE Reverse transfer	The bytes will be swapped.	PORT, FILE	Read/Write	Ignored	Not reverse transfer
ATR_SBITS Stop bits	This specifies the number of stop bits for the serial port.	PORT	Read/Write	SBITS_1:1 bit SBITS_15: 1.5 bits SBITS_2:2 bits	SBITS_1
ATR_TIMEOUT Timeout	If specified, an error will be returned by IO_STATUS if the read takes longer than the specified attribute value.	TP/CRT, PORT	Read only	Any integer value (units are in msec)	0 (external)
ATR_UF Unformatted transfer	If specified, a binary transfer is performed. For read operations, the terminator character (EOL) will not terminate the read, and therefore automatically assumes the “field” option. If not specified, ASCII transfer is performed.	PORT, FILE	Read/Write	Ignored	ASCII transfer
ATR_XONOFF XON/XOFF	If specified, the XON/XOFF for a serial port is changed to the specified attribute value.	PORT	Read/Write	XF_NOT_USED: Not used XF_USED: Used	XF_USED

**Modem line**

Valid device : PORT

Usage mode : Read/Write

Default value : MD\_NOT\_USED: DSR, DTR, and RTS not used

Valid attribute values : MD\_NOT\_USED: DSR, DTR, and RTS not used

MD\_USE\_DSR: DSR used

MD\_NOUSE\_DSR: DSR not used

MD\_USE\_DTR: DTR used

MD\_NOUSE\_DTR: DTR not used

MD\_USE\_RTS: RTS used

MD\_NOUSE\_RTS: RTS not used

- This attribute controls the operation of the modem line. The control is based on the following binary mask, where the flag bits are used to indicate what bit value you are changing.

RTS value	DSR value	DTR value	RTS flag	DSR flag	DTR flag
-----------	-----------	-----------	----------	----------	----------

- RTS (request to send) and DTR (data terminal ready) are both outputs.
- DSR (data set ready) is an input.
- Set the modem line attribute by doing the following.
  - To indicate RTS is used (HIGH/ON): status = SET\_PORT\_ATR (port\_name, ATR\_MODEM, MD\_USE\_RTS)
  - To indicate RTS is NOT used (LOW/OFF):status = SET\_PORT\_ATR (port\_name, ATR\_MODEM, MD\_NOUSE\_RTS)
  - To indicate RTS is used (HIGH/ON) and DTR is not used (LOW/OFF):status = SET\_PORT\_ATR (port\_name, ATR\_MODEM, MD\_USE\_RTS **or** MD\_NOUSE\_DTR)
- The following examples demonstrate how to use the returned attribute value from the GET\_PORT\_ATR built-in.
 

```
status = GET_PORT_ATR (port, ATR_MODEM, atr_value)
      — To determine if DTR is used:
      IF ((atr_value AND MD_USE_DTR) = MD_USE_DTR) THEN
          write ('DTR is in use',cr)
      ENDIF
      — To determine if DTR is not used (LOW/OFF)
```

```
IF (atr_value AND MD_USE_DTR) = MD_NOUSE_DTR) THEN
    write ('DTR is not in use', cr)
ENDIF
```

For more information on GET\_PORT\_ATR Built-in, refer to [Appendix A](#).

### **7.2.2 File String**

The file string in an OPEN FILE statement specifies a data file name and type, or a communication port.

- The OPEN FILE statement associates the data file or port specified by the file string with the file variable. For example, OPEN FILE file\_var ('RO', 'data\_file.dt') associates the data file called 'data\_file.dt' with the file file\_var.
- If the file string is enclosed in single quotes, it is treated as a literal. Otherwise, it is treated as a STRING variable or constant identifier.
- When specifying a data file, you must include both a file name and a valid KAREL file type (any 1, 2, or 3 character file extension).
- The following STRING values can be used to associate file variables with serial communication ports on the KAREL controller. Defaults for R-J3iB are:
  - **'FLPY: \filename'** - Floppy disk drive connected to the RS-232-C connector on the operator panel
  - **'P3:'** - CRT/KB connector on the inside of the operator panel
  - **'P4:'** - RS-232-C, JD17 connector on the Main CPU board
  - **'P5:'** - RS-422, JD17 connector on the Main CPU board
  - **'KB:tp kb'** - Input from numeric keypad on the teach pendant. TPDISPLAY or TPPROMPT are generally used, so OPEN FILE is not required.
  - **'KB:cr kb'** - Input from CRT/KB. INPUT or CRTPROMPT are generally used, so OPEN FILE is not required.
  - **'WD:window\_name'** - Writes to a window.
  - **'WD:window\_name</keyboard\_name>'**, where **keyboard\_name** is either '**tpkb**' or '**crkb**' - Writes to the specified window. Inputs are from the TP keypad (tpkb) or the CRT keyboard (crkb). Inputs will be echoed in the specified window.

**See Also:** [Chapter 9 FILE SYSTEM](#) , for a description of file names and file types.

### **7.2.3 Usage String**

The usage string in an OPEN FILE statement indicates how the file is to be used.

- It is composed of one usage specifier.
- It applies only to the file specified by the OPEN FILE statement and has no effect on other FILES.
- It must be enclosed in single quotes if it is expressed as a literal.
- It can be expressed as a variable or a constant.

**Table 7–4** lists each usage specifier, its function, and the devices or ports for which it is intended.

- “TP/CRT” indicates teach pendant and CRT/KB.
- “Ports” indicates serial ports.
- “Files” indicates data files.
- “Pipes” indicates pipe devices.
- “Valid” indicates a permissible use.
- “No use” indicates a permissible use that might have unpredictable side effects.

**Table 7–4. Usage Specifiers**

SPECIFIER	FUNCTION	TP/CRT	PORTS	FILES	PIPES
<b>RO</b>	<ul style="list-style-type: none"> <li>— Permits only read operations</li> <li>— Sets file position to beginning of file</li> <li>— File must already exist</li> </ul>	valid	valid	valid	valid
<b>RW</b>	<ul style="list-style-type: none"> <li>— Rewrites over existing data in a file, deleting existing data</li> <li>— Permits read and write operations</li> <li>— Sets file position to beginning of file</li> <li>— File will be created if it does not exist</li> </ul>	valid	valid	valid No use on FRx:	valid

Table 7-4. Usage Specifiers (Cont'd)

<b>AP</b>	<ul style="list-style-type: none"> <li>— Appends to end of existing data</li> <li>— Permits read and write (First operation must be a write.)</li> <li>— Sets file position to end of file</li> <li>— File will be created if it does not exist</li> </ul>	no use	valid	valid -RAM disk* no use on floppy disk or FRx:	valid
<b>UD</b>	<ul style="list-style-type: none"> <li>— Updates from beginning of existing data. (Number of characters to be written must equal number of characters to be replaced.)</li> <li>— Overwrites the existing data with the new data</li> <li>— Permits read and write</li> <li>— Sets file position to beginning of existing file</li> </ul>	no use	valid	valid -RAM disk* no use on floppy disk or FRx:	no use

\* AP and UD specifiers can only be used with uncompressed files on the RAM disk. Refer to [Chapter 9 FILE SYSTEM](#), for more information on the RAM disk and Pipe devices.

[File String Examples](#) shows a program that includes examples of various file strings in OPEN FILE statements. The CONST and VAR sections are included to illustrate how file and port strings are declared.

### File String Examples

```
PROGRAM open_luns
```

```

CONST
  part_file_c ='parts.dt' --data file STRING constant
  comm_port = 'P3:'           --port STRING constant

VAR
  file_var1 : FILE
  file_var2 : FILE
  file_var3 : FILE
  file_var4 : FILE
  file_var5 : FILE
  file_var12 : FILE
  temp_file : STRING[19]
    --a STRING size of 19 accommodates 4 character device names,
    --12 character file names, the period, and 2 character,
    --file types.
  port_var : STRING[3]

BEGIN
  --literal file name and type
  OPEN FILE file_var1 ('RO','log_file.dt')

  --constant specifying parts.dt
  OPEN FILE file_var2 ('RW', part_file_c)

  --variable specifying new_file_dt
  temp_file = 'RD:new_file.dt'
  OPEN FILE file_var3 ('AP', temp_file)

  --literal communication port
  OPEN FILE file_var4 ('RW', 'FLPY:')

  --constant specifying C0:
  OPEN FILE file_var5 ('RW', comm_port)

  --variable specifying C3:
  port_var = 'C3:'
  OPEN FILE file_var12 ('RW', port_var)

END open_luns

```

**See Also:** [Chapter 9 FILE SYSTEM](#) , for more information on the available storage devices

[Chapter 14 INPUT/OUTPUT SYSTEM](#) , for more information on the C0: and C3: ports

## **7.3 CLOSE FILE STATEMENT**

The CLOSE FILE statement is used to break the association between a specified file variable and its data file or communication port. It accomplishes two objectives:

- Any buffered data is written to the file or port.
- The file variable is freed for another use.

[CLOSE FILE Example](#) shows a program that includes an example of using the CLOSE FILE statement in a FOR loop, where several files are opened, read, and then closed. The same file variable is used for each file.

### **CLOSE FILE Example**

```
PROGRAM read_files
  VAR
    file_var      : FILE
    file_names   : ARRAY[10] OF STRING[15]
    loop_count   : INTEGER
    loop_file    : STRING[15]

  ROUTINE read_ops(file_spec:FILE) FROM util_prog
  --performs some read operations

  ROUTINE get_names(names:ARRAY OF STRING) FROM util_prog
  --gets file names and types

  BEGIN
    get_names(file_names)
    FOR loop_count = 1 TO 10 DO
      loop_file = file_names[loop_count]
      OPEN FILE file_var ('RO', loop_file)
      read_ops(file_var) --call routine for read operations
      CLOSE FILE file_var
    ENDFOR END read_files
```

**See Also:** CLOSE FILE Statement, [Appendix A](#).

IO\_STATUS Built-In Function, [Appendix A](#) for a description of errors.

## **7.4 READ STATEMENT**

The READ statement is used to read one or more specified data items from the indicated device. The data items are listed as part of the READ statement. The following rules apply to the READ statement:

- The OPEN FILE statement must be used to associate the file variable with the file opened in the statement before any read operations can be performed unless one of the predefined files is used (refer to [Table 7-1](#) ).
- If the file variable is omitted from the READ statement, then TPDISPLAY is used as the default.
- Using the %CRTDEVICE directive will change the default to INPUT (CRT input window).
- Format specifiers can be used to control the amount of data that is read for each data item. The effect of format specifiers depends on the data type of the item being read and on whether the data is in text (ASCII) or binary (unformatted) form.
- When the READ statement is executed (for ASCII files), data is read beginning with the next nonblank input character and ending with the last character before the next blank, end of line, or end of file for all input types except STRING.
- With STRING values, the input field begins with the next character and continues to the end of the line or end of the file. If a STRING is read from the same line following a nonstring field, any separating blanks are included in the STRING.
- ARRAY variables must be read element by element; they cannot be read in unsubscripted form. Frequently, they are read using a READ statement in a FOR loop.
- PATH variables can be specified as follows in a READ statement, where “path\_name” is a PATH variable and “n” and “m” are PATH node indexes:
  - path\_name : specifies that the entire path, starting with a header and including all of the nodes and their associated data, is to be read. The header consists of the path length and the associated data description in effect when the PATH was written.
  - path\_name [0] : specifies that only the header is to be read. The path header consists of the path length and the associated data description in effect when the PATH was written. Nodes are deleted or created to make the path the correct length, and all new nodes are set uninitialized.
  - path\_name [n] : specifies that data is to be read into node[n] from the current file position. The value of n must be in the range from 0 to the length of the PATH.
  - path\_name [n .. m] : specifies that data is to be read into nodes n through m. The value of n must be in the range from 0 to the length of the PATH and can be less than, equal to, or greater than the value of m. The value of m must be in the range from 1 to the length of the PATH.

If an error occurs while reading node n (where n is greater than 0), it is handled as follows:

**If n > original path length** (prior to the read operation), the nodes from n to the new path length are set uninitialized.

**If n <=original path length**, the nodes from n to the original path length remain as they were prior to the read operation and any new nodes (greater than the original path length) are set uninitialized.

- If the associated data description that is read from the PATH does not agree with the current user associated data, the read operation is terminated and the path will remain as it was prior to the read operation. The IO\_STATUS built-in function will return an error if this occurs.

- PATH data must be read in binary (unformatted) form.

[READ Statement Examples](#) shows several examples of the READ statement using a variety of file variables and data lists.

### READ Statement Examples

```
READ (next_part_no)      --uses default TPDISPLAY

OPEN FILE file_var ('RO','data_file.dt')
READ file_var (color, style, option)

READ host_line (color, style, option, CR)

FOR i = 1 TO array_size DO
  READ data (data_array[i])

ENDFOR
```

If any errors occur during input, the variable being read and all subsequent variables up to CR in the data list are set uninitialized unless the file variable is open to a window device.

If reading from a window device, an error message is displayed indicating the bad data\_item and you are prompted to enter a replacement for the invalid data\_item and to reenter all subsequent items.

The built-in function IO\_STATUS can be used to determine the success or failure (and the reason for the failure) of a READ operation.

**See Also:** [READ Statement](#), [Appendix A](#).

[IO\\_STATUS Built-In Functions](#), [Appendix A](#) for a list of I/O error messages

[%CRTDEVICE Translator Directive](#), [Appendix A](#).

## 7.5 WRITE STATEMENT

The WRITE statement is used to write one or more specified data items to the indicated device. The data items are listed as part of the WRITE statement. The following rules apply to the WRITE statement:

- The OPEN FILE statement must be used to associate the file variable with the file opened in the statement before any write operations can be performed unless one of the predefined files is used (refer to [Table 7-1](#)).
- If the file variable is omitted from the WRITE statement, then TPDISPLAY is used as the default.
- Using the %CRTDEVICE directive will change the default to OUTPUT (CRT output window).

- Format specifiers can be used to control the format of data that is written for each data\_item. The effect of format specifiers depends on the data type of the item being written and on whether the data is in text (ASCII) or binary (unformatted) form.
- ARRAY variables must be written element by element; they cannot be written in unsubscripted form. Frequently, they are written using a WRITE statement in a FOR loop.
- PATH variables can be specified as follows in a WRITE statement, where “path\_name” is a PATH variable and “n” and “m” are PATH node indexes:
  - path\_name : specifies that the entire path is to be written, starting with a header that provides the path length and associated data table, and followed by all of the nodes, including their associated data.
  - path\_name [0] : specifies that only the header is to be written. The path header consists of the path length and a copy of the associated data table.
  - path\_name [n] : specifies that node[n] is to be written.
  - path\_name [n .. m] : specifies that nodes n through m are to be written. The value of n must be in the range from 0 to the length of the PATH and can be less than, equal to, or greater than the value of m. The value of m must be in the range from 1 to the length of the PATH.
- PATH data must be written in binary (unformatted) form.

[WRITE Statement Examples](#) shows several examples of the WRITE statement using a variety of file variables and data lists.

### WRITE Statement Examples

```

      WRITE TPPROMPT('Press T.P. key "GO" when ready')
      WRITE TPFUNC (' GO      RECD      QUIT      BACK1      FWD-1')
      WRITE log_file (part_no:5, good_count:5, bad_count:5, operator:3,
CR)

      WRITE ('This is line 1', CR, 'This is line 2', CR)
      --uses default TPDISPLAY

      FOR i = 1 TO array_size DO
          WRITE data (data_array[i])

      ENDFOR
  
```

**See Also:** WRITE Statement, [Appendix A](#).

IO\_STATUS Built-In Functions, [Appendix A](#).

## 7.6 INPUT/OUTPUT BUFFER

An area of RAM, called a *buffer*, is used to hold up to 256 bytes of data that has not yet been transmitted during a read or write operation.

Buffers are used by the READ and WRITE statements as follows:

- During the execution of a READ statement, if more data was read from the file than required by the READ statement, the remaining data is kept in a buffer for subsequent read operations. For example, if you enter more data in a keyboard input line than is required to satisfy the READ statement the extra data is kept in a buffer.
- If a WRITE statement is executed to a non-interactive file and the last data item was not a CR, the data is left in a buffer until a subsequent WRITE either specifies a CR or the buffer is filled.
- The total data that can be processed in a single READ or WRITE statement is limited to 127 bytes.

## 7.7 FORMATTING TEXT (ASCII) INPUT/OUTPUT

This section explains the format specifiers used to read and write ASCII (formatted) text for each data type.

The following rules apply to formatting data types:

- For text files, data items in READ and WRITE statements can be of any of the simple data types (INTEGER, REAL, BOOLEAN, and STRING).
- Positional and VECTOR variables cannot be read from text files but can be used in WRITE statements.
- ARRAY variables cannot be read or written in unsubscripted form. The elements of an ARRAY are read or written in the format that corresponds to the data type of the ARRAY.
- PATH variables cannot be read or written.
- Some formats and data combinations are not read in the same manner as they were written or become invalid if read with the same format.

The amount of data that is read or written can be controlled using zero, one, or two format specifiers for each data item in a READ or WRITE statement. Each format specifier, represented as an INTEGER literal, is preceded by double colons (::).

Table 7–5 summarizes the input format specifiers that can be used with the data items in a READ statement. The default format of each data type and the format specifiers that can affect each data type are explained in [Section 7.7.1](#), through [Section 7.7.6](#).

**Table 7–5.** Text (ASCII) Input Format Specifiers

DATA TYPE	1ST FORMAT SPECIFIER	2ND FORMAT SPECIFIER
INTEGER	Total number of characters read	Number base in range 2 - 16
REAL	Total number of characters read	Ignored
BOOLEAN	Total number of characters read	Ignored
STRING	Total number of characters read	0 - unquoted STRING 2 - quoted STRING

**Table 7–6** summarizes the output format specifiers that can be used with the data items in a WRITE statement. The default format of each data type and the format specifiers that can affect each data type are explained in [Section 7.7.1](#) through [Section 7.7.6](#).

**Table 7–6.** Text (ASCII) Output Format Specifiers

DATA TYPE	1ST FORMAT SPECIFIER	2ND FORMAT SPECIFIER
INTEGER	Total number of characters written	Number base in range 2-16
REAL	Total number of characters written	Number of digits to the right of decimal point to be written  If negative, uses scientific notation
BOOLEAN	Total number of characters written	0 - Left justified  1 - Right justified
STRING	Total number of characters written	0 - Left justified  1 - Right justified  2 - Left justified in quotes (leading blank)  3 - Right justified n quotes (leading blank)

**Table 7-6.** Text (ASCII) Output Format Specifiers (Cont'd)

DATA TYPE	1ST FORMAT SPECIFIER	2ND FORMAT SPECIFIER
VECTOR	Uses REAL format for each component	Uses REAL format for each component
POSITION	Uses REAL format for each component	Uses REAL format for each component
XYZWPR	Uses REAL format for each component	Uses REAL format for each component
XYZWPREXT	Uses REAL format for each component	Uses REAL format for each component
JOINTPOSn	Uses REAL format for each component	Uses REAL format for each component

### **7.7.1 Formatting INTEGER Data Items**

INTEGER data items in a READ statement are processed as follows:

**Default:** Read as a decimal (base 10) INTEGER, starting with the next nonblank character on the input line and continuing until a blank or end of line is encountered. If the characters read do not form a valid INTEGER, the read operation fails.

**First Format Specifier:** Indicates the total number of characters to be read. The input field must be entirely on the current input line and can include leading, but not trailing, blanks.

**Second Format Specifier:** Indicates the number base used for the input and must be in the range of 2 (binary) to 16 (hexadecimal).

For bases over 10, the letters A, B, C, D, E, and F are used as input for the digits with values 10, 11, 12, 13, 14, and 15, respectively. Lowercase letters are accepted.

[Table 7-7](#) lists examples of INTEGER input data items and their format specifiers. The input data and the resulting value of the INTEGER data items are included in the table. (The symbol [eol] indicates end of line.)

**Table 7–7.** Examples of INTEGER Input Data Items

DATA ITEM	INPUT DATA	RESULT
int_var	-2[eol]	int_var = -2
int_var	20 30 ...	int_var = 20
int_var::3	10000	int_var = 100
int_var::5::2	10101 (base 2 input)	int_var = 21 (base 10 value)
int_var	1.00	format error (invalid INTEGER)
int_var::5	100[eol]	format error (too few digits)

INTEGER data items in a WRITE statement are formatted as follows:

**Default:** Written as a decimal (base 10) INTEGER using the required number of digits and one leading blank. A minus sign precedes the digits if the INTEGER is a negative value.

**First Format Specifier:** Indicates the total number of characters to be written, including blanks and minus sign. If the format specifier is larger than required for the data, leading blanks are added. If it is smaller than required, the field is extended as required.

The specifier must be in the range of 1 to 127 for a file or 1 to 126 for other output devices.

**Second Format Specifier:** Indicates the number base used for the output and must be in the range of 2 (binary) to 16 (hexadecimal).

If a number base other than 10 (decimal) is specified, the number of characters specified in the first format specifier (minus one for the leading blank) is written, with leading zeros added if needed.

For bases over 10, the letters A, B, C, D, E, and F are used as input for the digits with values 10, 11, 12, 13, 14, and 15, respectively.

**Table 7–8** lists examples of INTEGER output data items and their format specifiers. The output values of the INTEGER data items are also included in the table. Double quotes are used in the table as delimiters to show leading blanks; however, double quotes are not written by KAREL programs.

**Table 7-8.** Examples of INTEGER Output Data Items

DATA ITEM	OUTPUT	COMMENT
123	" 123 "	Leading blank
-5	" -5 "	Leading blank
123::6	" 123 "	Right justified (leading blanks)
-123::2	" -123 "	Expanded as required
1024::0::16	" 400 "	Hexadecimal output
5::6::2	" 00101 "	Binary output (leading zeros)
-1::9::16	" FFFFFFFF "	Hexadecimal output

### **7.7.2 Formatting REAL Data Items**

REAL data items in a READ statement are processed as follows:

**Default:** Read starting with the next nonblank character on the input line and continuing until a blank or end of line is encountered.

Data can be supplied with or without a fractional part. The E used for scientific notation can be in upper or lower case. If the characters do not form a valid REAL, the read operation fails.

**First Format Specifier:** Indicates the total number of characters to be read. The input field must be entirely on the current input line and can include leading, but not trailing, blanks.

**Second Format Specifier:** Ignored for REAL data items.

**Table 7-9** lists examples of REAL input data items and their format specifiers. The input data and the resulting value of the REAL data items are included in the table. The symbol [eol] indicates end of line and X indicates extraneous data on the input line.

**Table 7–9.** Examples of REAL Input Data Items

DATA ITEM	INPUT DATA	RESULT
real_var	1[eol]	1.0
real_var	1.000[eol]	1.0
real_var	2.5 XX	2.50
real_var	1E5 XX	100000.0
real_var::7	2.5 XX	format error (trailing blank)
real_var	1E	format error (no exponent)
real_var::4	1E 2	format error (embedded blank)

REAL data items in a WRITE statement are formatted as follows:

**Default:** Written in scientific notation in the following form:

(blank)(msign)(d).(d)(d)(d)(d)E(esign)(d)(d)

where:

(blank) is a single blank

(msign) is a minus sign, if required

(d) is a digit

(esign) is a plus or minus sign

**First Format Specifier:** Indicates the total number of characters to be written, including all the digits, blanks, signs, and a decimal point. If the format specifier is larger than required for the data, leading blanks are added. If it is smaller than required, the field is extended as required.

In the case of scientific notation, character length should be greater than (8 + 2nd format specifier) to write the data completely.

The specifier must be in the range of 1 to 127 for a file or 1 to 126 for other output devices.

**Second Format Specifier:** Indicates the number of digits to be output to the right of the decimal point, whether or not scientific notation is to be used.

The absolute value of the second format specifier indicates the number of digits to be output to the right of the decimal point.

If the format specifier is positive, the data is displayed in fixed format (that is, without an exponent). If it is negative, scientific notation is used.

**Table 7–10** lists examples of REAL output data items and their format specifiers. The output values of the REAL data items are also included in the table. Double quotes are used in the table as delimiters to show leading blanks; however, double quotes are not written by KAREL programs.

**Table 7–10. Examples of REAL Output Data Items**

DATA ITEM	OUTPUT	COMMENT
123.0	" 1.23000E+02 "	Scientific notation (default format)
123.456789	" 1.23457E+02 "	Rounded to 5 digits in fractional part
.00123	" 1.23000E-03 "	Negative exponent
-1.00	" -1.00000E+00 "	Negative value
-123.456::9	" -1.234560E+02 "	Field expanded
123.456::12	" 1.234560E+02 "	Leading blank added
123.456::9::2	" 123.46 "	Right justified and rounded
123::12::-3	" 1.230E+02 "	Scientific notation

### 7.7.3 Formatting BOOLEAN Data Items

BOOLEAN data items in a READ statement are formatted as follows:

**Default:** Read starting with the next nonblank character on the input line and continuing until a blank or end of line is encountered.

Valid input values for TRUE include TRUE, TRU, TR, T, and ON. Valid input values for FALSE include FALSE, FALS, FAL, FA, F, OFF, and OF. If the characters read do not form a valid BOOLEAN, the read operation fails.

**First Format Specifier:** Indicates the total number of characters to be read. The input field must be entirely on the current input line and can include leading, but not trailing, blanks.

**Second Format Specifier:** Ignored for BOOLEAN data items.

[Table 7–11](#) lists examples of BOOLEAN input data items and their format specifiers. The input data and the resulting value of the BOOLEAN data items are included in the table. (The symbol [eol] indicates end of line and X indicates extraneous data on the input line.)

**Table 7–11. Examples of BOOLEAN Input Data Items**

DATA ITEM	INPUT DATA	RESULT
bool_var	FALSE[eol]	FALSE
bool_var	FAL 3...	FALSE
bool_var	T[eol]	TRUE
bool_var:::1	FXX	FALSE (only reads “ F”)
bool_var	O[eol]	format error (ambiguous)
bool_var	1.2[eol]	format error (not BOOLEAN)
bool_var:::3	F [eol]	format error (trailing blanks)
bool_var:::6	TRUE[eol]	format error (not enough data)

BOOLEAN data items in a WRITE statement are formatted as follows:

**Default:** Written as either “TRUE” or “FALSE”. (Double quotes are used in the table as delimiters to show leading blanks; however, double quotes are not written by KAREL programs.)

**First Format Specifier:** Indicates the total number of characters to be written, including blanks (a leading blank is always included). If the format specifier is larger than required for the data, trailing blanks are added. If it is smaller than required, the field is truncated on the right.

The specifier must be in the range of 1 to 127 for a file or 1 to 126 for other output devices.

**Second Format Specifier:** Indicates whether the data is left or right justified. If the format specifier is equal to 0, the output word is left justified in the output field with one leading blank, and trailing blanks as required. If it is equal to 1, the output word is right justified in the output field, with leading blanks as required.

**Table 7–12** lists examples of BOOLEAN output data items and their format specifiers. The output values of the BOOLEAN data items are also included in the table. Double quotes are used in the table as delimiters to show leading blanks; however, double quotes are not written by KAREL programs.

**Table 7–12. Examples of BOOLEAN Output Data Items**

DATA ITEM	OUTPUT	COMMENT
FALSE	" FALSE "	Default includes a leading blank
TRUE	" TRUE "	TRUE is shorter than FALSE
FALSE::8	" FALSE "	Left justified (default)
FALSE::8::1	" FALSE "	Right justified
TRUE::2	" T "	Truncated

#### 7.7.4 Formatting STRING Data Items

STRING data items in a READ statement are formatted as follows:

**Default:** Read starting at the current position and continuing to the end of the line. If the length of the data obtained is longer than the declared length of the STRING, the data is truncated on the right. If it is shorter, the current length of the STRING is set to the actual length.

**First Format Specifier:** Indicates the total field length of the input data. If the field length is longer than the declared length of the STRING, the input data is truncated on the right. If it is shorter, the current length of the STRING is set to the specified field length.

**Second Format Specifier:** Indicates whether or not the input STRING is enclosed in single quotes. If the format specifier is equal to 0, the input is not enclosed in quotes.

If it is equal to 2, the input must be enclosed in quotes. The input is scanned for the next nonblank character. If the character is not a quote, the STRING is not valid and the read operation fails.

If the character is a quote, the remaining characters are scanned until another quote or the end of line is found. If another quote is not found, the STRING is not valid and the read operation fails.

If both quotes are found, all of the characters between them are read into the STRING variable, unless the declared length of the STRING is too short, in which case the data is truncated on the right.

[Table 7-13](#) lists examples of STRING input data items and their format specifiers, where str\_var has been declared as a STRING[5]. The input data and the resulting value of the STRING data items are included in the table. The symbol [eol] indicates end of line and X indicates extraneous data on the input line.

**Table 7-13. Examples of STRING Input Data Items**

DATA ITEM	INPUT DATA	RESULT
str_var	"ABC[eol]"	"ABC"
str_var	"ABCDEFG[eol]"	"ABCDE" (FG is read but the STRING is truncated to 5 characters)
str_var	" 'ABC' XX"	" 'AB"
str_var::0::2	" 'ABC' XX"	" 'ABC' " (read ends with second quote)

STRING data items in a WRITE statement are formatted as follows:

**Default:** Content of the STRING is written with no trailing or leading blanks or quotes.

The STRING must not be over 127 bytes in length for files or 126 bytes in length for other output devices. Otherwise, the program will be aborted with the “STRING TOO LONG” error.

**First Format Specifier:** Indicates the total number of characters to be written, including blanks. If the format specifier is larger than required for the data, the data is left justified and trailing blanks are added. If the format specifier is smaller than required, the STRING is truncated on the right.

The specifier must be in the range of 1 to 127 for a file or 1 to 126 for other output devices.

**Second Format Specifier:** Indicates whether the output is to be left or right justified and whether the STRING is to be enclosed in quotes using the following values:

0 left justified, no quotes

1 right justified, no quotes

2 left justified, quotes

3 right justified, quotes

Quoted STRING values, even if left justified, are preceded by a blank. Unquoted STRING values are not automatically preceded by a blank.

**Table 7–14** lists examples of STRING output data items and their format specifiers. The output values of the STRING data items are also included in the table. Double quotes are used in the table as delimiters to show leading blanks; however, double quotes are not written by KAREL programs.

**Table 7–14. Examples of STRING Output Data Items**

DATA ITEM	OUTPUT	COMMENT
'ABC'	"ABC"	No leading blanks
'ABC'::2	"AB"	Truncated on right
'ABC'::8	"ABC "	Left justified
'ABC'::8::0	"ABC "	Same as previous
'ABC'::8::1	" ABC"	Right justified
'ABC'::8::2	" 'ABC' "	Note leading blank
'ABC'::8::3	" 'ABC'"	Right justified
'ABC'::4::2	" 'A'"	Truncated

Format specifiers for STRING data items can cause the truncation of the original STRING values or the addition of trailing blanks when the values are read again.

If STRING values must be successively written and read, the following guidelines will help you ensure that STRING values of varying lengths can be read back identically:

- The variable into which the STRING is being read must have a declared length at least as long as the actual STRING that is being read, or truncation will occur.
- Some provision must be made to separate STRING values from preceding variables on the same data line. One possibility is to write a ' ' (blank) between a STRING and the variable that precedes it.
- If format specifiers are not used in the read operation, write STRING values at the ends of their respective data lines (that is, followed in the output list by a CR) because STRING variables without format specifiers are read until the end of the line is reached.

- The most general way to write string values to a file and read them back is to use the format ::0::2 for both the read and write.

### **7.7.5 Formatting VECTOR Data Items**

VECTOR data items cannot be read from text (ASCII) files. However, you can read three REAL values and assign them to the elements of a VECTOR variable. VECTOR data items in a WRITE statement are formatted as three REAL values on the same line.

**Table 7–15** lists examples of VECTOR output data items and their format specifiers, where vect.x = 1.0, vect.y= 2.0, vect.z = 3.0. The output values of the VECTOR data items are also included in the table. Double quotes are used in the table as delimiters to show leading blanks; however, double quotes are not written by KAREL programs.

**See Also:** [Section 7.7.2](#), “Formatting REAL Data Items,” for information on the default output format and format specifiers used with REAL data items

**Table 7–15. Examples of VECTOR Output Data Items**

DATA ITEM	OUTPUT
vect	" 1. 2. 3."
vect::6::2	" 1.00 2.00 3.00"
vect::12::-3	" 1.000E+00 2.000E+00 3.000E+00"

### **7.7.6 Formatting Positional Data Items**

Positional data items cannot be read from text (ASCII) files. However, you can read six REAL values and a STRING value and assign them to the elements of an XYZWPR variable or use the POS built-in function to compose a POSITION. The CNV\_STR\_CONF built-in can be used to convert a STRING to a CONFIG data type.

POSITION and XYZWPR data items in a WRITE statement are formatted in three lines of output. The first line contains the location (x,y,z) component of the POSITION, the second line contains the orientation (w,p,r), and the third line contains the configuration string.

The location and orientation components are formatted as six REAL values. The default format for the REAL values in a POSITION is the default format for REAL(s). Refer to [Section 7.7.2](#).

The configuration string is not terminated with a CR, meaning you can follow it with other data on the same line.

[Table 7–16](#) lists examples of POSITION output data items and their format specifiers, where p = POS(2.0,-4.0,8.0,0.0,90.0,0.0,config\_var). The output values of the POSITION data items are also included in the table. Double quotes are used in the table as delimiters to show leading blanks; however, double quotes are not written by KAREL programs.

**Table 7–16.** Examples of POSITION Output Data Items (p = POS(2.0,-4.0,8.0,0.0,90.0,0.0,config\_var))

DATA ITEM	OUTPUT
p	" 2. -4. 8. " 0. 9. 0. "N, 127, , -1"
p::7::2	" 2.00-4.00 8.00" " 0.0090.00 0.00" "N, 127, , -1"

JOINTPOS data items in a WRITE statement are formatted similarly to POSITION types with three values on one line.

**See Also:** [Section 7.7.2](#) , for information on format specifiers used with REAL data items

POS Built-In Function, [Appendix A](#).

## 7.8 FORMATTING BINARY INPUT/OUTPUT

This section explains the format specifier used in READ and WRITE statements to read and write binary (unformatted) data for each data item. Binary input/output operations are sometimes referred to as unformatted, as opposed to text (ASCII) input/output operations that are referred to as formatted.

The built-in SET\_FILE\_ATR with the ATR\_UF attribute is used to designate a file variable for binary operations. If not specified, ASCII text operations will be used.

Data items in READ and WRITE statements can be any of the following data types for binary files:

- INTEGER
- REAL
- BOOLEAN
- STRING
- VECTOR
- POSITION
- XYZWPR

XYZWPREXT  
JOINTPOS

Vision and array variables cannot be read or written in unsubscripted form. The elements of an ARRAY are read or written in the format that corresponds to the data type of the ARRAY.

Entire PATH variables can be read or written, or you can specify that only node[0] (containing the PATH header), a specific node, or a range of nodes be read or written. Format specifiers have no effect on PATH data. PATH data can be read or written only to a file and not to a serial port, CRT/KB, or teach pendant.

Binary I/O is preferred to text I/O when creating files that are to be read only by KAREL programs for the following reasons:

- Positional, VECTOR, and PATH variables cannot be read directly from text input.
- Some formats and data combinations are not read in the same manner as they were written in text files or they become invalid if read with the same format.
- Binary data is generally more compact, reducing both the file size and the I/O time.
- There is some inevitable loss of precision when converting from REAL data to its ASCII representation and back.

Generally, no format specifiers need to be used with binary I/O. If this rule is followed, all input data can be read exactly as it was before it was written.

However, if large numbers of INTEGER values are to be written and their values are known to be small, writing these with format specifiers reduces both storage space and I/O time.

For example, INTEGER values in the range of -128 to +127 require only one byte of storage space, and INTEGER values in the range of -32768 to +32767 require two bytes of storage space. Writing INTEGER values in these ranges with a first format specifier of 1 and 2, respectively, results in reduced storage space and I/O time requirements, with no loss of significant digits.

**Table 7–17** summarizes input and output format specifiers that can be used with the data items in READ and WRITE statements. The default format of each data type is also included. Sections 7.8.1 through 7.8.6 explain the effects of format specifiers on each data type in more detail.

**See Also:** SET\_FILE\_ATR Built-In Routine, [Appendix A](#).

**Table 7-17. Binary Input/Output Format Specifiers**

DATA TYPE	DEFAULT	1ST FORMAT SPECIFIER	2ND FORMAT SPECIFIER
INTEGER	Four bytes read or written	Specified number of least significant bytes read or written, starting with most significant (1-4)	Ignored
REAL	Four bytes read or written	Ignored	Ignored
BOOLEAN	Four bytes read or written	Specified number of least significant bytes read or written, starting with most significant (1-4)	Ignored
STRING	Current length of string (1 byte), followed by data bytes	Number of bytes read or written	Ignored
VECTOR	Three 4-byte REAL numbers read or written	Ignored	Ignored
POSITION	56 bytes read or written	Ignored	Ignored
XYZWPR	32 bytes read or written	Ignored	Ignored
XYZWPREXT	44 bytes read or written	Ignored	Ignored
JOINTPOSn	4 + n*4 bytes read or written	Ignored	Ignored
PATH	Depends on size of structure	Ignored	Ignored

### **7.8.1 Formatting INTEGER Data Items**

INTEGER data items in a READ or WRITE statement are formatted as follows:

**Default:** Four bytes of data are read or written starting with the most significant byte.

**First Format Specifier:** Indicates the number of least significant bytes of the INTEGER to read or write, with the most significant of these read or written first. The sign of the most significant byte read is extended to unread bytes. The format specifier must be in the range from 1 to 4.

For example, if an INTEGER is written with a format specifier of 2, bytes 3 and 4 (where byte 1 is the most significant byte) will be written. There is no check for loss of significant bytes when INTEGER values are formatted in binary I/O operations.

**Note** Formatting of INTEGER values can result in undetected loss of high order digits.

**Second Format Specifier:** Ignored for INTEGER data items.

### **7.8.2 Formatting REAL Data Items**

REAL data items in a READ or WRITE statement are formatted as follows:

**Default:** Four bytes of data are read or written starting with the most significant byte.

**First Format Specifier:** Ignored for REAL data items.

**Second Format Specifier:** Ignored for REAL data items.

### **7.8.3 Formatting BOOLEAN Data Items**

BOOLEAN data items in a READ or WRITE statement are formatted as follows:

**Default:** Four bytes of data are read or written. In a read operation, the remainder of the word, which is never used, is set to 0.

**First Format Specifier:** Indicates the number of least significant bytes of the BOOLEAN to read or write, the most significant of these first. The format specifier must be in the range from 1 to 4. Since BOOLEAN values are always 0 or 1, it is always safe to use a field width of 1.

**Second Format Specifier:** Ignored for BOOLEAN data items.

### **7.8.4 Formatting STRING Data Items**

STRING data items in a READ or WRITE statement are formatted as follows:

**Default:** The current length of the STRING (not the declared length) is read or written as a single byte, followed by the content of the STRING. STRING values written without format specifiers have their lengths as part of the output, while STRING values written with format specifiers do not.

Likewise, if a STRING is read without a format specifier, the length is expected in the data, while if a STRING is read with a format specifier, the length is not expected.

This means that, if you write and then read STRING data, you must make sure your use of format specifiers is consistent.

**First Format Specifier:** Indicates the number of bytes to be read or written.

**Second Format Specifier:** Ignored for STRING data items.

In a read operation, if the first format specifier is greater than the declared length of the STRING, the data is truncated on the right. If it is less than the declared length of the STRING, the current length of the STRING is set to the number of bytes read.

In a write operation, if the first format specifier indicates a shorter field than the current length of the STRING, the STRING data is truncated on the right. If it is longer than the current length of the STRING, the output is padded on the right with blanks.

Writing STRING values with format specifiers can cause truncation of the original STRING values or padding blanks on the end of the STRING values when reread.

### **7.8.5 Formatting VECTOR Data Items**

VECTOR data items in a READ or WRITE statement are formatted as follows:

**Default:** Data is read or written as three 4-byte binary REAL numbers.

**First Format Specifier:** Ignored for VECTOR data items.

**Second Format Specifier:** Ignored for VECTOR data items.

### **7.8.6 Formatting POSITION Data Items**

POSITION data items in a READ or WRITE statement are formatted as follows:

**Default:** Read or written in the internal format of the controller, which is 56 bytes long.

### **7.8.7 Formatting XYZWPR Data Items**

XYZWPR data items in a READ or WRITE statement are formatted as follows:

**Default:** Read or written in the internal format of the controller, which is 32 bytes long.

### **7.8.8 Formatting XYZWPREXT Data Items**

XYZWPREXT data items in a READ or WRITE statement are formatted as follows:

**Default:** Read or written in the internal format of the controller, which is 44 bytes long.

### **7.8.9 Formatting JOINTPOS Data Items**

JOINTPOS data items in a READ or WRITE statement are formatted as follows:

**Default:** Read or written in the internal format of the controller, which is 4 bytes plus 4 bytes for each axis.

## **7.9 USER INTERFACE TIPS**

Input and output to the teach pendant or CRT/KB is accomplished by executing "READ" and "WRITE" statements within a KAREL program. If the USER menu is not the currently selected menu, the input will remain pending until the USER menu is selected. The output will be written to the "saved" windows that will be displayed when the USER menu is selected. You can have up to eight saved windows.

### **7.9.1 USER Menu on the Teach Pendant**

The screen that is activated when the USER menu is selected from the teach pendant is named "t\_sc". The windows listed in [Table 7-18](#) are defined for "t\_sc".

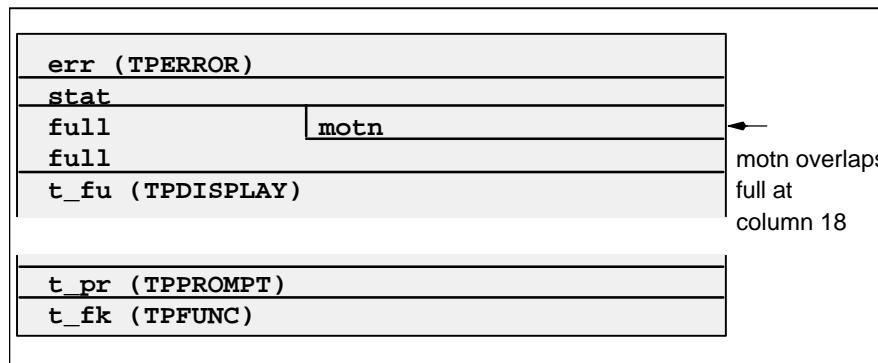
**Table 7-18. Defined Windows for t\_sc"**

Window Name	Lines	Predefined FILE Name	Scrolled	Rows
"t_fu"	10	TPDISPLAY	yes	5-14
"t_pr"	1	TPPROMPT	no	15
"t_st"	3	TPSTATUS	no	2-4
"t_fk"	1	TPFUNC	no	16

Table 7-18. Defined Windows for t\_sc" (Cont'd)

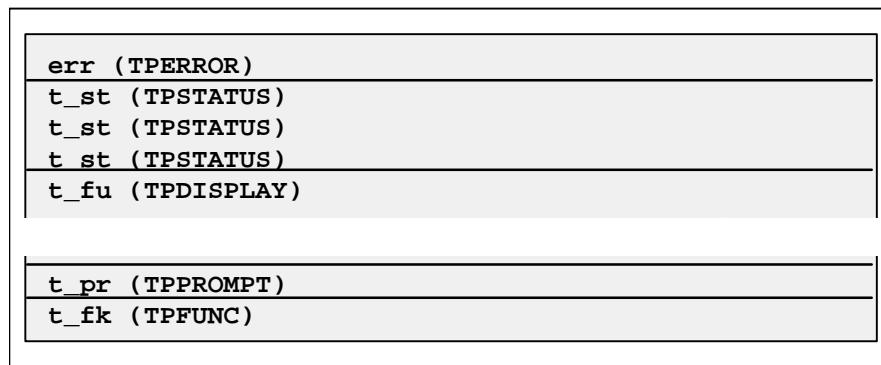
Window Name	Lines	Predefined FILE Name	Scrolled	Rows
"err"	1	TPERROR	no	1
"stat"	1		no	2
"full"	2		no	3-4
"motn"	1		no	3

By default, the USER menu will attach the "err", "stat", "full", "motn", "t\_fu", "t\_pr", and "t\_fk" windows to the "t\_sc" screen. See [Figure 7-1](#).

[Figure 7-1. "t\\_sc" Screen](#)

The following system variables affect the teach pendant USER menu:

- **\$TP\_DEFPROG: STRING** - Identifies the teach pendant default program. This is automatically set when a program is selected from the teach pendant SELECT menu.
- **\$TP\_INUSER: BOOLEAN** - Set to TRUE when the USER menu is selected from the teach pendant.
- **\$TP\_LCKUSER: BOOLEAN** - Locks the teach pendant in the USER menu while \$TP\_DEFPROG is running and \$TP\_LCKUSER is TRUE.
- **\$TP\_USESTAT: BOOLEAN** - Causes the user status window "t\_st" (TPSTATUS) to be attached to the user screen while \$TP\_USESTAT is TRUE. While "t\_st" is attached, the "stat", "motn", and "full" windows will be detached. See [Figure 7-2](#).

**Figure 7–2.** "t\_sc" Screen with \$TP\_USESTAT = TRUE

### **7.9.2 USER Menu on the CRT/KB**

The screen that is activated when the USER menu is selected from the CRT is named "c\_sc". The windows listed in [Table 7–19](#) are defined for "c\_sc".

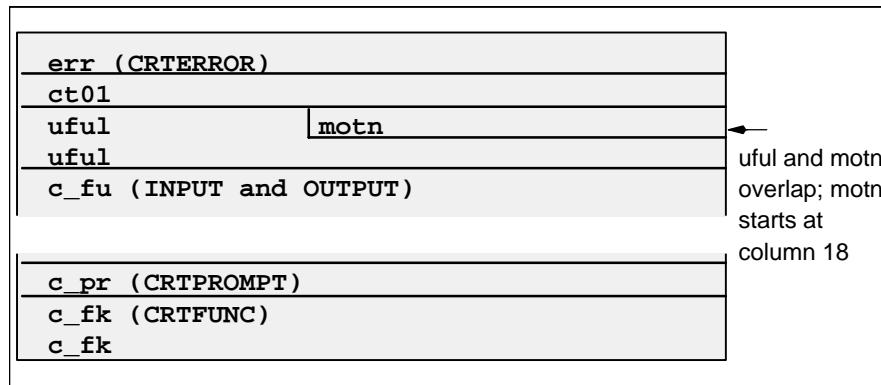
**Table 7–19.** Defined Windows for c\_sc"

Window Name	Lines	Predefined FILE Name	Scrolled	Rows
"c_fu"	17	INPUT and OUTPUT	yes	5-21
"c_pr"	1	CRTPROMPT	no	22
"c_st"	3	CRTSTATUS	no	2-4
"c_fk"	2	CRTFUNC	no	23-24
"err"	1	CRTERROR	no	1
"ct01"	1		no	2

**Table 7-19.** Defined Windows for c\_sc" (Cont'd)

"uful"	2		no	3-4
"motn"	1		no	3

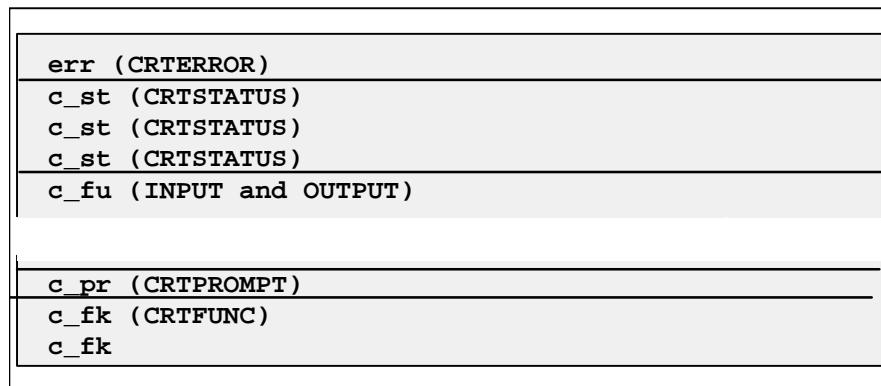
By default, the USER menu will attach the "err", "ct01", "uful", "motn", "c\_fu", "c\_fk", and "uftn" windows to the "c\_sc" screen. The "c\_fk" window will label the function keys and show FCTN and MENUS for F9 and F10. See [Figure 7-3](#).

**Figure 7-3.** "c\_sc" Screen

The following system variables affect the CRT USER menu:

- **\$CRT\_DEFPROG: STRING** - This variable identifies the CRT default program. This is automatically set when a program is selected from the CRT SELECT menu.
- **\$CRT\_INUSER: BOOLEAN** - This variable is set to TRUE when the USER menu is selected from the CRT.
- **\$CRT\_LCKUSER: BOOLEAN** - This variable locks the CRT in the USER menu while \$CRT\_DEFPROG is running and \$CRT\_LCKUSER is TRUE.
- **\$CRT\_USERSTAT: BOOLEAN** - This variable causes the user status window "c\_st" (CRTSTATUS) to be attached to the user screen while \$CRT\_USERSTAT is TRUE. While "c\_st" is attached, the "ct01", "motn", and "uful" windows will be detached. See [Figure 7-4](#).

Figure 7–4. "c\_sc" Screen with \$CRT\_USERSTAT = TRUE





# Chapter 8

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## MOTION

## Contents

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In robotic applications, single segment motion is the movement of the tool center point (TCP) from an initial position to a desired destination position. The KAREL system represents positional data in terms of location (x, y, z), orientation (w, p, r), and configuration. The location and orientation are defined relative to a Cartesian coordinate system (user frame), making them independent of the robot joint angles. Configuration represents the unique set of joint angles at a particular location and orientation.

The KAREL system uses the motion environment to control motion. KAREL motion control regulates the characteristics of the movement including trajectory, acceleration/deceleration , speed, and termination.

In addition to single segment motion, KAREL can control multiple segment motion including path motion and provides for the estimation of cycle times.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, personnel could be injured, and equipment could be damaged.**

## **8.1 POSITIONAL DATA**

The KAREL language uses the POSITION, XYZWPR, XYZWPREXT, JOINTPOS, and PATH data types to represent positional data. The POSITION data type is composed of the following:

- Three REAL values representing an x, y, z location expressed in millimeters
- Three REAL values representing a w, p, r orientation expressed in degrees
- One CONFIG Data Type, consisting of 4 booleans and 3 integers, which represent the configuration in terms of joint placement and turn number. Before you specify the config data type, make sure it is valid for the robot being used. Valid joint placement values include:
  - ‘R’ or ‘L’ (shoulder right or left)
  - ‘U’ or ‘D’ (elbow up or down)
  - ‘N’ or ‘F’ (wrist no-flip or flip)
  - ‘T’ or ‘B’ (config front or back)

A turn number is the number of complete turns a multiple turn joint makes beyond the required rotation to reach a position. [Table 8-1](#) lists the valid turn number definitions.

**Table 8–1.** Turn Number Definitions

Turn Number	Rotation (degrees)
-8	-2700 to -3059
-7	-2340 to -2699
-6	-1980 to -2339
-5	-1620 to -1979
-4	-1260 to -1619
-3	-900 to -1259
-2	-540 to -899
-1	-180 to -539
0	-179 to 179
1	180 to 539
2	540 to 899
3	900 to 1259
4	1260 to 1619
5	1620 to 1979
6	1980 to 2339
7	2340 to 2699

The PATH data type consists of a varying-length list of elements called path nodes.

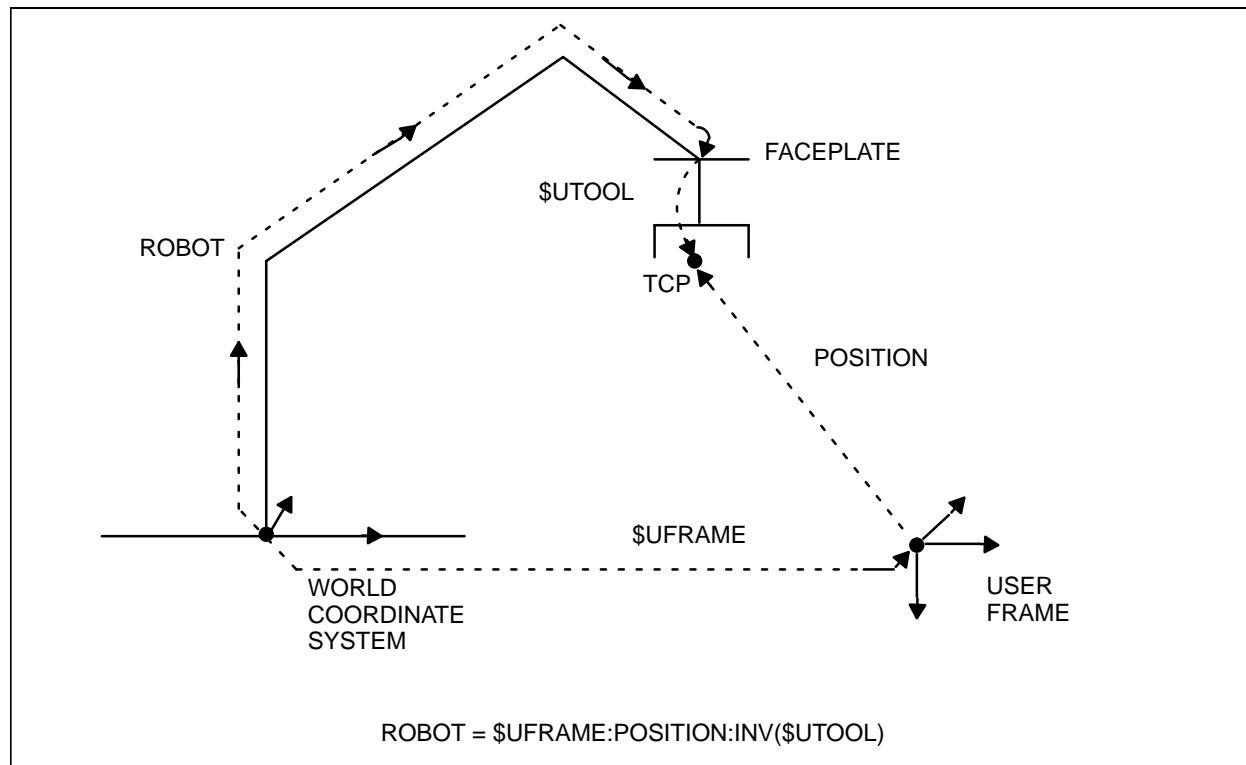
**See Also:** The appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual* for configuration information on each supported robot model. The

POSITION, XYZWPR, XYZWPREXT, JOINTPOS, and PATH Data Types, Appendix A, “KAREL Language Alphabetical Description.”

## **8.2 FRAMES OF REFERENCE**

The KAREL system defines the location and orientation of positional data relative to a user-defined frame of reference, called user frame, as shown in [Figure 8–1](#).

**Figure 8–1. Referencing Positions in KAREL**



Three frames of reference exist:

- WORLD - predefined
- UFRAME - determined by the user
- UTOOL - defined by the tool

Using kinematic equations, the controller computes its positional information based on the known world frame and the data stored in the system variables \$UFRAME (for user frame) and \$UTOOL (for tool frame).

### **8.2.1 World Frame**

The world frame is predefined for each robot. It is used as the default frame of reference. The location of world frame differs for each robot model.

### **8.2.2 User Frame (UFRAME)**

The programmer defines user frame relative to the world frame by assigning a value to the system variable \$UFRAME.



#### **Warning**

**Be sure \$UFRAME is set to the same value whether you are teaching positional data or running a program with that data, or damage to the tool could occur.**

The location of UFRAME represents distances along the x-axis, y-axis, and z-axis of the world coordinate system; the orientation represents rotations around those axes.

By default, the system assigns a (0,0,0) location value and a (0,0,0) orientation value to \$UFRAME, meaning the user frame is identical to that of the world coordinate system. All positions are recorded relative to UFRAME.

To use a teach pendant user frame in a KAREL program, set \$GROUP[group\_no].\$UFRAME = \$MNUFRAME[group\_no, \$MNUFRAMENUM[group\_no]] before executing any motion.

### **8.2.3 Tool Definition (UTOOL)**

The *tool center point (TCP)* is the origin of the UTOOL frame of reference. The programmer defines the position of the TCP relative to the faceplate of the robot by assigning a value to the system variable \$UTOOL. By default, the system assigns a (0,0,0) location and a (0,0,0) orientation to \$UTOOL, meaning \$UTOOL is identical to the faceplate coordinate system. The positive z-axis of UTOOL defines the *approach vector* of the tool.



#### **Warning**

**Be sure \$UTOOL correctly defines the position of the TCP for the tool you are using, or damage to the tool could occur.**

The faceplate coordinate system has its origin at the center of the faceplate surface. Its orientation is defined with the plane of the x-axis and y-axis on the faceplate and the positive z-axis pointing straight out from the faceplate.

To use a teach pendant tool frame in a KAREL program, set \$GROUP[group\_no].\$utool = \$MNUTOOL[group\_no], \$MNUTOOLNUM[group\_no] before you execute any motion.

**Note** Do not use more than one motion group in a KAREL program. If you need to use more than one motion group, you must use a teach pendant program.



#### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, personnel could be injured, and equipment could be damaged.**

### 8.2.4 Using Frames in the Teach Pendant Editor (TP)

The system variable \$USEUFRAME defines whether the current value of \$MNUFRAMENUM[group\_no] will be assigned to the position's user frame when it is being recorded or touched up.

- When **\$USEUFRAME = FALSE**, the initial recording of positions and the touching up of positions is done with the user frame number equal to 0, regardless of the value of \$MNUFRAMENUM[group\_no].
- When **\$USEUFRAME = TRUE**, the initial recording of positions is done with the position's user frame equal to the user frame defined by \$MNUFRAMENUM[group\_no]. The touching up of positions must also be done with the position's user frame equal to the user frame defined by \$MNUFRAMENUM[group\_no].

When a position is recorded in the teach pendant editor, the value of the position's tool frame will always equal the value of \$MNUTOOLNUM[group\_no] at the time the position was recorded. When a teach pendant program is executed, you must make sure that the user frame and the tool frame of the position equal the values of \$MNUFRAMENUM[group\_no] and \$MNUTOOLNUM[group\_no]; otherwise, an error will occur. Set the values of \$MNUFRAMENUM[1] and \$MNUTOOLNUM[1] using the UFRAME\_NUM = n and UTOOL\_NUM = n instructions in the teach pendant editor before you record the position to guarantee that the user and tool frame numbers match during program execution.

## 8.3 JOG COORDINATE SYSTEMS

The KAREL system provides five different jog coordinate systems:

- **JOINT** - a joint coordinate system in which individual robot axes move. The motion is joint interpolated.

- **WORLD** - a Cartesian coordinate system in which the TCP moves parallel to, or rotates around, the x, y, and z-axes of the predefined WORLD frame. The motion is linearly interpolated.
- **TOOLFRAME** - a Cartesian coordinate system in which the TCP moves parallel to, or rotates around, the x, y, and z-axes of the currently selected tool frame. The motion is linearly interpolated. The tool frame is normally selected using the SETUP Frames menu. To jog using \$GROUP[group\_no].\$utool, set \$MNUTOOLNUM[group\_no] = 14.
- **JOGFRAME** - a Cartesian coordinate system in which the TCP moves parallel to, or rotates around, the x, y, and z-axes of the coordinate system defined by the \$JOG\_GROUP[group\_no].\$jogframe system variable. The motion is linearly interpolated.
- **USER FRAME** - a Cartesian coordinate system in which the TCP moves parallel to, or rotates around, the x, y, and z-axes of the currently selected user frame. The motion is linearly interpolated. The user frame is normally selected using the SETUP Frames menu. To jog using \$GROUP[group\_no].\$uframe, set \$MNUFRAENUM[group\_no] = 14.

The robot can be jogged in any one of these jog coordinate systems to reach a destination position. Once that position is reached, however, the positional data is recorded with reference to the user frame as discussed in [Section 8.2](#).

**See Also:** The application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual* for step-by-step explanations of how to jog and define frames.

## **8.4 MOTION CONTROL**

A single segment motion is the simplest form of motion. This motion consists of accelerating from the initial position, traveling along the desired trajectory at the programmed speed, and decelerating to arrive at the destination position.

Motion control regulates the characteristics of the movement which includes:

- Trajectory
- Acceleration/Deceleration
- Speed
- Termination

These motion characteristics are explained in terms of single segment motion. In some applications, motion control extends to the movement of extended axes as well.

In addition to single segment motion, the KAREL system can control multiple segment motion (movement to a sequence of positions without stopping). Motion times can be estimated using the tables and formulas included in this section. In the KAREL system, motion can be initiated in two ways:

- Manually, by jogging the robot or issuing a KCL motion command.

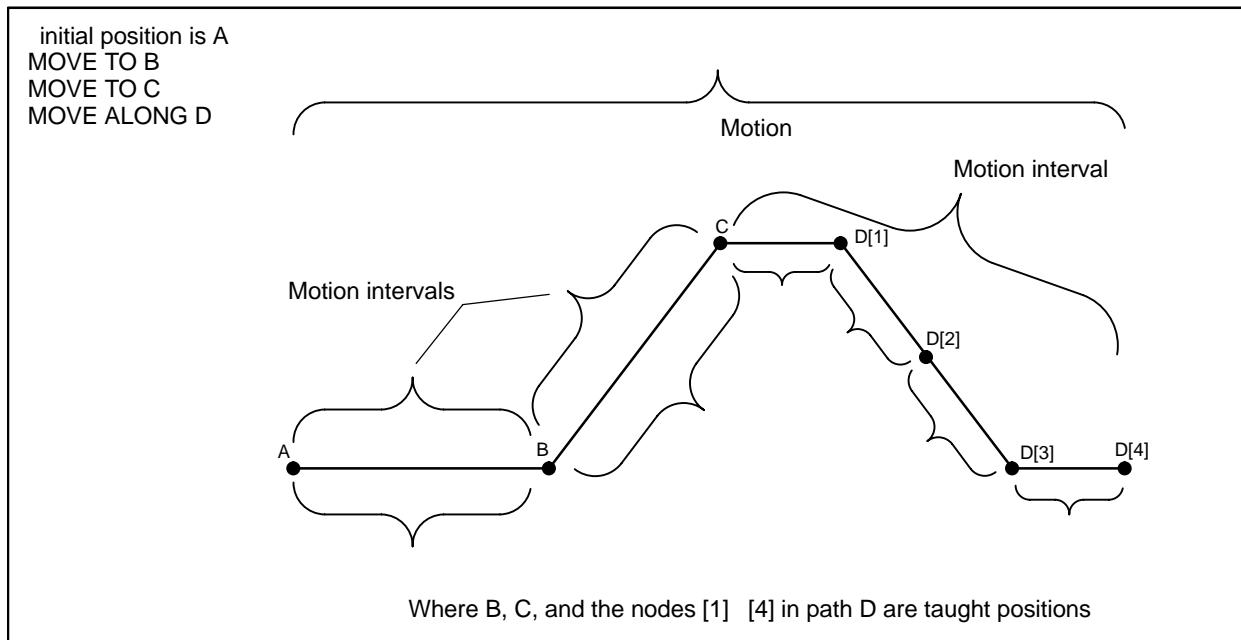
- By issuing KAREL program statements. All motion that is generated by a KAREL program is program controlled motion.

The motion environment executes program controlled motion as follows:

- Program statements are executed by the KAREL interpreter.
- When the interpreter encounters a motion statement, it passes the information to the motion environment, which carries out the motion.
- The motion environment runs in parallel with the interpreter so that, when necessary, motion can be carried out simultaneously with the execution of other program statements.

The following terms, which are illustrated in [Figure 8–2](#), help clarify the relationship between a motion statement and how it is carried out by the motion environment:

- **Motion** - The physical movement of the robot from the time it starts moving to the time it stops. During continuous path motion, several motion statements executed sequentially can compose a single motion.
- **Motion Interval** - The motion generated by a single motion statement, for example, a MOVE TO or a MOVE ALONG statement.
- **Taught Position** - A position you teach or calculate in a program. It can be a destination for a MOVE TO statement, an intermediate position for a MOVE ALONG statement, or any other position that is used in a motion statement.
- **Motion Segment** - The part of a motion between two taught positions. A motion interval can be composed of a single motion segment, or several motion segments can be combined into one motion interval in which the robot moves near or through taught positions without stopping.

**Figure 8–2.** Motion Terms

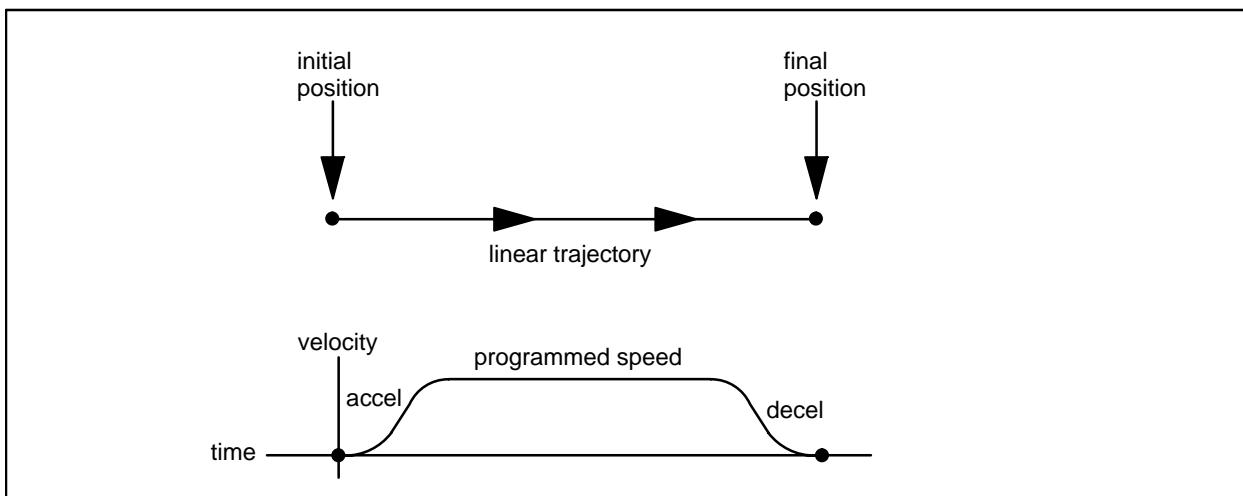
Several characteristics of a motion are controlled by the motion environment and can be specified by changing the appropriate system variables. They are illustrated in [Figure 8–3](#) and can be categorized as follows:

- **Trajectory** The path of the TCP as the robot moves from its initial to final position. The trajectory includes orientation as well as location of the TCP.
- **Acceleration/Deceleration** Acceleration is the initial phase of a motion during which the speed of the robot increases to the programmed speed. At the end of a motion, the robot decelerates to a stop.

The programmed segment time specified in the KAREL program, which defines the time required to finish the motion segment, does not include deceleration time.

During continuous path motion, which includes multiple segments, acceleration and deceleration might occur at the taught positions as the robot changes speed and direction of motion.

- **Programmed Speed** The speed is designated in the KAREL program (or by the teach pendant for manual motion). In between acceleration and deceleration the robot moves at the programmed speed.
- **Motion Interval Termination** The criterion by which the motion environment determines when a motion interval is complete. Motion interval termination is important in synchronizing program statements with the actual motion.

**Figure 8–3. Motion Characteristics**

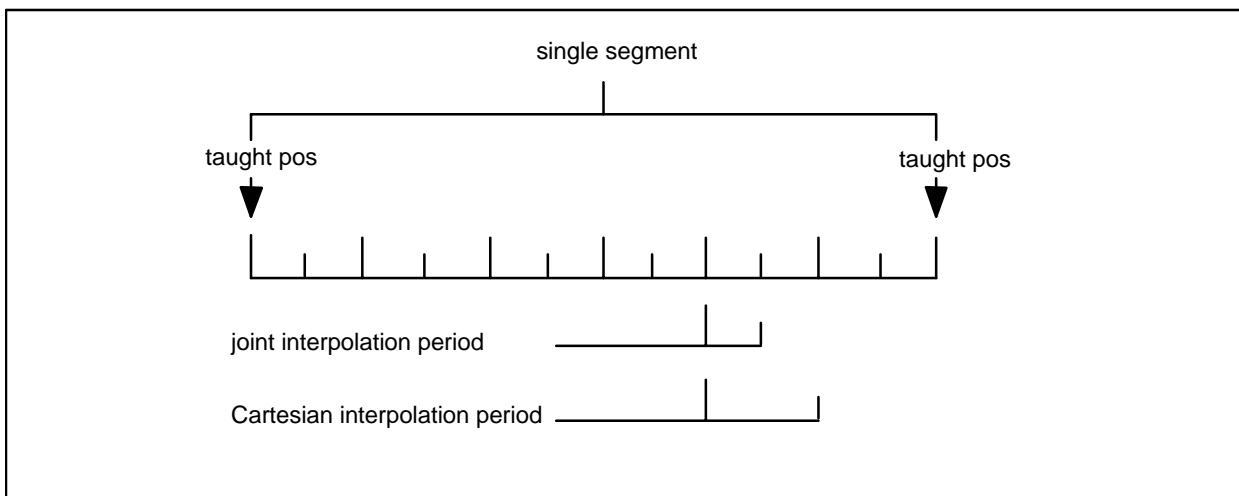
#### **8.4.1 Motion Trajectory**

The motion trajectory between two taught positions is generated by interpolating various sets of variables from their initial values at the start position to their final values at the destination position.

The two basic interpolation methods are joint interpolation and Cartesian interpolation.

- During **joint interpolation**, the joint angles of the robot are linearly interpolated from their initial to final values.
- **Cartesian interpolation** is categorized into linear and circular interpolation of the location of the TCP and, for each of these, there are several possible schemes for interpolating the orientation of the TCP. See [Figure 8–4](#).

Both location and orientation are interpolated during all robot motions. The system variable, \$MOTYPE, governs the basic motion type or how the location of the TCP is interpolated during a motion interval.

**Figure 8–4.** Interpolation Rates

### Location Interpolation

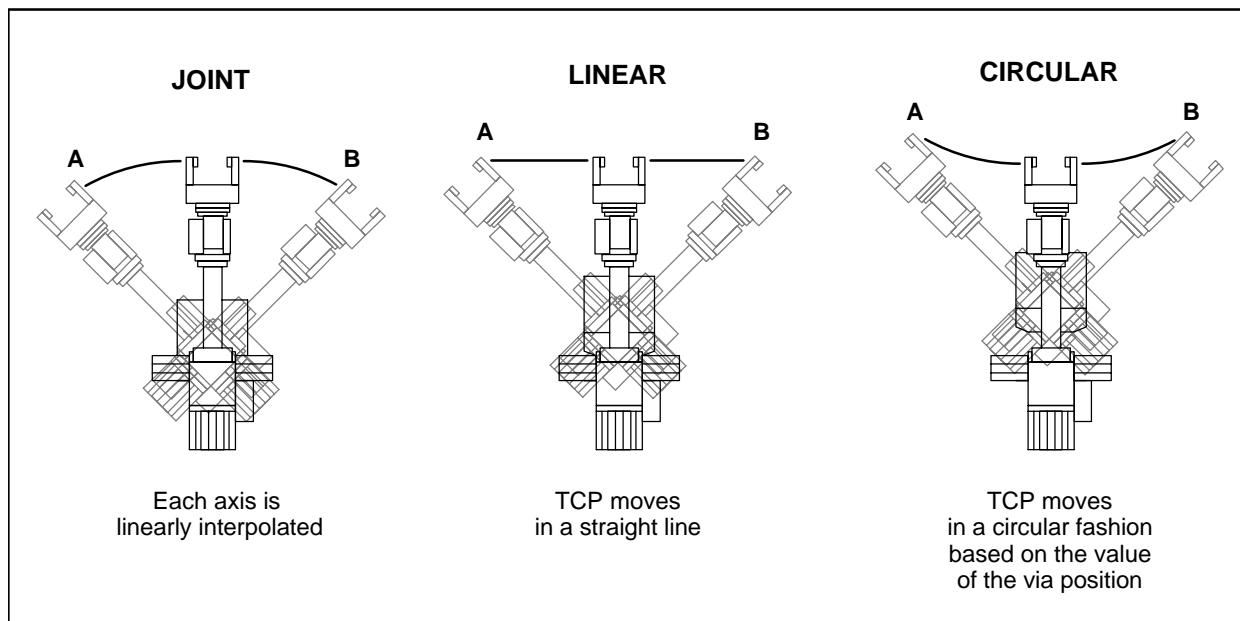
\$MOTYPE has three possible enumerated values:

- JOINT (6)
- LINEAR (7)
- CIRCULAR (8)

The value of \$MOTYPE can be assigned using the teach pendant, CRT/KB, or by issuing a KAREL assignment statement. Each time a KAREL program is executed, \$MOTYPE is initialized to JOINT.

Figure 8–5 shows the difference between the three values for \$MOTYPE.

**Figure 8–5. Location Interpolation of the TCP**



#### • **JOINT** Interpolated Motion

The following rules apply to joint interpolated motion:

- All axes start moving at the same time and reach the beginning of the deceleration at the same time.
- The trajectory is not a simple geometric shape such as a straight line. However, the path is repeatable.
- The motion is defined by computing the time for each axis to move from its current position to its final position at the programmed speed. The longest time among all axes is used as the segment time, and each axis begins and ends its motion in this amount of time.

The axis with the longest time, called the limiting axis, moves at its programmed speed. While the other axes move slower than their programmed speeds, using the same segment time for all axes allows them to arrive at the destination in the correct amount of time.

#### • **LINEAR** Interpolated Motion

The following rules apply to linear interpolated motion:

- The TCP moves in a straight line, from the initial position to the final position, at the programmed speed.
- The orientation of the tool is changed smoothly from the orientation at the initial position to the orientation at the destination.

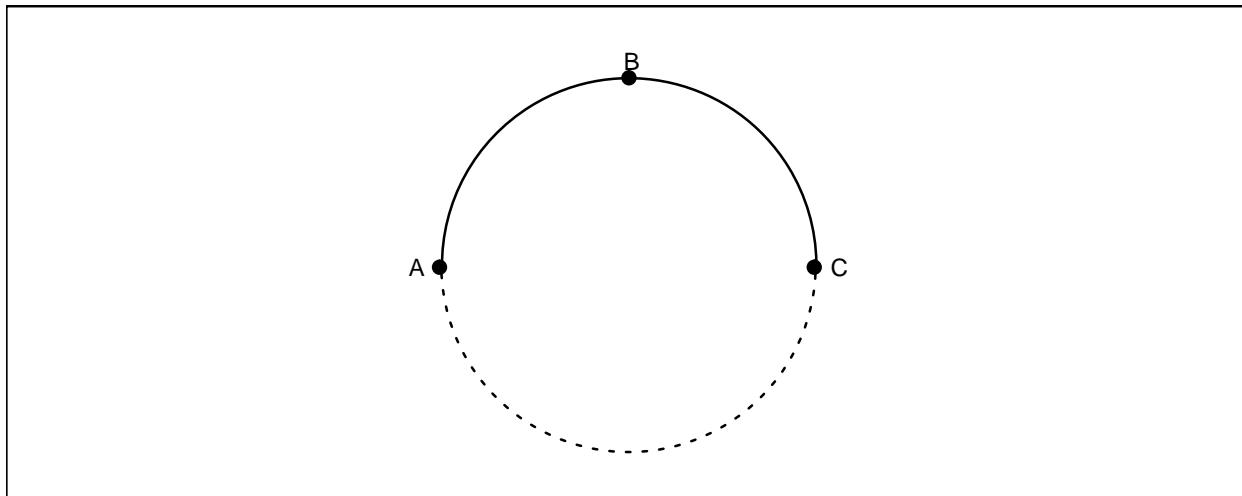
**See Also:** “Orientation Interpolation” for more information on these methods

- **CIRCULAR Interpolated Motion**

The following rules apply to circular interpolated motion.

- The TCP follows a circular arc from the initial position to the destination.
- An additional position, called the VIA position, must be specified in order for the motion environment to define the arc. See [Figure 8–6](#).

**Figure 8–6. CIRCULAR Interpolated Motion**



- The VIA position is specified with a VIA clause in a MOVE TO statement. If a VIA clause is not included with a MOVE TO statement that uses CIRCULAR interpolation, an error occurs and the program aborts.

For example, the following statements move the TCP from position A to position C, via position B, as shown in [Figure 8–6](#):

**\$MOTYPE = CIRCULAR MOVE TO C VIA B -- A is the current position**

- Using CIRCULAR interpolation in conjunction with a MOVE ALONG statement is not supported.
- The three-angle method of orientation interpolation is always used. Refer to the section on “Orientation Interpolation” below.

**See Also:** MOVE TO and MOVE ALONG Statements, [Appendix A](#).

### Orientation Interpolation

The KAREL system supports three methods of orientation interpolation:

- Two-Angle Method (RSWORLD)
- Three-Angle Method (AESWORLD)
- Wrist-Joint Method (WRISTJOINT)

The system variable \$ORIENT\_TYPE uses the predefined constants RSWORLD, AESWORLD, and WRISTJOINT to indicate the type of interpolation used to move from one orientation to another during a LINEAR motion. By default, the two-angle method (RSWORLD) is used.

If the motion is CIRCULAR, the three-angle method or the wrist joint method can be used.

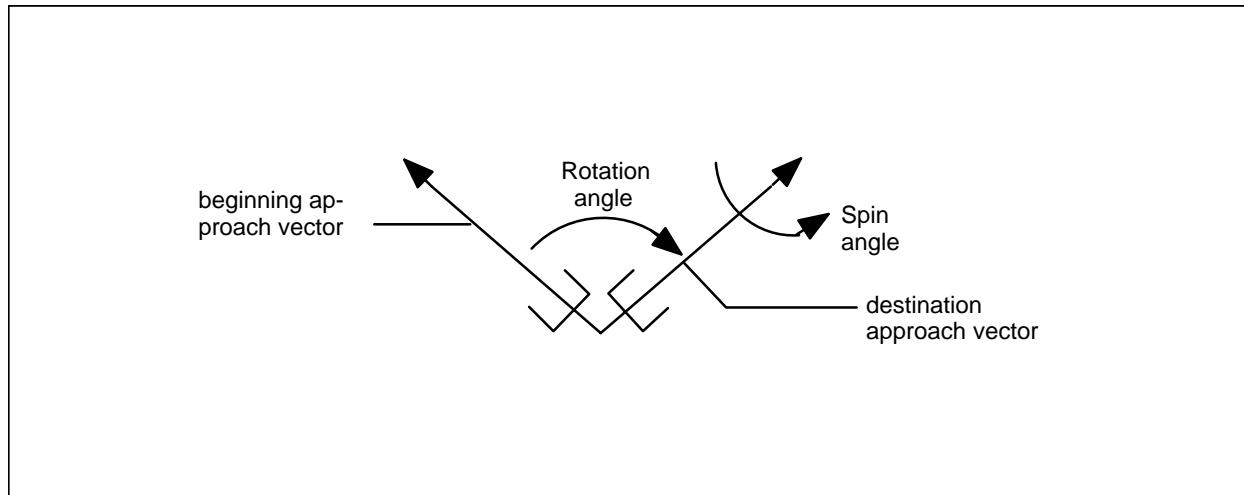
The three methods of orientation interpolation are described as follows:

- **Two-Angle Method (RSWORLD)**

For the two-angle method (RSWORLD), orientation interpolation is done by linearly interpolating the values of two rotation angles, tool rotation and tool spin, which are defined for each LINEAR motion segment.

The tool rotation angle is the angle about the common normal between the beginning tool approach vector and the destination approach vector. The tool spin angle is the angle about the approach vector from the beginning position to the destination position. See [Figure 8–7](#).

**Figure 8–7. Two-Angle Orientation Control**

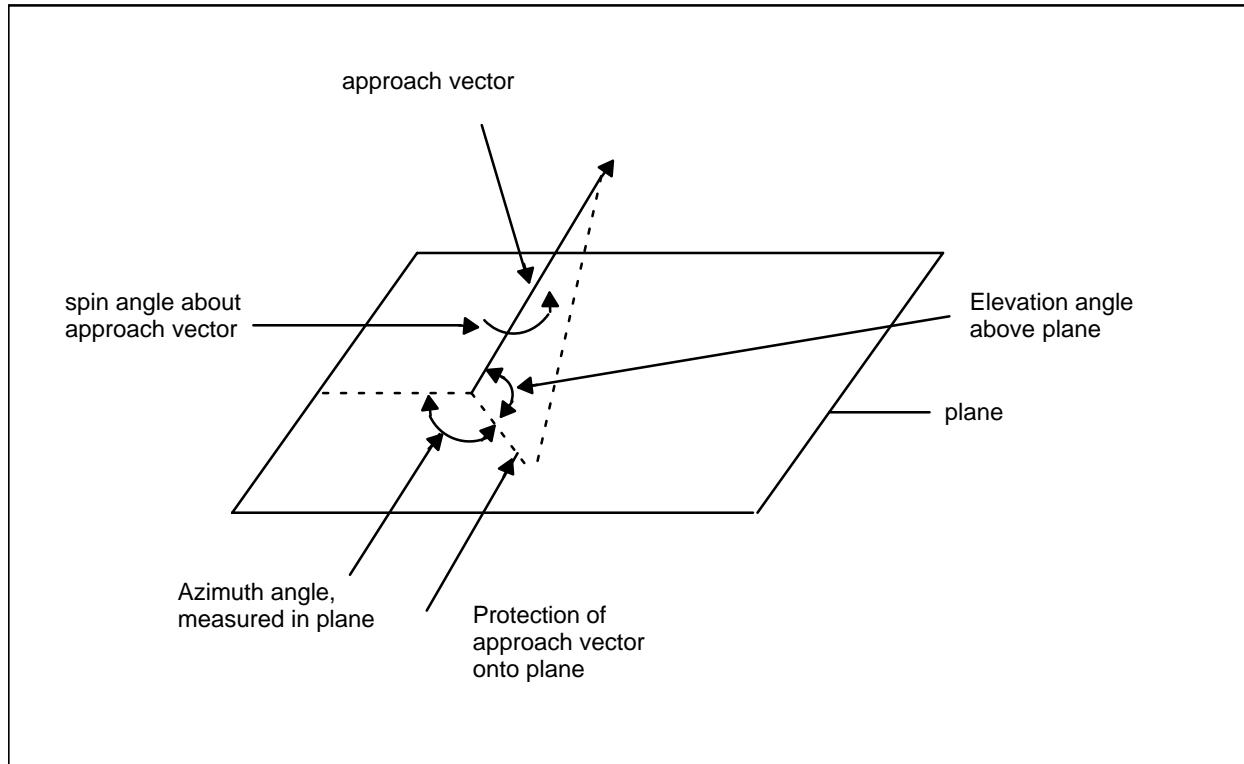


- **Three-Angle Method (AESWORLD)**

For the three-angle method (AESWORLD), orientation interpolation is done by linearly interpolating the values of three rotation angles: *azimuth*, *elevation*, and *spin*.

For LINEAR motions, elevation and azimuth are defined with respect to the world coordinate horizontal plane. That is, elevation is the elevation angle of the tool approach vector above the horizontal, and azimuth is the angle of the projected approach vector in the horizontal plane. Spin is the rotation angle about the approach vector. See [Figure 8–8](#).

**Figure 8–8. Three-Angle Orientation Control**



For CIRCULAR interpolation, elevation and azimuth are defined with respect to the plane of the circle being interpolated.

- **Wrist-Joint Method (WRISTJOINT)**

For the WRISTJOINT method of orientation interpolation, the three wrist joints are joint interpolated. The remaining joints are interpolated so that the TCP moves in a straight line. Note that the starting and ending orientation will be used as taught, but because of the joint interpolation, the orientation during the move is not predictable, although it is repeatable.

### Orientation Trajectory

Regardless of the orientation interpolation method used for Cartesian moves, there are usually at least two possible orientation trajectories between two taught positions—one in a positive direction and one in a negative direction.

For example, during a move in which the azimuth of the tool approach vector is  $0^\circ$  at the initial position and  $50^\circ$  at the destination position and the TCP moves along a straight line, azimuth can change in a negative direction by  $310^\circ$  or in a positive direction by  $50^\circ$ .

- For calculating LINEAR interpolation, the shortest distance for each interpolated variable is always used. That is, for the two-angle method, the smallest change in both spin and rotation will be used, and, for the three-angle method, the smallest change in all three angles will be used.
- For CIRCULAR interpolation, keeping the orientation of the TCP fixed with respect to the path is often more important than the distance traveled while changing orientation.

For example, during a move in which the TCP follows a complete circle with the tool approach vector pointing toward the center of the circle throughout the entire move, the azimuth angle changes by  $360^\circ$ . If the shortest distance,  $0^\circ$ , is used for the move instead, the tool approach vector will be pointing toward the inside of the circle sometimes and toward the outside at other times during the move.

- In general, when the tool approach vector points from outside the circle toward the inside, the tool approach vector is “outside” the circle, while “inside” the circle means that the approach vector points from the inside toward the outside.
- The following rules are used to determine orientation trajectories for CIRCULAR interpolation:
  - If all the initial, via, and final approach vectors are outside, then the approach vector will remain outside for the entire segment.
  - If all the initial, via, and final approach vectors are inside, then the approach vector will remain inside for the entire segment.
  - If the initial and final approach vectors are on opposite sides, then the shortest change in azimuth will be executed.

In the following cases very small changes in the orientation of a taught position will make a very large difference in the orientation trajectory:

- The approach vector at a taught position is tangent to the circle. This is the point between “inside” and “outside.”
- The approach vector is perpendicular to the plane of the circle. In this case, the azimuth angle is taken as  $0^\circ$ .
- The circle degenerates into a straight line. In this case, the reference frame for three-angle control is computed as follows:
  1. The x-axis is measured along the direction of the motion.
  2. The y-axis is the cross-product of the x-axis and the world z-axis.

3. Elevation is computed with respect to the xy-plane.
4. Azimuth is computed with respect to the x-axis.

The VIA position is used to determine the location trajectory, and also for orientation trajectory interpolation. The benefit of using a VIA position is that a circular motion will go through the VIA position as it is taught or programmed. This allows the user more control over the tool orientation throughout a circular motion.

It is important to maintain uniform speed along the location trajectory. Circular interpolation maintains a uniform location speed throughout the starting arc (initial to VIA position) and the ending arc (VIA to final position.) However, orientation speeds for the two arcs might be different.

Typically, the location movement of a circular motion dominates that of the orientation movement. The segment time is determined by the location movement and the location speed. The same time will be used for orientation trajectory interpolation. However, in cases where the orientation motion dominates that of the location motion, the programmed location speed might not be maintained. In this case, the system posts the following warning "Speed limits used."

## Configuration

- In JOINT interpolated motion, the Boolean value of the system variable \$USE\_TURNS indicates whether the turn numbers of the initial and destination positions are used in determining the joint distance.
  - If \$USE\_TURNS is TRUE, the turn numbers are used. In this case, it is possible for a single segment to turn a joint through several revolutions if that is what the turn numbers specify.
  - If \$USE\_TURNS is FALSE, the turn numbers are ignored. This means that the shortest distance between the initial and destination joint positions will be used.
- In CARTESIAN interpolated motion, the robot cannot move along the interpolated location trajectory, maintain control of orientation, and change the configuration. However, if orientation control is not important to the application, the WRISTJOINT method of interpolation can be used. WRISTJOINT is useful if changing configuration is required, while maintaining the location trajectory. The use of the turn numbers of the wrist joints are determined as follows:
  - If \$USE\_WJURNS is TRUE, the turn numbers of the wrist joints are used in determining the wrist joint distances.
  - If \$USE\_WJURNS is FALSE, the turn numbers are ignored and the shortest wrist joint distances are used.
- The Boolean value of the system variable \$USE\_CONFIG indicates how this physical restriction is handled if you are not using the WRISTJOINT method of orientation interpolation:
  - If \$USE\_CONFIG is TRUE, different configurations are not allowed. An error condition that pauses the program occurs if different configurations are specified.

- If \$USE\_CONFIG is FALSE, the stored configuration for the destination position is ignored and the initial configuration is maintained.
- The configuration contains both the configuration for joint placement (flip/noflip) and turn number. If \$USE\_CONFIG is TRUE, the turn number from the taught position will be used to check the joint limit. If \$USE\_CONFIG is FALSE, the turn number from the taught point will be ignored.
- The physical requirements of executing a Cartesian path also limit the joint motions to  $\pm 180^\circ$  from the starting position of that joint. This makes it necessary to ignore the destination turn numbers specified in the taught data. Multiple turn joints, however, always can be returned to their taught positions by executing joint interpolated motions with \$USeturns being TRUE.

### **8.4.2 Motion Trajectories with Extended Axes**

Extended Axes are linear or rotary axes in addition to the robot axes. There are two kinds of extended axes: integrated and non-integrated.

#### **Integrated Extended Axes**

- Extended axes are said to be integrated when the positions of the auxiliary axes are integrated into the calculations of the robot TCP position. This includes trajectory calculations of the TCP for Cartesian moves, as well as calculations of the TCP position displayed from the teach pendant or the CRT/KB. In particular, the world coordinate system is moved from the base of the robot to the zero position of the extended axis. Up to three auxiliary axes can be integrated.

For example, if a robot is mounted on top of an extended axis, such as a rail, you would want to have the extended axis integrated with the robot axes. Once integrated, the world position of the TCP changes as the rail moves, such as during joint jogging of the rail axis. This change occurs even when the robot axes are not moving. You can observe the change in the current robot TCP position in the world coordinate, from the teach pendant.

#### **Non-Integrated Extended Axes**

- Non-Integrated extended axes are also called auxiliary axes. The position of these auxiliary axes has no effect on the robot TCP position.

Robot axis numbers begin at 1 and extended axis numbers begin at a number one more than the last robot axis. The number of robot axes is indicated by the value of the system variable \$SCR\_GRP[ ].\$num\_rob\_axs. The highest extended axis number is indicated by the value of the system variable \$SCR\_GRP[ ].\$num\_axes.

Regardless of whether the extended axes are integrated or not, the extended axes motion is always joint interpolated. This is true even in integrated extended axes, when the TCP might be moving simultaneously under Cartesian interpolation. For example, if a LINEAR motion is specified for the TCP, the TCP will move along a straight line while the integrated extended axes are joint interpolated from their initial to final locations.

For more information on setting up extended axes, refer to the *FANUC Robotics SYSTEM R-J3iB Controller Auxiliary Axis Connection and Maintenance Manual*.

### **8.4.3 Acceleration and Deceleration**

During a single segment motion, the robot accelerates from rest at the initial position and decelerates to rest at the destination position.

For motions long enough to reach the programmed speed before deceleration must begin, the acceleration time is always the same regardless of the programmed speed. Therefore, because the acceleration time is fixed, the average acceleration value is proportional to the programmed speed.

#### **Fast Acceleration**

KAREL uses fixed acceleration times to generate the acceleration and deceleration profile regardless of the program speed. However, you can reduce the acceleration time linearly based on the program speed by setting the system variable \$GROUP[ ].\$usemaxaccel. If \$GROUP[ ].\$usemaxaccel is TRUE, the required acceleration/deceleration time will be adjusted and it will improve corner rounding and cycle time percentages.

- Setting the system variable \$GROUP[ ].\$usemaxaccel to TRUE causes the acceleration time to be reduced based on the program speed. Therefore, the rate of acceleration is kept constant and the acceleration time changes.
- For short motions, where the programmed speed cannot be reached, the acceleration time is reduced to permit faster short motions.
- A two-stage acceleration/deceleration algorithm is used to produce a second order velocity profile during acceleration and deceleration. This second order method produces smoother derivatives than, for example, a first order method. Therefore, it induces less structural vibration on the robot during acceleration and deceleration.
- For Cartesian motions, the acceleration times are the same for all axes, and are determined by the system variables, \$PARAM\_GROUP[ ].\$cart\_accel1 and \$PARAM\_GROUP[ ].\$cart\_accel2, which are integers representing the times in milliseconds of each stage of the acceleration/deceleration algorithm.
- For joint interpolated motions, the acceleration times for each joint are permitted to be different. These times are determined by two arrays, \$PARAM\_GROUP[ ].\$accel\_time1[ ] and \$PARAM\_GROUP[ ].\$accel\_time2[ ], with each array having one element for each robot or extended axis. The values of each array represents the lengths, in milliseconds, of each stage of the acceleration/deceleration algorithm.
- By varying the ratio of the two stage lengths, various profiles can be achieved. A first order profile is achieved when either of the two stages is zero length. A purely second order profile is achieved when the two stages have the same length.

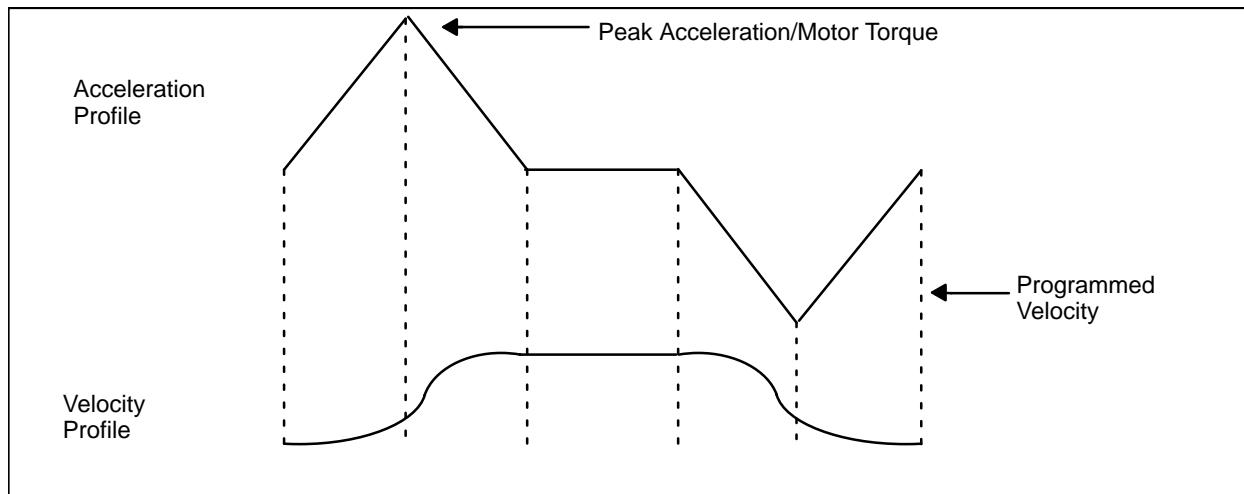
- With any other ratio, a mixed profile is achieved, with a portion of the acceleration being first order and the remainder, second order. This approach makes it possible to achieve profiles with both low peak torque and smooth higher order derivatives.

[Figure 8–9](#), [Figure 8–10](#), and [Figure 8–11](#) show the effect of varying the relative lengths of the two stages.

**See Also:** “Short Motions”

In [Figure 8–9](#) both stages are the same length, producing a second order profile over the entire acceleration profile. In [Figure 8–10](#), the second stage is zero length, producing a first order profile over the entire acceleration period. The peak acceleration in [Figure 8–9](#) is twice that in [Figure 8–10](#) for a given total acceleration time.

**Figure 8–9. Acceleration and Velocity Profile with Stage\_1 = Stage\_2**



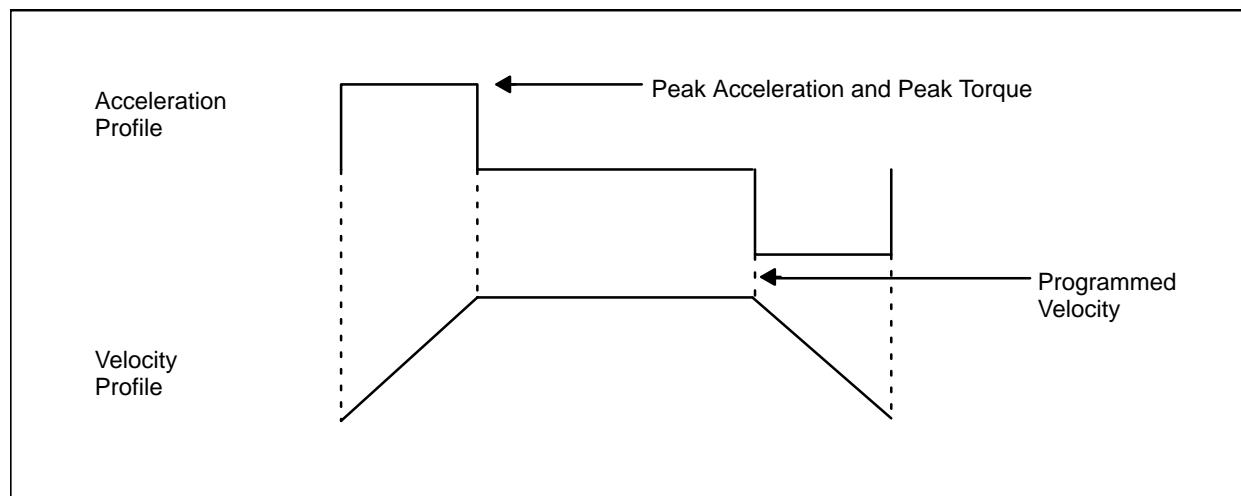
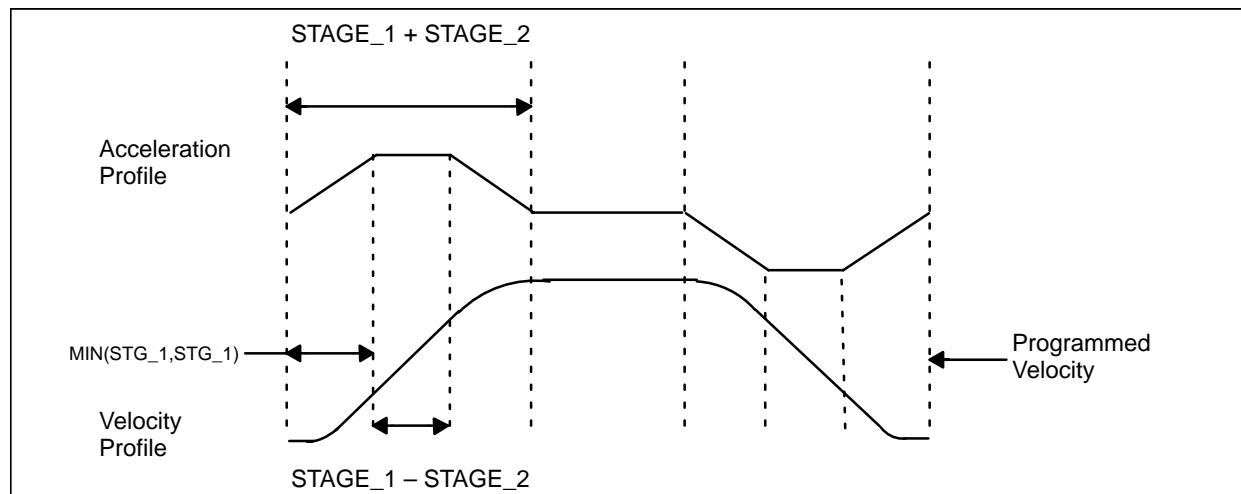
**Figure 8–10.** Acceleration and Velocity Profile with Stage\_2 = 0

Figure 8–11 shows a desirable compromise between the profiles shown in Figure 8–9 and Figure 8–10. The first stage is two times the length of the second stage, reducing the peak acceleration, while still maintaining a second order profile over the beginning and end of the acceleration period.

**Figure 8–11.** Acceleration and Velocity Profile with Stage\_1 = 2\* Stage\_2

For most FANUC Robotics robot models, the default values of the first and second stages of the acceleration/deceleration algorithm are established so that the first stage is twice the second stage in length, but this can vary from model to model. The sum of the two stages is determined so that the maximum acceleration capability is achieved when maximum speed is programmed.

**See Also:** *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for system variable descriptions

### Acceleration and Deceleration Times

In [Figure 8–10](#), the velocity profile changes from second order to first order and back to second order during the acceleration period. The time of the straight line portion is the absolute difference in the lengths of the two stages. The times of the curved portions of the profile are each equal to the shorter of the two stage lengths. Acceleration and deceleration times can be calculated using the following:

$$\text{Total Time} = (\text{Stage\_1} + \text{Stage\_2}) \quad (1)$$

$$\text{Straight - part Time} = (|\text{Stage\_1} - \text{Stage\_2}|) \quad (2)$$

$$\text{Curved - part Time} = \text{MIN}(\text{Stage\_1}, \text{Stage\_2}) \quad (3)$$

(For Cartesian motion, the stage lengths are \$GROUP\_PARAM[ ].\$cart\_accel1 and \$GROUP\_PARAM[ ].\$cart\_accel2. For joint interpolated motions, the stage lengths are \$GROUP\_PARAM[ ].\$accel\_time1[i] and \$GROUP\_PARAM[ ].\$accel\_time2[i].)

### Peak Acceleration Times

The example in [Figure 8–10](#), where Stage\_2 = 0, is referred to as the constant acceleration case. This also represents the average acceleration of the general case.

The value of the average acceleration is calculated by dividing programmed velocity by total acceleration time:

(4) where A represents average acceleration.

$$A = \frac{\$GROUP[ ].\$speed}{(\text{Stage\_1} + \text{Stage\_2})}$$

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The average acceleration, “A”, can then be multiplied by a “peak constant”, Kp, to determine the peak acceleration. Refer to [Figure 8–4](#).

$$\text{peak acceleration} = \text{Kp} * \text{A} \quad (5)(6)$$

$$Kp = \frac{(\text{Stage\_1} + \text{Stage\_2})}{\text{MAX}(\text{Stage\_1}, \text{Stage\_2})}$$

-XXXXXXXX

For example, if Stage\_1 = Stage\_2 ([Figure 8–9](#) ), peak acceleration is double the constant acceleration value or twice the average acceleration. If Stage\_1 is two times Stage\_2 ( [Figure 8–11](#) ), then peak acceleration is 3/2, or 1.5, times the average acceleration.

#### **8.4.4 Motion Speed**

System variables determine the speed of robot motion.

- Speed overrides are scaling constants that allow motion to be executed at slower than programmed speeds.
- For manual motion, the speed is a percentage of a maximum value that is dependent on the robot model.
- For programmed motion, the speed is generally specified in millimeters per second for Cartesian motions and a scaled percent of maximum for joint interpolated motions.
- For Cartesian motion, additional variables are also used to impose limits on the rotational speed for the tool. Rotational speed refers to how fast the TCP rotates and spins (in degrees per second) in order to control the orientation.

##### **Speed Override**

For testing or fine tuning a process, speed overrides allow a motion to be executed at a slower speed than the programmed speed without changing the program. Speed overrides are scaling constants that scale all speed values by a percentage.

The system variables \$MCR[],\$genoverride (general override) and \$MCR[],\$prgoverride (program override) are both speed overrides. \$MCR[],\$genoverride can be altered from the teach pendant and from the CRT/KB, but affects both programmed and manual motion. \$MCR[],\$prgoverride can be altered from a KAREL program, the teach pendant, and from the CRT, and only affects programmed motion.

The two variables are multiplied together to achieve an overall override percentage for programmed motion.

The path value of \$CNSTNT\_PATH can also affect the execution of a programmed path. When \$CNSTNT\_PATH is FALSE the filter length is not adjusted meaning the path will vary with the speed override value (\$MCR[],\$genoverride or \$MCR[],\$prgoverride.) If \$CNSTNT\_PATH is TRUE the programmed motion will not be affected by the speed override value.

##### **Manual Motion Speed**

The formulas for calculating manual motion speed are different than those used for calculating programmed motion speed.

- Manual motion speed is calculated by multiplying a maximum speed value by the scaling factor \$MCR[].\$genoverride.

- The maximum speed for each joint for joint interpolation is represented by the array \$PARAM\_GROUP[].speedlimjnt, multiplied by a limiting factor \$SCR\_GRP[].\$joglim\_jnt.
- The maximum speed for Cartesian interpolation is represented by \$PARAM\_GROUP[].\$speedlim multiplied by \$MCR[].\$genoverride.

The following equations are used to calculate manual motion speed:

Joint Speed (in joint units) equals: (7)

$$\frac{\$PARAM\_GROUP[i].\$SPEEDLIMJNT * \underline{\$MCR[ ].\$GENOVERRIDE}}{100} * \frac{\$SCR\_GRP[i].\$JOGLIM\_JNT}{100}$$

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Cartesian Translational Speed (in mm/sec) equals: (8)

$$\frac{\$PARAM\_GROUP[i].SPEEDLIM * \underline{\$MCR[ ].\$GENOVERRIDE}}{100} * \frac{\$SCR\_GRP[i].\$JOGLIM}{100}$$

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Cartesian Rotational Speed (in mm/sec) equals: (9)

$$\frac{\$PARAM\_GROUP[i].ROTSPEEDLIM * \underline{\$MCR[ ].\$GENOVERRIDE}}{100} * \frac{\$SCR\_GRP[i].\$JOGLIMROT}{100}$$

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### **Programmed Motion Speed**

The system variable \$GROUP[].\$speed governs the translational speed of all programmed motions.

- For Cartesian interpolation, the value of \$GROUP[].\$speed is the speed of the TCP in millimeters per second. The system variable \$PARAM\_GROUP[].\$speedlim determines the maximum value that can be used for \$GROUP[].\$speed for Cartesian motions.
- For a single segment motion, the robot accelerates, moves at the programmed speed, \$GROUP.\$speed, then decelerates to a stop. The average speed of the motion, therefore, is less than the programmed speed.
- In some arm configurations, limits on joint and motor speeds will inhibit the robot from reaching the programmed speed in a Cartesian move. This can also result in the TCP varying from the expected path trajectory.

- For joint interpolation, the value of the system variable \$GROUP[].\$speed is converted by a conversion constant to a fraction of maximum joint speeds. The conversion constant is \$PARAM\_GROUP[].\$speedlimjnt.
- \$PARAM\_GROUP[].\$speedlimjnt is set so that the average speed of the TCP is approximately the same as the Cartesian speed would be near the center of the working range of the major axis. This conversion constant permits you to assign one value for \$SPEED that can be used for both Cartesian and joint motions.
- \$PARAM\_GROUP[].\$speedlimjnt is also the maximum value of \$GROUP[].\$speed for joint interpolated motions. That is, there is a different maximum value for Cartesian motions than for joint interpolated motions for most robot models, (\$PARAM\_GROUP[].\$speedlim < \$PARAM\_GROUP[].\$speedlimjnt).

Consequently, if you always want to move the robot at maximum speeds regardless of motion type, you need to use different values of \$SPEED for different motion types.

For example, the KAREL statement, \$GROUP[].\$speed = \$PARAM\_GROUP[].\$speedlim, causes all Cartesian motions to run at maximum speed, and the KAREL statement, \$GROUP[].\$speed = \$PARAM\_GROUP[].\$speedlimjnt, causes all joint motions to run at maximum speed.

- \$PARAM\_GROUP[].\$speedlimjnt can be changed when the robot is installed to be equal to \$PARAM\_GROUP[].\$speedlim so that one value for \$SPEED may be used to achieve maximum speed for either joint or Cartesian motions. (\$PARAM\_GROUP[].\$speedlimjnt should not be changed after programs have been written for the system.)
- \$PARAM\_GROUP[].\$speedlimjnt is only a scale factor and consequently has no effect on ultimate joint speed limits. These are determined by \$PARAM\_GROUP[].\$jntvellim, which should not be changed.

You might also want to change \$PARAM\_GROUP[].\$speedlimjnt so that \$GROUP[].\$speed is a percent of maximum. This can be achieved by setting \$PARAM\_GROUP[].\$speedlimjnt to 100. However, you should be aware that this will cause drastically different motion speeds for Cartesian and joint motions that use the same value for \$GROUP[].\$speed.

The following equations are used to calculate programmed motion speed:

Joint Speed equals: (10)

$$\frac{\$GROUP\$SPEED}{\$PARAM\_GROUP\$SPEEDLIMJNT} * \frac{\$MCR.\$GENOVERRIDE}{100} * \frac{\$MCR.\$PRGOVERRIDE}{100} * \frac{PARAM\_GROUP.\$JNTVELLIM[i]}{100}$$

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Cartesian Translational Speed (in mm/sec) equals: (11)

$\$GROUP.\$SPEED * \frac{\$MCR.\$GENOVERRIDE}{100} * \frac{\$MCR.\$PRGOVERRIDE}{100}$   
TR-XXXXXXX

### Rotational Speed

Normally you are interested in the translation speed of the TCP. However, some motions involve a rotation of the TCP about some fixed point or line, and some motions involve both translation and rotation.

- For Cartesian motion with rotation only, \$GROUP[].\$speed has little meaning. Because there is no translation, it would theoretically take zero time to move the TCP zero distance regardless of the programmed speed. With no other restrictions, the motion environment would attempt to move the joints infinitely fast.
- For two-angle orientation control, system variable \$GROUP[].\$rotspeed is defined to limit the “ROTation” speed of the tool around the common normal between the beginning approach vector and the destination approach vector and the “SPIN” speed of the tool around the approach vector during interpolation.
- For three-angle orientation control, the system variable \$GROUP[].\$rotspeed is used for all three angular speed limits.
- For a Cartesian motion, two speed variables are used, \$GROUP[].\$speed and \$GROUP[].\$rotspeed. In the planning for each motion, a segment time is computed based on each of these speeds. The longest time is used as the segment time.
- The system variable \$PARAM\_GROUP[].\$rotspeedlim determines the maximum values that can be used for \$GROUP[].\$rotspeed.
- If \$GROUP[].\$rotspeed is set to the same value as \$PARAM\_GROUP.\$rotspeedlim, and if the segment time is determined by this speed value, the following error message will be displayed, "MOTN-056 Speed limits used."
- The two speed values, translational speed \$GROUP.\$speed and rotational speed, \$GROUP.\$rotspeed, are both used for the calculation of segment time. The speed which results in the longest segment time determines the dominant motion and that time will be used for the final segment time. This can have the effect of causing one of the speeds (\$SPEED or \$ROTSPEED) to not be attained. Also, the transitional speed will not be attained in the case of dominant rotational motion.
- The warning "MOTN-056 Speed limits used" is displayed as an indication that the rotational speed is dominant even though the command speed is at the maximum value. This warning is also displayed independent of rotspeed values if time based motion (segtime) is used and the time value would exceed the limit of \$PARAM\_GROUP.\$speedlim or \$PARAM\_GROUP.\$speedlimjnt.

### Extended Axis Speed Control

In KAREL extended axes and robot axes move simultaneously, meaning they both start and end at the same time for each motion segment.

The system variable \$GROUP[].\$ext\_speed controls extended axis motion speed control.

- A non-zero value indicates the percentage of maximum extended axis speed to be used for extended axes segment time computation. The default is 100.
- In order to achieve simultaneous motion, the robot motion time is compared with the extended axis segment time during planning. The longer time is used, for both the robot and the extended axis, so that they both reach the destination at the same time.
- If robot motion time is longer than extended axis motion time, the actual extended axes speed will be lower than its programmed value so that robot motion speed is maintained.
- If extended axis motion time is longer than robot motion time, the actual robot speed will be lower than its programmed speed in order to maintain simultaneous motion.
- If there is only extended axis motion but no robot motion, the programmed extended axis speed will be used as specified, even if it could be the default maximum speed.

### Other Speed Limits

In Cartesian motions, the TCP moves at a constant speed, meaning the individual joint speeds can vary. During execution of a Cartesian motion, speed limits might be encountered if a particular joint attempts to move too fast, exceeding its speed limits. For example, when moving in a straight line through a singularity point, some axes of a robot move rapidly in an attempt to maintain the straight line.

- Two types of speed limits can be encountered,
  - Joint speed limits
  - Motor speed limits
- The values of joint speed limits are stored in the system variable \$PARAM\_GROUP[].\$jntvellim and the values of motor speed limits are stored in \$PARAM\_GROUP[].\$mot\_spd\_lim.
- The system variable \$MCR[].\$chk\_jnt\_spd determines whether or not joint speed limits are used. By default, \$MCR[].\$chk\_jnt\_spd is set to TRUE, meaning the joint speeds are checked against the value of \$PARAM\_GROUP[].\$jntvellim.
- If a joint speed limit is encountered, the motion will be slowed down at the point where the limit is reached. All joint speeds are scaled at this point so that the original trajectory is maintained, and the warning message, “JOINT SPEED LIMIT USED,” is issued. The TCP will return to the programmed speed after the joint rate has slowed to below its limit providing that the programmed speed is not so high that the limit is encountered again.
- If a joint speed limit is encountered, the cycle time will be longer than expected, because the motion is slowed down. For programs that are dependent on cycle time, reteaching positions might allow you to avoid the joint speed limits.

- If a motor speed limit is encountered, cycle time is not changed. The motion will be slowed down and the warning message, “MOTOR SPEED LIMIT USED,” will be issued. However, after the motor rate slows to below its limit, the motion speeds up faster than programmed speed to maintain the original cycle time.

### Fixed Segment Time

- The \$GROUP[].\$seg\_time system variable can be used to specify a fixed segment time for any motion instead of specifying a program speed. If the value is greater than 0, it will be used as the segment time. If the value is less than or equal to zero, the value of the system variable \$GROUP[].\$speed will be used to compute the segment time.

If the speed, that is computed based on the value of \$GROUP[].\$seg\_time, exceeds the maximum speed, a warning message, “Segment time too short,” is displayed and the maximum speed is used. If \$GROUP[].\$seg\_time is specified in a MOVE ALONG path statement, \$GROUP[].\$speed will control the motion speed to the first node of the path. All subsequent motion segments will be controlled by \$GROUP[].\$seg\_time.

#### 8.4.5 Motion Termination

- Motion termination involves two critical relationships:
  - One between the motion interval and the actual motion of the robot
  - One between the motion interval and the program statement that caused that interval
- The motion “interval” is defined to be that part of the motion generated by a single motion statement. The interval, in the absence of any other motion statements, will correspond closely to the actual motion. That is, the robot will start moving at the beginning of the interval, and it will stop moving at or about the same time that the interval terminates. However, several motion statements can be combined to produce one continuous motion. In that case, it is not obvious where one interval ends and the next one begins.
- Interval termination is important to both the program environment and to the motion environment.

The program environment uses interval termination as the criterion to continue program execution. That is, the interpreter normally will wait at each motion statement for the interval generated by that statement to be completed before going on to the next statement.

- If the NOWAIT clause is used in a motion statement, the interpreter will continue program execution at the beginning of the interval instead of at the end. The motion environment uses interval termination as the criterion for beginning interpolation of the next interval.
- Normally the motion environment determines when a motion interval will be terminated based on the proximity of the robot to its destination position. That is, termination of the actual motion will cause termination of the interval. This is referred to as “termination based on position.”

- In some cases, however, a signal from outside the motion environment will cause early or abnormal interval termination. In these cases termination of the interval causes the motion to be terminated. The termination in these cases is referred to as “abnormal termination.”

See Also: [Section 8.4.6](#), “Multiple Segment Motion”

### Termination Based on Position

When position is used as the criterion for terminating motion, the system variable \$TERMTYPE is used to determine when the interval will be terminated based on how close the robot must be to its destination.

- Values for \$TERMTYPE are:

FINE - robot moves to path node and stops before beginning next motion

COARSE - robot moves to path node and stops before beginning next motion

NOSETTLE - robot moves close to path node but does not stop before beginning next motion

NODECEL - robot moves past the path node on its way to next path node without deceleration

VARDECCEL - robot approaches the node and then, at the distance from the path node determined by the value of the deceleration tolerance specified in \$DECCELTOL, the robot decelerates

- The value can be assigned at the CRT/KB or by executing a KAREL assignment statement. Each time a KAREL program is executed, \$TERMTYPE is initialized to COARSE. \$TERMTYPE has no effect on manual motions.

Each value for \$TERMTYPE is described briefly in the following list.

#### — COARSE and FINE Tolerances

COARSE and FINE are specified as detector pulses in the system variable array \$PARAM\_GROUP[ ].\$stoptol. That is, when all axes are within the specified number of detector pulses from the destination position, the motion environment signals motion interval completion. The effect for both termination types is the same.

#### — NOSETTLE

NOSETTLE causes the motion environment to signal interval completion as soon as the deceleration profile is complete. In this case, there is no settling time incurred waiting for the robot to position itself precisely within the FINE or COARSE tolerance.

You can use this value for \$TERMTYPE when it is not important that the robot be precisely in position before subsequent actions are acted upon or motion statements are executed.

#### — NODECEL

NODECEL is used to permit continuous motion near taught positions. In this case motion interval termination is signaled to the interpreter as soon as the axes begin to decelerate.

#### — VARDECEL

VARDECEL is used to permit variable deceleration. When VARDECEL is specified, you can select a value between NODECEL and NOSETTLE for a deceleration tolerance. When the robot is within the selected deceleration tolerance of the taught position, acceleration toward the next position can begin.

The \$GROUP[].\$deceltol system variable represents a percentage of the distance to the destination position at the time deceleration begins. \$DECELTOL percentages can be set to values from 1 to 99. Any value outside of the range 1 to 99, uses the value in \$GROUP[].\$deceltol.

#### **Abnormal Interval Termination**

A CANCEL operation might be issued to the motion environment when a local condition handler, such as a MOVE statement with an UNTIL clause, is executed and the condition specified in the handler occurs. In this case, the interval is considered completed immediately. The motion environment immediately signals the interpreter and the MOVE statement is terminated.

At the same time, the robot begins to decelerate. Note that in this case the value of \$TERMTYPE has no effect on interval termination.

- Motions can be canceled by many conditions including error conditions and those governed by local condition handlers and global condition handlers as well as by the CANCEL statement.
- Two types of CANCEL conditions can occur:
  - Local CANCEL - caused by a local condition handler
  - Global CANCEL - caused by a global condition handler or a CANCEL statement
- The difference between a local CANCEL operation and global CANCEL operation is that pending motion intervals are also canceled by global CANCEL operations, while only the current interval is canceled by a local CANCEL.

#### **Stopping a Motion**

STOP causes the motion of the axes to stop. However, it does not cause interval termination. For example, a MOVE statement waiting for interval termination continues to wait. STOP causes the robot to stop moving, but in this case the motion can be resumed. The interval will not terminate until the motion has been resumed and terminated normally.

In this special case it is possible for intervals caused by an interrupt service routine to be processed in the middle of a stopped interval.

A STOP operation can be caused by a STOP statement, STOP action, or an error with STOP or SVAL severity.

## 8.4.6 Multiple Segment Motion

Multiple segment motion occurs when the robot continues moving as it passes near or through taught positions, thus extending a motion through multiple segments.

For example, continuous path operations such as sealing, arc welding, and painting require this multiple segment motion.

Two primary methods are used for multiple segment motion in the KAREL system:

- **PATH Data Type and MOVE ALONG Statement**

One method is by using the PATH data type in a MOVE ALONG path statement. In this case, several taught positions can be stored in a single PATH variable. When the MOVE ALONG statement is executed, the motion interval extends over the entire path, which is made up of motion segments joining each of the taught positions.

**See Also:** [Section 8.4.7 , “Path Motion,”](#) for more information on this method

- **MOVE TO Statements with NODECEL or VARDECCEL**

The second method is by using a sequence of MOVE TO statements with the NODECEL or VARDECCEL value for \$TERMTYPE. In this case, the interval is terminated as the robot decelerates to the destination position designated in a MOVE TO statement.

Because interval termination has been signaled to the interpreter, the next motion statement can be immediately executed, and acceleration towards the next taught position begins. That is, deceleration for one segment is overlapped with acceleration for the next segment.

- When multiple segment motion is used, the robot does not pass through the taught positions but passes near them, rounding the corners near the taught positions. The amount by which the taught position is missed depends on the angle between the trajectories of the connecting motion segments and on the programmed speed, \$GROUP[].\$speed.
- If VARDECCEL is used, this amount also depends on the deceleration tolerance specified by \$DECCELTEL. The VARDECCEL termination type is provided so that you can control the distance by which a taught position is missed (at the expense of increased cycle time).
- It is important to remember that with either NODECEL or VARDECCEL termination types, the amount of corner rounding is dependent on programmed speed.

### Effect of NOWAIT

Using the NOWAIT clause with a motion statement allows you to take advantage of the fact that the motion environment and program interpreter run in parallel.

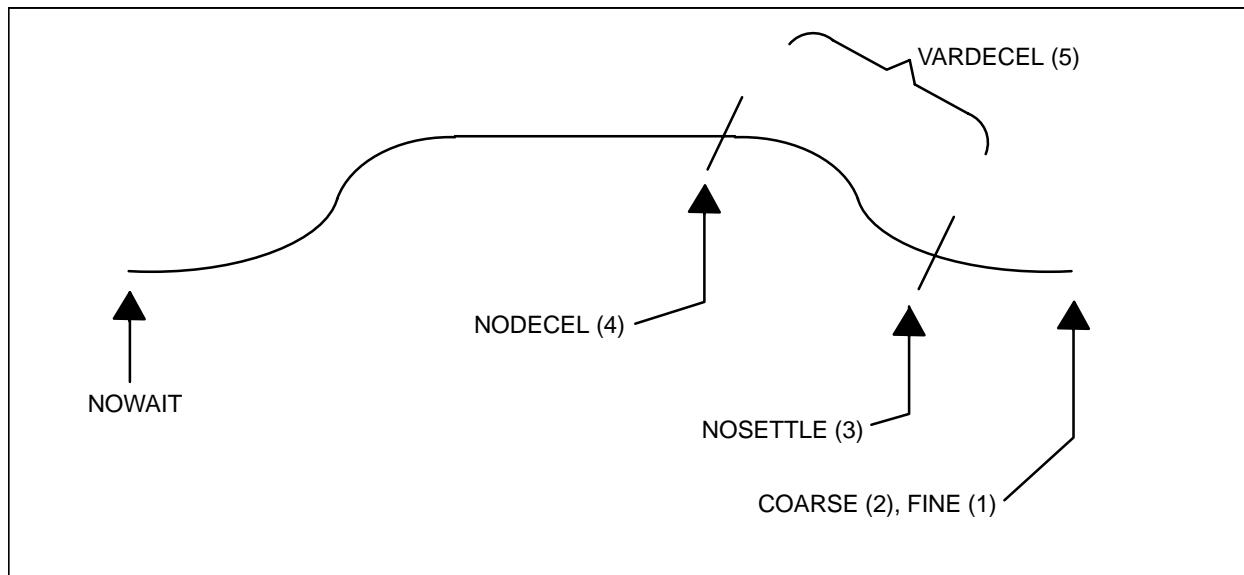
- If you do not use NOWAIT, which is the normal case for simple programs, the interpreter waits at each motion statement for the motion interval for that statement to be completed.

- If you use NOWAIT, the interpreter can continue program execution beyond the current motion statement while the motion environment carries out the motion. The interpreter is permitted to continue at the beginning of the interval instead of at the end of the interval. Because the interpreter waits for each interval to begin, it can execute a motion ahead by at most one motion statement.
- The NOWAIT clause has no effect on how a motion is executed by the motion environment. However, because it has an effect on the timing of subsequent motion statements, NOWAIT can affect the start of planning for succeeding motions and, thus, can have an indirect effect on continuous path motions, as the following paragraphs explain.
- There is always a slight delay between the time the interval completion is signaled and the time that the motion environment can plan and begin executing the next segment. There is also a deceleration in this case before acceleration to the next segment begins.
- If the NOWAIT clause is used in conjunction with the NODECEL termination type, the next motion statement will already have been executed and the next segment planned when the current interval is terminated. Thus, motion along the next segment can begin with no deceleration between intervals. See [Figure 8–13](#).

### Effect of \$TERMTYPE on Trajectory

[Figure 8–12](#) shows a motion where the robot is initially stationary, accelerates up to the programmed velocity, and decelerates to a stop. The times in this cycle at which the various termination types (\$TERMTYPE) are satisfied are also indicated.

**Figure 8–12. Effect of \$TERMTYPE on Timing**



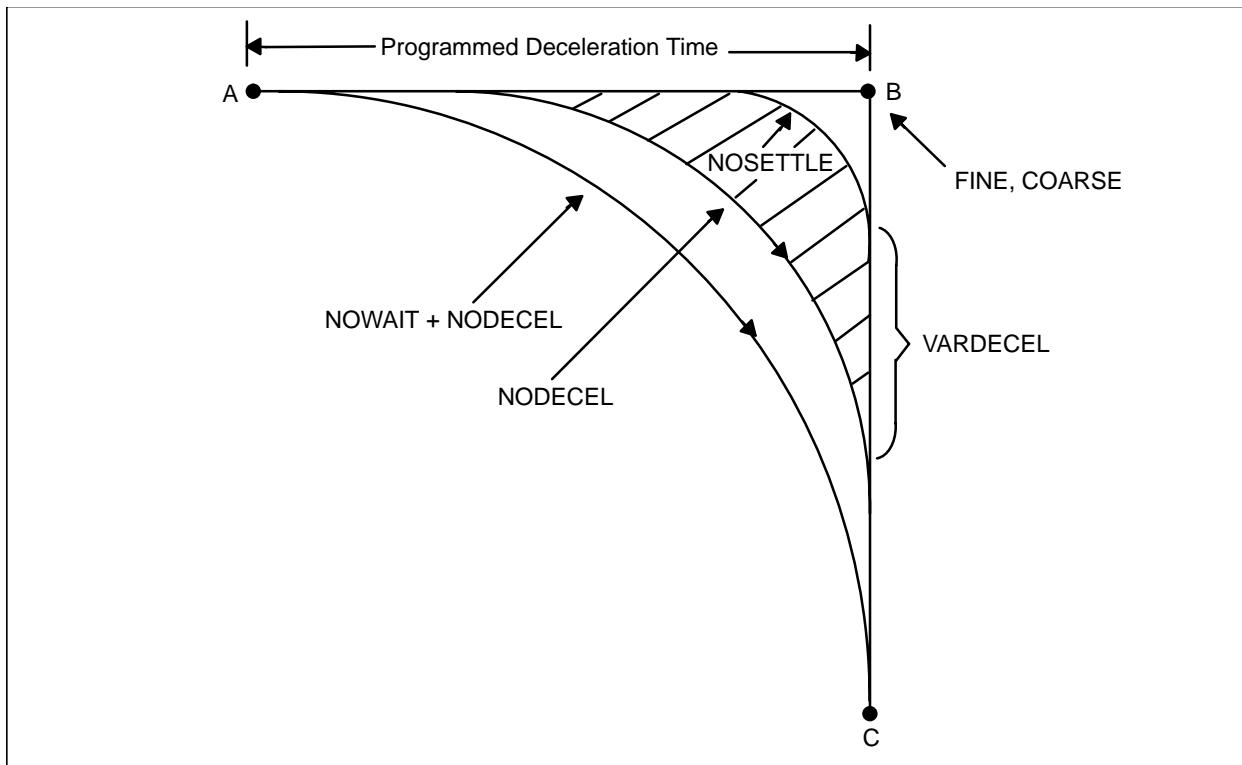
- NOWAIT is not a termination type but indicates the point in the segment at which the interpreter is permitted to continue.

- The following is a section of a test program in which the termination type is set and two consecutive LINEAR moves are made. The motion segments, from the initial position to B and from B to C, are at 90 degrees to each other.

```
$TERMTYPE = ?
-- (FINE | COARSE | NOSETTLE | NODECEL | VARDECCEL)
$MOTYPE = LINEAR
MOVE TO B -- add NOWAIT for NOWAIT case
MOVE TO C
```

- This section explains the different values for \$TERMTYPE and the uses of the NOWAIT clauses which are also shown in [Figure 8–13](#).

**Figure 8–13. Effect of \$TERMTYPE on Path**



- For termination types of COARSE and FINE, not only has the deceleration profile been completed but also all axes are within a specified number of detector pulse counts of their destination. The distance corresponding to these pulse counts depends on the type of robot.

- If the termination type is NOSETTLE, the complete deceleration profile will be generated by the software but there still is some lag due to the servo system. The robot will be very close to point B before the MOVE TO C is processed by the interpreter.
- In the case of NODECEL, the interpreter can process the MOVE TO C as soon as deceleration to B starts. There will be a slight delay (from 30 ms to 100 ms depending on robot model) for the next statement to be processed and the interval to begin, but this is small compared to the times required for many FANUC robots to decelerate.
- Some deceleration will occur during this time. This small deceleration will be eliminated if the NOWAIT clause is used with the MOVE TO B statement, as the succeeding statement will be processed and the next segment planned before deceleration begins. The next segment would then begin immediately.

[Figure 8–13](#) shows that using NODECEL along with NOWAIT will produce maximum corner rounding. Slightly less rounding results if NOWAIT is not used.

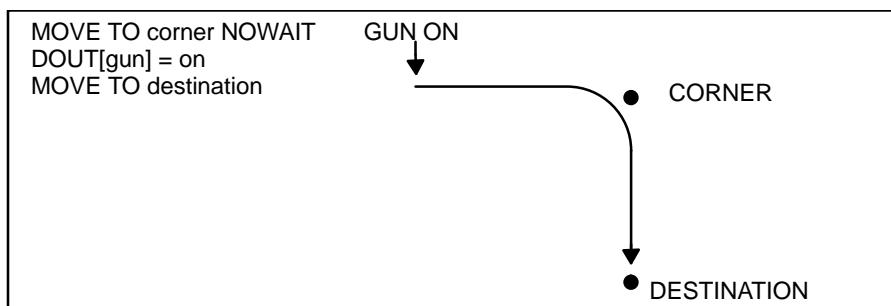
- If the termination type VARDECCEL is used, corner rounding depends on the value of the system variable \$DECCELTOOL. If a value of 1 is used, the rounding will be nearly equivalent to NODECEL. If a value of 99 is used, the rounding will be nearly equivalent to NOSETTLE. Values in between will yield a trajectory in between those two cases, as indicated by the shaded area in [Figure 8–13](#).

### Program Synchronization

[Figure 8–14](#), [Figure 8–15](#) and [Figure 8–16](#) show how program synchronization, including digital I/O signals, is affected by termination type, the NOWAIT clause, and local condition handlers.

- In [Figure 8–14](#), because NOWAIT is used, the digital output turns on at the beginning of the motion, even though the digital output statement is placed after the motion statement.

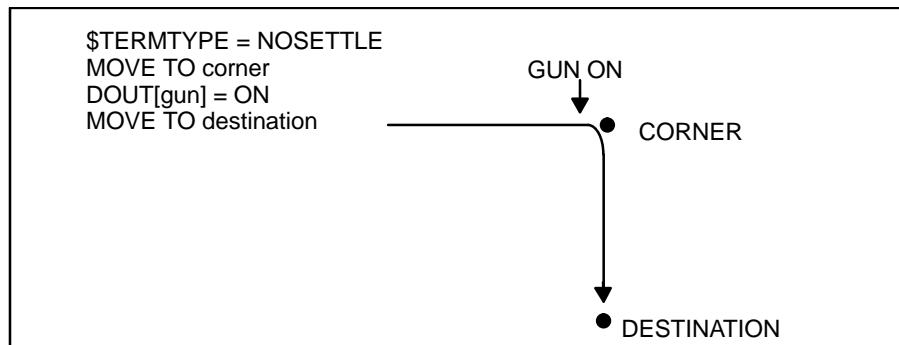
**Figure 8–14. NOWAIT Example**



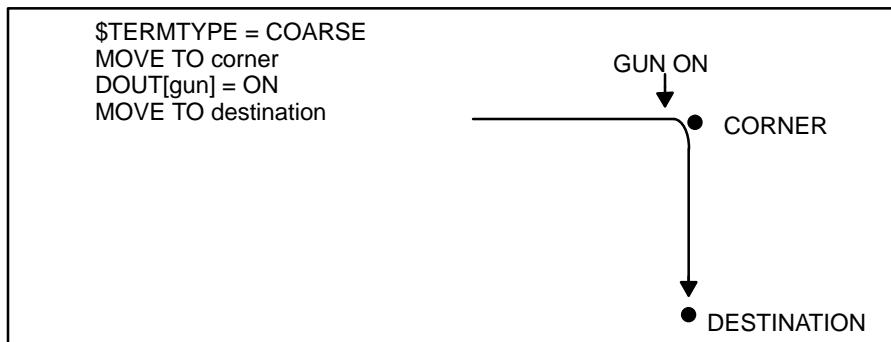
- In [Figure 8–15](#), the interpreter waits until the interval is terminated before going ahead. With NODECEL, the gun turns on at the beginning of the motion towards DESTINATION, which still occurs well before the robot reaches CORNER.

**Figure 8–15.** NODECEL Example

- If VARDECCEL is used, the digital output turns on as soon as the deceleration tolerance specified in \$DECCELTOL is satisfied-somewhere between the NODECEL case of [Figure 8–15](#) and the NOSETTLE case of [Figure 8–16](#).
- For the NOSETTLE case, the digital output turns on as soon as the controller has finished generating the deceleration profile, and the robot is only the “servo lag” distance from CORNER.

**Figure 8–16.** NOSETTLE Example

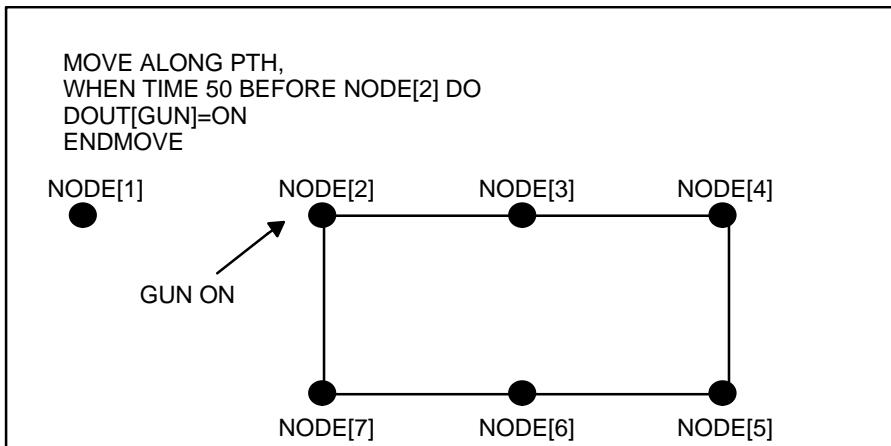
- In [Figure 8–17](#), the digital output turns on as soon as the controller has finished generating the deceleration profile and all axes are within the COARSE tolerance of being in position.

**Figure 8–17.** COARSE Example

- For the FINE case, all axes are within the FINE tolerance of being in position before the digital output turns on (the closest possible control).

[Figure 8–18](#) shows how to affect program synchronization using local condition handlers.

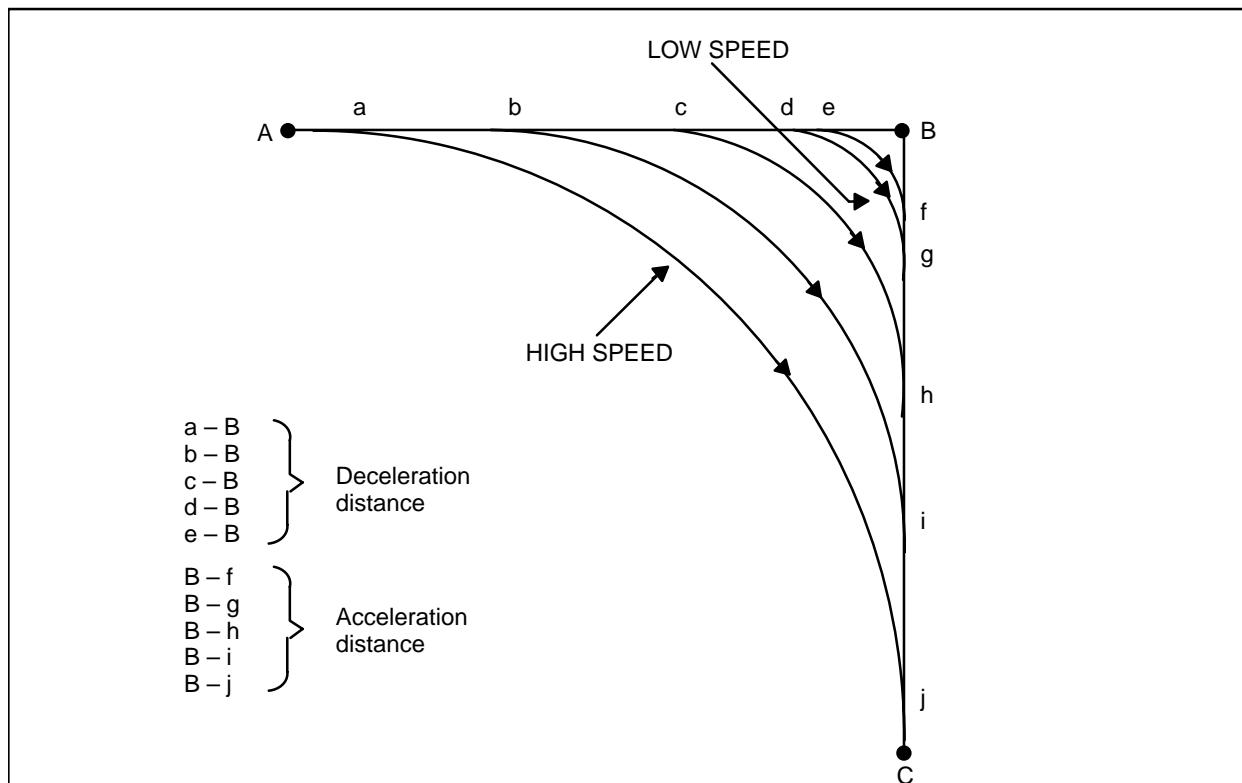
In [Figure 8–18](#), the digital output turns on 50 milliseconds before node 2 is reached.

**Figure 8–18.** Local Condition Handler When Timer Before Example

### Effect of Motion Speed and Overrides

The main concern with continuous path motion is not that the taught position is missed as a result of the cornering, but that the path taken near the taught position will vary with the programmed speed.

This variation is because the time for acceleration and deceleration between the two segments is constant while the total segment time of the two-segment motion varies with speed. See [Figure 8–19](#).

**Figure 8–19. Effect of Speed on Path**

- It is sometimes difficult to teach continuous path positions, because the path generated at production speed is different than the one generated at low speed, making it impossible to see the actual path.
- The speed override feature of KAREL makes this possible, because for speed override, the acceleration times are changed to make acceleration distance constant. This allows you to see the path that will be generated at production speed, while running the robot at reduced speed.
- For special applications, the constant path can be disabled by setting the system variable \$CNSTNT\_PATH to FALSE.
- When the HOLD key is pressed during playback with speed override, the deceleration distance again is kept constant, keeping the path the same as it would be at production speed. Therefore, the time required to stop the robot is also extended.
- EMERGENCY STOP time is not affected by speed override.

### 8.4.7 Path Motion

A PATH variable is a varying-length list of elements called path nodes. A path node consists of a position, called NODEPOS, and any associated data.

There are two primary uses of PATH variables:

- As a bookkeeping aid in programming
- For improved performance in continuous path motions

You can define a single PATH variable to include several positions instead of teaching several POSITION variables by name. Then, instead of using a separate MOVE TO statement for each position, a single MOVE TO statement can be used in a loop that indexes through the path nodes.

The following KAREL program statements illustrate the use of a path variable as a bookkeeping aid:

```
VAR path1 : PATH...FOR i = 1 TO PATH_LEN(path1) MOVE TO path1[i] ENDFOR
```

- This use of PATH variables saves memory space both because programs can be made shorter and because a single variable name is used instead of many. In addition, it enhances the separation of code and data because positions can be inserted, deleted, and appended without modifying the program.
- For improved performance in continuous path motions, a single PATH variable can be used to create a multiple segment motion in a single MOVE ALONG statement. The motion environment will plan several segments ahead of the current motion of the robot. Any delay between segments is thus minimized and taught position throughput is maximized.
- The MOVE ALONG path statement causes the motion environment to generate a continuous motion through (or near) all the positions in the path by creating a multiple segment motion interval. The beginning of the interval is at the start of the first segment in the path, and the end of the interval is determined by the termination of the last segment of the path.
- The motion type of each segment is controlled by the associated data for the path node. By default, the motion type specified by \$MOTYPE is used.
- The termination type for each segment is specified by the SEGTERMTYPE associated data field. The termination type for the last segment is always determined by \$TERMTYPE regardless of the value of SEGTERMTYPE.
- A segment termination type, \$SEGTERMTYPE, is also defined for paths. This system variable can take on the same values as \$TERMTYPE, namely FINE, COARSE, NOSETTLE, NODECEL, and VARDECCEL. However, unlike \$TERMTYPE, \$SEGTERMTYPE is used only by the motion environment to determine when acceleration into the next segment should begin. It has no effect on statement termination.
- With \$SEGTERMTYPE set to its default, NODECEL, the path is executed in the same way as one executed by a series of MOVE TO instructions with NOWAIT and NODECEL, with the improvement that taught positions can be spaced more closely without any deceleration near the taught positions.

This improvement is possible because the interpreter does not have to execute intermediate motion statements and the motion environment can plan further ahead.

However, the same continuous path anomalies also exist. Changing program speed will change the path near the taught positions. Circular interpolation with paths can be used to overcome some of these anomalies, as discussed in the following section.

- In a MOVE ALONG statement, either the path name or the path name with an index value of [n..m] can be specified. When the path name is specified, the motion environment executes the entire path from node[1] to node[n]. If a range of nodes is specified, the robot will move along the path from node[n] to node[m].

If  $n < m$ , the robot will move along the path in ascending order. The SEGTERMTYPE and SEGTYPE associated data fields from node[i] is used (if other than the default value) for the motion segment toward node[i].

### Associated Data

A path node includes other information besides the taught position. This additional information is called *associated data* and is intended to permit teaching additional information which might change at each node without having to program such changes explicitly.

There are two kinds of associated data:

- Group
- Common

The following rules apply to associated data:

- All associated data fields are referenced by name.
- The teach pendant is used to define the names and types of user-defined fields.
- Each node of every path on the system must have the same field definitions. You can then reference these fields by using built-in routines in a KAREL program, using the teach pendant, or by KCL.

The names of the standard fields are listed below.

**See Also:** The application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual* for more information on setting standard and user-defined associated data

### Group Associated Data

- Each path node contains a position and at least four fields of group associated data. These fields are used by the motion environment to permit various motion characteristics to be changed at each segment of a path. Each group associated data is group-based.
- These fields are used only during the execution of a path using the MOVE ALONG statement. They are not used when using MOVE TO for individual path nodes.

- SEGRELSPEED allows you to override the SPEED, both higher or lower.

The SEGRELSPEED field is an INTEGER field, representing percentage, with a range of 0 to 4000 (400.0%) that permits a relative multiplier to be applied to the programmed speed for each segment.

For example, if \$SPEED were set to 200 mm per second and SEGRELSPEED were set to 500 (50.0%) for node 3 of a path, then the robot would slow down to 50 percent of its set speed or 100 mm per second for the segment toward node 3. Likewise, if SEGRELSPEED were set to 1500 (150.0%) for node 3 of a path, then the robot would speed up 150 percent of its set speed or 300 mm per second for the segment toward node 3.

Even though a maximum of 4000 percent (400.0%) is permitted, the absolute maximums discussed in [Section 8.4.4](#) still apply. Thus if \$SPEEDLIM is 1500 for a particular robot and \$SPEED is set to 1500, any value larger than 1000 (100.0%) used for SEGRELSPEED will cause a planning error.

The default value of SEGRELSPEED is 0 which is interpreted to mean the same as a value of 1000.

- SEGMOTYPE

The SEGMOTYPE field permits you to change the motion type at each node of a path. This field can be set to the enumerated values JOINT (6), LINEAR (7), or CIRCULAR (8).

The default value will be the value of the system variable, \$MOTYPE, which determines the motion type for the overall motion.

**See Also:** [Section 8.4.1](#).

- SEGORIENTYPE

The SEGORIENTYPE field indicates the type of orientation control to be used when the LINEAR motion interpolation type is used between segments. It can be assigned the same values that are used for \$ORIENT\_TYPE. By default, SEGORIENTYPE is set to RSWORLD.

This field can be set to the enumerated values: RSWORLD (1), AESWORLD (2), WRISTJOINT (3).

**See Also:** [Section 8.4.1](#).

- SEGBREAK The SEGBREAK field functionality is not yet implemented. If this field is set, it will be ignored.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, personnel could be injured, and equipment could be damaged.**

**Common Associated Data**

- In addition to group associated data, KAREL paths also support common associated data fields. Two common associated data fields are supported. Each field of common associated data applies to all groups.
  - SEGTERMTYPE

The SEGTERMTYPE field permits you to change the termination condition for each segment of a path. This field may be set to FINE (1), COARSE (2), NOSETTLE (3), NODECEL (4), or VARDECEL (5), or it may be left uninitialized, which will cause a default value to be used.

The default value will be the value of the system variable, \$SEGTERMTYPE, which is normally NODECEL. The termination type for each segment is specified by the SEGTERMTYPE associated data field. The termination type for the last segment is always determined by \$TERMTYPE regardless of the value of SEGTERMTYPE.

**See Also:** [Section 8.4.5, “Motion Termination”](#)

- SEGDECETOL

When the value of the SEGTERMTYPE field is VARDECEL, the SEGDECETOL field specifies a deceleration tolerance for the segment, within a range of 1 to 99. If it is set to 0, which is the default value, the value of the system variable \$DECETOL is used.

- SEGRELACCEL The SEGRELACCEL field functionality is not yet implemented. If this field is set, it will be ignored.
- SEGTIMESHFT The SEGTIMESHFT field functionality is not yet implemented. If this field is set, it will be ignored.

### **8.4.8 Motion Times**

To estimate the cycle time of a particular application before actual implementation, you can use the following tables and formulas.

- The formulas can be used for either single or multiple segment motions. Generally, the cycle time for a motion is the sum of all computed segment times plus the time to decelerate at the end of

the motion, plus any settling time. (You can think of the time to accelerate at the beginning of a motion as being part of the computed segment time.)

- The formulas assume that there is no deceleration between segments in multiple segment motions and that FINE or COARSE is used at the end of the motion. If necessary, appropriate adjustments can be made in the formulas.

For example, if you use NOSETTLE for \$TERMTYPE, then there would be no settling time between motions. If you use something other than NODECEL for \$SEGTERMTYPE when using paths, then treat each segment as a separate motion.

- The value to use for settling time at the end of a motion depends on many robot dependent variables, but a worst case value of 100 ms would be a conservative estimate for large robots under heavy load.

**Table 8–2** defines the symbols that are used in the following formulas. For estimating motion times, values of 100% are assumed for all override and relative speed variables.

**Table 8–2. Motion Time Symbols**

SYMBOL	MEANING
Ts	Calculated segment time
Tm	Actual motion time
Taccdec	Acceleration or deceleration time (accel + decel = 2 * Taccdec)
Tsettle	Settling time after servo reference is stable
D	Cartesian distance between initial and final position
ROT	Rotation angle of approach vector (two-angle method); rotation angle of all three angles (three-angle method)
SPIN	Spin angle about approach vector
Ji	Change in angle for <i>i</i> th axis from initial to final position

For Cartesian motion: (11)

$$Ts = MAX ( \frac{D}{\$GROUP.\$SPEED}, \frac{ROT}{\$GROUP.\$ROTSPEED}, \frac{SPIN}{\$GROUP.\$ROTSPEED} )$$

For Joint motion: (12)

$$Ts = MAX ( \frac{J_i}{(\$PARAM\_GROUP.\$JNTVELLIM[i] * \frac{\$GROUP.\$SPEED}{\$PARAM\_GROUP.\$SPEEDLIMJNT})} )$$

For all motions:  $Tm = SUM (Ts \text{ for all segments}) + Taccdec + Tsettle$  (13)

Formula 13 indicates that regardless of the distance of a motion, the time to execute that motion is at least Taccdec (not 2 \* Taccdec which you might expect), which is normally determined by the times set in the system variables \$PARAM\_GROUP[].\$accel\_time1 and \$PARAM\_GROUP[].\$accel\_time2.

If a fixed time algorithm were always used for acceleration and deceleration, the minimum motion time would be the fixed acceleration/deceleration time plus the settling time. However, a different algorithm is used for computing Taccdec for short motions.

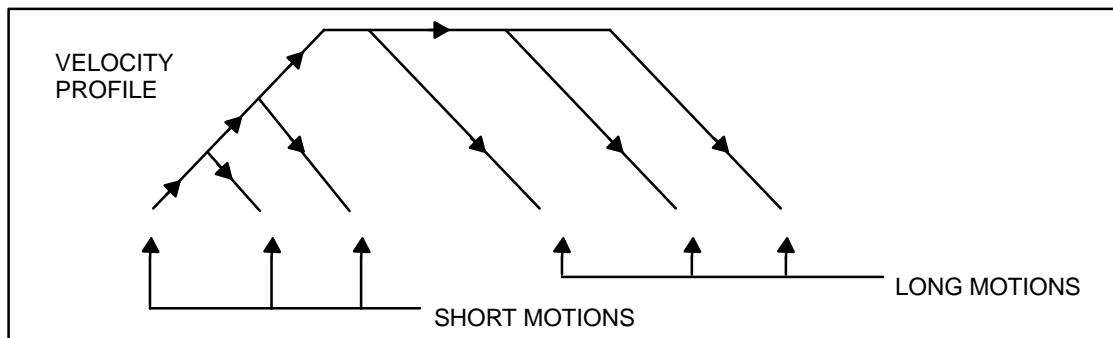
### Short Motions

A short motion is defined as one which is so short that the programmed speed cannot be reached before deceleration must begin. That is, a constant speed is never reached because the robot accelerates, then immediately decelerates.

With the normal constant time acceleration algorithm used in KAREL, as the planned segment time approaches 0, the total motion time approaches a constant equal to that acceleration time. (Refer to Formula 12.)

An ideal algorithm would permit the total motion time to approach 0 as the distance to move approaches 0. This requires a different acceleration algorithm for short motions.

[Figure 8–20](#) indicates the approach taken for short motions. Note that, for the sake of simplicity, the diagrams show first order velocity profiles, when in actuality the second order approach is used for short motions.

**Figure 8–20. Short Motions and Long Motions**

**Figure 8–20** indicates that as motions get shorter, the total time gets shorter, which is the general objective.

However, as motion times get shorter, the reference wave forms that drive the robot begin to look like sine waves of higher and higher frequencies. These short pulses begin to excite resonance in the mechanical structure of the robot, in turn causing vibrations.

For this reason, a minimum motion time is imposed. That is, acceleration times get shorter with shorter moves, as the diagram indicates, but only down to a limit. This limit is represented as a minimum acceleration time, kept in the system variable \$PARAM\_GROUP[ ].\$min\_acctime[].

As the diagram indicates, the total actual motion time for short motions is twice the computed acceleration time.

Another way of looking at it is that the acceleration and deceleration times are shortened from their fixed time values to be the same as the computed segment time  $T_s$ . The short motion algorithm is imposed when  $T_s$  is less than the fixed time acceleration/deceleration times.

The formulas for calculating Short Motion Times are as follows:

For short motion:  $T_s = (\text{same computations as long motion})$  (14)

However,  $T_s$  is no shorter than dictated by \$PARAM\_GROUP[ ].\$min\_acctime[]

$(T_s > \$PARAM\_GROUP[ ].\$min\_acctime[])$  (15)

$T_{accdec} = T_s$  (16)

$T_m = T_s + T_{accdec} + T_{settle}$  (17)

(same formula as long motion) or

$T_m = (2 * T_s) + T_{settle}$  (18)

Note that the value of \$PARAM\_GROUP[].\$min\_acctime[] is a “total acceleration time.” For long motions, the total acceleration time is the sum of \$PARAM\_GROUP[].\$accel\_time1[] and \$PARAM\_GROUP[].\$accel\_time2[], as discussed earlier. In general then, the value of \$PARAM\_GROUP[].\$min\_acctime[] is less than the sum of \$PARAM\_GROUP[].\$accel\_time1[] and \$PARAM\_GROUP[].\$accel\_time2[]. in no case should it ever be greater than the sum.

### **8.4.9 Correspondence Between Teach Pendant Program Motion and KAREL Program Motion**

The motion control functions that are supported both in the \$GROUP system variable and in the teach pendant motion instruction use the value that is specified in the teach pendant motion instruction.

[Table 8–3](#) shows the relationship between the \$GROUP system variables used for KAREL program motion and the teach pendant motion instruction.

**Table 8–3. Correspondence between \$GROUP System Variables and Teach Pendant Motion Instructions**

KAREL System Variable	Teach Pendant Motion Instruction
\$GROUP.\$motype	Motion type
\$GROUP.\$speed	Speed - mm/sec, cm/min, inch/min
\$GROUP.\$rotspeed	Speed - deg/sec
\$GROUP.\$seg_time	Speed - sec
\$GROUP.\$termttype	Termination type
\$GROUP.\$orient_type	Wrist joint motion option
\$GROUP.\$accel_ovrd	Acceleration override (ACC) motion option
\$GROUP.\$ext_indep	Simultaneous/independent EV motion option
\$GROUP.\$ext_speed	Simultaneous/independent EV motion option
\$GROUP.\$cnt_shortmo	PTH motion option

The single value of the speed field in the teach pendant motion instruction can take on the function of three system variables:

- If **translational speed (mm/sec, cm/min, inch/min)** is specified, then the rotational speed (\$GROUP.\$rotspeed) is set to \$PARAM\_GROUP.\$rotspeedlim. The resulting motion is limited first by the command translational speed and second by the rotational speed limit.
- If **rotational speed (deg/sec)** is specified, then the translational speed (\$GROUP.\$speed) is set to \$PARAM\_GROUP.\$speedlim. The resulting motion is limited first by the command rotational speed and second by the translational speed limit.
- If **time-based motion (sec)** is specified, then the translational speed limit uses \$PARAM\_GROUP.\$speedlim (or \$PARAM\_GROUP.\$jntvellim for joint motion) and \$PARAM\_GROUP.\$rotspeedlim as speed limits. This is similar to how KAREL programs handle time-based motion.

Refer to the *SYSTEM R-J3iB Controller Software Reference Manual* for more detailed information on system variables.

# Chapter 9

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## FILE SYSTEM

### Contents

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The file system provides a means of storing data on CMOS RAM, F-ROM, or external storage devices. The data is grouped into units, with each unit representing a file. For example, a file can contain the following:

- Source code statements for a KAREL program
- A sequence of KCL commands for a command procedure
- Variable data for a program

Files are identified by file specifications that include the following:

- The name of the device on which the file is stored
- The name of the file
- The type of data included in the file

The KAREL system includes five types of storage devices where files can be stored:

- RAM Disk
- F-ROM Disk
- Disks
- IBM PC
- Memory Card

**RAM Disk** is a portion of SRAM (formerly CMOS RAM) or DRAM memory that functions as a separate storage device. Any file can be stored on the RAM Disk. RAM Disk files should be copied to disks for permanent storage.

**F-ROM Disk** is a portion of F-ROM memory that functions as a separate storage device. Any file can be stored on the F-ROM disk. However, the hardware supports a limited number of read and write cycles. Therefore, if a file needs to store dynamically changing data, the RAM disk should be used instead.

**Disks** store information and transfer files using disk drives. Three disk drives can be used:

- PS-100 disk drive
- PS-110 disk drive
- PS-200 disk drive

**IBM PC or compatible computers** can be used to store files off-line. You can use OLPC, the FANUC Robotics off-line storage software for the PC, to store files on a magnetic (floppy) disk. The files on these storage devices are accessible in the following ways:

- Through the FILE menu on the teach pendant and CRT/KB
- Through KAREL programs

**Memory Card** refers to the ATA Flash File storage and SRAM memory cards. The memory card interface is located on the controller operator panel.

For more information on storage devices and memory, refer to [Section 1.4.1](#), “Memory.”

## **9.1 FILE SPECIFICATION**

File specifications identify files. The specification indicates:

- The name of the device on which the file is stored, refer to [Section 9.1.1](#).
- The name of the file, refer to [Section 9.1.2](#).
- The type of data the file contains, refer to [Section 9.1.3](#).

The general form of a file specification is:

**device\_name:file\_name.file\_type**

### **9.1.1 Device Name**

A device name consists of at least two characters that indicate the device on which a file is stored. Files can be stored on RAM disk, F-ROM disk, disk drive units, off-line on a PC, Memory Card, or PATH Composite Device. The device name always ends with a colon (:). The following is a list of valid storage devices.

- **RD: (RAM Disk)**

The RD: device name refers to files stored on the RAM Disk of the controller. RD: is used as the default device name.

- **FR: (F-ROM Disk)**

The FR: device name refers to files stored on the F-ROM disk of the controller.

- **MC: (Memory Card Device)**

The memory card can be formatted and used as an MS-DOS file system. It can be read from and written to on the controller and an IBM PC equipped with the proper hardware and software. If the memory card is used as an MS-DOS file system, it should be formatted only on the R-J3iB controller. Refer to the application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual* for information on formatting the memory card on the R-J3iB controller.

- **MD: (Memory Device)**

The memory device treats the controller's program memory as if it were a file device. You can access all teach pendant programs, KAREL programs, KAREL variables, system variables, and error logs that are loaded in the controller. See [Section 9.4](#) for further details.

- **MDB: (Memory Device Backup)**

The memory device backup device (MDB:) allows the user to copy the same files as provided by the Backup function on the File Menu. This allows the user to back up the controller remotely.

- **CONS: (Console Device)**

The console device provides access to the console log text files CONSLOG.LS and CONSTAIL.LS. It is used for diagnostic and debug purposes and not as a storage device.

- **MF: (Memory File Device)**

The MF: device name refers to files stored on both the RAM and F-ROM disks. Since a file cannot be on both disks at the same time, there will be no duplicate file names.

- **FLPY: (Disk Drive Unit)**

The FLPY: device name refers to files stored on optional KAREL external diskette drive units (models PS-100, PS-110, and PS-200) or on an optional off-line PC. The disk drive device is connected to the P2 port on the controller.

- **PATH: (Composite Device)**

The PATH: device is a read-only device that searches the F-ROM disk (FD:), memory card (MC:0, and floppy disk (FLPY:) in that order, for a specified file. The PATH: device eliminates the user's need to know on which storage device the specified file exists.

- **PIP: (File Pipe Device)**

The PIP: device provides a way to write data from one application and, at the same time, read it from another application. The PIP: device also allows the last set of data written to be retained for analysis. The PIP: device allows you to access any number of pipe files. This access is to files that are in the controller's memory. This means that the access to these files is very efficient. The size of the files and number of files are limited by available controller memory. This means that the best use of a file pipe is to buffer data or temporarily hold it.

## **9.1.2 File Name**

A file name is an identifier that you choose to represent the contents of a file.

The following rules apply to file names:

- File names are limited to eight characters.
- Files should be named according to the rules defined in [Section 2.1.4](#).

### **9.1.3 File Type**

A file type consists of two characters that indicate what type of data a file contains. A file type always begins with a period (.). **Table 9–1** is an alphabetical list of each available file type and its function.

**Table 9–1. File Type Descriptions**

<b>File Type</b>	<b>Description</b>
. BMP	<b>Bit map files</b> contain bit map images used in robot vision systems.
. CF	<b>KCL command files</b> are ASCII files that contain a sequence of KCL commands for a command procedure.
. CH	<b>Condition handler files</b> are used as part of the condition monitor feature.
. DF	<b>Default file</b> are binary files that contain the default motion instructions for each teach pendant programming.
. DG	<b>Diagnostic files</b> are ASCII files that provide status or diagnostic information about various functions of the controller.
. DT	<b>KAREL data file</b> An ASCII or binary file that can contain any data that is needed by the user.
. IO	<b>Binary files</b> that contain I/O configuration data - generated when an I/O screen is displayed and the data is saved.
. KL	<b>KAREL source code files</b> are ASCII files that contain the KAREL language statements for a KAREL program.
. LS	<b>KAREL listing files</b> are ASCII files that contain the listing of a KAREL language program and line number for each KAREL statement.
. MN	<b>Mnemonic</b> program files are supported in previous versions of KAREL.

**Table 9–1.** File Type Descriptions (Cont'd)

File Type	Description
.ML	<b>Part model files</b> contain part model information used in robot vision systems.
.PC	<b>KAREL p-code files</b> are binary files that contain the p-code produced by the translator upon translation of a .KL file.
.SV	<b>System files</b> are binary files that contain data for system variables (SYSVARS.SV), mastering (SYSMAST.SV), servo parameters (SYSSERVO.SV), and macros (SYSMACRO.SV).
.TP	<b>Teach pendant program files</b> are binary files that contain instructions for teach pendant programs.
.TX	<b>Text files</b> are ASCII files that can contain system-defined text or user-defined text.
.VR	<b>Program variable files</b> are binary files that contain variable data for a KAREL program.
.VA	<b>ASCII variable files</b> are contain the listing of a variable file with variable names, types, and contents.
.LS	<b>Listing files</b> are teach pendant programs, error logs, and description histories in ASCII format.

## **9.2 STORAGE DEVICE ACCESS**

The KAREL system can access only those storage devices that have been formatted and mounted. These procedures are performed when the devices are first installed on the KAREL system.

The following rules apply when accessing storage devices:

- Formatting a device
  - Deletes any existing data on the device. For example, if you format RD2:, you will also reformat any data existing on RD: thru RD7:.
  - Records a directory on the device

- Records other data required by the KAREL system
- Assigns a volume name to the device
- You can format diskettes for the disk drive unit, which is dismounted and mounted automatically.

For more information on formatting a device, refer to the FORMAT\_DEV Built-in in [Appendix A](#), "KAREL Language Alphabetical Description" or the FORMAT Command in [Appendix C](#), "KCL Command Alphabetical Description."

### **9.2.1 Memory File Devices**

The RAM and F-ROM disks allocate files using blocks. Each block is 512 bytes.

The system variable \$FILE\_MAXSEC specifies the number of blocks to allocate for the RAM disk. If the specified number is less than zero, the RAM disk is allocated from DRAM. If it is greater than zero, RAM disk is allocated from CMOS RAM. To change the number of blocks to allocate for the RAM disk, perform the following steps from the KCL prompt:

1. Backup all files on the RAM disk. For more information on how to back up files, refer to Chapter 8, "Program and File Manipulation" in the appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual*.

2. Enter DISMOUNT RD:

**KCL>DISMOUNT RD:**

3. Enter SET VAR \$FILE\_MAXSEC

**KCL>SET VAR**

**\$FILE\_MAXSEC = <new value>**

4. Enter FORMAT RD:

**KCL>FORMAT RD:**

All files will be removed from the RAM Disk when the format is performed.

5. Enter MOUNT RD:

**KCL>MOUNT RD:**

The RAM disk will be reformatted automatically on INIT start.

The F-ROM disk can only be formatted from the BootROM because the system software also resides on F-ROM. The number of blocks available is set by the system. The hardware supports a limited number of read and write cycles, so while the F-ROM disk will function similar to the RAM disk, it does not erase files that have been deleted or overwritten.

After some use, the F-ROM disk will have used up all blocks. At that time, a purge is required to erase the F-ROM blocks which are no longer needed. For more information on purging, refer to the PURGE\_DEV Built-in in [Appendix A](#), "KAREL Language Alphabetical Descriptions" or the PURGE Command in [Appendix C](#), "KCL Command Alphabetical Description."

For more information on memory, refer to [Section 1.4.1](#), "Memory."

### **9.2.2 Virtual Devices**

KAREL Virtual Devices are similar to DOS subdirectories. For example

- In DOS, to access a file in a subdirectory, you would view **FR:|FR1:>test.kl**.
- In KAREL, to access the same file in a virtual device, you would view **FR1:test.kl**.

The controller supports 7 virtual devices. A number, which identifies the virtual device, is appended to the device name (FR1 :). [Table 9–2](#) shows some of the valid virtual devices available.

**Table 9–2. Virtual Devices**

Device Name	Actual Storage
RD:	RAM disk
FR:	F-ROM disk - compressed and uncompressed files
MF:	Refers to files on both RD: and FR:
RD1: - RD7:	RAM disk - compressed and uncompressed files
FR1: - FR7:	F-ROM disk - compressed and uncompressed files
MF1: - MF7:	Refers to files on both the RAM disk and F-ROM disk of the respective virtual device

#### **Rules for Virtual Devices**

The following rules apply to virtual devices.

- A file name on a virtual device is unique. A file could exist on either the RAM or F-ROM disks, but not both. For example: RD:test.kl and FR:test.kl could not both exist.
- A file name could be duplicated across virtual devices. For example: RD:test.kl, RD1:test.kl, and FR2:test.kl could all exist.
- The MF: device name could be used in any file operation to find a file on a virtual device, when the actual storage device is unknown. For example: MF:test.kl finds either RD:test.kl or FR:test.kl.

- When you use the MF: device as a storage device, the RAM disk is used by default when RD: is in CMOS and \$FILE\_MAXSEC > 0. The F-ROM disk is used by default when RD: is in DRAM and \$FILE\_MAXSEC < 0. For example: KCL>COPY FILE FLPY:test.kl to MF2 : The file will actually exist on RD2:
- When listing the MF: device directory, all files on the RAM and F-ROM disks are listed. However, only the files in the specified virtual device are displayed.
- If the RD5: directory is specified instead of MF5:, only those files on the RAM disk in virtual device 5 are listed. If the FR3: directory is specified, only those files on the F-ROM disk in virtual device 3 are listed. For example: KCL>DIR RD5:
- A file could be copied from one virtual device to another virtual device. A file could also be copied from the RAM disk to the F-ROM disk, and vice versa, if the virtual device is different. For example: KCL>COPY RD1:test.kl to FR3:
- A file could be renamed only within a virtual device and only on the same device. For example: KCL>RENAME FR2:test.kl FR2:example.kl
- A file could be moved within a virtual device from the RAM disk to the F-ROM disk and vice versa, using a special command which is different from copy. For example: KCL>MOVE MF1:test.kl moves test.kl from the F-ROM disk to the RAM disk. KCL>COPY FR1:test.kl TO RD1:test.kl will also move the file from the F-ROM Disk to the RAM Disk. This is because unique file names can only exist on one device. For more information on moving files, refer to the MOVE\_FILE Built-in in [Appendix A](#), "KAREL Language Alphabetical Descriptions" or the MOVE FILE Command in [Appendix C](#), "KCL Command Alphabetical Description."
- Formatting the RAM disk, RD: or MF:, clears all the RAM disk files on all the virtual devices. The files on the F-ROM disk remain intact. For example: **KCL>FORMAT RD1:** reformats all RAM disk virtual devices (RD: through RD7:). Reformatting will cause existing data to be removed.
- Purge erases all blocks that are no longer needed for all the virtual devices. For more information on purging, refer to the PURGE\_DEV Built-in in [Appendix A](#), "KAREL Language Alphabetical Description" or the PURGE Command in [Appendix C](#), "KCL Command Alphabetical Description."

### **9.2.3 File Pipes**

The PIP: device allows you to access any number of pipe files. This access is to files that are in the controller's memory. This means that the access to these files is very efficient. The size of the files and number of files are limited by available controller memory. This means that the best use of a file pipe is to buffer data or temporarily hold it.

The file resembles a water pipe where data is poured into one end by the writing task and the data flows out the other end into the reading task. This is why the term used is a pipe. This concept is very similar to pipe devices implemented on UNIX, Windows and Linux.

Files on the pipe device have a limited size but the data is arranged in a circular buffer. This is also called a circular queue. This means that a file pipe of size 8kbytes (this is the default size) will contain

the last 8k of data written to the pipe. When the user writes the ninth kilobyte of data to the pipe, the first kilobyte will be overwritten.

Since a pipe is really used to transfer data from one place to another some application will be reading the data out of the pipe. In the default mode, the reader will WAIT until information has been written. Once the data is available in the pipe the read will complete. A KAREL application might use BYTES\_AHEAD to query the pipe for the amount of data available to read. This is the default read mode.

A second read mode is provided which is called "snapshot." In this mode the reader will read out the current content of the pipe. Once the current content is read the reader receives an end of the file. This can be applied in an application like a "flight recorder". This allows you to record information leading up to an event (such as an error) and then retrieve the last set of debug information written to the pipe. Snapshot mode is a read attribute. It is configured using SET\_FILE\_ATTR builtin. By default, the read operation is not in snapshot mode.

Typical pipe applications involve one process writing data to a pipe. The data can debug information, process parameters or robot positions. The data can then be read out of the pipe by another application. The reading application can be a KAREL program which is analyzing the data coming out of the pipe or it can be KCL or the web server reading the data out and displaying it to the user in ASCII form.

### KAREL Examples

The following apply to KAREL examples.

- Two KAREL tasks can share data through a pipe. One KAREL task can write data to the pipe while a second KAREL task reads from the pipe. In this case the file attribute ATR\_PIPWAIT can be used for the task that is reading from the pipe. In this case the reading KAREL task will wait on the read function until the write task has finished writing the data. The default operation of the pipe is to return an end of file when there is no data to be read from the pipe.
- A KAREL application might be executing condition handlers at a very fast data rate. In this case it might not be feasible for the condition handler routine to write data out to the teach pendant display screen because this would interfere with the performance of the condition handler. In this case you could write the data to the PIP: device from the condition handler routine. Another KAREL task might read the data from the PIP: device and display it to the teach pendant. In this case the teach pendant display would not be strictly real time. The PIP: device acts as a buffer in this case so that the condition handler can move on to its primary function without waiting for the display to complete. You can also type the file from KCL at the same time the application is writing to it.

PIP: devices are similar to other devices in the following ways:

- The pipe device is similar in some ways to the RD: device. The RD: device also puts the file content in the system memory. The PIP device is different primarily because the pipe file can be opened simultaneously for read and write.
- Similarly to MC: and FR: devices, the PIP: device is used when you want to debug or diagnose real time software. This allows you to output debug information that you can easily view without

interfering with the operation that is writing the debug data. This also allows one task to write information that another task can read.

- The function of the PIP: device is similar to all other devices on the controller. This means that all file I/O operations are supported on this device. All I/O functions are supported and work the same except the following: Chdir, Mkdir, and Rmdir.
- The PIP: device is similar to writing directly to a memory card. However, writing to a memory card will delay the writing task while the delay to the PIP: device is much smaller. This means that any code on the controller can use this device. It also has the ability to retain data through a power cycle.

### Rules for PIP: Devices

The following rules apply to PIP: devices:

- The PIP: device can be used by any application or you can specify an associated common option such as KAREL.
- The device is configurable. You can configure how much memory it uses and whether that memory is CMOS (retained) or DRAM (not retained). You are also able to configure the format of the data in order to read out formatted ASCII type data. The device is configured via the PIPE\_CONFIG built-in.

### Installation, Setup and Operation Sequence

In general the PIP: device operates like any other device. A typical operation sequence includes:

```
OPEN myfile ('PIP:/myfile.dat', 'RW',)
Write myfile ('Data that I am logging', CR)
Close myfile
```

If you want to be able to access myfile.dat from the Web server, put a link to it on the diagnostic Web page.

The files on the PIP: device are configurable. By default the pipe configuration is specified in the \$PIPE\_CONFIG system variable. The fields listed in [Table 9–3](#) have the following meanings:

**Table 9–3. System Variable Field Descriptions**

FIELD	DEFAULT	DEFINITION
\$sectors	8	Number of 1024 byte sectors in the pipe.
\$filedata		Pointer to the actual pipe data (not accessible).
\$recordsize	0	Binary record size, zero means its not tracked.

**Table 9–3. System Variable Field Descriptions (Cont'd)**

\$auxword	0	Dictionary element if dictionary format or type checksum.
\$memtyp	0	If non zero use CMOS.
\$format	Undefined	Formatting mode: undefined, function, format string or KAREL type.
\$formatter		Function pointer, "C" format specifier pointer or type code depending on \$format.

Each pipe file can be configured via the pipe\_config built-in. The pipe\_config built-in will be called before the pipe file is opened for writing. Refer to [Section A.16, "pipe\\_config built-in"](#) for more details.

### Operational Examples

The following example writes data from one KAREL routine into a pipe and then reads it back from another routine. These routines can be called from separate tasks so that one task was writing the data and another task can read the data.

#### Program

```

program pipuform
%nolockgroup
var

    pipe, in_file, mcfile, console:file
    record: string[80]
    status: integer
    parm1, parm2: integer
    msg: string[127]
    cmos_flag: boolean
    n_sectors: integer
    record_size: integer
    form_dict: string[4]
    form_ele: integer

    --
    --initialize file attributes

    routine file_init (att_file :FILE)

    begin
        set_file_attr(att_file, ATR_IA)    --force reads to completion
        set_file_attr(att_file, ATR_FIELD)  --force write to completion

```

```

set_file_attr(att_file, ATR_PASSALL) --ignore cr
set_file_attr(att_file, ATR_UF)    --binary
end file_init

routine write_pipe
begin
--file is opened
file_init (pipe)
open file pipe ('rw', 'pip:example.dat')
status = io_status(pipe)
write console ('Open pipe status:',status,cr)
-- write extra parameters to pipe
write pipe (msg::8)
status = io_status(pipe)
end write_pipe

routine read_pipe
var
    record: string[128]
    status: integer
    entry: integer
    num_bytes: integer

begin
file_init (in_file)
open file in_file ('ro', 'pip:example.dat')
BYTES_AHEAD(in_file, entry, status)
status = 0
read in_file (parm1::4)
status = IO_STATUS(in_file)
write console ('parm1 read',status,cr)
write console ('parm1',parm1,cr)
read in_file (parm2::4)
status = IO_STATUS(in_file)
write console ('parm2 read',parm2,status,cr)
end read_pipe

begin
SET_FILE_ATTR(console, atr_ia, 0) --ATR_IA is defined in flbt.ke
OPEN FILE console ('RW','CONS:')
if(uninit(msg)) then
    msg = 'Example'
endif
if(uninit(n_sectors)) then
    cmos_flag = true
    n_sectors = 16

```

```
record_size = 128
form_dict = 'test'
form_ele = 1
endif
--      [in] pipe_name: STRING;name of tag
--      [in] cmos_flag: boolean;
--      [in] n_sectors: integer;
--      [in] record_size: integer;
--      [in] form_dict: string;
--      [in] form_ele: integer;
--      [out] status: INTEGER
pipe_config('pip:example.dat',cmos_flag, n_sectors,
            record_size,form_dict,form_ele,status)
write_pipe
read_pipe
close file pipe
close file in_file
end pipuform
```

## **9.3 FILE ACCESS**

You can access files using the FILE and SELECT screens on the CRT/KB or teach pendant, or by using KAREL language statements. During normal operations, files will be loaded automatically into the controller. However, other functions could need to be performed.

## **9.4 MEMORY DEVICE**

The Memory device (MD:) treats controller memory programs and variable memory as if it were a file device. Teach pendant programs, KAREL programs, program variables, SYSTEM variables, and error logs are treated as individual files. This provides expanded functions to communication devices, as well as normal file devices. For example:

1. FTP can load a PC file by copying it to the MD: device.
2. The error log can be retrieved and analyzed remotely by copying from the MD: device.
3. An ASCII listing of teach pendant programs can be obtained by copying XXX.LS from the MD: device.
4. An ASCII listing of system variables can be obtained by copying SYSVARS.VA from the MD: device.

Refer to [Table 9–4](#) for listings and descriptions of files available on the MD device.

**Table 9–4.** File Listings for the MD Device

<b>File Name</b>	<b>Description</b>
ACCNTG.DG	This file shows the system accounting of Operating system tasks.
ACCOFF.DG	This file shows the system accounting is turned off.
AXIS.DG	This file shows the Axis and Servo Status.
CONFIG.DG	This file shows a summary of system configuration
CONSLOG.DG	This file is an ASCII listing of the system console log.
CONSTAIL.DG	This file is an ASCII listing of the last lines of the system console log.
CURPOS.DG	This file shows the current robot position.
*.DF	This file contains the TP editor default setting.
DIOCFGSV.IO	This file contains I/O configuration information in binary form.
DIOCFGSV.VA	This file is an ASCII listing of DIOCFGSV.IO.
ERRACT.LS	This file is an ASCII listing of active errors.
ERRALL.LS	This file is an ASCII listing of error logs.
ERRAPPLS	This file is an ASCII listing of application errors.
ERRCOMM .LS	This file shows communication errors.
ERRCURR.LS	This file is an ASCII listing of system configuration.
ERRHIST.LS	This file is an ASCII listing of system configuration.
ERRMOT.LS	This file is an ASCII listing of motion errors.
ERRPWD.LS	This file is an ASCII listing of password errors.

**Table 9–4.** File Listings for the MD Device (Cont'd)

<b>File Name</b>	<b>Description</b>
ERRSYS.LS	This file is an ASCII listing of system errors.
ETHERNET	This file shows the Ethernet Configuration.
FRAME.DG	This file shows Frame assignments.
FRAMEVAR.SV	This file contains system frame and tool variable information in binary form.
FRAMEVAR.VA	This file is an ASCII listing of FRAMEVAR.SV.
HIST.LS	This file shows history register dumps.
HISTE.LS	This file is an ASCII listing of general fault exceptions.
HISTP.LS	This file is an ASCII listing of powerfail exceptions.
HISTS.LS	This file is an ASCII listing of servo exceptions.
IOCONFIG.DG	This file shows IO configuration and assignments.
IOSTATE.DG	This file is an ASCII listing of the state of the I/O points.
LOG CONSTAIL.DG	This file is the last line of Console Log.
NUMREG.VA	This file is an ASCII listing of NUMREG.VR.
NUMREG.VR	This file contains system numeric registers.
MACRO.DG	This file shows the Macro Assignment.
MEMORY.DG	This file shows current memory usage.
PORT.DG	This file shows the Serial Port Configuration.
POSREG.VA	This file is an ASCII listing of POSREG.VR.

**Table 9–4. File Listings for the MD Device (Cont'd)**

<b>File Name</b>	<b>Description</b>
POSREG.VR	This file contains system position register information.
PRGSTATE.DG	This file is an ASCII listing of the state of the programs.
SFTYSIG.DG	This file is an ASCII listing of the state of the safety signals.
STATUS.DG	This file shows a summary of system status
SUMMARY.DG	This file shows diagnostic summaries
SYCLDINT.VA	This file is an ASCII listing of system variables initialized at a Cold start.
SYMOTN.VA	This file is an ASCII listing of motion system variables.
SYNOSAVE.VA	This file is an ASCII listing of non-saved system variables.
SYSMACRO.SV	This file is a listing of system macro definitions.
SYSMACRO.VA	This file is an ASCII listing of SYSMACRO.SV.
SYSMAST.SV	This file is a listing of system mastering information.
SYSMAST.VA	This file is an ASCII listing of SYSMAST.SV.
SYSSERVO.SV	This file is a listing of system servo parameters.
SYSSERVO.VA	This file is an ASCII listing of SYSSERVO.SV.
SYSTEM.DG	This file shows a summary of system information
SYSTEMIZE	This file is an ASCII listing of non motion system variables.
SYSVARS.SV	This file is a listing of system variables.
SYSVARS.VA	This file is an ASCII listing of SYSVARS.SV.

**Table 9–4.** File Listings for the MD Device (Cont'd)

File Name	Description
SYSXXXX.SV	This file contains application specific system variables.
SYSXXXX.VA	This file is an ASCII listing of SYSXXXX.VA.
TASKLIST.DG	This file shows the system task information.
TESTRUN.DG	This file shows the Testrun Status.
TIMERS.DG	This file shows the System and Program Timer Status.
TPACCN.DG	This file shows TP Accounting Status.
VERSION.DG	This file shows System, Software, and Servo Version Information.
XXX.PC	This file is a KAREL binary program.
XXX.VA	This file is an ASCII listing of KAREL variables.
XXX.VR	This file contains KAREL variables in binary form.
YYY.LS	This file is an ASCII listing of a teach pendant program.
YYY.TP	This file is a teach pendant binary program.

Refer to [Table 9–5](#) for a listing of restrictions when using the MD: device.

**Table 9–5.** Testing Restrictions when Using the MD: Device

File Name or Type	READ	WRITE	DELETE	Comments
XXX.DG	YES	NO	NO	Diagnostic text file.
XXX.PC	NO	YES	YES	
XXX.VR	YES	YES	YES	With restriction of no references.

**Table 9–5. Testing Restrictions when Using the MD: Device (Cont'd)**

File Name or Type	READ	WRITE	DELETE	Comments
XXX.LS	YES	NO	NO	
YYY.TP	YES	YES	YES	
YYY.LS	YES	NO	NO	
FFF.DF	YES	YES	NO	
SYSXXX.SV	YES	YES	NO	Write only at CTRL START.
SYSXXX.VA	YES	NO	NO	
ERRXXX.LS	YES	NO	NO	
HISTX.LS	YES	NO	NO	
XXXREG.VR	YES	YES	NO	
XXXREG.VA	YES	NO	NO	
DIOCFGSV.IO	YES	YES	NO	Write only at CTRL START.
DIOCFGSV.VA	YES	NO	NO	



# Chapter 10

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## DICTIONARIES AND FORMS

### Contents

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Dictionaries and forms are used to create operator interfaces on the teach pendant and CRT/KB screens with KAREL programs.

This chapter includes information about

- Creating user dictionary files, refer to [Section 10.1](#).
- Creating and using forms, refer to [Section 10.2](#).

In both cases, the text and format of a screen exists outside of the KAREL program. This allows easy modification of screens without altering KAREL programs.

## **10.1 CREATING USER DICTIONARIES**

A *dictionary file* provides a method for customizing displayed text, including the text attributes (blinking, underline, double wide, etc.), and the text location on the screen, without having to re-translate the program.

The following are steps for using dictionaries.

1. Create a formatted ASCII dictionary text file with a .UTX file extension.
2. Compress the dictionary file using the KCL COMPRESS DICT command. This creates a loadable dictionary file with a .TX extension. Once compressed, the .UTX file can be removed from the system. **Only the compressed dictionary (.TX) file is loaded.**
3. Load the compressed dictionary file using the KCL LOAD DICT command or the KAREL ADD\_DICT built-in.
4. Use the KAREL dictionary built-ins to display the dictionary text. Refer to [Section 10.1.12](#), "Accessing Dictionary Elements from a KAREL Program," for more information.

Dictionary files are useful for running the same program on different robots, when the text displayed on each robot is slightly different. For example, if a program runs on only one robot, using KAREL WRITE statements is acceptable. However, using dictionary files simplifies the displaying of text on many robots, by allowing the creation of multiple dictionary files which use the same program to display the text.

**Note** Dictionary files are useful in multi-lingual programs.

### **10.1.1 Dictionary Syntax**

The syntax for a user dictionary consists of one or more dictionary elements. Dictionary elements have the following characteristics:

- A dictionary element can contain multiple lines of information, up to a full screen of information. A user dictionary file has the following syntax:

```
<*comment>
$<,ele_name><@cursor_pos><&res_word><#chr_code><"Ele_text"><&res_wor d>
<#chr_code><+nest_ele>
<*comment>
<$n+1>
```

- Items in brackets <> are optional.
- \*comment is any item beginning with \*. All text to the end of the line is ignored. Refer to [Section 10.1.9](#).
- \$n specifies the element number. n is a positive integer 0 or greater. Refer to [Section 10.1.2](#).
- ,ele\_name specifies a comma followed by the element name. Refer to [Section 10.1.3](#).
- @cursor\_pos specifies a cursor position (two integers separated by a comma.) Cursor positions begin at @1,1. Refer to [Section 10.1.4](#).
- &res\_word specifies a dictionary reserve word. Refer to [Section 10.1.6](#).
- "Ele\_text" specifies the element text to be displayed. Refer to [Section 10.1.5](#).
- +nest\_ele specifies the next dictionary text. Refer to [Section 10.1.8](#).
- A dictionary element does not have to reside all on one line . Insert a carriage return at any place a space is allowed, except within quoted text. Quoted text must begin and end on the same line.
- Dictionary elements can contain text, position, and display attribute information. [Table 10–2](#) lists the attributes of a dictionary element.

## 10.1.2 Dictionary Element Number

A dictionary element number identifies a dictionary element. A dictionary element begins with a “\$” followed by the element number. Element numbers have the following characteristics:

- Element numbers begin at 0 and continue in sequential order.
- If element numbers are skipped, the dictionary compressor will add an extra overhead of 5 bytes for each number skipped. Therefore you should not skip a large amount of numbers.
- If you want the dictionary compressor to automatically generate the element numbers sequentially, use a “-” in place of the number. In the following example, the “-” is equated to element number 7.

\$1

\$2

\$3

\$6

\$-

### **10.1.3 Dictionary Element Name**

Each dictionary element can have an optional element name. The name is separated from the element number by a comma and zero or more spaces. Element names are case sensitive. Only the first 12 characters are used to distinguish element names.

The following are examples of element names:

\$1, KCMN\_SH\_LANG

\$2, KCMN\_SH\_DICT

Dictionary elements can reference other elements by their name instead of by number. Additionally, element names can be generated as constants in a KAREL include file.

### **10.1.4 Dictionary Cursor Positioning**

Dictionary elements are displayed in the specified window starting from the current position of the cursor. In most cases, move the cursor to a particular position and begin displaying the dictionary element there.

- The cursor position attribute "@" is used to move the cursor on the screen within the window.
- The "@" sign is followed by two numbers separated by a comma. The first number is the window row and the second number is the window column.

**For example, on the teach pendant,** the "t\_fu" window begins at row 5 of the "t\_sc" screen and is 10 rows high and 40 columns wide.

- Cursor position "@1,1" is the upper left position of the "t\_fu" window and is located at the "t\_sc" screen row 5 column 1.
- The lower right position of the "t\_fu" window is "@10,40" and is located at the "t\_sc" screen row 15 column 40.

Refer to [Section 7.9.1](#) for more information on the teach pendant screens and windows.

**For example, on the CRT/KB,** the "c\_fu" window begins at row 5 of the "c\_sc" screen and is 17 rows high and 80 columns wide.

- Cursor position "@1,1" is the upper left position of the "c\_fu" window and is located at the "c\_sc" screen row 5 column.

- The lower right position of the window is "@17,80" and is located at the "c\_sc" screen row 21, column 80.

Refer to [Section 7.9.2](#) for more information on the CRT/KB screens and windows.

The window size defines the display limits of the dictionary elements.

### **10.1.5 Dictionary Element Text**

Element text, or quoted text, is the information (text) you want to be displayed on the screen.

- The element text must be enclosed in double quote characters “ ”.
- To insert a back-slash within the text, use \\ (double back-slash.)
- To insert a double-quote within the text, use \" (back-slash, quote.)
- More than one element text string can reside in a dictionary element, separated by reserve words. Refer to [Section 10.1.6](#) for more information.
- To include the values of KAREL variables in the element text, use the KAREL built-ins. WRITE\_DICT\_V and READ\_DICT\_V, to pass the values of the variables.
- To identify the place where you want the KAREL variables to be inserted, use *format specifiers* in the text.
- A format specifier is the character “%” followed by some optional fields and then a conversion character. A format specifier has the following syntax:

%<-><+><width><.precision>conversion\_character<^argument\_number r>

#### **Format Specifier**

- Items enclosed in < > are optional.
- The - sign means left justify the displayed value.
- The + sign means always display the sign if the argument is a number.
- The width field is a number that indicates the minimum number of characters the field should occupy.
- .precision is the . character followed by a number. It has a specific meaning depending upon the conversion character:
- conversion\_characters identify the data type of the argument that is being passed. They are listed in [Table 10-1](#).
- ^argument\_number is the ^ (up-caret character) followed by a number.

### Conversion Character

The conversion character is used to identify the data type of the KAREL variable that was passed. [Table 10–1](#) lists the conversion characters:

**Table 10–1.** Conversion Characters

Character	Argument Type: Printed As
d	INTEGER; decimal number.
o	INTEGER; unsigned octal notation (without a leading zero).
x, X	INTEGER; unsigned hexadecimal notation (without a leading 0x or 0X), using abcdef or ABCDEF for 10, ..., 15.
u	INTEGER; unsigned decimal notation.
s	STRING; print characters from the string until end of string or the number of characters given by the precision.
f	REAL; decimal notation of the form <->mmm.ddddd, where the number of d's is given by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
e, E	REAL; decimal notation of the form <->mmm.ddddd, where the number of d's is given by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
g, G	REAL; %e or %E is used if the exponent is less than -4 or greater than or equal to the precision; otherwise %f is used. Trailing zeros and a trailing decimal pointer are not printed.
%	No argument is converted; print a %.

- The characters **d**, **o**, **x**, **X**, and **u**, can be used with the INTEGER, SHORT, BYTE, and BOOLEAN data types. A BOOLEAN data type is displayed as 0 for FALSE and 1 for TRUE.
- The **f**, **e**, **E**, **g**, and **G** characters can be used with the REAL data type.
- The character **s** is for a STRING data type.

**Caution**

Make sure you use the correct conversion character for the type of argument passed. If the conversion character and argument types do not match, unexpected results could occur.

**Width and Precision**

The optional width field is used to fix the minimum number of characters the displayed variable occupies. This is useful for displaying columns of numbers.

Setting a width longer than the largest number aligns the numbers.

- If the displayed number has fewer characters than the width, the number will be padded on the left (or right if the “-” character is used) by spaces.
- If the width number begins with “0”, the field is padded with zeros instead.

The precision has the following meaning for the specified conversion character

- **d** , **o** , **x** , **X** , and **u** - The minimum number of digits to be printed. If the displayed integer is less than the precision, leading zeros are padded. This is the same as using a leading zero on the field width.
- **s** - The maximum number of characters to be printed. If the string is longer than the precision, the remaining characters are ignored.
- **f** , **e** , and **E** - The number of digits to be printed after the decimal point.
- **g** and **G** - The number of significant digits.

**Argument Ordering**

An element text string can contain more than one format specifier. When a dictionary element is displayed, the first format specifier is applied against the first argument, the second specifier for the second argument, and so on. In some instances, you may need to apply a format specifier out of sequence. This can happen if you develop your program for one language, and then translate the dictionary to another language.

To re-arrange the order of the format specifiers, follow the conversion character with the “^” character and the argument number. As an example,

```
$20, file_message "File %s^2 on device %s^1 not found" &new_line
```

means use the second argument for the first specifier and the first argument for the second specifier.

**Caution**

You cannot re-arrange arguments that are SHORT or BYTE type because these argument are passed differently than other data types. Re-arranging SHORT or BYTE type arguments could cause unexpected results.

### **10.1.6 Dictionary Reserved Word Commands**

Reserve words begin with the “&” character and are used to control the screen. They effect how, and in some cases where, the text is going to be displayed. They provide an easy and self-documenting way of adding control information to the dictionary. Refer to [Table 10–2](#) for a list of the available reserved words.

**Table 10–2. Reserved Words**

Reserved Word	Function
&clear_win	Clear window (#128)
&clear_2_eol	Clear to end of line (#129)
&clear_2_eow	Clear to end of window (#130)
\$cr	Carriage return (#132)
\$lf	Line feed (#133)
&rev_lf	Reverse line feed (#134)
&new_line	New line (#135)
&bs	Back space (#136)
&home	Home cursor in window (#137)
&blink	Blink video attribute (#138)
&reverse	Reverse video attribute (#139)
&bold	Bold video attribute (#140)

**Table 10–2. Reserved Words (Cont'd)**

Reserved Word	Function
&under_line	Underline video attribute (#141)
&double_wide	Wide video size (#142) (refer to description below for usage)
&standard	All attributes normal (#143)
&graphics_on	Turn on graphic characters (#146)
&ascii_on	Turn on ASCII characters (#147)
&double_high	High video size (#148) (refer to description below for usage)
&normal_size	Normal video size (#153)
&multi_on	Turn on multi-national characters (#154)

The attributes &normal\_size, &double\_high, and &double\_wide are used to clear data from a line on a screen. However, they are only effective for the line the cursor is currently on. To use these attributes, first position the cursor on the line you want to resize. Then write the attribute, and the text.

- **For the teach pendant,** &double\_high means both double high and double wide are active, and &double\_wide is the same as &normal\_size.
- **For the CRT/KB,** &double\_high means both double high and double wide are active, and &double\_wide means double wide but normal height.

### **10.1.7 Character Codes**

A character code is the “#” character followed by a number between 0 and 255. It provides a method of inserting special printable characters, that are not represented on your keyboard, into your dictionary. Refer to [Appendix D](#), "Character Codes," for a listing of the ASCII character codes.

### **10.1.8 Nesting Dictionary Elements**

The plus “+” attribute allows a dictionary element to reference another dictionary element from the same dictionary, up to a maximum of five levels. These nested elements can be referenced by element

name or element number and can be before or after the current element. When nested elements are displayed, all the elements are displayed in their nesting order as if they are one single element.

### **10.1.9 Dictionary Comment**

The asterisk character (\*) indicates that all text, to the end of the line, is a comment. All comments are ignored when the dictionary is compressed. A comment can be placed anywhere a space is allowed, except within the element text.

### **10.1.10 Generating a KAREL Constant File**

The element numbers that are assigned an element name in the dictionary can be generated into a KAREL include file for KAREL programming. The include file will contain the CONST declarator and a constant declaration for each named element.

```
element_name = element_number
```

Your KAREL program can include this file and reference each dictionary element by name instead of number.

To generate a KAREL include file, specify “.kl”, followed by the file name, on the first line of the dictionary file. The KAREL include file is automatically generated when the dictionary is compressed.

The following would create the file kcmn.kl when the dictionary is compressed.

```
.kl kcmn  
$-, move_home, "press HOME to move home"
```

The kcmn.kl file would look as follows

```
-- WARNING: This include file generated by dictionary compressor.  
--  
-- Include File: kcmn.kl  
-- Dictionary file: apkcmneg.utx  
--CONST  
move_home = 0
```

**Note** If you make a change to your dictionary that causes the element numbers to be re-ordered, you must re-translate your KAREL program to insure that the proper element numbers are used.

### **10.1.11 Compressing and Loading Dictionaries on the Controller**

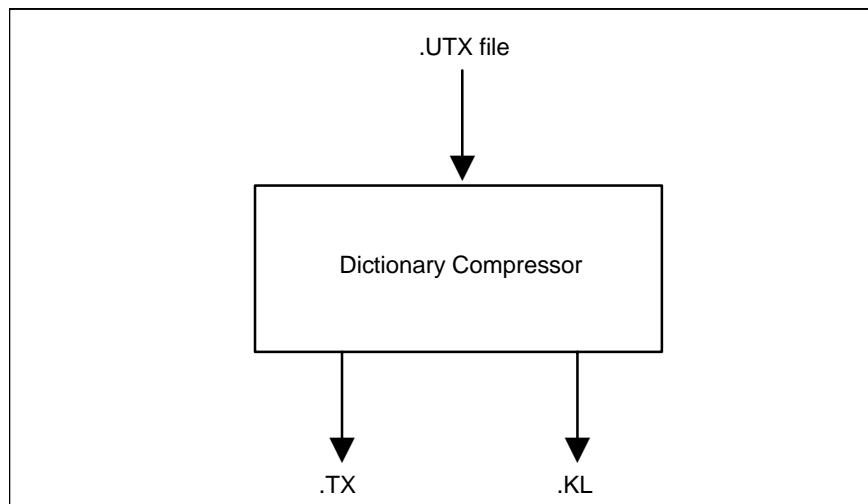
The KAREL editor can be used to create and modify the user dictionary. When you have finished editing the file, you compress it from the KCL command prompt.

```
KCL> COMPRESS DICT filename
```

Do not include the .UTX file type with the file name. If the compressor detects any errors, it will point to the offending word with a brief explanation of what is wrong. Edit the user dictionary and correct the problem before continuing.

A loadable dictionary with the name filename but with a .TX file type will be created. If you used the .kl symbol, a KAREL include file will also be created. [Figure 10–1](#) illustrates the compression process.

**Figure 10–1. Dictionary Compressor and User Dictionary File**



Before the KAREL program can use a dictionary, the dictionary must be loaded into the controller and given a dictionary name. The dictionary name is a one to four character word that is assigned to the dictionary when it is loaded. Use the KCL LOAD DICT command to load the dictionary.

```
KCL> LOAD DICT filename dictname <lang_name>
```

The optional lang\_name allows loading multiple dictionaries with the same dictionary name. The actual dictionary that will be used by your program is determined by the current value of \$LANGUAGE. This system variable is set by the KCL SET LANGUAGE command or the SET\_LANG KAREL built-in. The allowed languages are ENGLISH, JAPANESE, FRENCH, GERMAN, SPANISH, or DEFAULT.

The KAREL program can also load a dictionary. The KAREL built-in ADD\_DICT is used to load a dictionary into a specified language and assign a dictionary name.

### **10.1.12 Accessing Dictionary Elements from a KAREL Program**

Your KAREL program uses either the dictionary name and an element number, or the element name to access a dictionary element. The following KAREL built-ins are used to access dictionary elements:

- ADD\_DICT - Add a dictionary to the specified language.
- REMOVE\_DICT - Removes a dictionary from the specified language and closes the file or frees the memory it resides in.
- WRITE\_DICT - Write a dictionary element to a window.
- WRITE\_DICT\_V - Write a dictionary element that has format specifiers for a KAREL variable, to a window.
- READ\_DICT - Read a dictionary element into a KAREL STRING variable.
- READ\_DICT\_V - Read a dictionary element that has format specifiers into a STRING variable.
- CHECK\_DICT - Check if a dictionary element exists.

## **10.2 CREATING USER FORMS**

A *form* is a type of dictionary file necessary for creating menu interfaces that have the same "look and feel" as the System R-J3iB menu interface.

The following are steps for using forms.

1. Create an ASCII form text file with the .FTX file extension.
2. Compress the form file using the KCL COMPRESS FORM command. This creates a loadable dictionary file with a .TX extension and an associated variable file (.VR).
3. Load the form.
  - **From KCL** , use the KCL LOAD FORM command. This will load the dictionary file (.TX) and the associated variable file (.VR).
  - **From KAREL** , use the ADD\_DICT built-in to load the dictionary file (.TX), and the LOAD built-in to load the association variable file (.VR) .
4. Use the KAREL DISCTRL\_FORM built-in to display the form text. The DISCTRL\_FORM built-in handles all input operations including cursor position, scrolling, paging, input validation, and choice selections. Refer to the DISCTRL\_FORM built-in, [Appendix A](#) , "KAREL Language Alphabetical Description."

Forms are useful for programs which require the user to enter data. For example, once the user enters the data, the program must test this data to make sure that it is in an acceptable form. Numbers must be entered with the correct character format and within a specified range, text strings must not exceed a certain length and must be a valid selection. If an improper value is entered, the program must notify the user and prompt for a new entry. Forms provide a way to automatically validate entered data. Forms also allow the program to look as if it is integrated into the rest of the system menus, by giving the operator a familiar interface.

Forms must have the USER2 menu selected. Forms use the "t\_sc" and "c\_sc" screens for teach pendant and CRT/KB respectively. The windows that are predefined by the system are used for displaying the

form text. For both screens, this window is 10 rows high and 40 columns wide. This means that the &double\_high and &double\_wide attributes are used on the CRT/KB and cannot be changed.

### **10.2.1 Form Syntax**

A form defines an operator interface that appears on the teach pendant or CRT/KB screens. A form is a special dictionary element. Many forms can reside in the same dictionary along with other (non-form) dictionary elements.

**Note** If your program requires a form dictionary file (.FTX), you do not have to create a user dictionary file (.UTX). You may place your user dictionary elements in the same file as your forms.

To distinguish a form from other elements in the dictionary, the symbol “.form” is placed before the element and the symbol “.endform” is placed after the element. The symbols must reside on their own lines. The form symbols are omitted from the compressed dictionary.

The following is the syntax for a form:

#### **Form Syntax**

```
.form <form_attributes>
$n, form_name<@cursor_pos><&res_word>"Menu_title"<&res_word>&new_line
    <@cursor_pos><&res_word>"Menu_label"<&res_word>&new_line
    <@cursor_pos><&res_word><"-Selectable_item"<&res_word>&new_line>
    <@cursor_pos><&res_word><"-%Edit_item"<&res_word>&new_line>
    <@cursor_pos><&res_word><"Non_selectable_text"<&res_word>&new_line>
    <@cursor_pos><&res_word><"Display_only_item"<&res_word>&new_line>
    <^function_key &new_line>
    <?help_menu &new_line>
.endform

<$n,function_key
    <"Key_name" &new_line>
    <"Key_name" &new_line>
    <"Key_name" &new_line>
    <"Key_name" &new_line>
    <"Key_name" &new_line>
    <"help_label" &new_line>
    <"Key_name" &new_line>
    <"Key_name" &new_line>
    <"Key_name" &new_line>
    <"Key_name" &new_line>
    "Key_name"
>

<$n,help_menu
    <"Help_text" &new_line>
    <"Help_text" &new_line>
```

```
"Help_text">
```

### **Restrictions**

- Items in brackets <> are optional.
- Symbols not defined here are standard user dictionary element symbols (\$n, @cursor\_pos, &res\_word, &new\_line).
- form\_attributes are the key words *unnumber* and *unclear*.
- form\_name specifies the element name that identifies the form.
- "Menu\_title" and "Menu\_label" specify element text that fills the first two lines of the form and are always displayed.
- "- Selectable\_item" specifies element text that can be cursored to and selected.
- "-%Editable\_item" specifies element text that can be cursored to and edited.
- "Non\_selectable\_text" specifies element text that is displayed in the form and cannot be cursored to.
- "%Display\_only\_item" specifies element text using a format specifier. It cannot be cursored to.
- ^function\_key defines the labels for the function keys using an element name.
- ?help\_menu defines a page of help text that is associated with a form using an element name.
- "Key\_name" specifies element text displayed over the function keys.
- "Help\_label" is the special label for the function key 5. It can be any label or the special word HELP.
- "Help\_text" is element text up to 40 characters long.

### **10.2.2 Form Attributes**

Normally, a form is displayed with line numbers in front of any item the cursor can move to. To keep a form from generating and displaying line numbers, the symbol “.form unnumber” is used.

To keep a form from clearing any windows before being displayed, the symbol “.form noclear” is used. The symbols “noclear” and “unnumber” can be used in any order.

In the following example, MH\_TOOLDEFN is an unnumbered form that does not clear any windows. MH\_APPLIO is a numbered form.

```
.form unnumber noclear
$1, MH_TOOLDEFN
.endform
$2, MH_PORT
$3, MH_PORTFKEY
.form
$6, MH_APPLIO
```

```
.endform
```

### **10.2.3 Form Title and Menu Label**

The menu title is the first element of text that follows the form name. The menu label follows the menu title. Each consists of one row of text in a non-scrolling window.

- **On the teach pendant** the first row of the "full" window is used for the menu title. The second row is used for the menu label.
- **On the CRT/KB** the first row of the "cr05" widow is used for the menu title. The second row is used for the menu label.
- The menu title is positioned at row 3, column 1-21.
- The menu label is positioned at row 4, column 1-40.

Unless the "noclear" form attribute is specified both the menu title and menu label will be cleared.

The reserved word &home must be specified before the menu title to insure that the cursor is positioned correctly. The reserved word &reverse should also be specified before the menu title and the reserved word &standard should follow directly after the menu title. These are necessary to insure the menu appears to be consistent with the R-J3iB menu interface. The reserved word &new\_line must be specified after both the menu title and menu label to indicate the end of the text. The following is an example menu title and menu label definition.

```
.form
$1, mis_form
&home &reverse "Menu Title" &standard &new_line
"Menu Label" &new_line
.endform
```

If no menu label text is desired, the &new\_line can be specified twice after the menu title as in the following example.

```
.form
$1,misc_form
&home &reverse " Menu Title" &standard &new_line &new_line
.endform
```

If the cursor position attribute is specified, it is not necessary to specify the &new\_line reserved word. The following example sets the cursor position for the menu title to row 1, column 2, and the menu label to row 2, column 5.

```
.form
$1,misc_form
@1,2 &reverse "Menu Title" &standard
@2,5 "Menu Label"
.endform
```

### **10.2.4 Form Menu Text**

The form menu text follows the menu title and menu label. It consists of an unlimited number of lines that will be displayed in a 10 line scrolling window named “fscr” on the teach pendant and “ct06” on the CRT/KB. This window is positioned at rows 5-14 and columns 1-40. Unless the “noclear” option is specified, all lines will be cleared before displaying the form.

Menu text can consist of the following:

- Selectable menu items
- Edit data items of the following types:
  - INTEGER
  - INTEGER port
  - REAL
  - SHORT (32768 to 32766)
  - BYTE (0 to 255)
  - BOOLEAN
  - BOOLEAN port
  - STRING
  - Program name string
  - Function key enumeration type
  - Subwindow enumeration type
  - Subwindow enumeration type using a variable
  - Port simulation
- Non-selectable text
- Display only data items with format specifiers
- Cursor position attributes
- Reserve words or ASCII codes
- Function key element name or number
- Help element name or number

Each kind of menu text is explained in the following sections.

### **10.2.5 Form Selectable Menu Item**

Selectable menu items have the following characteristics:

- A selectable menu item is entered in the dictionary as a string enclosed in double quotes.
- The first character in the string must be a dash, ‘-’. This character will not be printed to the screen. For example,  
"- Item 1 "
  - The entire string will be highlighted when the selectable item is the default.
  - If a selectable item spans multiple lines, the concatenation character ‘+’ should be used as the last character in the string. The concatenation character will not be printed to the screen. The attribute &new\_line is used to signal a new line. For example,  
"- Item 1, line 1 +" &new\_line  
"- Item 1, line 2 "
    - The automatic numbering uses the first three columns and does not shift the form text. Therefore, the text must allow for the three columns by either adding spaces or specifying cursor positions. For example,  
"- Item 1 " &new\_line  
"- Item 2 " &new\_line  
"- Item 3 "

or

```
@3,4"- Item 1 "
@4,4"- Item 2 "
@5,4"- Item 3 "
```

- The first line in the scrolling window is defined as row 3 of the form.
- Pressing enter on a selectable menu item will always cause the form processor to exit with the termination character of ky\_select, regardless of the termination mask setting. The item number selected will be returned.
- Selecting the item by pressing the ITEM hardkey on the teach pendant will only highlight the item. It does not cause an exit.
- Short-cut number selections are not handled automatically, although they can be specified as a termination mask.

### **10.2.6 Edit Data Item**

You can edit data items that have the following characteristics:

- Data item is entered in the dictionary as a string enclosed in double quotes.
- The first character in the string must be a dash, ‘-’. This character is not printed to the screen.
- The second character in the string must be a ‘%’. This character marks the beginning of a format specifier.
- Each format specifier begins with a % and ends with a conversion character. All the characters between these two characters have the same meaning as user dictionary elements.

**Note** You should provide a field width with each format specifier, otherwise a default will be used. This default might cause your form to be mis-aligned.

Table 10–3 lists the conversion characters for an editable data item.

**Table 10–3. Conversion Characters**

Character	Argument Type: Printed As
d	INTEGER; decimal number.
o	INTEGER; unsigned octal notation (without a leading zero).
x, X	INTEGER; unsigned hexadecimal notation (without a leading 0x or 0X), using abcdef or ABCDEF for 10, ..., 15.
u	INTEGER; unsigned decimal notation.
pu	INTEGER port; unsigned decimal notation.
px	INTEGER port; unsigned hexadecimal notation (without a leading 0x or 0X), using abcdef or ABCDEF for 10, ..., 15.
f	REAL; decimal notation of the form <->mmm.ddddd, where the number of d's is given by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
e, E	REAL; decimal notation of the form <->m.ddddde+xx or <->m.ddddde-xx, where the number of d's is given by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
g, G	REAL; %e or %E is used if the exponent is less than -4 or greater than or equal to the precision; otherwise %f is used. Trailing zeros and a trailing decimal pointer are not printed.
h	SHORT; signed short.
b	BYTE; unsigned byte.
B	BOOLEAN; print characters from boolean enumeration string.

**Table 10-3. Conversion Characters (Cont'd)**

<b>Character</b>	<b>Argument Type: Printed As</b>
P	BOOLEAN port; print characters from boolean port enumeration string.
S	INTEGER or BOOLEAN port; print characters from port simulation enumeration string.
k	STRING; print characters from KAREL string until end of string or the number of characters given by the precision.
pk	STRING; print program name from KAREL string until end of string or the number of characters given by the precision.
n	INTEGER; print characters from function key enumeration string. Uses dictionary elements to define the enumeration strings.
w	INTEGER; print characters from subwindow enumeration string. Uses dictionary elements to define the enumeration strings.
v	INTEGER; print characters from subwindow enumeration string. Uses a variable to define the enumeration strings.
%	no argument is converted; print a %.

The following is an example of a format specifier:

"-%5d" or "-%-10s"

The form processor retrieves the values from the input value array and displays them sequentially. **All values are dynamically updated .**

#### **Edit Data Items: INTEGER, INTEGER Ports, REAL, SHORT, BYTE**

- You can specify a range of acceptable values by giving each format specifier a minimum and maximum value allowed "(min, max)." If you do not specify a minimum and maximum value, any integer or floating point value will be accepted. For example,  
"-%3d(1,255)" or "-%10.3f(0.,100000.)"
- When an edit data item is selected, the form processor calls the appropriate input routine. The input routine reads the new value (with inverse video active) and uses the minimum and maximum values specified in the dictionary element, to determine whether the new value is within the valid range.

- If the new value is out of range, an error message will be written to the prompt line and the current value will not be modified.
- If the new value is in the valid range, it will overwrite the current value.

### Edit Data Item: BOOLEAN

- The format specifier %B is used for KAREL BOOLEAN values, to display and select menu choice for the F4 and F5 function keys. The name of the dictionary element, that contains the function key labels, is enclosed in parentheses and is specified after the %B. For example, "%4B(enum\_bool)"

The dictionary element defining the function keys should define the FALSE value first (F5 label) and the TRUE value second (F4 label). For example,

```
$2,enum_bool
" NO" &new_line
" YES"
```

YES	NO
-----	----

The form processor will label the function keys when the cursor is moved to the enumerated item. The value shown in the field is the same as the function key label except all leading blanks are removed.

### Edit Data Item: BOOLEAN Port

- The format specifier %P is used for KAREL BOOLEAN port values, to display and select menu choices from the F4 and F5 function keys. The name of the dictionary element, that contains the function key labels, is enclosed in parentheses and is specified after the %P. For example, "%3P(enum\_bool)"

The dictionary element defining the function keys should define the 0 value first (F5 label) and the 1 value second (F4 label). For example,

```
$2,enum_bool
" OFF" &new_line
" ON"
```

YES	NO
-----	----

The form processor will label the function keys when the cursor is moved to the enumerated item. The value shown in the field is the same as the function key label except all leading blanks are removed.

### Edit Data Item: Port Simulation

- The format specifier %S is used for port simulation, to display and select menu choices from the F4 and F5 function keys. The name of the dictionary element, that contains the function key labels, is enclosed in parentheses and is specified after the %S. For example,  
"-%1S(sim\_fkey)"

The dictionary element defining the function keys should define the 0 value first (F5 label) and the 1 value second (F4 label). For example,

```
$-, sim_fkey  
" UNSIM " &new_line * F5 key label, port will be unsimulated  
"SIMULATE" &new_line * F4 key label, port will be simulated
```

The form processor will label the function keys when the cursor is moved to the enumerated item. The value shown in the field is the same as the function key label except all leading blanks are removed and the value will be truncated to fit in the field width.

### Edit Data Item: STRING

- You can choose to clear the contents of a string before editing it. To do this follow the STRING format specifier with the word "clear", enclosed in parentheses. If you do not specify "(clear)", the default is to modify the existing string. For example,  
"-%10k(clear)"

### Edit Data Item: Program Name String

- You can use the %pk format specifier to display and select program names from the subwindow. The program types to be displayed are enclosed in parenthesis and specified after %pk. For example,

```
"-%12pk(1)" * specifies TP programs  
"-%12pk(2)" * specifies PC programs  
"-%12pk(6)" * specifies TP, PC, VR  
"-%12pk(16)" * specifies TP & PC
```

All programs that match the specified type and are currently in memory, are displayed in the subwindow. When a program is selected, the string value is copied to the associated variable.

### Edit Data Item: Function Key Enumeration

- You can use the format specifier %n (for enumerated integer values) to display and select choices from the function keys. The name of the dictionary element that contains the list of valid choices is enclosed in parentheses and specified after %n. For example,

```
"-%6n(enum_fkey)"
```

The dictionary element defining the function keys should list one function key label per line. If function keys to the left of those specified are not active, they should be set to "". A maximum of 5 function keys can be used. For example,

```
$2,enum_fkey
" " &new_line *Specifies F1 is not active
"JOINT" &new_line *Specifies F2
"LINEAR" &new_line *Specifies F3
"CIRC" *Specifies F4
```

The form processor will label the appropriate function keys when the enumerated item is selected. When a function key is selected, the value set in the integer is as follows:

```
User presses F1, value = 1
User presses F2, value = 2
User presses F3, value = 3
User presses F4, value = 4
User presses F5, value = 5
```

The value shown in the field is the same as the function key label except all leading blanks are removed.

JOINT	LINEAR	CIRC
-------	--------	------

### Edit Data Item: Subwindow Enumeration

- You can use the format specifier %w (for enumerated integer values) to display and select choices from the subwindow. The name of the dictionary element, containing the list of valid choices, is enclosed in parentheses and specified after %w. For example,  
"-%8w(enum\_sub)"

One dictionary element is needed to define each choice in the subwindow. 35 choices can be used. If fewer than 35 choices are used, the last choice should be followed by a dictionary element that contains "\a". The choices will be displayed in 2 columns with 7 choices per page. If only 4 or less choices are used, the choices will be displayed in 1 column with a 36 character width. For example,

```
$2,enum_sub "Option 1"
$3 "Option 2"
$4 "Option 3"
$5 "\a"
```

The form processor will label F4 as "[CHOICE]" when the cursor is moved to the enumerated item. When the function key F4, [CHOICE] is selected, it will create the subwindow with the appropriate display. When a choice is selected, the value set in the integer is the number selected. The value shown in the field is the same as the dictionary label except all leading blanks are removed.

### Edit Data Item: Subwindow Enumeration using a Variable

- You can also use the format specifier %v (for enumerated integer values) to display and select choices from the subwindow. However, instead of defining the choices in a dictionary they are defined in a variable. The name of the dictionary element, which contains the program and variable name, is enclosed in parentheses and specified after %v. For example,

```
"-%8v(enum_var)"  
$-,enum_var  
"RUNFORM" &new_line * program name of variable  
"CHOICES" &new_line * variable name containing choices
```

[RUNFORM] CHOICES must be defined as a KAREL string array. Each element of the array should define a choice in the subwindow. This format specifier is similar to %w. However, the first element is related to the value 0 and is never used. Value 1 begins at the second element. The last value is either the end of the array or the first uninitialized value.

```
[RUNFORM] CHOICES:ARRAY[6] OF STRING[12] =  
[1] *uninit*  
[2] 'Red' <= value 1  
[3] 'Blue' <= value 2  
[4] 'Green' <= value 3  
[5] *uninit*  
[6] *uninit*
```

#### 10.2.7 Non>Selectable Text

Non-selectable text can be specified in the form. These items have the following characteristics:

- Non-selectable text is entered in the dictionary as a string enclosed in double quotes.
- Non-selectable text can be defined anywhere in the form, but must not exceed the maximum number of columns in the window.

#### 10.2.8 Display Only Data Items

Display only data items can be specified in the form. These items have the following characteristics:

- Display only data items are entered in the dictionary as a string enclosed in double quotes.
- The first character in the string must be a '%'. This character marks the beginning of a format specifier.
- The format specifiers are the same as defined in the previous section for an edit data item.

### **10.2.9 Cursor Position Attributes**

Cursor positioning attributes can be used to define the row and column of any text. The row is always specified first. The dictionary compressor will generate an error if the form tries to backtrack to a previous row or column. The form title and label are on rows 1 and 2. The scrolling window starts on row 3. For example,

```
@3,4 "- Item 1"
@4,4 "- Item 2
@3,4 "- Item 3" <- backtracking to row 3 not allowed
```

Even though the scrolling window is only 10 lines, a long form can specify row positions that are greater than 12. The form processor keeps track of the current row during scrolling.

### **10.2.10 Form Reserved Words and Character Codes**

Reserved words or character codes can be used. Refer to [Table 10–4](#) for a list of all available reserved words. However, only the reserved words which do not move the cursor are allowed in a scrolling window. Refer to [Table 10–5](#) for a list of available reserved words for a scrolling window.

**Table 10–4. Reserved Words**

Reserved Word	Function
&clear_win	Clear window (#128)
&clear_2_eol	Clear to end of line (#129)
&clear_2_eow	Clear to end of window (#130)
\$cr	Carriage return (#132)
\$lf	Line feed (#133)
&rev_lf	Reverse line feed (#134)
&new_line	New line (#135)
&bs	Back space (#136)
&home	Home cursor in window (#137)

**Table 10–4.** Reserved Words (Cont'd)

Reserved Word	Function
&blink	Blink video attribute (#138)
&reverse	Reverse video attribute (#139)
&bold	Bold video attribute (#140)
&under_line	Underline video attribute (#141)
&double_wide	Wide video size (#142) (refer to description below for usage)
&standard	All attributes normal (#143)
&graphics_on	Turn on graphic characters (#146)
&ascii_on	Turn on ASCII characters (#147)
&double_high	High video size (#148) (refer to description below for usage)
&normal_size	Normal video size (#153)
&multi_on	Turn on multi-national characters (#154)

[Table 10–5](#) lists the reserved words that can be used for a scrolling window.

**Table 10–5.** Reserved Words for Scrolling Window

Reserved Word	Function
&new_line	New line (#135)
&blink	Blink video attribute (#138)
&reverse	Reverse video attribute (#139)
&bold	Bold video attribute (#140)

**Table 10-5. Reserved Words for Scrolling Window (Cont'd)**

<b>Reserved Word</b>	<b>Function</b>
&under_line	Underline video attribute (#141)
&standard	All attributes normal (#143)
&graphics_on	Turn on graphic characters (#146)
&ascii_on	Turn on ASCII characters (#147)
&multi_on	Turn on multi-national characters (#154)

### **10.2.11 Form Function Key Element Name or Number**

Each form can have one related function key menu. A function key menu has the following characteristics:

- The function key menu is specified in the dictionary with a caret, ^, immediately followed by the name or number of the function key dictionary element. For example,

`^misc_fkey`

- The dictionary element defining the function keys should list one function key label per line. If function keys to the left of those specified are not active, then they should be set to "". A maximum of 10 function keys can be used. For example,

```
$3,misc_fkey
" F1" &new_line
" F2" &new_line
" F3" &new_line
" F4" &new_line
" HELP >" &new_line
" " &new_line
" " &new_line
" F8" &new_line
" F9" &new_line
```

- The form processor will label the appropriate function keys and return from the routine if a valid key is pressed. The termination character will be set to ky\_f1 through ky\_f10.
- The function keys will be temporarily inactive if an enumerated data item is using the same function keys.
- If function key F5 is labeled HELP, it will automatically call the form's help menu if one exists.



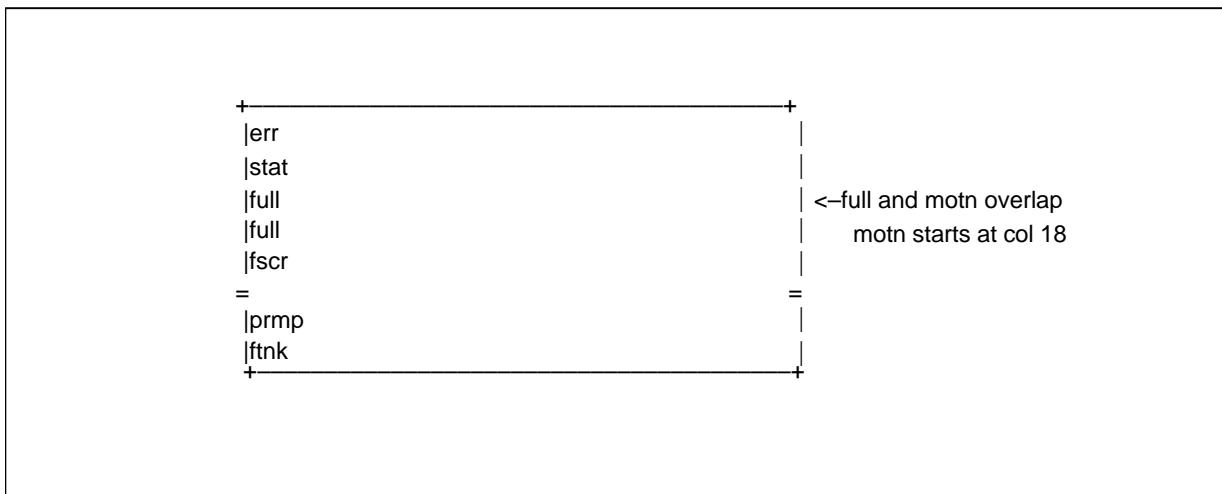
### **10.2.12 Form Help Element Name or Number**

Each form can have one related help menu. The help menu has the following characteristics:

- A help element name or number is specified in the dictionary with a question mark, ?, immediately followed by the name or number of the help dictionary element. For example, ?misc\_help
- The dictionary element defining the help menu is limited to 48 lines of text.
- The form processor will respond to the help key by displaying the help dictionary element in a predefined window. The predefined window is 40 columns wide and occupies rows 3 through 14.
- The help menu responds to the following inputs:
  - Up or down arrows to scroll up or down 1 line.
  - Shifted up or down arrows to scroll up or down 3/4 of a page.
  - Previous, to exit help. The help menu restores the previous screen before returning.

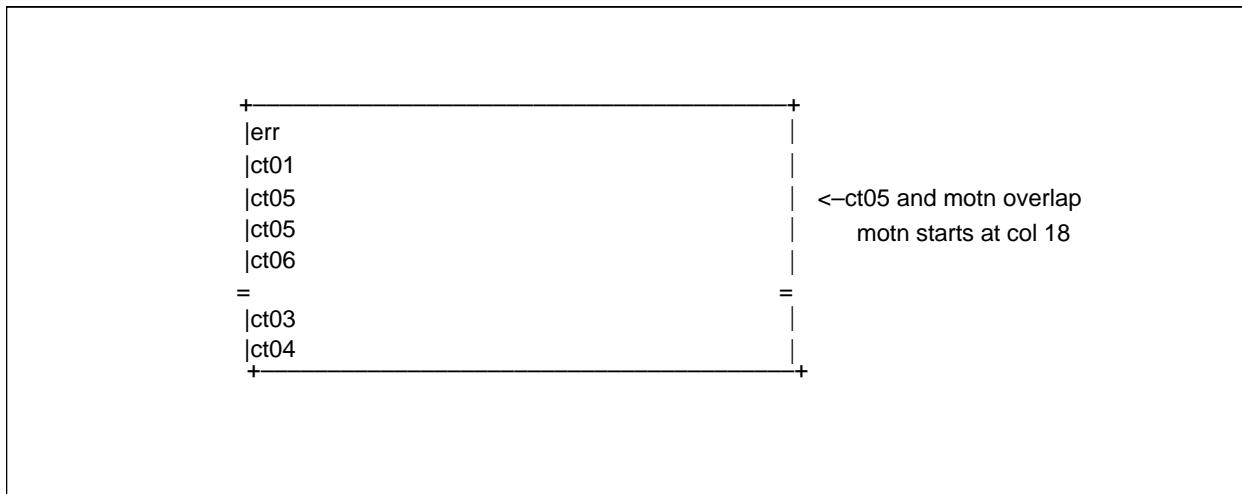
### **10.2.13 Teach Pendant Form Screen**

You can write to other active teach pendant windows while the form is displayed. The screen itself is named "tpsc." [Figure 10–2](#) shows all the windows attached to this screen. Unless the noclear option is specified, "full," "fscr," "prmp," and "ftnk" windows will be cleared before displaying the form.

**Figure 10–2.** Teach Pendant Form Screen

#### **10.2.14 CRT/KB Form Screen**

You can write to other active CRT/KB windows while the form is displayed. The screen itself is named “ctsc.” All lines in the screen are set to double high and double wide video size. [Figure 10–3](#) shows all the windows attached to this screen. Unless the “noclear” option is specified, “ct05,” “ct06,” “ct03,” and “ct04” windows will be cleared before displaying the form.

**Figure 10–3.** CRT/KB Form Screen

### **10.2.15 Form File Naming Convention**

Uncompressed form dictionary files must use the following file name conventions:

- The first two letters in the dictionary file name can be an application prefix.
- If the file name is greater than four characters, the form processor will skip the first two letters when trying to determine the dictionary name.
- The next four letters must be the dictionary name that you use to load the .TX file, otherwise the form processor will not work.
- The last two letters are optional and should be used to identify the language:
  - “EG” for ENGLISH
  - “JP” for JAPANESE
  - “FR” for FRENCH
  - “GR” for GERMAN
  - “SP” for SPANISH
- A dictionary file containing form text must have a .FTX file type, otherwise the dictionary compressor will not work. After it is compressed, the same dictionary file will have a .TX file type instead.

The following is an example of an uncompressed form dictionary file name:

MHPALTEG.FTX

MH stands for Material Handling, PALT is the dictionary name that is used to load the dictionary on the controller, and EG stands for English.

### **10.2.16 Compressing and Loading Forms on the Controller**

The form file can only be compressed on the RAM disk RD:. Compressing a form is similar to compressing a user dictionary. From the KCL command prompt, enter:

KCL> COMPRESS FORM filename

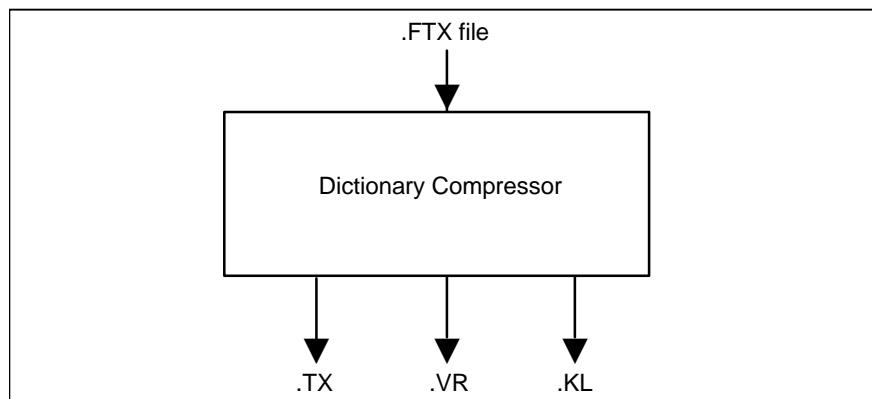
Do not include the .FTX file type. If the compressor detects any errors, it will point to the offending word with a brief explanation of what is wrong. Edit the form and correct the problem before continuing.

**Note** The form file must be an uncompressed file in order for the errors to point to the correct line.

Two files will be created by the compressor. One is a loadable dictionary file with the name filename but with a .TX file type. The other will be a variable file with a .VR file type but with the four character dictionary name as the file name. The dictionary name is extracted from filename as

described previously. A third file may also be created if you used the “.kl” symbol to generate a KAREL include file. [Figure 10–4](#) illustrates compressing.

**Figure 10–4. Dictionary Compressor and Form Dictionary File**



Each form will generate three kinds of variables. These variables are used by the form processor. They must be reloaded each time the form dictionary is recompressed. The variables are as follows:

1. Item array variable - The variable name will be the four-character dictionary name, concatenated with the element number, concatenated with \_IT.
2. Line array variable - The variable name will be the four-character dictionary name, concatenated with the element number, concatenated with \_LN.
3. Miscellaneous variable - The variable name will be the four-character dictionary name, concatenated with the element number, concatenated with \_MS.

The data defining the form is generated into KAREL variables. These variables are saved into the variable file and loaded onto the controller. The name of the program is the dictionary name preceded by an asterisk. For example, Dictionary MHPALTEG.FTX contains:

```

.form unnumber
$1, MH_TOOLDEFN
.endform
$2, MH_PORT
$3, MH_PORTFKEY
.form
$6, MH_APPLIO
.endform
  
```

As explained in the file naming conventions section, the dictionary name extracted from the file name is “PALT”. Dictionary elements 1 and 6 are forms. A variable file named PALT.VR is generated with the program name “\*PALT.” It contains the following variables:

PALT1\_IT, PALT1\_LN, and PALT1\_MS  
PALT6\_IT, PALT6\_LN, and PALT6\_MS

**Note** KCL CLEAR ALL will not clear these variables. To show or clear them, you can SET VAR \$CRT\_DEFPROG = '\*PALT' and use SHOW VARS and CLEAR VARS.

The form is loaded using the KCL LOAD FORM command.

```
KCL> LOAD FORM filename
```

The name filename is the name of the loadable dictionary file. After this file is loaded, the dictionary name is extracted from filename and is used to load the variable file. This KCL command is equivalent to

```
KCL> LOAD DICT filename dict_name DRAM
KCL> LOAD VARS dict_name
```

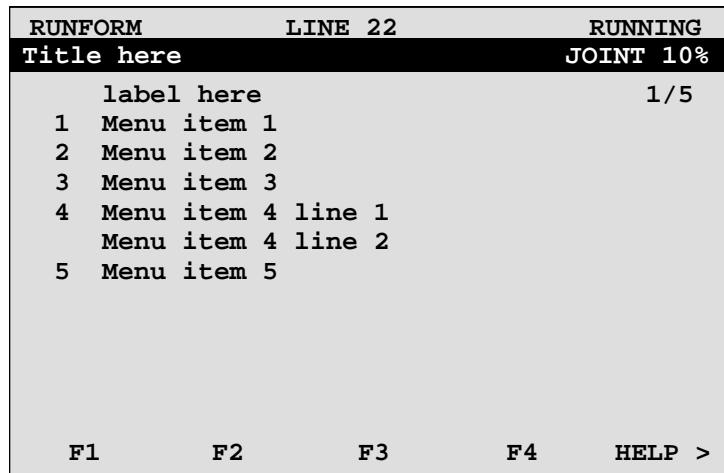
### 10.2.17 Displaying a Form

The DISCTRL\_FORM built-in is used to display and control a form on the teach pendant or CRT/KB screens. All input keys are handled within DISCTRL\_FORM. This means that execution of your KAREL program will be suspended until an input key causes DISCTRL\_FORM to exit the form. Any condition handlers will remain active while your KAREL program is suspended.

**Note** DISCTRL\_FORM will only display the form if the USER2 menu is the selected menu. Therefore, use FORCE\_SPMENU(device\_stat, SPI\_TPUSER2, 1) before calling DISCTRL\_FORM to force the USER2 menu.

Figure 10–5 shows the first template in FORM.FTX as displayed on the teach pendant. This example contains four selectable menu items.

**Figure 10–5. Example of Selectable Menu Items**



The dictionary elements in FORM.FTX, shown in [Example Form Dictionary for Selectable Menu Items](#), were used to create the form shown in [Figure 10–5](#).

### Example Form Dictionary for Selectable Menu Items

```

*      Dictionary Form File: form.ftx
*
*      Generate form.kl which should be included in your KAREL program
.form
$-,form1
    &home &reverse "Title here" &standard $new_line
    "    label here " &new_line
    @3,10    "- Menu item 1 "
    @4,10    "- Menu item 2 "
    @5,10    "- Menu item 3 "
    @6,10    "- Menu item 4 line 1 +"
    @7,10    " Menu item 4 line 2 "
    @8,10    "- Menu item 5 "
    * Add as many items as you wish.
    * The form manager will scroll them.
    ^form1_fkey      * specifies element which contains
                      * function key labels
    ?form1_help      * element which contains help
.endform

$-,form1_fkey      * function key labels
    "      F1" &new_line
    "      F2" &new_line
    "      F3" &new_line
    "      F4" &new_line
    "      HELP >" &new_line * help must be on F5
    "      F6" &new_line
    "      F7" &new_line
    "      F8" &new_line
    "      F9" &new_line
    "      F10 >"
    * you can have a maximum of 10 function keys labeled

$-, form1_help      * help text
    "Help Line 1" &new_line
    "Help Line 2" &new_line
    "Help Line3" &new_line
    * You can have a maximum of 48 help lines

```

The program shown in [Example Program for Selectable Menu Items](#) was used to display the form shown in [Figure 10–5](#).

**Example Program for Selectable Menu Items**

```

PROGRAM runform

%NOLOCKGROUP

%INCLUDE form           -- allows you to access form element numbers
%INCLUDE klevccdf
%INCLUDE klevkeys
%INCLUDE klevkmsk

VAR
    device_stat: INTEGER          --tp_panel or crt_panel
    value_array: ARRAY [1] OF STRING [1] --dummy variable for DISCTRL_FORM
    inact_array: ARRAY [1] OF BOOLEAN   --not used
    change_array: ARRAY [1] OF BOOLEAN   --not used
    def_item: INTEGER
    term_char: INTEGER
    status: INTEGER

BEGIN
    device_stat = tp_panel
    FORCE_SPMENU (device_stat, SPI_TPUSER2, 1)--forces the TP USER2
menu
    def_item = 1 -- start with menu item 1

    --Displays form named FORM1
    DISCTRL_FORM ("FORM", form1, value_array, inact_array,
                  change_array, kc_func_key, def_item, term_char, status)
    WRITE TPERROR (CHR(cc_clear_win))           --clear the TP error
window
    IF term_char = ky_select THEN
        WRITE TPERROR ("Menu item", def_item: :1, 'was selected.')
    ELSE
        WRITE TPERROR ('Func key', term_char: :1, ' was selected.')
    ENDIF
END runform

```

[Figure 10–6](#) shows the second template in FORM.FTX as displayed on the CRT/KB (only 10 numbered lines are shown at one time). This example contains all the edit data types.

**Figure 10–6.** Example of Edit Data Items

RUNFORM	LINE 22	RUNNING
<b>Title here</b>		JOINT 10%
label here		1 / 5
1 Menu item 1		
2 Menu item 2		
3 Menu item 3		
4 Menu item 4 line 1		
Menu item 4 line 2		
5 Menu item 5		

**F1      F2      F3      F4      HELP >**

The dictionary elements in FORM.FTX, shown in [Example Dictionary for Edit Data Items](#), were used to create the form shown in [Figure 10–6](#).

### Example Dictionary for Edit Data Items

```
* Dictionary Form File: form.ftx
*
* Generate form.kl which should be included in your KAREL program
.kl form
.form
$-,form2
&home &reverse " Title here" &standard
"    label here      "
"    Integer:        "      "-%10d"
"    Integer:        "      "-%10d(1,32767)"
"    Real:           "      "-%12f"
"    Boolean:        "      "-%10B(bool_fkey)"
"    String:         "      "-%-20k"
"    String:         "      "-%12k(clear)"
"    Byte:           "      "-%10b"
"    Short:          "      "-%10h"
"    DIN[1]:         "      "-%10P(dout_fkey)"
"    AIN[1]:         "      "-%10pu" " " "-%1S(sim_fkey)"
"    AOUT[2]:        "      "-%10px" " " "-%1S(sim_fkey)"
"    Enum Type:     "      "-%8n(enum_fkey)"
"    Enum Type:     "      "-%6w(enum_subwin)"
"    Enum Type:     "      "-%6V(ENUM_VAR)"
"    Prog Type:     "      "-%12pk(1)"
"    Prog Type:     "      "-%12pk(2)"
```

```

"      Prog Type:      "      "-%12pk(6)"          &new_line
"      Prog Type:      "      "-%12pk(16)"        &new_line
      ^form2_fkey
.endform

$-, form2_fkey
      EXIT" &new_line

*Allows you to specify the labels for F4 and F5 function keys
$-, bool_fkey
"FALSE"    &new_line  *  F5 key label, value will be set FALSE
"TRUE"     &new_line  *  F4 key label, value will be set TRUE

* Allows you to specify the labels for F4 and F5 function keys
$-, dout_fkey
"OFF"      &new_line  *  F5 key label, value will be set OFF
"ON"       &new_line  *  F4 key label, value will be set
ON

*Allows you to specify the labels for F4 and F5 function keys
$-, sim_fkey
" UNSIM "  &new_line  *  F5 key label, port will be unsimulated
"SIMULATE" &new_line  *  F4 key label, port will be simulated

*Allows you to specify the labels for 5 function keys
$-, enum_fkey
"FINE"      &new_line  * F1 key label, value will be set to 1

"COARSE"    &new_line  * F2 key label, value will be set to 2
"NOSETTL"   &new_line  * F3 key label, value will be set to 3
"NODECEL"   &new_line  * F4 key label, value will be set to 4
"VARDECEL"  &new_line  * F5 key label, value will be set to 5

*Allows you to specify a maximum of 35 choices in a subwindow
$-, enum_subwin
"Red"        *      value will be set to 1
$-
"Blue"       *      value will be set to 2
$-
"Green"
$-
"Yellow"
$-
"\a"         *      specifies end of subwindow list

* Allows you to specify the choices for the subwindow in a
* variable whose type is an ARRAY[m] of STRING[n].

```

```
$-, enum_var
"RUNFORM"    &new_line      *      program name of variable
"CHOICES"    &new_line      *      Variable name containing choices
```

The program shown in [Example Program for Edit Data Items](#) was used to display the form in [Figure 10-6](#).

### Example Program for Edit Data Items

```
PROGRAM runform

%NOLOCKGROUP

%INCLUDE form      -- allows you to access form element numbers
%INCLUDE klevccdf
%INCLUDE klevkeys
%INCLUDE klevkmsk

TYPE
    mystruc = STRUCTURE
        byte_var1: BYTE
        byte_var2: BYTE
        short_var: SHORT
    ENDSTRUCTURE

VAR
    device_stat: INTEGER -- tp_panel or crt_panel
    value_array: ARRAY [20] OF STRING [40]
    inact_array: ARRAY [1] OF BOOLEAN
    change_array: ARRAY[1] OF BOOLEAN
    def_item: INTEGER
    term_char: INTEGER
    status: INTEGER

    int_var1: INTEGER
    int_var2: INTEGER
    real_var: REAL
    bool_var: BOOLEAN
    str_var1: STRING[20]
    str_var2: STRING[12]
    struc_var: mystruc
    color_sel1: INTEGER
    color_sel2: INTEGER
    prog_name1: INTEGER[12]
    prog_name2: STRING[12]
    Prog_name3: STRING[12]
    prog_name4: STRING[12]
    choices: ARRAY[5] OF STRING[12]
```

```

BEGIN
    value_array [1] = 'int_var1'
    value_array [2] = 'int_var2'
    value_array [3] = 'real_var'
    value_array [4] = 'bool_var'
    value_array [5] = 'str_var1'
    value_array [6] = 'str_var2'
    value_array [7] = 'struc_var.byte_var1'
    value_array [8] = 'struc_var.short_var'
    value_array [9] = 'din[1]'
    value_array [10] = 'ain[1]'
    value_array [11] = 'ain[1]'
    value_array [12] = 'aout[2]'
    value_array [13] = 'aout[2]'
    value_array [14] = '[*system*]$group[1].$termtyp'
    value_array [15] = 'color_sel1'
    value_array [16] = 'color_sel2'
    value_array [17] = 'prog_name1'
    value_array [18] = 'prog_name2'
    value_array [19] = 'prog_name3'
    value_array [20] = 'prog_name4'
    choices [1] = ''           --not used
    choices [2] = 'Red'        --corresponds to color_sel12 = 1
    choices [3] = 'Blue'       --corresponds to color_sel12 = 2
    choices [4] = 'Green'      --corresponds to color_sel12 = 3
    choices [5] = 'Yellow'     --corresponds to color_sel12 = 4

-- Initialize variables
int_var1 = 12345
-- int_var2 is purposely left uninitialized
real_var = 0
bool_var = TRUE
str_var1 = 'This is a test'
-- str_var = is purposely left uninitialized
struc_var.byte_var1 = 10
struc_var.short_var = 30
color_sel1 = 3             --corresponds to third item of enum_subwin
color_sel2 = 1

device_stat = crt_panel      --specify the CRT/KB for displaying
form
FORCE_SPMENU(device_stat, SPI_TPUSER2,1)
def_item = 1 -- start with menu item 1
DISCTRL_FORM('FORM', form2, value_array, inact_array,
            change_array, kc_func_key, def_item, term_char, status);

```

```
END runform
```

[Figure 10–7](#) shows the third template in FORM.FTX as displayed on the teach pendant. This example contains display only items. It shows how to automatically load the form dictionary file and the variable data file, from a KAREL program.

**Figure 10–7. Example of Display Only Data Items**

RUNFORM	LINE 22	RUNNING		
<b>Title here</b>		JOINT 10%		
label here		1/5		
1 Menu item 1				
2 Menu item 2				
3 Menu item 3				
4 Menu item 4 line 1				
Menu item 4 line 2				
5 Menu item 5				
F1	F2	F3	F4	HELP >

The dictionary elements in FORM.FTX, shown in [Example Dictionary for Display Only Data Items](#), were used to create the form shown in [Figure 10–7](#).

#### Example Dictionary for Display Only Data Items

```
*      Dictionary Form File: form.ftx
*
*      Generate form.kl which should be included in your KAREL program
.kl form
.form
$-,form3
    &home &reverse "Title here" &standard      &new_line
    "label here"                                &new_line
                                                &new_line
"Int: " "%-10d" " Bool: " "%-10B(bool_fkey)" &new_line
"Real: " "%-10f" " Enum: " "%-10n(enum_fkey)" &new_line

"DIN[ "%1d" ]: " "%-10P(dout_fkey)" "%-12S(sim2_fkey)"

*You can have as many columns as you wish without exceeding * 40 columns.
*You can specify blank lines too.
.endform
$-,sim2_fkey
```

```
"UNSIMULATED" &new_line * F5 key label, port will be unsimulated
"SIMULATED" &new_line * F4 key label, port will be simulated
```

The program shown in [Example Program for Display Only Data Items](#) was used to display the form shown in [Figure 10-7](#).

### Example Program for Display Only Data Items

```
PROGRAM runform

%NOLOCKGROUP

%INCLUDE form      -- allows you to access form element numbers
%INCLUDE klevccdf
%INCLUDE klevkeys
%INCLUDE klevkmsk

    device_stat: INTEGER -- tp_panel or crt_panel
    value_array: ARRAY [20] OF STRING [40]
    inact_array: ARRAY [1] OF BOOLEAN -- not used
    change_array: ARRAY[1] OF BOOLEAN -- not used
    def_item: INTEGER
    term_char: INTEGER
    status: INTEGER
    loaded: BOOLEAN
    initialized: BOOLEAN

    int_var1: INTEGER
    int_var2: INTEGER
    real_var: REAL
    bool_var: BOOLEAN

BEGIN
-- Make sure 'FORM' dictionary is loaded.
CHECK_DICT('FORM', form3, status)

IF status <> 0 THEN
    WRITE TPPROMPT(CR,'Loading form.....')
    KCL ('CD MF2:',status)           --Use the KCL CD command to
                                    --change directory to MF2:
    KCL ( 'LOAD FORM', status)       --Use the KCL load for command
                                    --to load in the form
    IF status <> 0 THEN
        WRITE TPPROMPT(CR,'loading from failed, STATUS=',status)
        ABORT      --Without the dictionary this program cannot continue.
    ENDIF
ELSE
    WRITE TPPROMPT (CR,'FORM already loaded.')
END
```

```
ENDIF

    value_array [1] = 'int_var1'
    value_array [2] = 'bool_var'
    value_array [3] = 'real_var'
    value_array [4] = '[*system*]$group[1].$termtype'
    value_array [5] = 'int_var2'
    value_array [6] = 'din[1]'
    value_array [7] = 'din[1]'

    int_var1 = 12345
    bool_var = TRUE
    real_var = 0
    int_var2 = 1
    device_stat = tp_panel
    FORCE_SPMENU(device_stat, SPI_TPUSER2,1)
    def_item = 1 -- start with menu item 1
    DISCTRL_FORM('FORM', form3, value_array, inact_array,
                 change_array, kc_func_key, def_item, term_char, status);
END runform
```



# Chapter 11

---

## FULL SCREEN EDITOR

### Contents

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KAREL system software includes a full screen text editor that allows you to create new KAREL files or modify existing ones. Selecting KAREL EDITOR from the MENUS menu invokes the KAREL editor on the CRT/KB.

The editor can perform standard full screen manipulations on the following types of KAREL files:

- Source code files (.KL file type)
- Command files (.CF file type)
- Listing files (.LS file type)
- ASCII data files (.DT file type)
- Dictionary text files (.TX file type)

The editor can also invoke the KAREL language translator to produce KAREL p-code from KAREL source programs that you are editing.

The KAREL Command Language (KCL) is integrated into the editor so that your edit session can be preserved while you perform KCL functions. The KCL environment can be displayed on the CRT/KB by pressing F10, MENUS, from within the editor, and then selecting KCL. For VT-220 compatible CRT/KBs, pressing the DO key from within the editor displays KCL, pressing the SELECT key from KCL returns you to the editor, and pressing the NEXT key from within the editor selects the next edit window.

You direct the editor using editor commands selected from function key menus or by entering key sequences.

### Terminology

When you begin editing a file, the editor copies the contents of the file into an *edit buffer*. When the editor screen appears, a section of the edit buffer is displayed in an *edit window* on the screen. You modify the edit buffer through the edit window. The editor can have up to seven edit windows. Each edit buffer can display through a single edit window, or through multiple edit windows.

A *block* is a section of the edit buffer. A block has a beginning and an end. It can be displayed with no special markings or highlighted with reverse video. You can define, display, copy, delete, move, and search for a block.

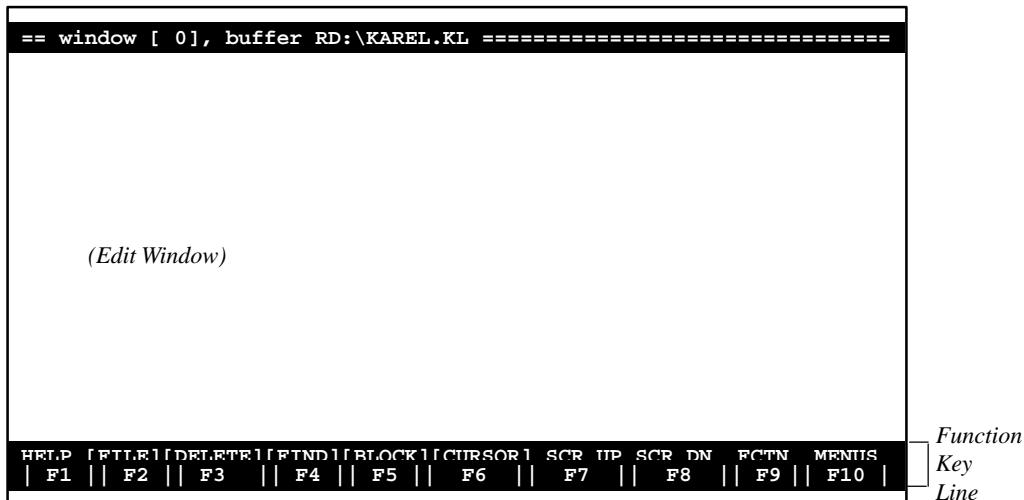
## **11.1 SCREEN LAYOUT**

You invoke the editor by entering “EDIT filename” from KCL, or by selecting KAREL EDITOR from MENUS, or by pressing the SELECT key on a VT-220 compatible CRT/KB. Invoking the editor causes the editor screen to be displayed on the CRT/KB. The editor screen includes one or more edit windows and a function key line.

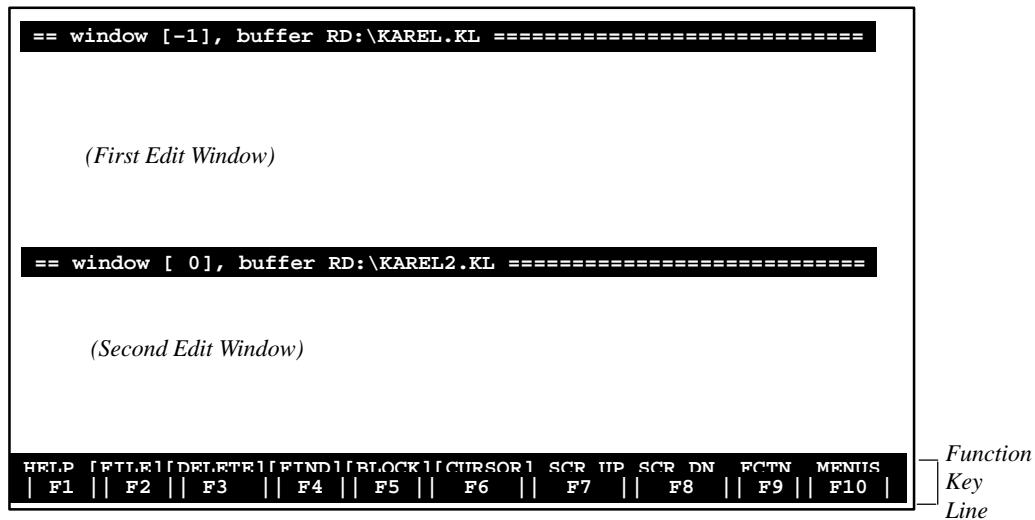
### 11.1.1 Edit Windows

The editor can display from one to seven edit windows. [Figure 11–1](#) shows the screen layout of an editor screen with one edit window and [Figure 11–2](#) shows the screen layout of an editor screen with two edit windows.

**Figure 11–1. KAREL Editor Screen, One Edit Window**



**Figure 11–2. KAREL Editor Screen, Two Edit Windows**



The current edit window is always "[0]".

**Size**

The size of the edit window depends on the number of edit windows you are using. For one edit window, the size is 21 lines. For two windows, the size of the first edit window is 10 lines and the size of the second edit window is 11 lines. Refer to [Table 11–1](#) for the size of each edit window for one- to seven-window screens.

**Table 11–1. Size of Edit Windows**

Number of Edit Windows	Window Number	Number of Lines	Number of Edit Windows	Window Number	Number of Lines
1	1	21	5	1	4
				2	4
				3	4
				4	4
				5	5
2	1	10	6	1	3
				2	3
				3	3
				4	3
				5	3
				6	6

Table 11-1. Size of Edit Windows (Cont'd)

Number of Edit Windows	Window Number	Number of Lines	Number of Edit Windows	Window Number	Number of Lines
3	1	7	7	1	3
	2	7		2	3
	3	7		3	3
				4	3
				5	3
				6	3
				7	3
4	1	5			
	2	5			
	3	5			
	4	6			

### Naming

Edit windows are normally **named** as follows:

- The **current edit window** is **0**.
- The **previous edit window** is **-1**.
- The **next edit window** is **1**.

#### 11.1.2 Function Key Line

The **function key line** displays function keys that when pressed will display menus of editor commands, except for F9 and F10, which are used for system menus. Refer to [Section 11.2](#) for information about editor commands.

## 11.2 EDITOR COMMAND SUMMARY

[Table 11–3](#) lists the editor commands available from each of the editor function keys. This section also contains a summary of editor commands for the following editor operations:

- Manipulating the cursor
- Scrolling text
- Inserting text and changing editing modes
- Deleting text
- Finding and replacing text
- Manipulating blocks of text
- Editing and manipulating multiple files
- Translating a KAREL program
- Using miscellaneous editor commands
- Saving a file and exiting the editor

Most editor commands can be issued by selecting items from function key menus. Some editor commands are available only through key sequences. Editor commands available through function key menus are also available through key sequences. [Table 11–3](#) lists the editor commands associated with function key menus, and their key sequences. The tables in [Section 11.2.1](#) through [Section 11.2.10](#) contain all editor commands.

### The Edit Process

When you begin editing a KAREL program, the KAREL editor copies the contents of the program file into an *edit buffer*. When the editor screen appears, a section of the edit buffer is displayed in the *edit window*. The editor can have up to seven edit windows. Each edit buffer can be displayed in a single edit window, or in multiple edit windows.

A *block* is a section of the edit buffer. A block has a beginning and an end. It can be displayed with no special markings or highlighted with reverse video. You can define, display, copy, delete, move, and search for a block.

During editing, the KAREL editor uses internal files. You will see the names of these internal files periodically displayed on the screen when you use the KAREL editor. HELP.FI is the help file that is created and displayed in a window when you select HELP. TEMP.FI is the backup file created when closing a file. TRANS.FI contains translator output. AUTOSAVE.FI is written every approximately 20 minutes to save your file during the edit process. If your edit session is aborted prematurely, AUTOSAVE.FI will be recovered the next time the editor is invoked. If your file contains tabs, you will see the “expanding tabs...” message each time you open the file.

The amount of memory available during an edit session for all edit buffers combined is defined by the system variable \$ED\_SIZE. By default, it is set to 30 KB. Refer to the *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for more information about \$ED\_SIZE.

**Note** If you edit a file that was created using another editor, it might contain control characters. A control character is normally non-printable and has an ASCII value of less than 32 or greater than 127. The KAREL editor is designed to work with ASCII files of printable characters, CR, LF, and tab. Remove all other control characters prior to usage with the KAREL editor and translator.

Refer to [Procedure 11-1](#) for information on using the KAREL editor.

## **Procedure 11-1 Using the KAREL Editor**

### **Condition**

- The RAM Disk has been set up.
- The RAM Disk is selected as the default device (for translation).

### **Step**

1. At the CRT/KB, press MENUS.
2. If you are using KCL, start the editing session **using KCL**:
  - a. Select KCL>.
  - b. Type the following and press ENTER:  
EDIT progname

Where program name is the name of the program you want to edit.

3. If you are using the menu, start the editing session **using a menu item**:
  - a. Select KAREL EDITOR.
  - b. Press ENTER.

See the following screen for an example.



## Key Sequences

A *key sequence* is a combination of keystrokes that issues an editor command. There are key sequences for each item on a function key menu and for additional commands.

A key sequence is represented by a control symbol (^), which indicates that the CONTROL key must be pressed, and followed by one or two letters, which indicate that specific letter keys on the keyboard be pressed simultaneously with the CONTROL key. For example, ^C indicates that you must simultaneously press the CONTROL and C keys; ^KQ indicates that you must simultaneously press the CONTROL and K keys, release the keys, and then press the Q key.

In most cases, you must press and hold the CONTROL key and press the indicated keys. Some CRT/KBs interpret control sequences beginning with ^Q, ^S, and ^W uniquely. [Table 11-2](#) lists the conversion of this sequence for DEC VT-220 terminals and the FANUC Industrialized Terminal.

**Table 11–2.** Alternate Key Sequences for ^Q, ^S, and ^W

Type of CRT/KB	Alternate Key Sequence
DEC VT-220 or compatible	<p><b>For ^Q</b>, press GOLD (PF1) and then press Q and any letters that follow ^Q.</p> <p><b>For ^S</b>, press GOLD (PF1) and then press S and any letters that follow ^S.</p> <p><b>For ^W</b>, press GOLD (PF1) and then press W and any letters that follow ^W.</p>
FANUC Industrialized Terminal	<p><b>For ^Q</b>, press the blank key to the right of F10 and then press Q and any letters that follow ^Q.</p> <p><b>For ^S</b>, press the blank key to the right of F10 and then press S and any letters that follow ^S.</p> <p><b>For ^W</b>, press the blank key to the right of F10 and then press W and any letters that follow ^W.</p>

The control symbol (^) will be used in all tables, even if the GOLD key is required for implementation.

**Table 11–3.** Editor Function Key Summary

Function Key	Item	Key Sequence	Description
HELP, F1	-	-	<p>Displays help information as follows:</p> <ul style="list-style-type: none"> <li>• If no help is currently displayed, help is displayed in a new window.</li> <li>• If help is currently displayed, but not in the current window, the window that contains help becomes the current window.</li> <li>• If help is currently displayed in the current window, help is closed.</li> </ul>

Table 11-3. Editor Function Key Summary (Cont'd)

Function Key	Item	Key Sequence	Description
FILE, F2	TRANS/BR	^KL	Saves the file, invokes the KAREL translator to process the file, and gives a brief report of the result: success, or error listing if failure. Loads p-code if translation is successful.
	TRANS/FU	^KM	Saves the file, invokes the KAREL translator to process the file, and gives a full report of the result, including line numbers and errors. Loads p-code if translation is successful.
	WINDOW	^OK	Creates a new edit buffer or changes edit buffer.
	NXT WIN	^O+	Selects the next edit window.*
	PRV WIN	^O-	Selects the previous edit window.
	QUIT/EX	^KQ	Does not save the contents of the edit buffer and exits the edit buffer.
	SAVE/CO	^KS	Saves the contents of the edit buffer and continues working in the edit buffer.
	SAVE/FI	^KT	Saves the contents of the edit buffer under a new file name and continues editing. The edit buffer name is unchanged.
	SAVE/EX		Saves the contents of the edit buffer only if changes have been made and exits the edit buffer.

Table 11-3. Editor Function Key Summary (Cont'd)

Function Key	Item	Key Sequence	Description
DELETE, F3	DEL C	^G	Deletes a character.
	DEL L	^Y	Deletes a line.
	DEL EOL	^QY	Deletes a line from current cursor position to end of line.
	DEL EOW	^T	Deletes from current cursor position to end of word.
	UNDO L	^QL	Restores a modified line to its original content.
FIND, F4	FIND	^QF	Finds a string.
	REPLACE	^QA	Finds a string and replaces it with another string.
	REPEAT	^L	Repeats the previous find or replace operation.
BLOCK, F5	MRK STRT	^KB	Marks the beginning of a block.
	MRK END	^KK	Marks the end of a block.
	COPY	^KC	Copies a marked block.
	MOVE	^KV	Moves a marked block to the current cursor position.
	DELETE	^KY	Deletes a marked block.
	READ/FI	^K@	Reads a file into a block at the current cursor position.
	WRITE/FI	^KW	Writes a block to a file at the current cursor position.
	HIDE/UN	^KH	Hides/displays block markers.

Table 11-3. Editor Function Key Summary (Cont'd)

Function Key	Item	Key Sequence	Description
CURSOR, F6	LINE	^QI	Moves the cursor to the beginning of the current line specified. If no line number is specified, the current line number is displayed.
	LEFT W	^A	Moves the cursor left one word.
	RIGHT W	^F	Moves the cursor right one word.
	START L	^QS	Moves the cursor to the beginning of the current line.
	END L	^QD	Moves the cursor to the end of the current line.
	START S	^QE	Moves the cursor to the beginning of the current edit window.
	END S	^QX	Moves the cursor to the end of the current edit window.
	START F	^QR	Moves the cursor to the beginning of the current edit buffer.
	END F	^QC	Moves the cursor to the end of the current edit buffer.
SCR UP, F7	-	-	Scrolls the screen up.
SCR DN, F8	-	-	Scrolls the screen down.
FCTN, F9	-	-	Displays the FUNCTIONS menu.
MENUS, F10	-	-	Displays the MENUS menu.
DO*	-	-	Displays the KCL screen while in the editor.

**Table 11-3.** Editor Function Key Summary (Cont'd)

Function Key	Item	Key Sequence	Description
SELECT*	-	-	Displays the editor while in the KCL screen.
NEXT*	-	-	Selects the next edit window.

\* For VT-220 compatible CRT/KBs only.

**Note** When all active edit buffers have been exited, the editor transfers control of the CRT/KB to KCL.

### **11.2.1 Cursor Manipulation**

[Table 11-4](#) contains a summary of commands that allow you to manipulate the cursor within the editor.

**Table 11-4.** Cursor Manipulation

Operation	Function Key	Menu Item	Key Sequence
Move the cursor to the beginning of the specified line. If no line number is specified, the current line number is displayed.	F6, CURSOR	LINE	^QI
Move the cursor left (backward) one word.	F6, CURSOR	LEFT W	^A
Move the cursor right (forward) one word.	F6, CURSOR	RIGHT W	^F
Move the cursor to the beginning of the current line.	F6, CURSOR	START L	^QS
Move the cursor to the end of the current line.	F6, CURSOR	END L	^QD
Move the cursor to the beginning of the current edit window.	F6, CURSOR	START S	^QE
Move the cursor to the end of the current edit window.	F6, CURSOR	END S	^QX
Move the cursor to the beginning of the current edit buffer.	F6, CURSOR	START F	^QR

**Table 11–4. Cursor Manipulation (Cont'd)**

Operation	Function Key	Menu Item	Key Sequence
Move the cursor to the end of the current edit buffer.	F6, CURSOR	END F	^QC
Move the cursor down one line.	↓	-	^X
Move the cursor up one line.	↑	-	^E
Move the cursor right one character.	⇒	-	^D
Move the cursor left one character.	⇐	-	^S
Move the cursor down one screen.	F8, SCR DN	-	^C
Move the cursor up one screen.	F7, SCR UP	-	^R
Move the cursor to the beginning of a marked block.	-	-	^QB
Move the cursor to the end of a marked block.	-	-	^QK
Move the cursor to a marker, 0...9.	-	-	^Q0...^Q9
Move the cursor forward to the matched pair of (), {}, [], "", /*/, begin end.	-	-	^Q), ^Q{}, ^Q[], ^Q', ^Q", ^Q/*, ^Qbegin
Move the cursor backward to the matched pair of (), {}, [], "", /*/, begin end.	-	-	^Q), ^Q{}, ^Q[], ^Q', ^Q", ^Q*/^, ^Qend
Move the cursor to its previous position.	-	-	^QP

### **11.2.2 Text Scrolling**

Table 11–5 contains a summary of commands that allow you to scroll text within the editor.

**Table 11–5.** Text Scrolling

Operation	Function Key	Menu Item	Key Sequence
Scroll down one line.	-	-	<sup>^</sup> Z
Scroll up one line.	-	-	<sup>^</sup> W
Scroll down one page.	F8, SCR DN	-	<sup>^</sup> C or F8, SCR DN
Scroll up one page.	F7, SCR UP	-	<sup>^</sup> R or F7, SCR UP

### **11.2.3 Text Insertion and Editing Modes**

[Table 11–6](#) contains a summary of commands that allow you to insert text and change editing modes.

**Table 11–6.** Text Insertion and Editing Modes

Operation	Function Key	Menu Item	Key Sequence
Insert a new line at the cursor, leave the cursor on the current line.	-	-	<sup>^</sup> N
Insert a new line at the cursor, the cursor moves to the beginning of the new line.	-	-	RETURN or ENTER
Change insertion mode between inserting a character in front of the cursor and overwriting a character at the cursor position.	-	-	<sup>^</sup> V
Change editing mode between indenting a new line to match the previous and starting a new line at column 0.	-	-	<sup>^</sup> OI
Change editing mode between matching earlier indentation and deleting just one character.	-	-	<sup>^</sup> OU <BACKSPACE>

### **11.2.4 Text Deletion**

[Table 11–7](#) contains a summary of commands that allow you to delete text.

**Table 11–7. Text Deletion**

Operation	Function Key	Menu Item	Key Sequence
Delete a character to the left of the cursor and move cursor left.	-	-	BACKSPACE DEL
Delete the character in the current cursor position.	F3, DELET	DEL C	^G
Delete the current line.	F3, DELET	DEL L	^Y
Delete from the current cursor position to the end of a line.	F3, DELET	DEL EOL	^QY
Delete from the current cursor position to the end of a word.	F3, DELET	DEL EOW	^T
Restore a modified line to its original content.	F3, DELET	UNDO L	^QL
Delete a marked block of text.	F5, BLOCK	DELETE	^KY
Delete a window, do not save its contents.	F2, FILE	QUIT/EX	^KQ
Delete a window, save its contents.	F2, FILE	SAVE/EX	^KX

### **11.2.5 Text Find and Replace**

[Table 11–8](#) contains a summary of commands that allow you to find and replace text.

**Table 11–8.** Text Find and Replace

Operation	Function Key	Menu Item	Key Sequence
Find a text string‡	F4, FIND	FIND	^QF
Find a string and replace it with another string‡	F4, FIND	REPLACE	^QA
Repeat the previous find or replace operation.	F4, FIND	REPEAT	^L
Search forward for the matched pair of (), {}, [], "", /* */, begin end.	-	-	^Q(, ^Q{, ^Q[, ^Q', ^Q", ^Q/*, ^Qbegin
Search backward for the matched pair of (), {}, "", /* */, begin end.	-	-	^Q), ^Q}, ^Q], ^Q', ^Q", ^Q*/^Qend

‡Use the find/replace options and the search string editing options in [Table 11–9](#) and [Table 11–10](#).

**Table 11–9.** Find/Replace Options

Find/Replace Option	Value
Match/do not match the case of the search string.	M/U: Match/ Unmatch
Search backwards.	B: Backwards
Scan entire file (global).	G: Global
Scan marked block (local).	L: Local
Replace without asking.	N: No verify
Match entire words only.	W: Word
Perform find/replace <n> times.	<n>

**Table 11–10.** Editing Search Strings

Operation	Key Sequence
Move cursor left.	^S or LEFT ARROW
Move cursor right.	^D or RIGHT ARROW
Move cursor to beginning of string.	^E
Move cursor to end of string.	^X
Delete all of string.	^Y
Restore original string.	^R
Delete character under cursor.	^G
Delete character to left of cursor, printable characters are inserted at cursor.	BACKSPACE or DEL

### **11.2.6 Text Block Manipulation**

[Table 11–11](#) contains a summary of commands that allow you to manipulate blocks of text.

**Table 11–11.** Text Block Manipulation

Operation	Function Key	Menu Item	Key Sequence
Mark the beginning of a block.	F5, BLOCK	MRK STRT	^KB
Mark the end of a block.	F5, BLOCK	MRK END	^KK
Copy a block of text.	F5, BLOCK	COPY	^KC
Move a block of text to the current cursor position.	F5, BLOCK	MOVE	^KV
Delete a block of text.	F5, BLOCK	DELETE	^KY

**Table 11–11.** Text Block Manipulation (Cont'd)

Operation	Function Key	Menu Item	Key Sequence
Write a block of text to a file.	F5, BLOCK	WRITE/FI	^KW
Hide/display block markers.	F5, BLOCK	HIDE/UN	^KH
Read a file into a block of text at the current cursor position, expanding tabs and other formatting commands.	F5, BLOCK	READ/FI	^K@
Read a file into a block of text at the current cursor position.	-	-	^KR
Indent a block by the current tab size.	-	-	^KI
Unindent a block by the current tab size.	-	-	^KU

### **11.2.7 Window Manipulation**

Table 11–12 contains a summary of commands that allow you to manipulate edit windows.

**Table 11–12.** Window Manipulation

Operation	Function Key	Menu Item	Key Sequence
Create a new edit window to a new or existing edit buffer below the current edit window.	F2, FILE	WINDOW	^OK
Change to another window.	F2, FILE	WINDOW	^OK
Delete a window, do not save its contents.	F2, FILE	QUIT/EX	^KQ
Delete a window, save its contents.	F2, FILE	SAVE/EX	^KX

### **11.2.8 KAREL Program Translation**

[Table 11–13](#) contains a summary of the command that allows you to translate a KAREL program.

**Table 11–13. KAREL Program Translation**

Operation	Function Key	Menu Item	Key Sequence
Saves the file, invokes the translator for the edit buffer in the current edit window, and reports brief information about success or failure. If successful, loads p-code.	F2, FILE	TRANS/BR	^KL
Saves the file, invokes the translator for the edit buffer in the current edit window, and reports full information about success or failure, including errors and line numbers. If successful, loads p-code.	F2, FILE	TRANS/FU	^KM

### **11.2.9 Miscellaneous Editor Commands**

[Table 11–14](#) contains a summary of miscellaneous editor commands.

**Table 11–14. Miscellaneous Editor Commands**

Operation	Function Key	Menu Item	Key Sequence
Abort the current command.	-	-	^U
Obtain on-screen help.	F1	HELP	^J
Restore the current line.	-	-	^QL
Set the position marker 0...9.	-	-	^K0...K9
Redraw the entire display.	-	-	^\\
Set a tab stop interval.	-	-	^OT

### **11.2.10 File Save and Exit**

Table 11–15 contains a summary of commands you can use to save a file and exit the editor.

**Table 11–15. File Save and Exit**

Operation	Function Key	Menu Item	Key Sequence
Do not save the file and exit the edit buffer.	F2, FILE	QUIT/EX	^KQ
Save the file but continue editing the file.	F2, FILE	SAVE/CO	^KS
Save the file under a new name, continue editing.	F2, FILE	SAVE/FI	^KT
Save the file only if modified, then exit the edit buffer.	F2, FILE	SAVE/EX	^KX
Save the file and exit the edit buffer.	-	-	^KD

**Note** When all active edit buffers have been exited, the editor transfers control of the CRT/KB to KCL.



# Chapter 12

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## SYSTEM VARIABLES

### Contents

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System variables are variables that are declared as part of the KAREL system software. They have permanently defined variable names that begin with a dollar sign (\$). Many system variables are *structure variables*, in which case each field also begins with a dollar sign (\$). Many are robot specific, meaning their values depend on the type of robot that is attached to the system.

System variables have the following characteristics:

- They have predefined data types that can be any one of the valid KAREL data types.
- The initial values of the system variables are either internal default values or variables stored in the default system variable file, SYSDEF.SV.
- When loading and saving system variables from the FILE screen or KCL, the system variable file name defaults to SYSVARS.SV.
- Access rights govern whether or not you can examine or change system variables.
- Modified system variables can be saved to reflect the current status of the system.

**See Also:** [Chapter 2 LANGUAGE ELEMENTS](#) for more information on the data types available in KAREL

## **12.1 ACCESS RIGHTS**

The following rules apply to system variables:

- If a system variable allows a KAREL program to read its value, you can use that value in the same context as you use program variable values or constant values in KAREL programs.

For example, these system variables can be used on the right hand side of an assignment statement or as a test condition in a control statement.

- If a system variable allows a KAREL program to write its value, you can use that system variable in any context where you assign values to variables in KAREL programs.

The symbols for the program access rights are listed in [Table 12–1](#). These symbols are given for each of the system variables in the *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual*.

**Table 12-1.** Access Rights for System Variables

Access	Meaning
NO	No access
RO	Read only
RW	Read and write
FP	Field protection; if it is a structure variable, one of the first three access rights will apply.

**See Also:** *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for system variables

### **12.1.1 System Variables Accessed by KAREL Programs**

Many system variables pertaining to motion are defined as an ARRAY[n] or a structure type where “n” is the number of motion groups defined on the controller. The system variable \$GROUP is defined in this fashion. The KAREL language recognizes \$GROUP as a special system variable and performs a USING \$GROUP[def\_group] at the beginning of each routine. Therefore, if the \$GROUP[n] prefix is not specified, the group specified by the %DEFGROUP directive or 1 is assumed. See [Specifying a Motion Group with System Variables](#) for an example.

#### **Specifying a Motion Group with System Variables**

```
$GROUP[1].$SPEED = 300
$SPEED = 300 -- same result as above
motion_time = motion_dist / $SPEED
$GROUP[1].$UFRAME = aux_frame_1
```



#### **Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, and injure personnel or damage equipment.**

[Table 12-2](#) is a list of the system variables that can be accessed by a KAREL program in the WITH clause of a motion statement.

**Table 12-2. System Variables Accessed by Programs**

\$ACCEL_OVRD	\$SEG_TIME
\$ACCU_NUM	\$SPEED
\$CNSTNT_PATH	\$TERMTYPE
\$CONTAXISVEL	\$TIME_SHIFT
\$DECELTOL	\$UFRAME
\$DYN_I_COMP	\$USE_CARTACC
\$MOTYPE	\$USE_CONFIG
\$ORIENT_TYPE	\$USEMAXACCEL
\$REF_POS	\$USERELACCEL
\$ROTSPEED	\$USETIMESHFT
\$SEGTERMTYPE	\$UTOOL

## **12.2 STORAGE**

System variables are assigned an initial value upon power up based on

- Internal default values
- Values stored in the default system variable file, SYSDEF.SV

# Chapter 13

---

## KAREL COMMAND LANGUAGE (KCL)

### Contents

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The KAREL command language (KCL) environment contains a group of commands that can be used to direct the KAREL system. KCL commands allow you to develop and execute programs, work with files, get information about the system, and perform many other daily operations.

The KCL environment can be displayed on the CRT/KB by pressing MENUS (F10) and selecting KCL from the menu.

In addition to entering commands directly at the KCL prompt, KCL commands can be executed from command files.

## **13.1 COMMAND FORMAT**

A command entry consists of the command keyword and any arguments or parameters that are associated with that command. Some commands also require identifiers specifying the object of the command.

- KCL command keywords are action words such as LOAD, EDIT, and RUN. Command arguments, or parameters, help to define on what object the keyword is supposed to act.
- Many KCL commands have default arguments associated with them. For these commands, you need to enter only the keyword and the system will supply the default arguments.
- KCL supports the use of an asterisk (\*) as a wildcard, which allows you to specify a group of objects as a command argument for the following KCL commands:
  - COPY
  - DELETE FILE
  - DIRECTORY
- KCL identifiers follow the same rules as the identifiers in the KAREL programming language.
- All of the data types supported by the KAREL programming language are supported in KCL. Therefore, you can create and set variables in KCL.

**See Also:** [Chapter 2 LANGUAGE ELEMENTS](#) , and [Chapter 9 FILE SYSTEM](#) ,

### **13.1.1 Default Program**

Setting a program name as a default for program name arguments and file name arguments allows you to issue a KCL command without typing the name.

The KCL default program can be set by doing one of the following:

- Using the SET DEFAULT KCL command
- Selecting a program name at the SELECT menu on the CRT/KB

### **13.1.2 Variables and Data Types**

The KCL> CREATE VARIABLE command allows you to declare variables. The KCL> SET VARIABLE command permits you to assign values to declared variables. Assigned values can be INTEGER, REAL, BOOLEAN, and STRING data types. Values can be assigned to particular ARRAY elements or specified PATH nodes. VECTOR variables are assigned as three REAL values, and POSITION variables are assigned as six REAL values.

**See Also:** CREATE VARIABLE and SET VARIABLE KCL commands in [Appendix C](#), “KCL Command Alphabetical Description”

## **13.2 MOTION CONTROL COMMANDS**

KCL commands can also cause motion, provided the device from which the command is issued has motion control. Refer to the \$RMT\_MASTER description in the *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for more information about assigning motion control to a remote device.

Motion commands:

- Immediately cause robot and/or auxiliary axis motion, or have the potential to cause motion
- Can be executed only if a number of conditions are met

The following commands are motion commands:

- CONTINUE
- RUN



#### **Warning**

**Be sure that the robot work envelope is clear of personnel before issuing a motion command or starting a robot that automatically executes a program at power up. Otherwise, you could injure personnel or damage equipment.**

## **13.3 ENTERING COMMANDS**

You can enter KCL commands only from the CRT/KB.

To enter KCL commands:

1. Press MENUS (F10) at the CRT/KB.

2. Select KCL.
3. Enter commands at the KCL prompt.

By entering the first keyword of a KCL command that requires more than one keyword, and by pressing ENTER, a list of all additional KCL keywords will be displayed.

For example, entering **DELETE** at the KCL prompt will display the following list of possible commands: “FILE, NODE, or VARIABLE.”

**Note** The up arrow key can be used to recall any of the last ten commands entered.

### **13.3.1 Abbreviations**

Any KCL command can be abbreviated as long as the abbreviations are unique in KCL. For example, **TRAN** is unique to TRANSLATE and **ED**, to EDIT.

### **13.3.2 Error Messages**

If you enter a KCL command incorrectly, KCL displays the appropriate error message and returns the KCL> prompt, allowing you to reenter the command. An up arrow (^) indicates the offending character or the beginning of the offending word.

### **13.3.3 Subdirectories**

Subdirectories are available on the memory card device. Subdirectories allow both memory cards and Flash disk cards to be formatted on any MS-DOS file system. You can perform all KCL file related commands on subdirectories. You can nest subdirectories up to many levels. However, FANUC Robotics does not recommend nesting subdirectories greater than eight levels.

## **13.4 COMMAND PROCEDURES**

Command procedures are a sequence of KCL commands that are stored in a command file (.CF file type) and can be executed automatically in sequence.

- Command procedures allow you to use a sequence of KCL commands without typing them over and over.
- Command procedures are executed using the RUNCF command.

### **13.4.1 Command Procedure Format**

All KCL commands except RUNCF can be used inside a command procedure. For commands that require confirmation, you can enter either the command and confirmation on one line or KCL will prompt for the confirmation on the input line. [Confirmation in a Command Procedure](#) displays **CLEAR ALL** as the KCL command and **YES** as the confirmation.

#### **Confirmation in a Command Procedure**

Enter command and confirmation on one line:

```
CLEAR ALL YES
```

#### **Nesting Command Procedures**

Use the following guidelines when nesting command procedures:

- Command procedures can be nested by using %INCLUDE filename inside a command procedure.
- Nesting of command procedures is restricted to four levels.

If nesting of more than four command procedures is attempted, KCL will detect the error and take the appropriate action based on the system variable \$STOP\_ON\_ERR. Refer to [Section 13.4.3](#) for more information on \$STOP\_ON\_ERR.

**See Also:** [Section 13.4.3](#) , “Error Processing”

#### **Continuation Character**

The KCL continuation character, ampersand (&), allows you to continue a command entry across more than one line in a command procedure.

You can break up KCL commands between keywords or between special characters.

For example, use the ampersand (&) to continue a command across two lines:

```
CREATE VAR [TESTING_PROG.]PICK_UP_PNT &
:POSITION
```

#### **Comments**

Comment lines can be used to document command procedures. The following rules apply to using comments in command procedures:

- Precede comments with two consecutive hyphens ( -- ).
- Comments can be placed on a line by themselves or at the end of a command line.

### **13.4.2 Creating Command Procedures**

A command procedure can be created by typing in the list of commands into a command file and saving the file. This can be done using the full screen editor.

**See Also:** EDIT KCL commands, [Appendix C](#), “KCL Command Alphabetical Description”

### **13.4.3 Error Processing**

If the system detects a KCL error while a command procedure is being executed, the system handles the error in one of two ways, depending on the value of the system variable \$STOP\_ON\_ERR:

- If \$STOP\_ON\_ERR is TRUE when a KCL error is detected, the command procedure terminates and the KCL> prompt returns.
- If \$STOP\_ON\_ERR is FALSE, the system ignores KCL errors and the command procedure runs to completion.

### **13.4.4 Executing Command Procedures**

Each command in a command procedure is displayed as it is executed unless the SET VERIFY OFF command is used. Each command is preceded with the line number from the command file. However, if the file is not on the RD: device, the entire command file is read into memory before execution and line numbers will be omitted from the display.

Command procedures can be executed using the KCL RUNCF command.

# Chapter 14

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## INPUT/OUTPUT SYSTEM

### Contents

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The Input/Output (I/O) system provides user access with KAREL to user-defined I/O signals, system-defined I/O signals and communication ports. The user-defined I/O signals are controlled in a KAREL program and allow you to communicate with peripheral devices and the robot end-of-arm tooling. System-defined I/O signals are those that are designated by the KAREL system for specific purposes. Standard and optional communications port configurations also exist.

The number of user-defined I/O signals is dependent on the controller hardware and on the types and number of modules selected. The controller can use modular I/O and process I/O.

## **14.1 USER-DEFINED SIGNALS**

*User-defined signals* are those input and output signals whose meaning is defined by a KAREL program. You have access to user-defined signals through the following predefined port arrays:

- DIN (digital input) and DOUT (digital output)
- GIN (group input) and GOUT (group output)
- AIN (analog input) and AOUT (analog output)

In addition to the port arrays, you have access to robot hand control signals through KAREL OPEN and CLOSE HAND statements.

### **14.1.1 DIN and DOUT Signals**

The DIN and DOUT signals provide access to data on a single input or output line in a KAREL program.

The program treats the data as a BOOLEAN data type. The value is either ON (active) or OFF (inactive). You can define the polarity of the signal as either active-high (ON when voltage is applied) or active-low (ON when voltage is not applied).

Input signals are accessed in a KAREL program by the name DIN[n], where “n” is the signal number.

Evaluating DIN signals causes the system to perform read operations of the input port. Assigning a value to a DIN signal is an invalid operation unless the DIN signal has been simulated. These can never be set in a KAREL program, unless the DIN signal has been simulated.

Evaluating DOUT signals causes the system to return the currently output value from the specified output signal. Assigning a value to a DOUT signal causes the system to set the output signal to ON or OFF.

**To turn on a DOUT:**

DOUT[n] = TRUE or  
DOUT[n] = ON

**To turn off a DOUT:**

DOUT[n] = FALSE or  
DOUT[n] = OFF

You assign digital signals to the ports on process I/O board outputs and/or ports on digital output modules using teach pendant I/O menus or the KAREL built-in routine SET\_PORT\_ASG.

### **14.1.2 GIN and GOUT Signals**

The GIN and GOUT signals provide access to DINs and DOUTs as a group of input or output signals in a KAREL program. A group can have a size of 1 to 16 bits, with each bit corresponding to an input or output signal. You define the group size and the DINs or DOUTs associated with a specific group. The first (lowest numbered) port is the least significant bit of the group value.

The program treats the data as an INTEGER data type. The unused bits are interpreted as zeros.

Input signals are accessed in KAREL programs by the name GIN[n], where “n” is the group number.

Evaluating GIN signals causes the system to perform read operations of the input ports. Assigning a value to a GIN signal is an invalid operation unless the GIN signal has been simulated. These can never be set in a KAREL program, unless the GIN signal has been simulated.

Setting GOUT signals causes the system to return the currently output value from the specified output port. Assigning a value to a GOUT signal causes the system to perform an output operation.

To control a group output, the integer value equivalent to the desired binary output is used. For example the command GOUT[n] = 25 will have the following binary result “0000000000011001” where 1 = output on and 0 = output off, least significant bit (LSB) being the first bit on the right.

You assign group signals using teach pendant I/O menus or the KAREL built-in routine SET\_PORT\_ASG.

### **14.1.3 AIN and AOUT Signals**

The AIN and AOUT signals provide access to analog electrical signals in a KAREL program. For input signals, the analog data is digitized by the system and passed to the KAREL program as a 16 bit binary number, of which 14 bits, 12 bits, or 8 bits are significant depending on the analog module. The program treats the data as an INTEGER data type. For output signals, an analog voltage corresponding to a programmed INTEGER value is output.

[Table 14–1](#) and [Table 14–2](#) shows the correspondence between the actual signal voltage and the value assigned to the AIN or AOUT.

Input signals are accessed in KAREL programs by the name AIN[n], where “n” is the signal number.

Evaluating AIN signals causes the system to perform read operations of the input port. Setting an AIN signal at the Teach Pendant is an invalid operation unless the AIN signal has been simulated. These can never be set in a KAREL program.

The value displayed on the TP or read by a program from an analog input port are dependent on the voltage supplied to the port and the number of bits of significant data supplied by the analog-to-digital conversion. For positive input voltages, the values read will be in the range from 0 to  $2^{**}(N-1)$  -1, where N is the number of bits of significant data. For 12 bit devices (most FANUC modules), this is  $2^{**}11$ , or 2047.

For negative input voltages, the value will be in the range  $2^{**}N - 1$  to  $2^{**}(N-1)$  as the voltage varies from the smallest detectable negative voltage to the largest negative voltage handled by the device. For 12 bit devices, this is from 4095 to 2048.

An example of the KAREL logic for converting this input to a real value representing the voltage, where the device is a 12 bit device which handles a range from +10v to -10v would be as follows:

**Figure 14-1. KAREL Logic for Converting Input to a Real Value Representing the Voltage**

```
V: REAL
AINP: INTEGER
```

```
AINP = AIN[1]

IF (AINP <= 2047) THEN
V = AINP * 10.0 / 2047.0
ELSE
V = (AINP - 4096) * 10.0 / 2047
ENDIF
```

In TPP, the following logic would be used:

```
R[1] = AI[1]
IF (R[1] > 2047) JMP LBL[1]
R[2] = R[1] * 10
R[2] = R[2] / 2047
JMP LBL[2]
LBL[1]:
R[2] = R[1] - 4096
R[2] = R[2] * 10
R[2] = R[2] / 2047
LBL[2]
```

R[2] has the desired voltage.

Evaluating AOUT signals causes the system to return the currently output value from the specified output signal. Assigning a value to an AOUT signal causes the system to perform an output operation.

An AOUT can be turned on in a KAREL program with AOUT[n] = (an integer value). The result will be the output voltage on the AOUT signal line[n] of the integer value specified. For example,

AOUT[1] = 1000 will output a +5 V signal on Analog Output line 1 (using an output module with 12 significant bits). Refer to [Table 14–1](#) and [Table 14–2](#).

**Table 14–1.** Analog Input Module Configuration

Item	Specification	
Name	AAD04A	
Input channels	4 channels per module	
Analog input	-10 VDC ~ + 10 VDC (input resistance 4.7MΩ) -20 mADC ~ + 20 mADC (input resistance 250Ω) selectable	
Digital output	12 bit binary (complementary representation of 2)	
Input/output correspondence	<b>Analog Input</b> +10 V +5 V or 20 mA 0 V or 0 mA -5 V or -20 mA -10 V	<b>Digital Output</b> +2000 +1000 0 -1000 -2000

**Table 14–2.** Analog Output Module Configuration

Name	Specification
Name	ADA02A
Output channels	2 channels per module
Digital input	12 bit binary (complementary representation of 2)

**Table 14–2. Analog Output Module Configuration (Cont'd)**

Name	Specification	
Analog output	-10 VDC ~ + 10 VDC (input resistance 10KΩ or more) -20 mA DC ~ + 20 mA DC (input resistance 400Ω or less)	
Input/output correspondence	<b>Digital Output V</b> +2000 +1000 0 -1000 -2000	<b>Analog Input</b> +10 +5 V or 20 mA 0 V or 0 mA -5 V or -20 mA -10 V

You assign analog signals using teach pendant I/O menus or the KAREL built-in routine SET\_PORT\_ASG.

#### **14.1.4 Hand Signals**

You have access to a special set of robot hand control signals used to control end-of-arm tooling through the KAREL language HAND statements, rather than through port arrays. HAND signals provide a KAREL program with access to two output signals that work in a coordinated manner to control the tool. The signals are designated as the open line and the close line. The system can support up to two HAND signals.

HAND[1] uses the same physical outputs as RDO[1] and RDO[2].

HAND[2] uses the same physical outputs as RDO[3] and RDO[4].

The following KAREL language statements are provided for controlling the signal, where “n” is the signal number.

OPEN HAND n activates open line, and deactivates close line

CLOSE HAND n deactivates open line, and activates close line

RELAX HAND n deactivates both lines

## 14.2 SYSTEM-DEFINED SIGNALS

System-defined I/O signals are signals designated by the KAREL system for a specific purpose. Except for certain UOP signals, system-defined I/O cannot be reassigned.

You have access to system-defined I/O signals through the following port arrays:

- Robot digital input (RDI) and robot digital output (RDO)
- Operator panel input (OPIN) and operator panel output (OPOUT)
- Teach pendant input (TPIN) and teach pendant output (TPOUT)

### 14.2.1 Robot Digital Input and Output Signals (RDI/RDO)

Robot I/O is the input and output signals between the controller and the robot. These signals are sent to the EE (End Effector) connector located on the robot. The number of robot input and output signals (RDI and RDO) varies depending on the number of axes in the system. For more information on configuring Robot I/O, refer to the appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual*.

**RDI[1] through RDI[8]** are available for tool inputs. All or some of these signals can be used, depending on the robot model. Refer to the Maintenance Manual specific to your robot model, for more information.

**RDO[1] through RDO[8]** are available for tool control. All or some of these signals can be used, depending on the robot model. Refer to the Maintenance Manual specific to your robot model, for more information.

**RDO[1] through RDO[4]** are the same signals set using OPEN, CLOSE, and RELAX hand. See [Section 14.1.4](#) .

### 14.2.2 Operator Panel Input and Output Signals (OPIN/OPOUT)

Operator panel input and output signals are the input and output signals for the standard operator panel (SOP) and for the user operator panel (UOP).

Operator panel input signals are assigned as follows:

- The first 16 signals, OPIN[0] - OPIN[15], are assigned to the standard operator panel.
- The next 17 signals, OPIN[16] - OPIN[33], are assigned to the user operator panel (UOP). If you have a process I/O board, these 17 UOP signals are mapped to the first 17 input ports on the process I/O board.

Operator panel output signals are assigned as follows:

- The first 16 signals, OPOUT[0] - OPOUT[15], are assigned to the standard operator panel.
- The next 19 signals, OPOUT[16] - OPOUT[35], are assigned to the user operator panel (UOP). If you have a process I/O board, these 19 UOP signals are mapped to the first 19 output ports on the process I/O board.

### **Standard Operator Panel Input and Output Signals**

Standard operator panel input and output signals are recognized by the KAREL system as OPIN[0] - OPIN[15] and OPOUT[0] - OPOUT[15] and by the screens on the teach pendant as SI[0] - SI[15] and SO[0] - SO[15]. [Table 14-3](#) lists each standard operator panel input signal. [Table 14-4](#) lists each standard operator panel output signal.

**Table 14-3. Standard Operator Panel Input Signals**

OPIN[n]	SI[n]	Function	Description
OPIN[0]	SI[0]	NOT USED	-
OPIN[1]	SI[1]	FAULT RESET	This signal is normally turned OFF, indicating that the FAULT RESET button is not being pressed.
OPIN[2]	SI[2]	REMOTE	This signal is normally turned OFF, indicating that the controller is not set to remote.
OPIN[3]	SI[3]	HOLD	This signal is normally turned ON, indicating that the HOLD button is not being pressed.
OPIN[4]	SI[4]	USER PB#1 (PURGE ENABLE for P-series robots)	This signal is normally turned OFF, indicating that USER PB#1 is not being pressed.
OPIN[5]	SI[5]	USER PB#2	This signal is normally turned OFF, indicating that USER PB#2 is not being pressed.
OPIN[6]	SI[6]	CYCLE START	This signal is normally turned OFF, indicating that the CYCLE START button is not being pressed.
OPIN[7] - OPIN[15]	SI[7] - SI[15]	NOT USED	-

**Table 14–4.** Standard Operator Panel Output Signals

OPOUT[n]	SOI[n]	Function	Description
OPOUT[0]	SO[0]	REMOTE LED	This signal indicates that the controller is set to remote.
OPOUT[1]	SO[1]	CYCLE START	This signal indicates that the CYCLE START button has been pressed or that a program is running.
OPOUT[2]	SO[2]	HOLD	This signal indicates that the HOLD button has been pressed or that a hold condition exists.
OPOUT[3]	SO[3]	FAULT LED	This signal indicates that a fault has occurred.
OPOUT[4]	SO[4]	BATTERY ALARM	This signal indicates that the CMOS battery voltage is low.
OPOUT[5]	SO[5]	USER LED#1 (PURGE COMPLETE for P-series robots)	This signal is user-definable.
OPOUT[6]	SO[6]	USER LED#2	This signal is user-definable.
OPOUT[7]	SO[7]	TEACH PENDANT ENABLED	This signal indicates that the teach pendant is enabled.
OPOUT[8] - OPOUT[15]	SO[8] - SO[15]	NOT USED	-

### User Operator Panel Input and Output Signals

User operator panel input and output signals are recognized by the KAREL system as OPIN[16]-OPIN[33] and OPOUT[16]-OPOUT[35] and by the screens on the teach pendant as UI[1]-UI[18] and UO[1]-UO[20]. On the process I/O board, UOP input signals are mapped to the first 18 digital input signals and UOP output signals are mapped to the first 20 digital output signals. [Table 14–5](#) lists and describes each user operator panel input signal. [Table 14–6](#) lists each user operator panel output signal. [Figure 14–2](#) and [Figure 14–3](#) illustrate the timing of the UOP signals.

Table 14–5. User Operator Panel Input Signals

OPIN[n]	UI[n]	Process I/O Number	Function	Description
OPIN[16]	UI[1]	1	*IMSTP Always active	<p>*IMSTP is the immediate stop software signal. *IMSTP is a normally OFF signal held ON that when set to OFF will</p> <ul style="list-style-type: none"> <li>• Pause a program if running.</li> <li>• Shut off power to the servos.</li> <li>• Immediately stop the robot and applies robot brakes.</li> </ul> <p>Error code SRVO-037 *IMSTP Input (Group:i) will be displayed when this signal is lost. This signal is always active.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  <b>Warning</b> <p>*IMSTP is a software controlled input and cannot be used for safety purposes. Use *IMSTP with EMG1, EMG2, and EMGCOM to use this signal with a hardware controller emergency stop. Refer to the Maintenance Manual, specific to your robot model, for connection information of EMG1, EMG2, and EMGCOM.</p> </div>
OPIN[17]	UI[2]	2	*HOLD Always active	<p>*HOLD is the external hold signal. *HOLD is a normally OFF signal held ON that when set to OFF will</p> <ul style="list-style-type: none"> <li>• Pause program execution.</li> <li>• Slow motion to a controlled stop and hold.</li> <li>• Optional Brake on Hold shuts off servo power after the robot stops.</li> </ul>

Table 14-5. User Operator Panel Input Signals (Cont'd)

OPIN[n]	UI[n]	Process I/O Number	Function	Description
OPIN[18]	UI[3]	3	*SFSPD Always active	<p>*SFSPD is the safety speed input signal. This signal is usually connected to the safety fence.*SFSPD is a normally OFF signal held ON that when set OFF will</p> <ul style="list-style-type: none"> <li>• Pause program execution.</li> <li>• Reduce the speed override value to that defined in a system variable. This value cannot be increased while *SFSPD is OFF.</li> <li>• Display error code message MF-0004 Fence Open.</li> <li>• Not allow a REMOTE start condition. Start inputs from UOP or SOP are disabled when *SFSPD is set to OFF.</li> </ul>

Table 14-5. User Operator Panel Input Signals (Cont'd)

OPIN[n]	UI[n]	Process I/O Number	Function	Description
OPIN[19]	UI[4]	4	CSTOPI Always active	<p>CSTOPI is the cycle stop input. When CSTOPI becomes TRUE, the system variable \$CSTOP is set to TRUE. In addition, if the system variable \$SHELL_CONFIG.\$shell_name is not TRUE or is uninitialized at power up, CSTOPI functions as follows, depending on the system variable \$SHELL_CFG.\$USE_ABORT. <b>If the system variable \$SHELL_CFG.\$USE_ABORT is set to FALSE , the CSTOPI input</b></p> <ul style="list-style-type: none"> <li>• Clears the queue of programs to be executed that were sent by RSR signals.</li> </ul> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  <b>Warning</b>  <b>When \$SHELL_CFG.USE_ABORT is FALSE, CSTOPI does not immediately stop automatic program execution.</b> </div> <ul style="list-style-type: none"> <li>• Automatic execution will be stopped after the current program has finished executing.</li> </ul> <p><b>If the system variable \$SHELL_CFG.\$USE_ABORT is set to TRUE, the CSTOPI input</b></p> <ul style="list-style-type: none"> <li>• Clears the queue of programs to be executed that were sent by RSR signals.</li> <li>• Immediately aborts the currently executing program for programs that were sent to be executed by either RSR or PNS.</li> </ul>
OPIN[20]	UI[5]	5	FAULT_RESET Always active	<p>FAULT_RESET is the external fault reset signal. When this signal is received</p> <ul style="list-style-type: none"> <li>• Error status is cleared.</li> <li>• Servo power is turned ON.</li> <li>• A paused program <b>will not be resumed</b>.</li> </ul>

Table 14-5. User Operator Panel Input Signals (Cont'd)

OPIN[n]	UI[n]	Process I/O Number	Function	Description
OPIN[21]	UI[6]	6	START  Active when the robot is in a remote condition (CMDENBL = ON)	START is the remote start input. How this signal functions depends on the system variable \$SHELL_CFG.\$CONT_ONLY. If the system variable \$SHELL_CFG.\$CONT_ONLY is set to FALSE, the START input signal will <ul style="list-style-type: none"> <li>Resume a paused program.</li> <li>If a program is not paused, the currently selected program starts from the position of the cursor.</li> </ul> If the system variable \$SHELL_CFG.\$CONT_ONLY is set to TRUE, the START input signal will <ul style="list-style-type: none"> <li>Resume a paused program only. The PROD_START input must be used to start a program from the beginning.</li> </ul>
OPIN[22]	UI[7]	7	HOME  Active when the robot is in a remote condition	HOME is the home input. When this signal is received the robot moves to the defined home position.
OPIN[23]	UI[8]	8	ENBL  Always active	ENBL is the enable input. This signal must be ON to have motion control ability. When this signal is OFF, robot motion can be done. When ENBL is ON and the REMOTE switch on the operator panel is in the REMOTE position, the robot is in a remote operating condition.

Table 14–5. User Operator Panel Input Signals (Cont'd)

OPIN[n]	UI[n]	Process I/O Number	Function	Description
OPIN[24]- OPIN[27]	UI[9]- UI[12]	9- 12	RSR1/PNS1, RSR2/PNS2, RSR3/PNS3, RSR4/PNS4  Active when the robot is in a remote condition (CMDENBL = ON)	<b>RSR1-4</b> are the robot service request input signals. When one of these signals is received, the corresponding RSR program is executing or, or a program is running currently, stored in a queue for later execution. RSR signals are used for production operation and can be received while an ACK output is being pulsed. See <a href="#">Figure 14–2</a> . <b>PNS 1-8</b> are program number select input signals. PNS selects programs for execution, <b>but does not execute programs</b> . Programs that are selected by PNS are executed using the START input or the PROD_START input depending on the value of the system variable \$SHELL_CFG.\$CONT_ONLY. The PNS number is output by pulsing the SNO signal (selected number output) and the SNACK signal (selected number acknowledge). See <a href="#">Figure 14–3</a> .
OPIN[28]- OPIN[31]	UI[13]- UI[16]	13- 16	PNS5, PNS6, PNS7, PNS8 Active when the robot is in a remote condition (CMDENBL = ON)	<b>PNS 1-8</b> are program number select input signals. PNS selects programs for execution, <b>but does not execute programs</b> . Programs that are selected by PNS are executed using the START input or the PROD_START input depending on the value of the system variable \$SHELL_CFG.\$CONT_ONLY. The PNS number is output by pulsing the SNO signal (selected number output) and the SNACK signal (selected number acknowledge). See <a href="#">Figure 14–3</a> .
OPIN[32]	UI[17]	17	PNSTROBE Active when the robot is in a remote condition (CMDENBL = ON)	The PNSTROBE input is the program number select strobe input signal. See <a href="#">Figure 14–3</a> .
OPIN[33]	UI[18]	18	PROD_START Active when the robot is in a remote condition (CMDENBL = ON)	The PROD_START input, when used with PNS, will initiate execution of the selected program from the PNS lines. When used without PNS, PROD_START executes the selected program from the current cursor position. See <a href="#">Figure 14–3</a> .

Table 14–6. User Operator Panel Output Signals

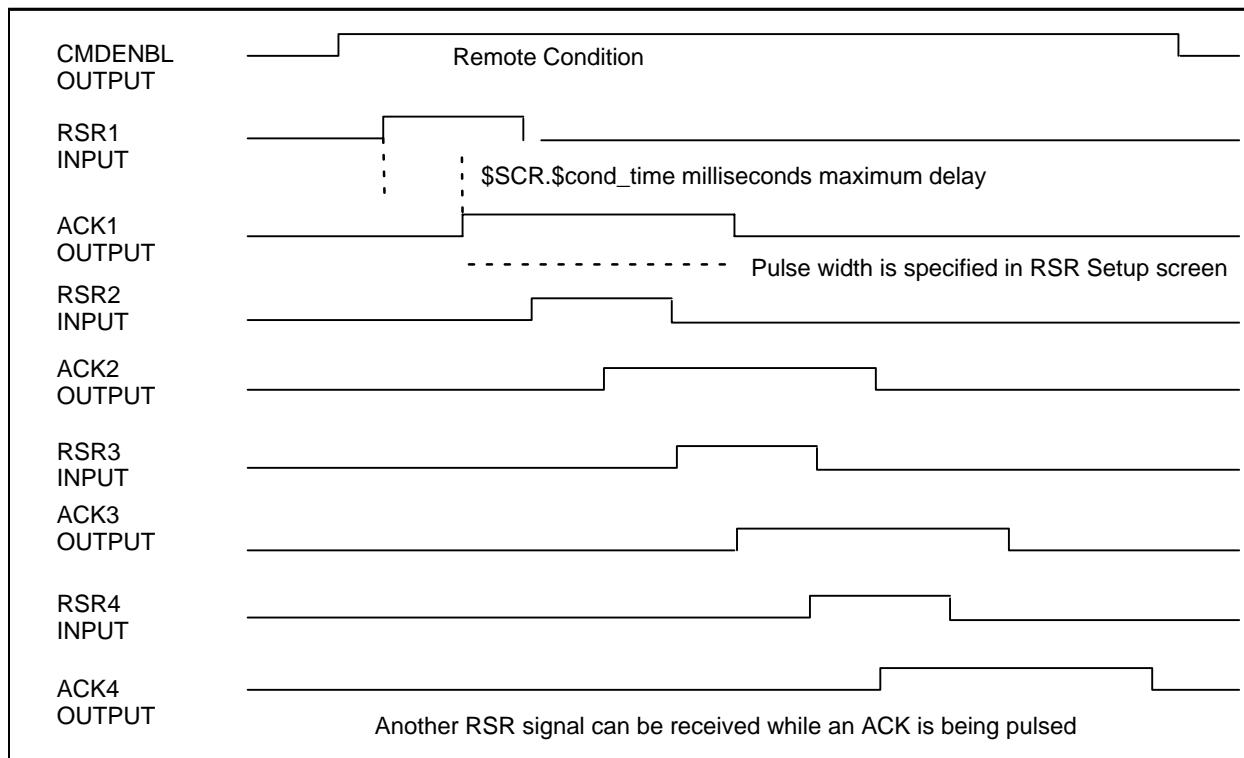
OPOUT[n]	UO[n]	Process I/O Number	Function	Description
OPOUT[16]	UO[1]	1	CMDENBL	CMDENBL is the command enable output. This output indicates that the robot is in a remote condition. This signal goes ON when the REMOTE switch is turned to ON or when the ENBL input is received. This output only stays on when the robot is not in a fault condition. See <a href="#">Figure 14–2</a> and <a href="#">Figure 14–3</a> .
OPOUT[17]	UO[2]	2	SYSRDY	SYSRDY is the system ready output. This output indicates that servos are turned ON.
OPOUT[18]	UO[3]	3	PROGRUN	PROGRUN is the program run output. This output turns on when a program is running. See <a href="#">Figure 14–3</a> .
OPOUT[19]	UO[4]	4	PAUSED	PAUSED is the paused program output. This output turns on when a program is paused.
OPOUT[20]	UO[5]	5	HELD	HELD is the hold output. This output turns on when the SOP HOLD button has been pressed, or the UOP *HOLD input is OFF.
OPOUT[21]	UO[6]	6	FAULT	FAULT is the error output. This output turns on when a program is in an error condition.
OPOUT[22]	UO[7]	7	ATPERCH	Not supported. Refer to the appropriate application-specific <i>FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual</i> , “Reference Position Utility” section.

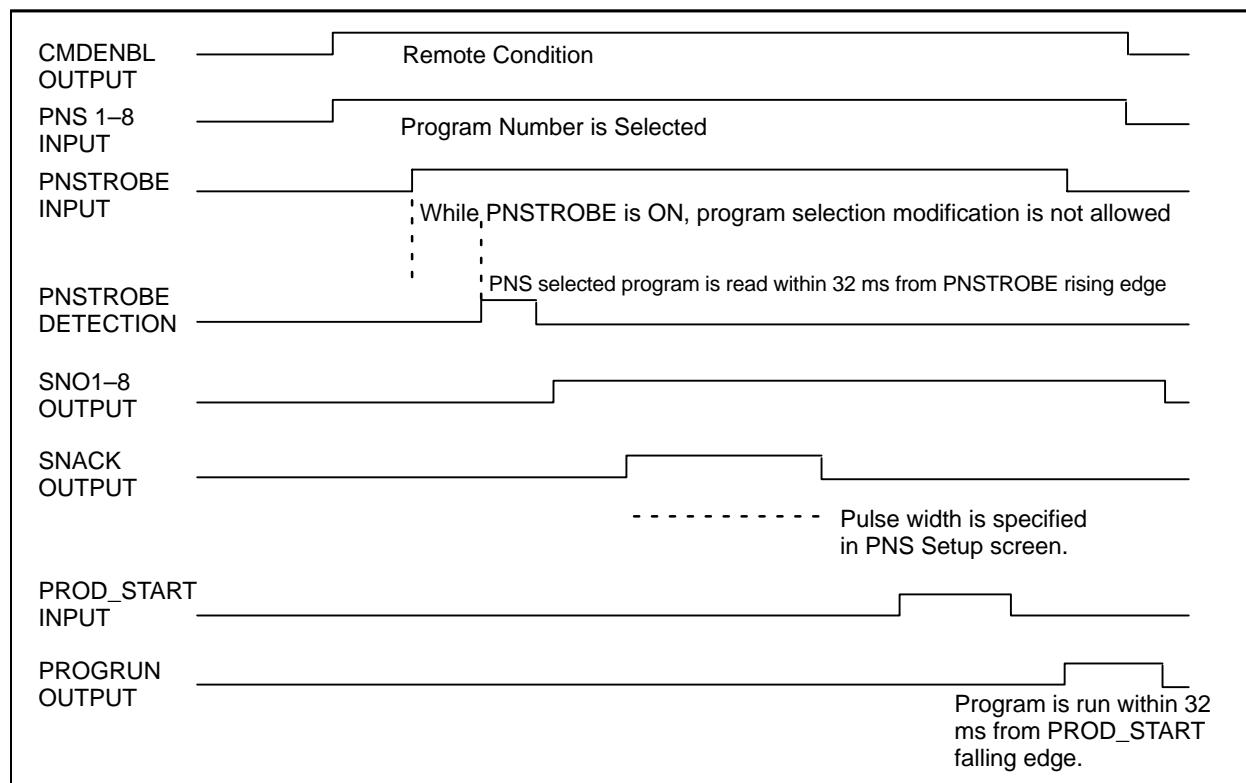
Table 14–6. User Operator Panel Output Signals (Cont'd)

OPOUT[n]	UO[n]	Process I/O Number	Function	Description
OPOUT[23]	UO[8]	8	TPENBL	TPENBL is the teach pendant enable output. This output turns on when the teach pendant is on.
OPOUT[24]	UO[9]	9	BATALM	BATALM is the battery alarm output. This output turns on when the CMOS RAM battery voltage goes below 3.6 volts.
OPOUT[25]	UO[10]	10	BUSYE	BUSYE is the processor busy output. This signal turns on when the robot is executing a program or when the processor is busy.
OPOUT[26] OPOUT[29]	UO[11]- UO[14]	11- 14	ACK1/SNO1, ACK2/SNO2, ACK3/SNO3, ACK4/SNO4	<b>ACK 1-4</b> are the acknowledge signals output 1 through 4. These signals turn on when the corresponding RSR signal is received. See <a href="#">Figure 14–2</a> . <b>SNO 1-8</b> are the signal number outputs. These signals carry the 8-bit representation of the corresponding PNS selected program number. If the program cannot be represented by an 8-bit number, the signal is set to all zeroes or off. See <a href="#">Figure 14–3</a> .
OPOUT[30] OPOUT[33]	UO[15]- UO[18]	15- 18	SNO5, SNO6, SNO7, SNO8	<b>SNO 1-8</b> are the signal number outputs. These signals carry the 8-bit representation of the corresponding PNS selected program number. If the program cannot be represented by an 8-bit number, the signal is set to all zeroes or off. See <a href="#">Figure 14–3</a> .
OPOUT[34]	UO[19]	19	SNACK	SNACK is the signal number acknowledge output. This output is pulsed if the program is selected by PNS input. See <a href="#">Figure 14–3</a> .

Table 14-6. User Operator Panel Output Signals (Cont'd)

OPOUT[n]	UO[n]	Process I/O Number	Function	Description
OPOUT[35]	UO[20]	20	RESERVED	-
OPOUT[36]	UO[21]	21	UNCAL (option)	UNCAL is the uncalibrated output. This output turns on when the robot is not calibrated. The robot is uncalibrated when the controller loses the feedback signals from one or all of the motors. Set \$OPWORK.\$OPT_OUT = 1 to use this signal.
OPOUT[37]	UO[22]	22	UPENBL (option)	UPENBL is the user panel enable output. This output indicates that the robot is in a remote condition. This signal goes on when the remote switch is turned to ON or when the ENBL input is received. <b>This output will stay on even if the robot is in a fault condition.</b> Set \$OPWORK.\$OPT_OUT = 1 to use this signal.
OPOUT[38]	UO[23]	23	LOCKED (option)	-
OPOUT[39]	UO[24]	24	CSTOPO (option)	CSTOPO is the cycle stop output. This output turns on when the CSTOPI input has been received. Set \$OPWORK.\$OPT_OUT = 1 to use this signal.

**Figure 14–2. RSR Timing Diagram**

**Figure 14–3. PNS Timing Diagram**

### **14.2.3 Teach Pendant Input and Output Signals (TPIN/TPOUT)**

The teach pendant input signals (TPIN) provide read access to input signals generated by the teach pendant keys. Teach pendant inputs can be accessed through the TPIN port arrays. A KAREL program treats teach pendant input data as a BOOLEAN data type. The value is either ON (active--the key is pressed) or OFF (inactive--the key is not pressed). TPIN signals are accessed in KAREL programs by the name TPIN[n], where “n” is the signal number, which is assigned internally. Refer to [Table 14–7](#) for teach pendant input signal assignments.

**Table 14–7.** Teach Pendant Input Signal Assignments

TPIN[n]	Teach Pendant Key
<b>EMERGENCY STOP AND DEADMAN</b>	
TPIN[250]	EMERGENCY STOP
TPIN[249]	ON/OFF switch
TPIN[247]	Right DEADMAN switch
TPIN[248]	Left DEADMAN switch
<b>Arrow Keys</b>	
TPIN[212]	Up arrow
TPIN[213]	Down arrow
TPIN[208]	Right arrow
TPIN[209]	Left arrow
TPIN[0]	Left and/or right shift
TPIN[204]	Shifted Up arrow
TPIN[205]	Shifted Down arrow
TPIN[206]	Shifted Right arrow
TPIN[207]	Shifted Left arrow
<b>Keypad Keys (shifted or unshifted)</b>	

**Table 14–7.** Teach Pendant Input Signal Assignments (Cont'd)

TPIN[n]	Teach Pendant Key
TPIN[13]	ENTER
TPIN[8]	BACK SPACE
TPIN[48]	0
TPIN[49]	1
TPIN[50]	2
TPIN[51]	3
TPIN[52]	4
TPIN[53]	5
TPIN[54]	6
TPIN[55]	7
TPIN[56]	8
TPIN[57]	9
<b>Function Keys</b>	

**Table 14–7.** Teach Pendant Input Signal Assignments (Cont'd)

TPIN[n]	Teach Pendant Key
TPIN[128]	PREV
TPIN[129]	F1
TPIN[131]	F2
TPIN[132]	F3
TPIN[133]	F4
TPIN[134]	F5
TPIN[135]	NEXT
TPIN[136]	Shifted PREV
TPIN[137]	Shifted F1
TPIN[138]	Shifted F2
TPIN[139]	Shifted F3
TPIN[140]	Shifted F4
TPIN[141]	Shifted F5
TPIN[142]	Shifted NEXT
<b>Menu Keys</b>	

**Table 14-7.** Teach Pendant Input Signal Assignments (Cont'd)

TPIN[n]	Teach Pendant Key
TPIN[143]	SELECT
TPIN[144]	MENUS
TPIN[145]	EDIT
TPIN[146]	DATA
TPIN[147]	FCTN
TPIN[148]	ITEM
TPIN[149]	+%
TPIN[150]	-%
TPIN[151]	HOLD
TPIN[152]	STEP
TPIN[153]	RESET
TPIN[240]	DISP
TPIN[203]	HELP
TPIN[154]	Shifted ITEM
TPIN[155]	Shifted +%
TPIN[156]	Shifted -%
TPIN[157]	Shifted STEP
TPIN[158]	Shifted HOLD
TPIN[159]	Shifted RESET
TPIN[227]	Shifted DISP
TPIN[239]	Shifted HELP

**Table 14-7. Teach Pendant Input Signal Assignments (Cont'd)**

TPIN[n]	Teach Pendant Key
<b>User Function Keys</b>	
TPIN[173]	USER KEY 1
TPIN[174]	USER KEY 2
TPIN[175]	USER KEY 3
TPIN[176]	USER KEY 4
TPIN[177]	USER KEY 5
TPIN[178]	USER KEY 6
TPIN[210]	USER KEY 7
TPIN[179]	Shifted USER KEY 1
TPIN[180]	Shifted USER KEY 2
TPIN[181]	Shifted USER KEY 3
TPIN[182]	Shifted USER KEY 4
TPIN[183]	Shifted USER KEY 5
TPIN[184]	Shifted USER KEY 6
TPIN[211]	Shifted USER KEY 7
<b>Motion Keys</b>	

Table 14-7. Teach Pendant Input Signal Assignments (Cont'd)

TPIN[n]	Teach Pendant Key
TPIN[185]	FWD
TPIN[186]	BWD
TPIN[187]	COORD
TPIN[188]	+X
TPIN[189]	+Y
TPIN[190]	+Z
TPIN[191]	+X rotation
TPIN[192]	+Y rotation
TPIN[193]	+Z rotation
TPIN[194]	-X
TPIN[195]	-Y
TPIN[196]	-Z
TPIN[197]	-X rotation
TPIN[198]	-Y rotation
TPIN[199]	-Z rotation
TPIN[226]	Shifted FWD
TPIN[207]	Shifted BWD
TPIN[202]	Shifted COORD

**Table 14–7.** Teach Pendant Input Signal Assignments (Cont'd)

TPIN[n]	Teach Pendant Key
<b>Motion Keys Cont'd</b>	
TPIN[214]	Shifted +X
TPIN[215]	Shifted +Y
TPIN[216]	Shifted +Z
TPIN[217]	Shifted +X rotation
TPIN[218]	Shifted +Y rotation
TPIN[219]	Shifted +Z rotation
TPIN[220]	Shifted -X
TPIN[221]	Shifted -Y
TPIN[222]	Shifted -Z
TPIN[223]	Shifted -X rotation
TPIN[224]	Shifted -Y rotation
TPIN[225]	Shifted -Z rotation

Three teach pendant output signals are available for use:

- TPOUT[6] - controls teach pendant USER LED #1
- TPOUT[7] - controls teach pendant USER LED #2
- TPOUT[8] - controls teach pendant USER LED #3

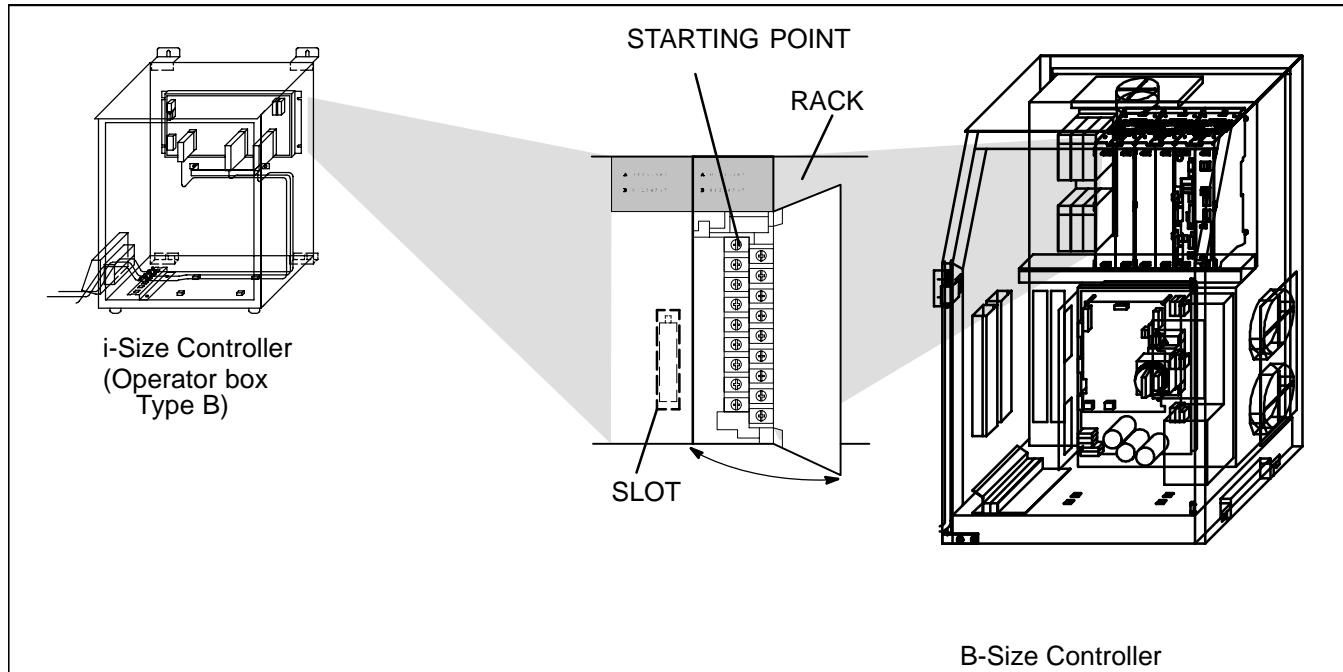
## **14.3 HARDWARE CONFIGURATIONS**

The I/O system consists of modular I/O hardware, process I/O hardware, and remote I/O hardware. In addition, your system might contain an optional weld control interface, which is a special type of process I/O hardware.

### 14.3.1 Modular I/O

Modular I/O are I/O units that fit into a slot on a rack within the controller. Each module contains one type of I/O. There are five-slot and ten-slot racks available. Your system can contain multiple racks. Each modular I/O signal is assigned to a rack, a slot in the rack, and the starting point or channel, if the module is analog. You can change the configuration of the rack, slot, and start point through the teach pendant I/O screen or through the SET\_PORT\_ASG KAREL built-in routine. See [Figure 14-4](#).

**Figure 14-4. Modular (Model A) I/O Hardware Layout For Digital I/O**



- **Rack** is the physical location on which the input or output board is mounted. Your system can contain multiple racks. The rack mounted closest to the main CPU board is considered rack 1. Rack 0 is reserved for system modules and process I/O boards.
- **Slot** is the space on the rack where the board is connected. The slots number from left to right, starting at 0. Slot 0 is not used.
- **Start point** for digital and group signals, and **channel** for analog signals is the physical position of the I/O port in the I/O module.

Modular I/O can be one of following types of I/O:

- Digital inputs and outputs
- Analog inputs and outputs

Modular I/O boards contain a specific number of inputs and outputs. [Table 14–8](#) through [Table 14–11](#) describe the types of modular I/O boards available.

**Table 14–8.** Digital Input Modules

Module Name	Points	Polarity	Rated Voltage	Rated Current	Response Time (maximum)
AID32A	32	Both	24 VDC	7.5 mA	20 ms
AID32B	32	Both	24 VDC	7.5 mA	2 ms
AID16C	16	Negative	24 VDC	7.5 mA	20 ms
AIA16D	16	Positive	24 VDC	7.5 mA	20 ms
AID32E	32	Both	24 VDC	7.5 mA	20 ms
AID32F	3	Both	24 VDC	7.5 mA	2 ms
AIA16G	16	-	100~120 VAC	10.5 mA	ON 35 ms OFF 45 ms

**Table 14–9.** Digital Output Modules

Module Name	Points	Polarity	Rated Voltage	Rated Current	Output Type
AOD32A	32	Negative	5~24 V	0.3 A	DC Non-insolated
AOD08C	8	Negative	12~24 V	2 A	DC insolated
AOD08D	8	Positive	12~24 V	2 A	DC insolated
AOD16C	16	Negative	12~24 V	0.5 A	DC insolated
AOD16D	16	Positive	12~24 V	0.5 A	DC insolated
AOD32C	32	Negative	12~24 V	0.3 A	DC insolated

**Table 14–9. Digital Output Modules (Cont'd)**

Module Name	Points	Polarity	Rated Voltage	Rated Current	Output Type
AOD32D	32	Positive	12~24 V	0.3 A	DC isolated
AOA05E	5	-	100~240 VA	2 A	AC output
AOA08E	8	-	100~240 VA	1 A	AC output
AOA12F	12	-	100~120 VA	0.5 A	AC output
AOR080	8	-	250 VAC / 30 VDC	4 A	Relay output
AOR160	16	-	250 VAC / 30 VDC	2 A	Relay output

**Table 14–10. Analog Input Module Configuration**

Item	Specification
Name	AAD04A
Input channels	4 channels per module
Analog input	-10 VDC ~+10 VDC (input resistance 4.7M Ω) -20 mADC ~+20 mADC (input resistance 250 Ω) selectable
Digital output	12 bit binary (complementary representation of 2)

**Table 14–10.** Analog Input Module Configuration (Cont'd)

<b>Item</b>	<b>Specification</b>	
Input/output correspondence	<b>Analog Input</b> +10 V +5 V or 20 mA 0 V or 0 mA -5 V or -20 mA -10 V	<b>Digital Output</b> +2000 +10000 V 0 -1000 -2000
Required input	64 points	

**Table 14–11.** Analog Output Module Configuration

<b>Item</b>	<b>Specification</b>
Name	ADA02A
Input channels	2 channels per module
Digital input	12 bit binary (complementary representation of 2)
Analog output	-10 VDC ~+10 VDC (input resistance 10K Ω or more) -20 mADC ~+20 mADC (input resistance 400 Ω or less) selectable

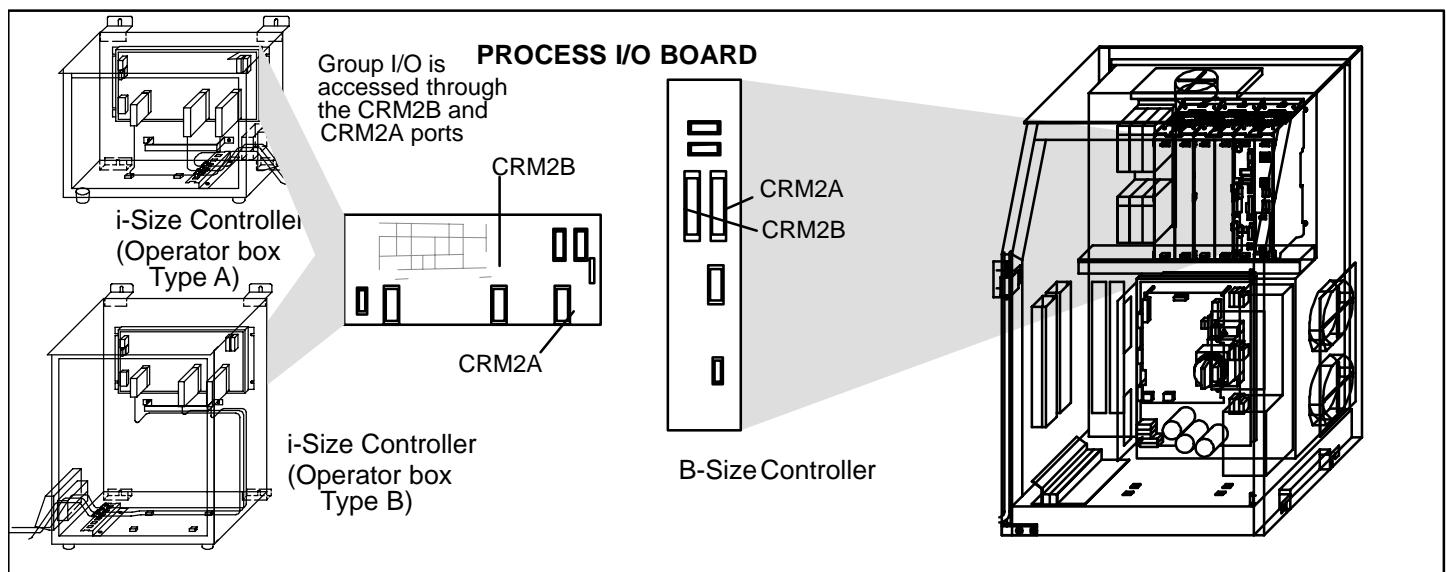
**Table 14–11.** Analog Output Module Configuration (Cont'd)

Item	Specification	
Input/output correspondence	<b>Digital Input</b> +2000 +1000 0 -1000 -2000	<b>Analog Output</b> +10 V +5 V or 20 mA 0 V or 0 mA -5 V or -20 mA -10 V
Required output	82 points	

### **14.3.2 PROCESS I/O**

A process I/O board is a board that can contain different types of I/O signals, including analog, digital, and welding. Process I/O boards contain specific numbers of inputs and outputs. The types of I/O vary according to the process I/O board.

Each process I/O signal is assigned to a rack (0), a slot in the rack, and the starting point for numbering. You can change the configuration of the slot and start point through the teach pendant I/O screen or through the SET\_PORT\_ASG KAREL built-in routine. Process I/O boards are always in rack 0. See [Figure 14–5](#).

**Figure 14–5.** Process I/O Board Hardware Layout for Group I/O

- **Rack** - Process I/O boards are always assigned rack 0.
- **Slot** refers to the process I/O board number. The slots number starting at 1. The slot closest to the main CPU board is slot 1.
- **Start point** for digital and group signals, and **channel** for analog signals is the physical position of the I/O port on the I/O board.

Process I/O boards contain a specific number and type of inputs and outputs. [Table 14–12](#) describes the types process I/O boards available.

**Table 14–12.** Process I/O Board Configurations

Board Number	Mounted On	DI	DO	WI	WO	AI	AO
A16B-2201-0470	Backplane	40	40	8	8	6	2
A16B-2200-0472	Backplane	40	40	-	-	-	-
A16B-2201-0480	Backplane	96	96	-	-	-	-

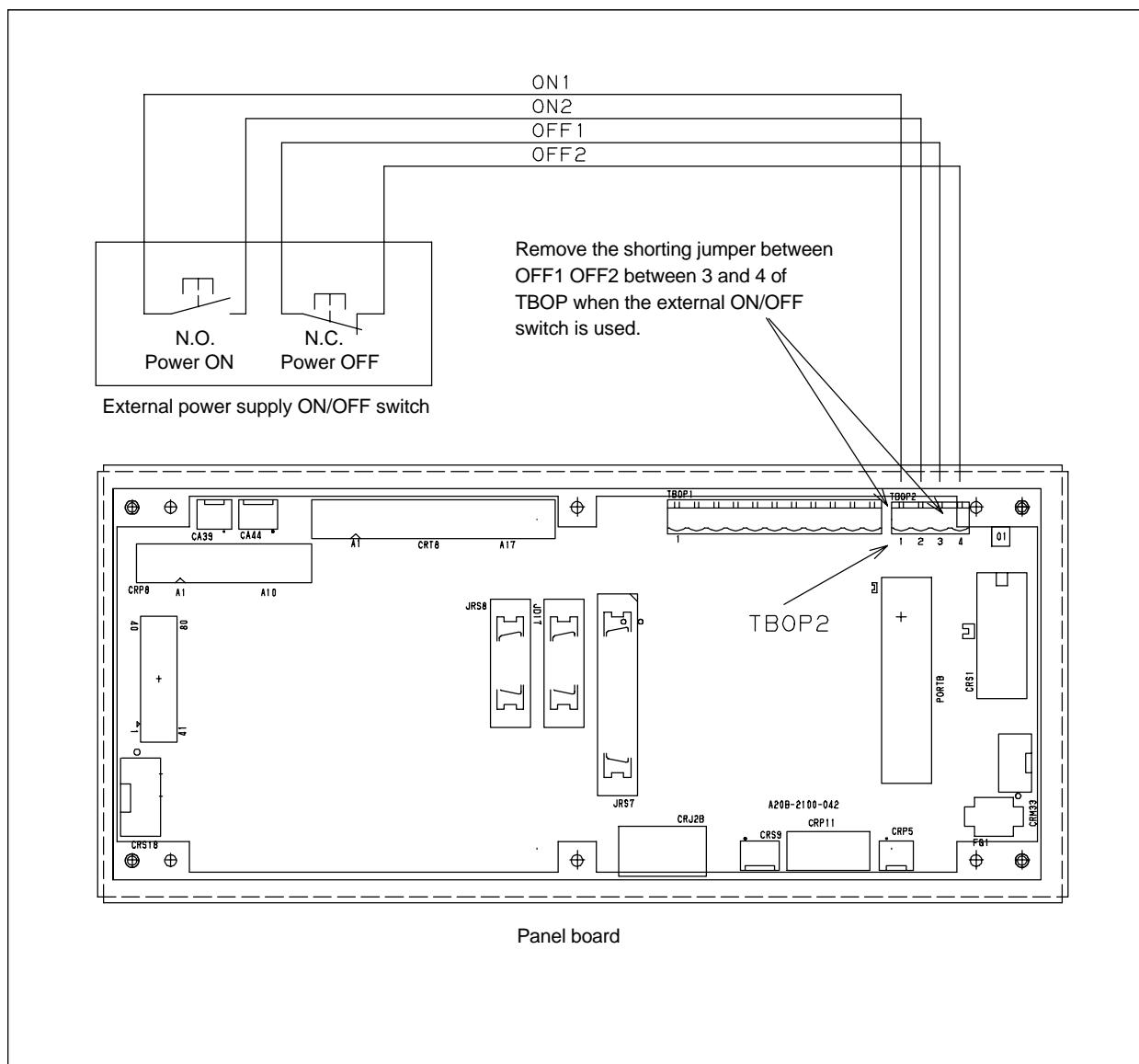
### **14.3.3 External Operator Panel Signals**

System control can be achieved from locations other than the controller operator panel through the use of a dedicated terminal block on which switches or buttons can be connected. These terminals, located on the operator panel interface board, allow you to connect the following:

- External ON and External OFF buttons
- External EMERGENCY STOP
- EMERGENCY STOP output
- EMERGENCY STOP through a safety fence

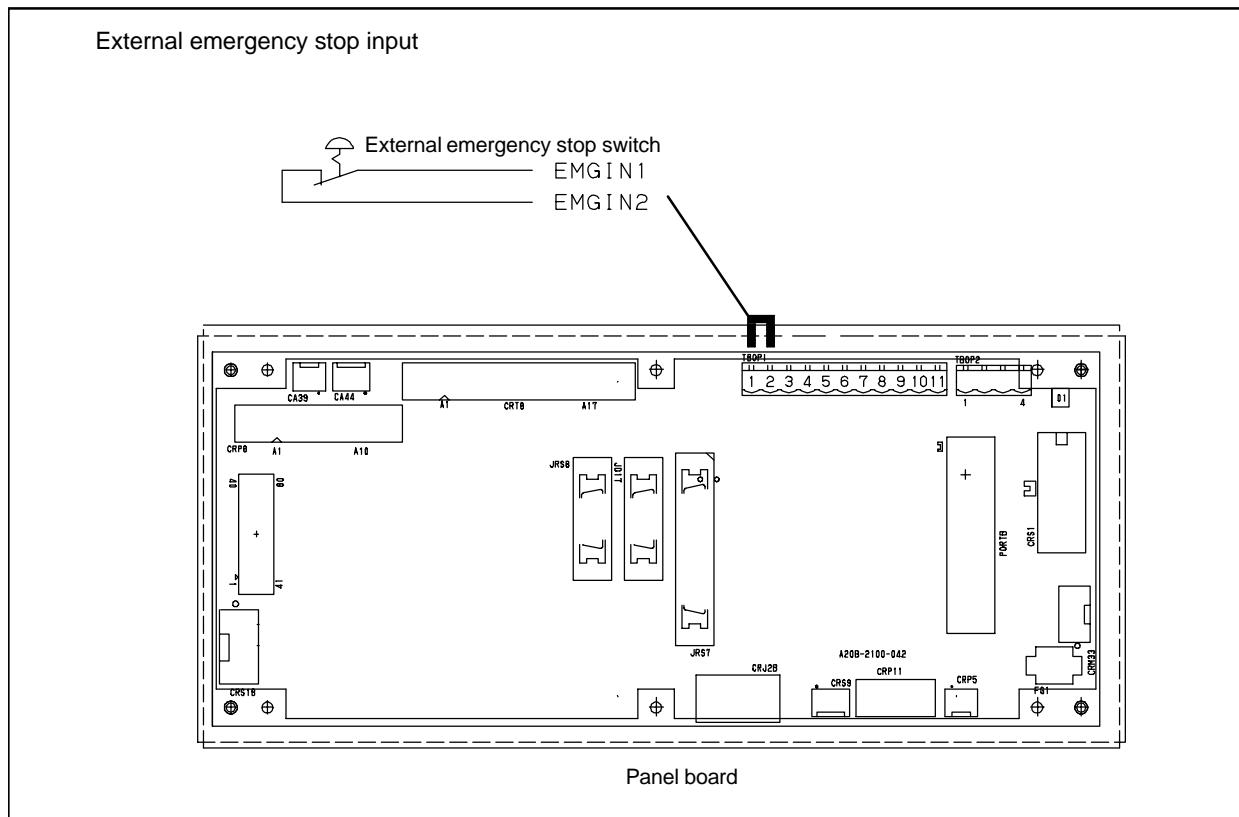
#### **External ON/OFF**

External ON and OFF buttons can be connected to the controller. The connections are made between EON and COM for the ON button and EOF and COM for the OFF button. See [Figure 14–6](#).

**Figure 14–6. External ON/OFF Buttons**

### External Emergency Stop

External emergency stop buttons can be connected to terminals EMGIN1 and EMGIN2. See [Figure 14–7](#). Both place the robot in an emergency stop condition; however, the effects of the emergency stop outputs differ. (Refer to Emergency Stop Outputs.)

**Figure 14–7. External Emergency Stop**

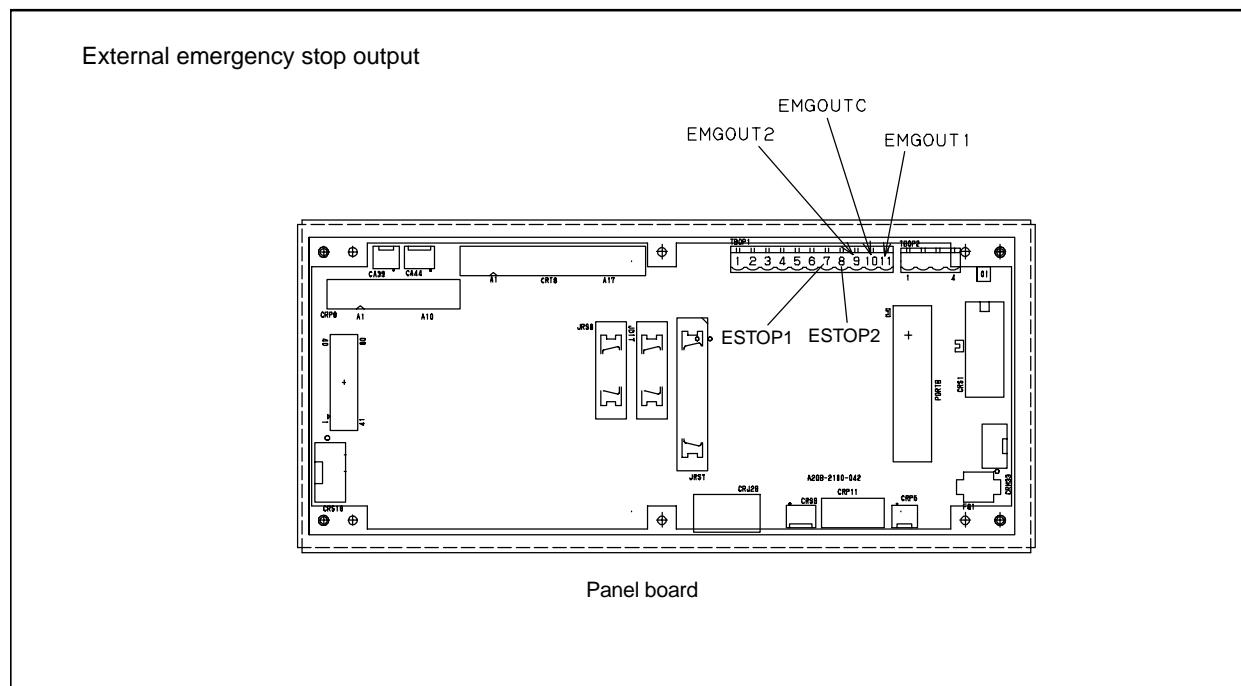
### **Emergency Stop Output**

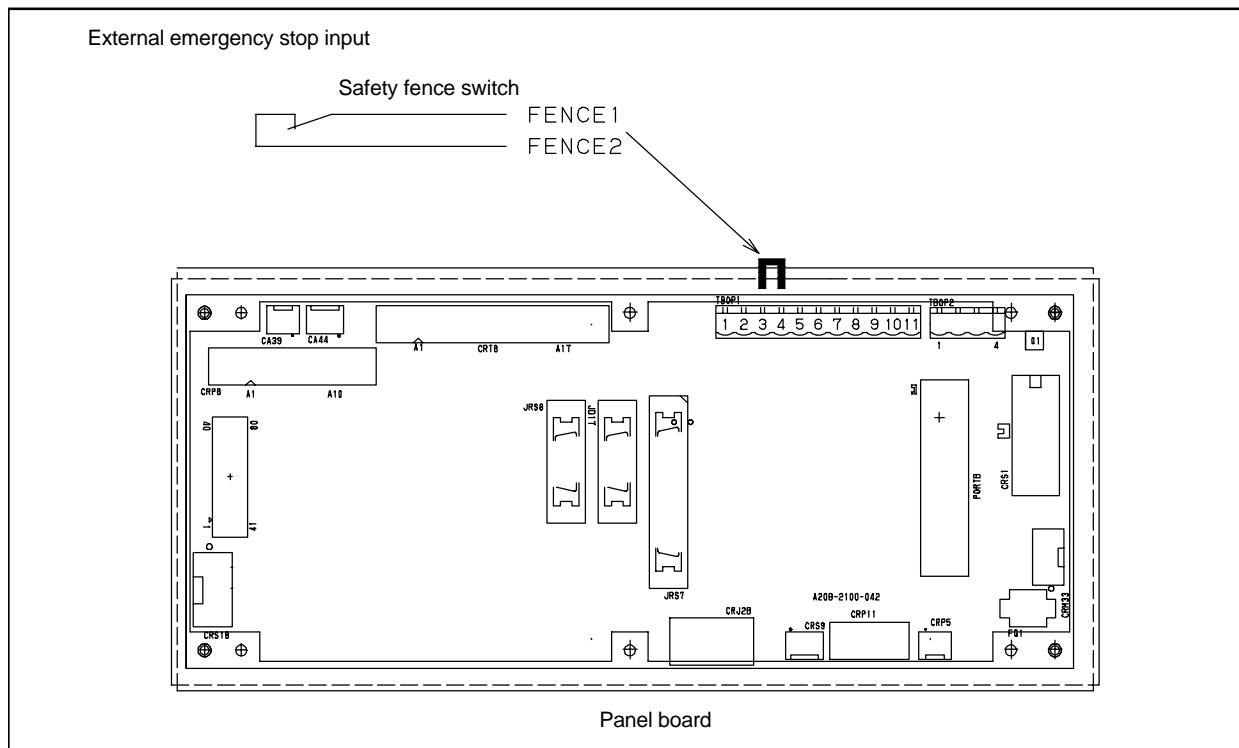
EMGOUT is the relay contact to output the emergency stop status of a controller. The polarity of the signal is as follows:

EMGOUT ON: Normal (closed)

OFF: ESTOP condition (opened)

The emergency stop output is activated by any hardwired ESTOP input. This includes the EMERGENCY STOP button on the operator panel, EMERGENCY STOP button on the teach pendant, DEADMAN switch, hand break detection, fence input, or robot overtravel. See [Figure 14–8](#).

**Figure 14–8. Emergency Stop Outputs**

**Figure 14–9. Emergency Stop Through a Safety Fence****Warning**

**Do not apply any circuitry with a voltage potential to the terminals. This input is monitoring an open or closed switch contact (continuity).**

#### 14.3.4 Serial Input/Output

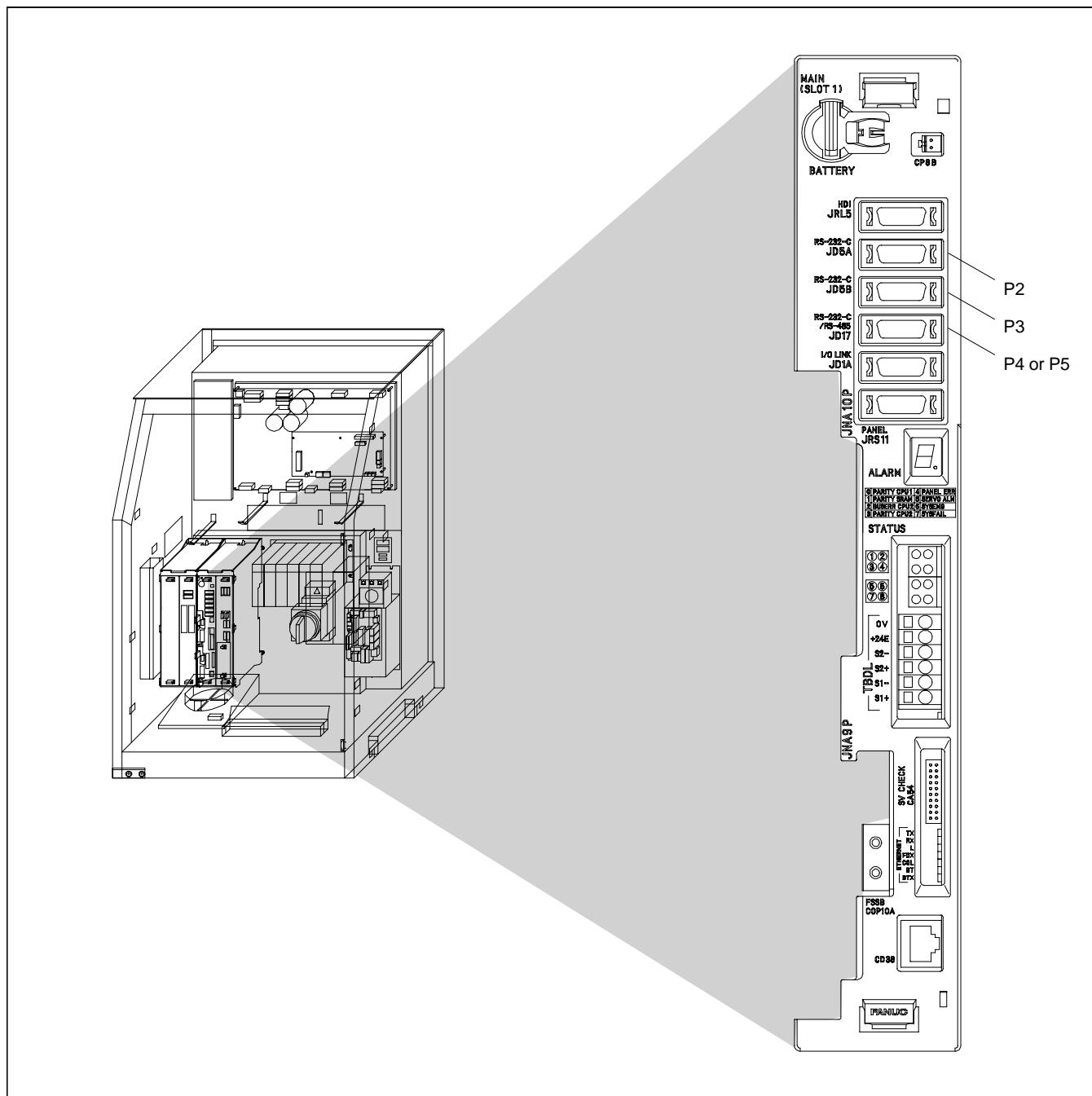
The serial I/O system allows you to communicate with peripheral serial devices connected to the KAREL system. For example, you could use serial I/O to write messages from one of the communications ports to a remote terminal across a cable that connects to the R-J3iB controller.

To use serial I/O you must provide a serial device and the appropriate cable. Refer to the Maintenance Manual, specific to your robot model, for electrical specifications.

The communications ports that you use to read and write serial data are defined in the system software. Each software port is associated with physical connectors on the R-J3iB controller to which you attach the communications cable.

### Ports

Up to five ports are available, P1-P5. [Figure 14–10](#) shows the location of the ports on the R-J3iB Controller.

**Figure 14–10.** Location of Ports on the Controller

Several different types of devices can be connected to these ports. You can set up ports P2 through P5 if you have them, but you cannot set up the teach pendant port, P1. You set up ports on the SETUP Port Init screen. [Table 14–13](#) lists the ports.

**Table 14–13.** Ports P1, P2, P3, and P4

Port	Item Name on Screen	Type of Port	Use	Default Device
P1	Teach Pendant <b>NOTE</b> This is a dedicated port and cannot change.	RS-422	Teach pendant	Teach pendant
P2	RS-232-C	RS-232-C	Any RS-232-C device, such as a printer or disk drive, or CRT/KB	Debug Console
P3	PORT 2	RS-232-C		KCL/CRT
P4	JD17 on operator panel board	RS-232-C		No use
P5	JD17 on operator panel board	RS-422		No use

### Port Configuration

You can use the SETUP Port Init screen on the teach pendant to configure the software ports. [Table 14–14](#) lists the default settings for each type of device you can connect to a port.

**Table 14–14.** Default Communications Settings for Devices

Device	Speed (baud)	Parity Bit	Stop Bit	Timeout Value (sec)
Handy file*	9600	None	2 bit	0
FANUC floppy*	9600	None	2 bit	0
PS-100/200 floppy disk	9600	None	1 bit	0
Printer**	4800	None	1 bit	0
Sensor*	4800	Odd	1 bit	0
Host Comm.*	4800	Odd	1 bit	0
KCL/CRT	9600	None	1 bit	0
Debug console	9600	None	1 bit	0
TP Demo Device	9600	None	1 bit	0
No Use	9600	None	1 bit	0
Current Position	For FANUC Robotics Use Only			
Development	For FANUC Robotics Use Only			
CIMPLICITY	For FANUC Robotics Use Only			

\* You can adjust these settings; however, if you do, they might not function as intended because they are connected to an external device.

\*\* You can use only a serial printer.

After the hardware has been connected and the appropriate port is configured and the external port is connected, you can use KAREL language OPEN FILE, READ, and WRITE statements to communicate with the peripheral device.

Higher levels of communication protocol are supported as an optional feature.

**See Also:** [Appendix A](#) for more information on the statements and built-ins available in KAREL



# Chapter 15

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## MULTI-TASKING

## Contents

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Multi-tasking allows more than one program to run on the controller on a time-sharing basis, so that multiple programs appear to run simultaneously.

Multi-tasking is especially useful when you are executing several sequences of operations which can generally operate independently of one another, even though there is some interaction between them. For example:

- A process of monitoring input signals and setting output signals.
- A process of generating and transmitting log information to a cell controller and receiving commands or other input data from a cell controller.

It is important to be aware that although multiple tasks seem to operate at the same time, they are sharing use of the same processor, so that at any instant only one task is really being executed. With the exception of interruptible statements, once execution of a statement is started, it must complete before statements from another task can be executed. The following statements are interruptible:

- MOVE
- READ
- DELAY
- WAIT
- WAIT FOR

Refer to [Section 15.4](#), “Task Scheduling” for information on how the system decides which task to execute first.

## **15.1 MULTI-TASKING TERMINOLOGY**

The following terminology and expressions are used in this chapter.

- **Task or User task**

A task, or user task, is a user program that is running or paused. A task is executed by an "interpreter." A task is created when the program is started and eliminated when the interpreter it is assigned to, becomes assigned to another task.

- **Interpreter**

An interpreter is a system component that executes user programs. At a cold or controlled start, (\$MAXNUMTASKS + 2) interpreters are created. These interpreters are capable of concurrently executing tasks.

- **Task name**

Task name is the program name specified when the task is created. When you create a task, specify the name of the program to be executed as the task name.

**Note** The task name does not change once the task is created. Therefore, when an external routine is executing, the current executing program name is not the same as the task name. When you send any requests to the task, use the task name, not the current program name.

- **Motion control**

Motion control is defined by a bit mask that specifies the motion groups of which a task has control. Only one task at a time can control a motion group. However, different tasks can control different motion groups simultaneously. Refer to [Section 15.3](#), “Motion Control,” for more information.

## **15.2 INTERPRETER ASSIGNMENT**

When a task is started, it is assigned to an interpreter. The interpreter it is assigned to (1, 2, 3, ...) determines its task number. The task number is used in PAUSE PROGRAM, ABORT PROGRAM and CONTINUE PROGRAM condition handler actions. The task number for a task can be determined using the GET\_TSK\_INFO built-in.

The following are rules for assigning a task to an interpreter:

- If the task is already assigned to an interpreter, it uses the same interpreter.
- A task is assigned to the first available interpreter that currently has no tasks assigned to it.
- If all interpreters are assigned to tasks, a new task will be assigned to the first interpreter that has an aborted task.
- If none of the above can be done, the task cannot be started.

## **15.3 MOTION CONTROL**

An important restriction in multi-tasking is in the control of the various motion groups. Only one task can have control, or use of, a group of axes. A task requires control of the group(s) in the following situations:

- When the task starts, if the controller directive %NOLOCKGROUP is not used. If the %LOCKGROUP directive is not used, the task requires control of all groups by default. If %LOCKGROUP is used, control of the specified groups is required.

For teach pendant programs, motion control is required when the program starts, unless the DETAIL page from the SELECT screen is used to set the Group Mask to [\*,\*,\*,\*].

- When a task executes the LOCK\_GROUP built-in, it requires the groups specified by the group mask.
- When a task executes a MOVE statement, it requires control of the group.

- When a task calls a ROUTINE or teach pendant program, it requires control of those group(s). The group(s) required by a ROUTINE or TPP+ program are those specified, or implied, by controller directives or in the teach pendant DETAIL setup.

A task will be given control of the required group(s), assuming:

- No other task has control of the group.
- The teach pendant is not enabled, with the exception that motion control can be given to a program when it is started using shift-FWD at the teach pendant or if it has the %TPMOTION directive.
- There are no emergency stops active.
- The servos are ready.
- The UOP signal IMSTP is not asserted.

A task will be paused if it is not able to get control of the required group(s).

After a task gets control of a group, it keeps it until one of the following:

- The task ends (aborts).
- The task executes the UNLOCK\_GROUP built-in.
- The task passes control of the group(s) in a RUN\_TASK built-in.
- The ROUTINE or teach pendant program returns, and groups were required by a ROUTINE or teach pendant program, but not by the calling program.



#### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, personnel could be injured, and equipment could be damaged.**

## 15.4 TASK SCHEDULING

A task that is currently running (not aborted or paused) will execute statements until one of the following:

- A hold condition occurs.
- A higher priority program becomes ready to run.
- The task time slice expires.
- The program aborts or pauses.

The following are examples of hold conditions:

- Waiting for a read operation to complete.
- Waiting for a motion to complete.
- Waiting for a WAIT, WAIT FOR, or DELAY statement to complete.

A task is ready to run when it is in running state and has no hold conditions. Only one task is actually executed at a time. There are two rules for determining which task will be executed when more than one task is ready to run:

- Priority - If two or more tasks of different priority are ready to run, the task with higher priority is executed first. Refer to [Section 15.4.1](#), “Priority Scheduling,” for more information.
- Time-slicing - If two tasks of the same priority are ready to run, execution of the tasks is time-sliced. Refer to [Section 15.4.2](#), “Time Slicing,” for more information.

### **15.4.1 Priority Scheduling**

If two or more tasks with different priorities are ready to run, the task with the highest priority will run first. The priority of a task is determined by its priority number. Priority numbers must be in the range from -8 to 143. The lower the priority number, the higher the task priority.

For example: if TASK\_A has a priority number of 50 and TASK\_B has a priority number of 60, and both are ready to run, TASK\_A will execute first, as long as it is ready to run.

A task priority can be set in one of the following ways:

- By default, each user task is assigned a priority of 50.
- KAREL programs may contain the %PRIORITY translator directive.
- The SET\_TSK\_ATTR built-in can be used to set the current priority of any task.

In addition to affecting other user tasks, task priority also affects the priority of the interpreter executing it, relative to that of other system functions. If the user task has a higher priority (lower priority number) than the system function, as long as the user task is ready to run, the system function will not be executed. The range of user task priorities is restricted at the high priority end. This is done so that the user program cannot interfere with motion interpolation. Motion interpolation refers to the updates required to cause a motion, or path segment, to complete.

The following table indicates the priority of some other system functions.

**Table 15–1. System Function Priority Table**

Priority	System Function	Effect of Delaying Function
-8	Maximum priority	New motions, or continuation nodes of a MOVE ALONG path statement delayed.
-1	Motion Planner	New motions, or continuation nodes of a MOVE ALONG path statement delayed.
4	TP Jog	Jogging from the Teach Pendant delayed.
54	Error Logger	Update of system error log delayed.
73	KCL	Execution of KCL commands delayed.
82	CRT manager	Processing of CRT soft-keys delayed.
88	TP manager	General teach pendant activity delayed.
143	Lowest priority	Does not delay any of the above.

#### **15.4.2 Time Slicing**

If two or more tasks of the same priority are ready to run, they will share the system resources by time-slicing, or alternating use of the system.

A time-slice permits other tasks of the same priority to execute, but not lower priority tasks.

The default time-slice for a task is 256 msec. Other values can be set using the %TIMESLICE directive or the SET\_TSK\_ATTR built-in.

## **15.5 STARTING TASKS**

There are a number ways to start a task.

- KCL RUN command. Refer to [Appendix C](#), “KCL Command Alphabetic Descriptions.”
- Operator Panel start key. Refer to the appropriate application- specific *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual*.

- User operator panel start signal. Refer to the appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller HandlingTool Setup and Operations Manual*.
- User operator panel PNS signal. Refer to [Section 15.5.1](#), “Running Programs from the User Operator Panel (UOP) PNS Signal,” for more information.
- Teach pendant shift-FWD key. Refer to the appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller HandlingTool Setup and Operations Manual*, Chapter on “Testing a Program and Running Production,” for more information.
- Teach pendant program executes a RUN instruction. Refer to [Section 15.5.2](#), “Child Tasks,” for more information.
- KAREL program executes the RUN\_TASK built-in. Refer to [Section 15.5.2](#), “Child Tasks,” for more information.

In each case, the task will not start running if it requires motion control that is not available.

### **15.5.1 Running Programs from the User Operator Panel (UOP) PNS Signal**

A program is executed:

- If the binary value of the UOP PNS signals is non-zero and the UOP PROGSTART signal is asserted
- If there is currently a program with the name “PNSnnnn,” where nnnn is the decimal value of the PNS signals plus the current value of \$SHELLCFG.\$jobbase.

A program is not executed:

- If the binary value of the PNS signals is zero.

Multiple programs can be started in this way, as long as there is no motion group overlap.

If the task name determined from the PNS is in a paused state, the PROGSTART signal is interpreted as a CONTINUE signal. If \$SHELLCFG.\$contonly is TRUE, this is the only function of the PNS/PROGSTART signals.

If \$SHELLCFG.\$useabort is TRUE, the PNS signals can be used to abort a running task. The name of the task to be aborted is the same as that used with the PROGSTART signal. In this case, abort is triggered by the UOP CSTOPI signal

### **15.5.2 Child Tasks**

A running task can create new tasks. This new task is called a child task. The task requesting creation of the child task is called the parent task. In teach pendant programs, a new task is created by executing a RUN instruction. In KAREL programs a new task can be created using the RUN\_TASK built-in.

The parent and child task may not require the same motion group. In the case of RUN\_TASK, however, it is possible to release control of motion groups for use by the child task.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly, and could injure personnel or damage equipment.**

Once a child task is created, it runs independently of its parent task, with the following exception:

- If a parent task is continued and its child task is paused, the child task is also continued.
- If a parent task is put in STEP mode, the child task is also put in STEP mode.

If you want the child task to be completely independent of the parent, a KAREL program can initiate another task using the KCL or KCL\_NOWAIT built-ins to issue a KCL>RUN command.

## **15.6 TASK CONTROL AND MONITORING**

There are three environments from which you can control and monitor tasks:

1. Teach Pendant Programs (TPP) - [Section 15.6.1](#)
2. KAREL Programs - [Section 15.6.2](#)
3. KCL commands - [Section 15.6.3](#)

### **15.6.1 From TPP Programs**

The TPP instruction RESUME\_PROG can be used to continue a PAUSED task.

### **15.6.2 From KAREL Programs**

There are a number of built-ins used to control and monitor other tasks. See the description of these built-ins in [Appendix A](#).

- RUN\_TASK executes a task.
- CONT\_TASK resumes execution of a PAUSED task.
- PAUSE\_TASK pauses a task.

- ABORT\_TASK aborts a task.
- CONTINUE condition handler action causes execution of a task.
- ABORT condition handler action causes a task to be aborted.
- PAUSE condition handler action causes a task to be paused.
- GET\_TSK\_INFO determines whether a specified task is running, paused, or aborted. Also determines what program and line number is being executed, and what, if anything, the task is waiting for.

### **15.6.3 From KCL**

The following KCL commands can be used to control and monitor the status of tasks. Refer to [Appendix C](#), "KCL Command Alphabetic Descriptions," for more information.

- RUN <task\_name> starts or continues a task.
- CONT <task\_name> continues a task.
- PAUSE <task\_name> pauses a task.
- ABORT <task\_name> aborts a task.
- SHOW TASK <task\_name> displays the status of a task.
- SHOW TASKS displays the status of all tasks.

## **15.7 USING SEMAPHORES AND TASK SYNCHRONIZATION**

Good design dictates that separate tasks be able to operate somewhat independently. However, they should also be able to interact.

The KAREL controller supports counting semaphores. The following operations are permitted on semaphores:

- **Clear a semaphore** (KAREL: CLEAR\_SEMA built-in; TPP: SEMAPHORE = OFF instruction): sets the semaphore count to zero.

All semaphores are cleared at cold start. It is good practice to clear a semaphore prior to using it. Before several tasks begin sharing a semaphore, one and only one of these task, should clear the semaphore.

- **Post to a semaphore** (KAREL: POST\_SEMA built-in, TPP: SEMAPHORE[n] = ON): adds one to the semaphore count.

If the semaphore count is zero or greater, when the post semaphore is issued, the semaphore count will be incremented by one. The next task waiting on the semaphore will decrement the semaphore count and continue execution. Refer to [Figure 15–1](#).

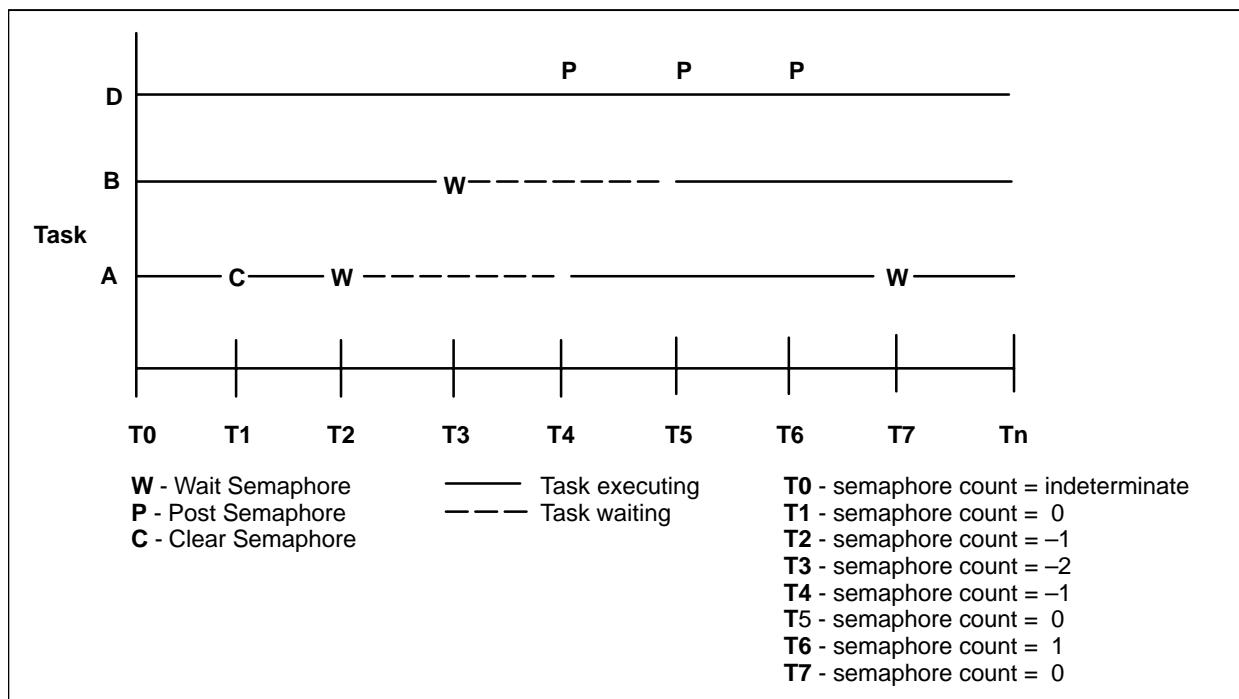
If the semaphore count is negative, when the post semaphore is issued, the semaphore count will be incremented by one. The task which has been waiting on the semaphore the longest will then continue execution. Refer to [Figure 15–1](#).

- **Read a semaphore** (KAREL: SEMA\_COUNT built-in): returns the current semaphore count.
- **Wait for a semaphore** (KAREL: PEND\_SEMA built-in, SIGNAL SEMAPHORE Action; TPP : WAIT SEMAPHORE[n] instruction):

If the semaphore count is greater than zero when the wait semaphore is issued, the semaphore count will be decremented and the task will continue execution. Refer to [Figure 15–1](#).

If the semaphore count is less than or equal to zero (negative), the wait semaphore will decrement the semaphore count and the task will wait to be released by a post semaphore. Tasks are released on a first-in/first-out basis. For example, if *task A* waits on semaphore 1, then *task B* waits on semaphore 1. When *task D* posts semaphore 1, only *task A* will be released. Refer to [Figure 15–1](#).

**Figure 15–1. Task Synchronization Using a Semaphore**



**Example:** Semaphores can be used to implement a task that acts as a request server. In the following example, the main task waits for the server to complete its operation. Semaphore[4]

is used to control access to rqst\_param or R[5]. Semaphore[5] is used to signal the server task that service is being requested; semaphore[6] is used by the server to signal that the operation is complete.

The main task would contain the following KAREL or TPP code:

### Main Task

--KAREL	--TPP
CLEAR_SEMA( 4 )	SEMAPHORE[ 4 ]=OFF
CLEAR_SEMA( 5 )	SEMAPHORE[ 5 ]=OFF
CLEAR_SEMA( 6 )	SEMAPHORE[ 6 ]=OFF
RUN TASK('server', 0, TRUE, TRUE, 1, STATUS)	RUN SERVER
PEND_SEMA( 4 ,max_time,time_out )	WAIT SEMAPHORE[ 4 ]
rqst_param=10	R[ 5 ]=10
POST_SEMA( 5 )	SEMAPHORE[ 5 ]=ON
PEND_SEMA( 6 ,max_time,time_out )	WAIT SEMAPHORE[ 6 ]

The server task would contain the following KAREL or TPP code:

### Server Task

--KAREL	--TPP
POST_SEMA( 4 )	SEMAPHORE[ 4 ]=ON
WHILE TRUE DO	LBL[ 100 ]
PEND_SEMA( 5 ,max_time,time_out )	WAIT SEMAPHORE[ 5 ]
IF rqst_param=10 THEN	IF R[ 5 ]=10, CALL do_something
do_something	
ENDIF	
POST_SEMA( 4 )	SEMAPHORE[ 4 ]=ON
POST_SEMA( 6 )	SEMAPHORE[ 6 ]=ON
ENDWHILE	GOTO LBL[ 100 ]

**Example:** The program example in [Semaphore and Task Synchronization Program Example - MAIN TASK](#) thru [Semaphore and Task Synchronization Program Example - TASK B](#) shows how semaphores and tasks can be used together for synchronization. *MAIN\_TASK.KL* is used to initialize the semaphore (MOTION\_CTRL) and then runs both *TASK\_A.KL* and *TASK\_B.KL*. *MAIN\_TASK.KL* then waits for *TASK\_A* and *TASK\_B* to abort before completing. *TASK\_A* waits until you press F1 and then moves the robot to the HOME position. *TASK\_B* waits until you press F2 and then moves the robot along a path.

### Semaphore and Task Synchronization Program Example - MAIN TASK

```

PROGRAM main_task
%nolockgroup

VAR
    motion_ctrl: INTEGER

```

```

tsk_a_done : BOOLEAN
tsk_b_done : BOOLEAN
tmr       : INTEGER
status     : INTEGER
-----
-- INIT_LOCK: Initialize the semaphore      --
--          to make sure its count is at    --
--          zero before using it. Then    --
--          post this semaphore which will --
--          allow the first pend to the    --
--          semaphore to continue        --
--          execution.                  --
-----
ROUTINE init_lock
BEGIN
  CLEAR_SEMA (motion_ctrl) -- makes sure semaphore is zero before using it.
  POST_SEMA  (motion_ctrl) -- makes motion_ctrl available immediately
END init_lock
-----
-- IS_TSK_DONE : Find out if the specified   --
--               task is running or not.      --
--               If the task is aborted then   --
--               return TRUE otherwise FALSE. --
-----
ROUTINE is_tsk_done (task_name:STRING): BOOLEAN
VAR
  status  : INTEGER      -- The status of the operation of GET_TSK_INFO
  task_no : INTEGER      -- Receives the current task number for task_name
  attr_out: INTEGER      -- Receives the TSK_STATUS output
  dummy   : STRING[2]    -- Does not receive any information
BEGIN
  GET_TSK_INFO (task_name, task_no, TSK_STATUS, attr_out, dummy, status)
  IF (attr_out = PG_ABORTED) THEN
    RETURN (TRUE) -- If task is aborted then return TRUE
  ENDIF

  RETURN(FALSE) -- otherwise task is not aborted and return
  FALSE

END is_tsk_done
BEGIN
  motion_ctrl = 1 -- Semaphore to allow motion control

```

```

init_lock -- Make sure this is done just once

FORCE_SPMENU ( tp_panel, spi_tpuser, 1) -- Force the Teach Pendant
                                         -- user screen to be seen

RUN_TASK('task_a', 1, FALSE, FALSE, 1, status) -- Run task_a

RUN_TASK('task_b', 1, FALSE, FALSE, 1, status) -- Run task_b

REPEAT
    tsk_a_done = is_tsk_done ('task_a')
    tsk_b_done = is_tsk_done ('task_b')
    delay (100)
UNTIL (tsk_a_done and tsk_b_done) -- Repeat until both task_a
END main_task -- and task_b are aborted

```

### Semaphore and Task Synchronization Program Example - TASK A

```

PROGRAM task_a
%nolockgroup
VAR
    motion_ctrl FROM main_task: INTEGER
    home_pos           : POSITION
    status              : INTEGER
-----
--          --
--  RUN_HOME   : Lock the robot motion      --
--               control. This task is       --
--               moving the robot and must  --
--               have control.            --
--          --
-----

ROUTINE run_home
VAR
    time_out: BOOLEAN

BEGIN
    PEND_SEMA(motion_ctrl,-1,time_out)-- lock motion_ctrl from other tasks
                                         -- keep other tasks from moving robot

    LOCK_GROUP (1, status)
    MOVE TO home_pos -- move to the home position
    UNLOCK_GROUP (1, status)

    POST_SEMA(motion_ctrl) -- unlock motion_ctrl
                           -- allow other task to move robot

```

```

END run_home

BEGIN
    set_cursor (tpfunc, 1, 4, status)
    write tpfunc ('HOME',CR)
    wait for TPIN[129]+      -- wait for F1 to be pressed
    run_home

END task_a

```

**Semaphore and Task Synchronization Program Example - TASK B**

```

PROGRAM task_b
%nolockgroup

VAR
    motion_ctrl FROM main_task : INTEGER
    work_path                 : PATH
    status                     : INTEGER
-----
-- do_work      : Lock the robot from other --
--                  tasks and do work. This --
--                  task is doing motion and --
--                  must lock motion control so --
--                  that another task does not --
--                  try to do motion at the --
--                  same time.
-----

ROUTINE do_work
VAR
    time_out: BOOLEAN
BEGIN

    PEND_SEMA (motion_ctrl,-1,time_out) -- lock motion_ctrl from other
                                         -- tasks keep other tasks from
                                         -- moving robot
    LOCK_GROUP (1, status)
    MOVE ALONG work_path      -- move along the work path
    UNLOCK_GROUP (1, status)

    POST_SEMA(motion_ctrl)     -- unlock motion_ctrl allow
                                -- other task to move robot

END do_work

BEGIN

```

```

set_cursor(tpfunc, 1, 10, status)
write tpfunc('WORK',CR)
wait for TPIN[131]+      -- wait until F2 is pressed
do_work

END task_b

```

## **15.8 USING QUEUES FOR TASK COMMUNICATIONS**

Queues are supported only in KAREL. A queue is a first-in/first-out list of integers. They are used to pass information to another task sequentially. A queue consists of a user variable of type QUEUE\_TYPE and an ARRAY OF INTEGER. The maximum number of entries in the queue is determined by the size of the array.

The following operations are supported on queues:

- INIT\_QUEUE initializes a queue and sets it to empty.
- APPEND\_QUEUE adds an integer to the list of entries in the queue.
- GET\_QUEUE: reads the oldest (top) entry from the queue and deletes it.

These, and other built-ins related to queues ( DELETE\_QUEUE, INSERT\_QUEUE, COPY\_QUEUE) are described in [Appendix A](#).

A QUEUE\_TYPE Data Type has one user accessible element, *n\_entries*. This is the number of entries that have been added to the queue and not read out. The array of integer used with a queue, is used by the queue built-ins and should not be referenced by the KAREL program.

**Example:** The following example illustrates a more powerful request server, in which more than one task is posting requests and the requester does not wait for completion of the request.

The requester would contain the following code:

### **Requester**

```

--declarations
VAR
    rqst_queue FROM server: QUEUE_TYPE
    rqst_data FROM server: ARRAY[100] OF INTEGER
    status: INTEGER
    seq_no: INTEGER
    -- posting to the queue --
    APPEND_QUEUE (req_code, rqst_queue, rqst_data, seq_no, status)

```

The server task would contain the following code:

**Server**

```
PROGRAM server
VAR
    rqst_queue: QUEUE_TYPE
    rqst_data : ARRAY[100] OF INTEGER
    status      : INTEGER
    seq_no      : INTEGER
    rqst_code   : INTEGER
BEGIN
    INIT_QUEUE(rqst_queue)    --initialization
    WHILE TRUE DO             --serving loop
        WAIT FOR rqst_code.n_entries > 0
        GET_QUEUE (rqst_queue, rqst_data, rqst_code, seq_no, status)
        SELECT rqst_code OF
        CASE (1): do_something
        ENDSELECT
    ENDWHILE
END server
```

# **Appendix A**

---

## **KAREL LANGUAGE ALPHABETICAL DESCRIPTION**

### **Contents**

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This appendix describes, in alphabetical order, each standard KAREL language element, including:

- Data types
- Executable statements and clauses
- Condition handler conditions and actions
- Built-in routines
- Translator directives

A brief example of a typical use of each element is included in each description.

**Note** If, during program execution, any uninitialized variables are encountered as arguments for built-in routines, the program pauses and an error is displayed. Either initialize the variable, KCL> SET VARIABLE command, or abort the program, using the KCL> ABORT command.

### Conventions

This section describes each standard element of the KAREL language in alphabetical order. Each description includes the following information:

- **Purpose:** Indicates the specific purpose the element serves in the language
- **Syntax:** Describes the proper syntax needed to access the element in KAREL. Table A-1 describes the syntax notation that is used.

**Table A-1. Syntax Notation**

Syntax	Meaning	Example	Result
< >	Enclosed words are optional	AAA <BBB>	AAA AAA BBB
{ }	Enclosed words are optional and can be repeated	AAA {BBB}	AAA AAA BBB AAA BBB BBB AAA BBB BBB BBB
	Separates alternatives	AAA   BBB	AAA BBB

**Table A-1.** Syntax Notation (Cont'd)

Syntax	Meaning	Example	Result
<   >	Separates an alternative if only one or none can be used	AAA <BBB   CCC>	AAA AAA BBB AAA CCC
	Exactly one alternative must be used	AAA    BBB   CCC	AAA BBB AAA CCC
{   }	Any combination of alternatives can be used	AAA {BBB   CCC}	AAA AAA BBB AAA CCC AAA BBB CCC AAA CCC BBB AAA BBB CCC BBB BBB
<<   >>	Nesting of symbols is allowed. Look at the innermost notation first to see what it describes, then look at the next innermost layer to see what it describes, and so forth.	AAA <BBB <CCC   DDD>	AAA AAA BBB AAA BBB CCC AAA BBB DDD

If the built-in is a function, the following notation is used to identify the data type of the value returned by the function:

Function Return Type: data\_typ

Input and output parameter data types for functions and procedures are identified as:

[in] param\_name: data\_type

[out] param\_name: data\_type

where :

[in] specifies the data type of parameters which are passed into the routine

[out] specifies the data type of parameters which are passed back into the program from the routine

%ENVIRONMENT Group specifies the %ENVIRONMENT group for built-in functions and procedures, which is used by the off-line translator. Valid values are: BYNAM, CTDEF, ERRS, FDEV, FLBT, IOSETUP, KCL, MEMO, MIR, MOTN, MULTI, PATHOP, PBQMGR, REGOPE, STRNG, SYSDEF, TIM, TPE, TRANS, UIF, VECTR. The SYSTEM group is automatically used by the off-line translator.

- **Details:** Lists specific rules that apply to the language element. An italics-type font is used to denote keywords input by the user within the syntax of the element.
- **See Also:** Refers the reader to places in the document where more information can be found.
- **Example:** Displays a brief example and explanation of the element. [Table A-2](#) through [Table A-8](#) list the KAREL language elements, described in this appendix, by the type of element. [Table A-9](#) lists these elements in alphabetical order.

**Table A-2. Actions**

ABORT Action
Assignment Action
CANCEL Action
CONTINUE Action
DISABLE Action
ENABLE Action
HOLD Action
NOABORT Action
NOMESSAGE Action
NOPAUSE Action
PAUSE Action
Port_Id Action
PULSE Action
RESUME Action
SIGNAL EVENT Action
SIGNAL SEMAPHORE Action
STOP Action
UNHOLD Action
UNPAUSE Action

**Table A-3.** Clauses

EVAL Clause
FROM Clause
IN Clause
NOWAIT Clause
UNTIL Clause
VIA Clause
WHEN Clause
WITH Clause

**Table A-4.** Conditions

ABORT Condition
AT NODE Condition
CONTINUE Condition
ERROR Condition
EVENT Condition
PAUSE Condition
Port_Id Condition
Relational Condition
SEMAPHORE Condition
TIME Condition

**Table A-5.** Data Types

ARRAY Data Type
BOOLEAN Data Type
BYTE Data Type
COMMON_ASSOC Data Type
CONFIG Data Type
DISP_DAT_T Data Type
FILE Data Type
GROUP_ASSOC Data Type
INTEGER Data Type
JOINTPOS Data Type
PATH Data Type
POSITION Data Type
QUEUE_TYPE Data Type
REAL Data Type
SHORT Data Type
STD_PTH_NODE Data Type
STRING Data Type
VECTOR Data Type
XYZWPR Data Type
XYZWPREXT Data Type

**Table A-6.** Directives

%ALPHABETIZE
%CMOSVARS
%COMMENT
%CRTDEVICE
%DEFGROUP
%DELAY
%ENVIRONMENT
%INCLUDE
%LOCKGROUP
%NOABORT
%NOBUSYLAMP
%NOLOCKGROUP
%NOPAUSE
%NOPAUSESHFT
%PRIORITY
%STACKSIZE
%TIMESLICE
%TPMOTION

**Table A-7.** Builtin Functions and Procedures

<b>Category</b>	<b>Identifier</b>		
<b>Byname</b>	CALL_PROG	CURR_PROG	PROG_LIST
	CALL_PROGLIN	FILE_LIST	VAR_INFO VAR_LIST
<b>Error Code Handling</b>	ERR_DATA	POST_ERR	
<b>File and Device Operation</b>	CHECK_NAME	FORMAT_DEV	PRINT_FILE
	COPY_FILE	MOUNT_DEV	PURGE_DEV
	DELETE_FILE	MOVE_FILE	RENAME_FILE
	DISMOUNT_DEV		
<b>Serial I/O, File Usage</b>	BYTES_AHEAD	GET_PORT_ATR	SET_PORT_ATR
	BYTES_LEFT	IO_STATUS	VOL_SPACE
	CLR_IO_STAT	MSG_CONNECT	
	GET_FILE_POS	MSG_DISCO	
		MSG_PING	
		PIPE_CONFIG	
		SET_FILE_ATR	
		SET_FILE_POS	
<b>Process I/O Setup</b>	CLR_PORT_SIM	GET_PORT_VAL	SET_PORT_CMT
	GET_PORT_ASG	IO_MOD_TYPE	SET_PORT_MOD
	GET_PORT_CMT	SET_PORT_ASG	SET_PORT_SIM
	GET_PORT_MOD		SET_PORT_VAL
	GET_PORT_SIM		

**Table A-7.** BuiltIn Functions and Procedures (Cont'd)

Category	Identifier		
<b>KCL Operation</b>	KCL	KCL_NO_WAIT	KCL_STATUS
<b>Memory Operation</b>	CLEAR	LOAD_STATUS	SAVE
	CREATE_VAR	RENAME_VAR	
	LOAD	RENAME_VARS	
<b>MIRROR</b>	MIRROR		
<b>Program and Motion Control</b>	CNCL_STP_MTN	MOTION_CTL	RESET
<b>Multi-programming</b>	ABORT_TASK	PAUSE_TASK	SET_TSK_ATTR
	CLEAR_SEMA	PEND_SEMA	SET_TSK_NAME
	CONT_TASK	POST_SEMA	UNLOCK_GROUP
	GET_TSK_INFO	RUN_TASK	
	LOCK_GROUP	SEMA_COUNT	
<b>Path Operation</b>	APPEND_NODE	INSERT_NODE	PATH_LEN
	COPY_PATH	NODE_SIZE	
	DELETE_NODE		
<b>Personal Computer Communications</b>	ADD_BYNAMEPC	ADD_STRINGPC	
	ADD_INTPC	SEND_DATAPC	
	ADD_REALPC	SEND_EVENTPC	
<b>Queue Manager</b>	APPEND_QUEUE	GET_QUEUE	MODIFY_QUEUE
	COPY_QUEUE	INIT_QUEUE	
	DELETE_QUEUE	INSERT_QUEUE	

**Table A-7. Builtin Functions and Procedures (Cont'd)**

<b>Category</b>	<b>Identifier</b>		
<b>Register Operation</b>	CLR_POS_REG	GET_REG	SET_JPOS_REG
	GET_JPOS_REG	POS_REG_TYPE	SET_POS_REG
	GET_POS_REG	SET_EPOS_REG	SET_REAL_REG
		SET_INT_REG	
<b>String Operation</b>	CNV_CONF_STR	CNV_REAL_STR	CNV_STR_INT
	CNV_INT_STR	CNV_STR_CONF	CNV_STR_REAL
<b>System</b>	ABS	CURPOS	SET_PERCH
	ACOS	EXP	SET_VAR
	ARRAY_LEN	FRAME	SIN
	ASIN	GET_VAR	SQRT
	ATAN2	IN_RANGE	STR_LEN
	BYNAME	INDEX	SUB_STR
	CHECK_EPOS	INV	TAN
	CHR	J_IN_RANGE	TRUNC
	CNV_JPOS_REL	LN	UNINIT
	CNV_REL_JPOS	ORD	UNPOS
	COS	POS	
	CURJPOS	ROUND	
<b>Time-of-Day Operation</b>	CNV_STR_TIME	GET_TIME	
	CNV_TIME_STR	SET_TIME	

**Table A-7. BuiltIn Functions and Procedures (Cont'd)**

<b>Category</b>	<b>Identifier</b>		
<b>TPE Program</b>	AVL_POS_NUM	GET_JPOS_TPE	SET_ATTR_PRG
	CLOSE_TPE	GET_POS_FRM	SET_EPOS_TPE
	COPY_TPE	GET_POS_TPE	SET_JPOS_TPE
	CREATE_TPE	GET_POS_TYP	SET_POS_TPE
	DEL_INST_TPE	GET_TPE_CMT	SET_TPE_CMT
	GET_ATTR_PRG	GET_TPE_PRM	SET_TRNS_TPE
		OPEN_TPE	
		SELECT_TPE	
<b>Translate</b>	TRANSLATE		

**Table A-7. BuiltIn Functions and Procedures (Cont'd)**

Category	Identifier		
<b>User Interface</b>	ACT_SCREEN	DEF_WINDOW	PUSH_KEY_RD
	ADD_DICT	DET_WINDOW	READ_DICT
	ATT_WINDOW_D	DISCTRL_ALPH	READ_DICT_V
	ATT_WINDOW_S	DISCTRL_FORM	READ_KB
	CHECK_DICT	DISCTRL_LIST	REMOVE_DICT
	CNC_DYN_DISB	DISCTRL_PLMN	SET_CURSOR
	CNC_DYN_DISE	DISCTRL_SBMN	SET_LANG
	CNC_DYN_DISI	DISCTRL_TBL	WRITE_DICT
	CNC_DYN_DISP	FORCE_SPMENU	WRITE_DICT_V
	CNC_DYN_DISR	INI_DYN_DISB	
	CNC_DYN_DISS	INI_DYN_DISE	
	DEF_SCREEN	INI_DYN_DISI	
		INI_DYN_DISP	
		INI_DYN_DISR	
		INI_DYN_DISS	
		INIT_TBL	
		POP_KEY_RD	
<b>Vector</b>	APPROACH	ORIENT	

**Table A-8.** Items

CR Input/Output Item
----------------------

**Table A-9.** Statements

ABORT Statement Assignment Statement ATTACH Statement CANCEL Statement CANCEL FILE Statement CLOSE FILE Statement CLOSE HAND Statement CONDITION..ENDCONDITION Statement CONNECT TIMER Statement DELAY Statement DISABLE CONDITION Statement DISCONNECT TIMER Statement ENABLE CONDITION Statement FOR..ENDFOR Statement GO TO Statement HOLD Statement IF..ENDIF Statement MOVE ABOUT Statement MOVE ALONG Statement MOVE AWAY Statement MOVE AXIS Statement MOVE NEAR Statement MOVE RELATIVE Statement MOVE TO Statement OPEN FILE Statement OPEN HAND Statement PAUSE Statement PROGRAM Statement PULSE Statement PURGE Statement READ Statement RELAX HAND Statement RELEASE Statement REPEAT...UNTIL Statement RESUME Statement RETURN Statement ROUTINE Statement SELECT..ENDSELECT Statement SIGNAL EVENT Statement STOP Statement UNHOLD Statement USING..ENDUSING Statement WAIT FOR Statement WHILE..ENDWHILE Statement WRITE Statement
--

## A.1 - A - KAREL LANGUAGE DESCRIPTION

### A.1.1 ABORT Action

**Purpose:** Aborts execution of a running or paused task

**Syntax :** ABORT <PROGRAM[n]>

**Details:**

- If task execution is running or paused, the ABORT action will abort task execution.
- The ABORT action can be followed by the clause PROGRAM[n], where **n** is the task number to be aborted. Use GET\_TASK\_INFO to get a task number.
- If PROGRAM[n] is not specified, the current task execution is aborted.

**See Also:** GET\_TSK\_INFO Built-in

[Chapter 6 CONDITION HANDLERS](#)

**Example:** Refer to [Section B.6](#), "Path Variables and Condition Handlers Program (PTH\_MOVE.KL)," for a detailed program example.

### A.1.2 ABORT Condition

**Purpose:** Monitors the aborting of task execution

**Syntax :** ABORT <PROGRAM[n]>

- The ABORT condition is satisfied when the task is aborted. The actions specified by the condition handler will be performed.
- If PROGRAM [n] is not specified, the current task number is used.
- Actions that are routine calls will not be executed if task execution is aborted.
- The ABORT condition can be followed by the clause PROGRAM[n], where n is the task number to be monitored. Use GET\_TSK\_INFO to get a task number.

**See Also:** CONDITION ... ENDCONDITION Statement, GET\_TSK\_INFO Built-in, [Chapter 6 CONDITION HANDLERS](#), [Appendix E](#), "Syntax Diagrams," for additional syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.6](#), "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

### **A.1.3 ABORT Statement**

**Purpose:** Terminates task execution and cancels any motion in progress (or pending)

**Syntax :** ABORT <PROGRAM[n]>

- After an ABORT, the program cannot be resumed. It must be restarted.
- The statement can be followed by the clause PROGRAM[n], where n is the task number to be aborted.

**See Also:** , “Syntax Diagrams,” for additional syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

### **A.1.4 ABORT\_TASK Built-In Procedure**

**Purpose:** Aborts the specified running or paused task

**Syntax :** ABORT\_TASK(task\_name, force\_sw, cancel\_mtn\_sw, status)

Input/Output Parameters:

[in] task\_name :STRING

[in] force\_sw :BOOLEAN

[in] cancel\_mtn\_sw :BOOLEAN

[out] status :INTEGER

%ENVIRONMENT Group :MULTI

**Details:**

- *task\_name* is the name of the task to be aborted. If task name is '\*ALL\*', all executing or paused tasks are aborted except the tasks that have the "ignore abort request" attribute set.
- *force\_sw*, if true, specifies to abort a task even if the task has the "ignore abort request" set. *force\_sw* is ignored if *task\_name* is '\*ALL\*'.
- *cancel\_mtn\_sw* specifies whether motion is canceled for all groups belonging to the specified task.

**Note** Do not use more than one motion group in a KAREL program. If you need to use more than one motion group, you must use a teach pendant program.



#### Warning

**Do not run a KAREL program that includes more than one motion group. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CONT\_TASK, RUN\_TASK, PAUSE\_TASK Built-In Procedures, NO\_ABORT Action, %NO\_ABORT Translator Directive, [Chapter 15 MULTI-TASKING](#)

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

### A.1.5 ABS Built-In Function

**Purpose:** Returns the absolute value of the argument *x*, which can be an INTEGER or REAL expression

**Syntax :** ABS(*x*)

Function Return Type :INTEGER or REAL

Input/Output Parameters :

[in] *x* :INTEGER or REAL expression

%ENVIRONMENT Group :SYSTEM

**Details:**

- Returns the absolute value of *x*, with the same data type as *x*.

**Example:** Refer to [Section B.7](#), "Listing Files and Programs and Manipulating Strings (LIST\_EX.KL)," for a detailed program example.

### **A.1.6 ACOS Built-In Function**

**Purpose:** Returns the arc cosine (cos-1) in degrees of the specified argument

**Syntax :** ACOS(x)

Function Return Type :REAL

Input/Output Parameters :

[in] x :REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- x must be between -1.0 and 1.0; otherwise the program will abort with an error.
- Returns the arccosine of x.

**Example:** The following example sets ans\_r to the arccosine of -1 and writes this value to the screen. The output for the following example is 180 degrees.

#### **ACOS Built-In Function**

```
routine take_acos
var
    ans_r: real
begin
    ans_r = acos (-1)
    WRITE ('acos -1 ', ans_r, CR)
END take_acos
```

The second example causes the program to abort since the input value is less than -1 and not within the valid range.

#### **ACOS Built-In Function**

```
routine take_acos
var
    ans_r: real
begin
    ans_r = acos (-1.5) -- causes program to abort
    WRITE ('acos -1.5 ', ans_r, CR)
END take_acos
```

### A.1.7 ACT\_SCREEN Built-In Procedure

**Purpose:** Activates a screen

**Syntax :** ACT\_SCREEN

Input/Output Parameters :

[in] screen\_name :STRING

[out] old\_screen\_n :STRING

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- Causes the display device associated with the screen to be cleared and all windows attached to the screen to be displayed.
- *screen\_name* must be a string containing the name of a previously defined screen, see DEF\_SCREEN Built-in.
- The name of the screen that this replaces is returned in *old\_screen\_n*.
- Requires the USER or USER2 menu to be selected before activating the new screen, otherwise the status will be set to 9093.
  - To force the selection of the teach pendant user menu before activating the screen, use FORCE\_SPMENU (tp\_panel, SPI\_TPUSER, 1).
  - To force the selection of the CRT/KB user menu before activating the screen, use FORCE\_SPMENU (crt\_panel, SPI\_TPUSER, 1).
- If the USER menu is exited and re-entered, your screen will be reactivated as long as the KAREL task which called ACT\_SCREEN continues to run. When the KAREL task is aborted, the system's user screen will be re-activated. Refer to [Section 7.9](#) for details on the system's user screen.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** DEF\_SCREEN Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.12](#) , "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

### A.1.8 ADD\_BYNAMEPC Built-In Procedure

**Purpose:** To add an integer, real, or string value into a KAREL byte given a data buffer.

**Syntax :** ADD\_BYNAMEPC(dat\_buffer, dat\_index, prog\_name, var\_name, status)

Input/Output Parameters :

[in] dat\_buffer :ARRAY OF BYTE

[in,out] dat\_index :INTEGER

[in] prog\_name :STRING

[in] var\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :PC

**Details:**

- *dat\_buffer* - an array of up to 244 bytes.
- *dat\_index* - the starting byte number to place the string value.
- *prog\_name* - specifies the name of the program that contains the specified variable.
- *var\_name* - refers to a static program variable. This is only supported by an integer, real, or string variable (arrays and structures are not supported).
- *status* - the status of the attempted operation. If not 0, then an error occurred and data was not placed into the buffer.

The ADD\_BYNAMEPC built-in adds integer, real, and string values to the data buffer in the same manner as the KAREL built-ins ADD\_INTPC, ADD\_REALPC, and ADD\_STRINGPC.

**See Also:** ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, ADD\_STRINGPC

**Example:** See the following for an example of the ADD\_BYNAMEPC built-in.

#### ADD\_BYNAMEPC Built-In Procedure

```

PROGRAM TESTBYNM
%ENVIRONMENT PC
CONST
    er_abort = 2
VAR
    dat_buffer: ARRAY[100] OF BYTE
    index:      INTEGER
    status:     INTEGER
BEGIN
    index = 1
    ADD_BYNAMEPC(dat_buffer, index, 'TESTDATA', 'INDEX', status)
    IF status<>0 THEN

```

```
    POST_ERR(status, '' ,0,er_abort)
    ENDIF
END testbynm
```

### **A.1.9 ADD\_DICT Built-In Procedure**

**Purpose:** Adds the specified dictionary to the specified language.

**Syntax :** ADD\_DICT(file\_name, dict\_name, lang\_name, add\_option, status)

Input/Output Parameters :

[in] file\_name :STRING

[in] dict\_name :STRING

[in] lang\_name :STRING

[in] add\_option :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *file\_name* specifies the device, path, and file name of the dictionary file to add. The file type is assumed to be '.TX' (text file).
- *dict\_name* specifies the name of the dictionary to use when reading and writing dictionary elements. Only 4 characters are used.
- *lang\_name* specifies to which language the dictionary will be added. One of the following pre-defined constants should be used:

dp\_default

dp\_english

dp\_japanese

dp\_french

dp\_german

dp\_spanish

- The default language should be used unless more than one language is required.

- *add\_option* should be the following:

dp\_dram Dictionary will be loaded to DRAM memory and retained until the next INIT START.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred adding the dictionary file.

**See Also:** READ\_DICT, WRITE\_DICT, REMOVE\_DICT Built-In Procedures, [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** Refer to the following sections for detailed program examples:

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.12, "Dictionary Files" \(DCALPHEG.UTX\)](#)

### **A.1.10 ADD\_INTPC Built-In Procedure**

**Purpose:** To add an INTEGER value (type 16 - 10 HEX) into a KAREL byte data buffer.

**Syntax :** ADD\_INTPC(dat\_buffer, dat\_index, number, status)

Input/Output Parameters :

[in] dat\_buffer :ARRAY OF BYTE

[in,out] dat\_index :INTEGER

[in] number :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PC

**Details:**

- *dat\_buffer* - an array of up to 244 bytes.
- *dat\_index* - the starting byte number to place the integer value.
- *number* - the integer value to place into the buffer.
- *status* - the status of the attempted operation. If not 0, then an error occurred and data was not put into the buffer.

The KAREL built-ins ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, and ADD\_STRINGPC can be used to format a KAREL byte buffer in the following way: INTEGER data is added to the buffer as follows (buffer bytes are displayed in HEX):

beginning index = dat\_index

2 bytes - variable type

4 bytes - the number

2 bytes of zero (0) - end of buffer marker

The following is an example of an INTEGER placed into a KAREL array of bytes starting at index = 1:

**0 10 0 0 0 5 0 0**

where:

**0 10** = INTEGER variable type

**0 0 0 5** = integer number 5

**0 0** = end of data in the buffer

On return from the built-in, index = 7.

**See Also:** ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, ADD\_STRINGPC

**Example:** Refer to the TESTDATA example in the built-in function SEND\_DATAPC.

### **A.1.11 ADD\_REALPC Built-In Procedure**

**Purpose:** To add a REAL value (type 17 - 11 HEX) into a KAREL byte data buffer.

**Syntax :** ADD\_REALPC(dat\_buffer, dat\_index, number, status)

Input/Output Parameters :

[in] dat\_buffer :ARRAY OF BYTE

[in,out] dat\_index :INTEGER

[in] number :REAL

[out] status :INTEGER

%ENVIRONMENT Group :PC

**Details:**

- *dat\_buffer* - an array of up to 244 bytes.

- *dat\_index* - the starting byte number to place the real value.
- *number* - the real value to place into the buffer.
- *status* - the status of the attempted operation. If not 0, then an error occurred and data was not placed into the buffer.

The KAREL built-ins ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, and ADD\_STRINGPC can be used to format a KAREL byte buffer in the following way:

REAL data is added to the buffer as follows (buffer bytes are displayed in HEX):

beginning index = *dat\_index*

2 bytes - variable type

4 bytes - the number

2 bytes of zero (0) - end of buffer marker

The following is an example of an REAL placed into a KAREL array of bytes starting at index = 1:

**0 11 43 AC CC CD 0 0**

where:

**0 11** = REAL variable type

**43 AC CC CD** = real number 345.600006

**0 0** = end of data in the buffer

On return from the built-in, index = 7.

**See Also:** ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, ADD\_STRINGPC

**Example:** Refer to the TESTDATA example in the built-in function SEND\_DATAPC.

### **A.1.12 ADD\_STRINGPC Built-In Procedure**

**Purpose:** To add a string value (type 209 - D1 HEX) into a KAREL byte data buffer.

**Syntax :** ADD\_STRINGPC(dat\_buffer, dat\_index, item, status)

Input/Output Parameters :

[in] dat\_buffer :ARRAY OF BYTE

[in,out] dat\_index :INTEGER

[in] item :string

[out] status :INTEGER

%ENVIRONMENT Group :PC

**Details:**

- *dat\_buffer* - an array of up to 244 bytes.
- *dat\_index* - the starting byte number to place the string value.
- *item* - the string value to place into the buffer.
- *status* - the status of the attempted operation. If not 0, then an error occurred and data was not placed into the buffer.

The KAREL built-ins ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, and ADD\_STRINGPC can be used to format a KAREL byte buffer in the following way:

STRING data is added to the buffer as follows:

beginning index = dat\_index

2 bytes - variable type

1 byte - length of text string

text bytes

2 bytes of zero (0) - end of buffer marker

The following is an example of an STRING placed into a KAREL array of bytes starting at index = 1:

**0 D1 7 4D 48 53 48 45 4C 4C 0 0 0**

where:

**0 D1** = STRING variable type

**7** = there are 7 characters in string 'MHSHELL'

**4D 48 53 48 45 4C 4C 0** = 'MHSHELL' with end of string 0

**0 0** = end of data in the buffer

On return from the built-in, index = 12.

**See Also:** ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, ADD\_STRINGPC

**Example:** Refer to the TESTDATA example in the built-in function SEND\_DATAPC.

### **A.1.13 %ALPHABETIZE Translator Directive**

**Purpose:** Specifies that static variables will be created in alphabetical order when p-code is loaded.

**Syntax :** %ALPHABETIZE

**Details:**

- Static variables can be declared in any order in a KAREL program and %ALPHABETIZE will cause them to be displayed in alphabetical order in the DATA menu or KCL> SHOW VARS listing.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.5, "Using Register Built-ins" \(REG\\_EX.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

### **A.1.14 APPEND\_NODE Built-In Procedure**

**Purpose:** Adds an uninitialized node to the end of the PATH argument

**Syntax :** APPEND\_NODE(path\_var, status)

Input/Output Parameters :

[in] path\_var :PATH

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *path\_var* is the path variable to which the node is appended.

- The appended PATH node is uninitialized. The node can be assigned values by directly referencing its NODEDATA structure.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** DELETE\_NODE, INSERT\_NODE Built-In Procedures

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

### A.1.15 APPEND\_QUEUE Built-In Procedure

**Purpose:** Appends an entry to a queue if the queue is not full

**Syntax :** APPEND\_QUEUE(value, queue, queue\_data, sequence\_no, status)

Input/Output Parameters :

[in] value :INTEGER

[in,out] queue :QUEUE\_TYPE

[in,out] queue\_data :ARRAY OF INTEGER

[out] sequence\_no :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBQMGR

**Details:**

- *value* specifies the value to be appended to the queue.
- *queue* specifies the queue variable for the queue.
- *queue\_data* specifies the array used to hold the data in the queue. The length of this array determines the maximum number of entries in the queue.
- *sequence\_no* is returned with the sequence number of the entry just appended.
- *status* is returned with the zero if an entry can be appended to the queue. Otherwise it is returned with 61001, "Queue is full."

**See Also:** DELETE\_QUEUE, INSERT\_QUEUE Built-In Procedures. Refer to [Section 15.8](#), "Using Queues for Task Communication," for more information and an example.

### A.1.16 APPROACH Built-In Function

**Purpose:** Returns a unit VECTOR representing the z-axis of a POSITION argument

**Syntax :** APPROACH(posn)

Function Return Type :VECTOR

Input/Output Parameters :

[in] posn :POSITION

%ENVIRONMENT Group :VECTR

**Details:**

- Returns a VECTOR consisting of the approach vector (positive z-axis) of the argument *posn*.

**Example:** This program allows you to move the TCP to a position that is 500 mm away from another position along the z-axis.

#### APPROACH Function

```
PROGRAM p_approach
VAR
    start_pos    : POSITION
    app_vector   : VECTOR

BEGIN
    MOVE TO start_pos

    app_vector = APPROACH (start_pos) --sets app_vector equal to the
                                      --z-axis of start_pos

    start_pos.location = start_pos.location + app_vector *500
                           --moves start_pos + 500 mm
                           --in z direction
    WITH $MOTYPE = LINEAR, MOVE TO start_pos

END p_approach
```

**Note** Approach has been left in for older versions of KAREL. You should now directly access the vectors of a POSITION (i.e., posn. approach.)

### A.1.17 ARRAY Data Type

**Purpose:** Defines a variable, function return type, or routine parameter as ARRAY data type

**Syntax :** ARRAY<[size{,size}]> OF data\_type

where:

size : an INTEGER literal or constant

data\_type : any type except PATH

**Details:**

- *size* indicates the number of elements in an ARRAY variable.
- *size* must be in the range 1 through 32767 and must be specified in a normal ARRAY variable declaration. The amount of available memory in your controller might restrict the maximum size of an ARRAY.
- Individual elements are referenced by the ARRAY name and the subscript *size*. For example, table[1] refers to the first element in the ARRAY table.
- An entire ARRAY can be used only in assignment statements or as an argument in routine calls. In an assignment statement, both ARRAY variables must be of the same *size* and *data\_type*. If *size* is different, the program will be translated successfully but will be aborted during execution, with error 12304, "Array Length Mismatch."
- *size* is not specified when declaring ARRAY routine parameters; an ARRAY of any size can be passed as an ARRAY parameter to a routine.
- *size* is not used when declaring an ARRAY return type for a function. However, the returned ARRAY must be of the same size as the ARRAY to which it is assigned in the function call.
- Each element is of the same type designated by *data\_type*.
- Valid ARRAY operators correspond to the valid operators of the individual elements in the ARRAY.
- Individual elements of an array can be read or written only in the format that corresponds to the data type of the ARRAY.
- Arrays of multiple dimensions can be defined. Refer to Chapter 2 for more information.
- Variable-sized arrays can be defined. Refer to Chapter 2 for more information.

**See Also:** ARRAY\_LEN Built-In Function, [Chapter 5 ROUTINES](#), for information on passing ARRAY variables as arguments in routine calls [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#)

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.8, "Generating and Moving Along a Hexagon Path" \(GEN\\_HEX.KL\)](#)

[Section B.9, "Using the File and Device Built-ins" \(FILE\\_EX.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

### **A.1.18 ARRAY\_LEN Built-In Function**

**Purpose:** Returns the number of elements contained in the specified array argument

**Syntax :** ARRAY\_LEN(ary\_var)

Function Return Type :INTEGER

Input/Output Parameters :

[in] ary\_var :ARRAY

%ENVIRONMENT Group :SYSTEM

- The returned value is the number of elements declared for *ary\_var* , not the number of elements that have been initialized in *ary\_var* .

**Example:** Refer to [Section B.7, "Listing Files and Programs and Manipulating Strings" \(LIST\\_EX.KL\)](#), for a detailed program example.

### **A.1.19 ASIN Built-In Function**

**Purpose:** Returns arcsine (sin-1) in degrees of the specified argument

**Syntax :** ASIN(x)

Function Return Type :REAL

Input/Output Parameters :

[in] x :REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- Returns the arcsine of x.
- x must be between -1 and 1, otherwise the program will abort with an error.

**Example:** The following example sets ans\_r to the arcsine of -1 and writes this value to the screen. The output for the following example is -90 degrees.

### ASIN Built-In Function

```
ROUTINE take_asin
VAR
    ans_r: REAL
BEGIN

    ans_r = ASIN (-1)
    WRITE ('asin -1 ', ans_r, CR)
END take_asin
```

The second example causes the program to abort since the input value is less than -1 and not within the valid range.

### ASIN Built-In Function

```
ROUTINE take_asin
VAR
    ans_r: REAL
BEGIN

    ans_r = ASIN (-1.5) -- causes program to abort
    WRITE ('asin -1.5 ', ans_r, CR)
END take_asin
```

## A.1.20 Assignment Action

**Purpose:** Sets the value of a variable to the result of an evaluated expression

**Syntax :** variable {[subscript{,subscript}]} . field} = expn

where:

variable : any KAREL variable

subscript : an INTEGER expression

expn : a valid KAREL expression

field : any field from a structured variable

#### Details:

- *variable* can be any user-defined variable, system variable with write access, or output port array with write access.

- *subscript* is used to access elements of an array.
- *field* is used to access fields in a structure.
- *expn* must be of the same type as the variable or element of *variable*.
- An exception is that an INTEGER expression can be assigned to a REAL. Any positional types can be assigned to each other.
- Only system variables with write access (listed as RW in Table 11-3, “System Variables Summary”) can be used on the left side of an assignment statement. System variables with read only (RO) or read write (RW) access can be used on the right side.
- Input port arrays cannot be used on the left side of an assignment statement.

**See Also:** [Chapter 3 USE OF OPERATORS](#), for detailed information about expressions and their evaluation [Chapter 6 CONDITION HANDLERS](#), for more information about using assignment actions.

**Example:** The following example uses the assignment action to turn DOUT[1] off and set **port\_var** equal to DOUT[2] when EVENT[1] turns on.

### Assignment Action

```
CONDITION[1]:
  WHEN EVENT[1] DO
    DOUT[1] = OFF
    port_var = DOUT[2]
  ENDCONDITION
```

## A.1.21 Assignment Statement

**Purpose:** Sets the value of a variable to the result of an evaluated expression

**Syntax :** variable {[subscript{,subscript}]} . field = expn

where:

variable : any KAREL variable

subscript : an INTEGER expression

expn : a valid KAREL expression

field : any field from a structured variable

### Details:

- *variable* can be any user-defined variable, system variable with write access, or output port array with write access.

- *subscript* is used to access elements of an array.
- *field* is used to access fields in a structure.
- *expn* must be of the same type as the variable or element of *variable*.
- An exception is that an INTEGER expression can be assigned to a REAL. Any positional types can be assigned to each other. INTEGER, SHORT, and BYTE can be assigned to each other.
- If *variable* is of type ARRAY, and no subscript is supplied, the expression must be an ARRAY of the same type and size. A type mismatch will be detected during translation. A size mismatch will be detected during execution and causes the program to abort with error 12304, "Array Length Mismatch."
- If *variable* is a user-defined structure, and no field is supplied, the expression must be a structure of the same type.
- Only system variables with write access (listed as RW in Table 11-3, "System Variables Summary") can be used on the left side of an assignment statement. System variables with read only (RO) or read write (RW) access can be used on the right side.

If read only system variables are passed as parameters to a routine, they are passed by value, so any attempt to modify them (with an assignment statement) through the parameter in the routine has no effect.

- Input port arrays cannot be used on the left side of an assignment statement.

**See Also:** [Chapter 3 USE OF OPERATORS](#), for detailed information about expressions and their evaluation, [Chapter 2 LANGUAGE ELEMENTS](#). Refer to Appendix B, "KAREL Example Programs," for more detailed program examples.

**Example:** The following example assigns an INTEGER literal to an INTEGER variable and then increments that variable by a literal and value.

### Assignment Statement

```
int_var = 5  
int_var = 5 + int_var
```

**Example:** The next example multiplies the system variable \$SPEED by a REAL value. It is then used to assign the ARRAY variable **array\_1**, element `loop_count` to the new value of the system variable \$SPEED.

### Assignment Statement

```
$SPEED = $SPEED * .25  
array_1[loop_count] = $SPEED
```

**Example:** The last example assigns all the elements of the ARRAY **array\_1** to those of ARRAY **array\_2**, and all the fields of structure **struc\_var\_1** to those of **struc\_var\_2**.

### Assignment Statement

```
array_2 = array_1
```

---

```
struc_var_2 = struc_var_1
```

### A.1.22 AT NODE Condition

**Purpose:** Condition is satisfied when a specified PATH node or position has been reached

**Syntax :** AT NODE[n]

where:

n :an INTEGER expression or \* (asterisk)

**Details:**

- The AT NODE condition can be used only in local condition handlers.
- If the move is along a PATH or to a path node, n specifies the path node. If n is a wildcard (\*) or negative one (-1), any node will satisfy the AT NODE condition.
- If the move is to a position, n = 1 (node 1) can be used to indicate the destination.
- If n is greater than the length of the path (or greater than 1 if the move is to a position), the condition is never satisfied.
- If n is less than zero or greater than 1000, the program is aborted with an error.

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , for more information on synchronizing local condition handlers with the motion environment. PATH\_LEN Built-In Function

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.1.23 ATAN2 Built-In Function

**Purpose:** Returns a REAL angle, measured counterclockwise in degrees, from the positive x-axis to a line connecting the origin and a point whose x- and y- coordinates are specified as the x- and y- arguments

**Syntax :** ATAN2(x1, y1)

Function Return Type :REAL

Input/Output Parameters :

[in] x1 :REAL

[in] y1 :REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- $x1$  and  $y1$  specify the x and y coordinates of the point.
- If  $x1$  and  $y1$  are both zero, the interpreter will abort the program.

**Example:** The following example uses the values 100, 200, and 300 respectively for **x**, **y**, and **z** to compute the orientation component **direction**. The position, **p1** is then defined to be a position with **direction** as its orientation component.

### ATAN2 Built-In Function

```
PROGRAM p_atan2

VAR
    p1 : POSITION
    x, y, z, direction : REAL

BEGIN
    x = 100 -- use appropriate values
    y = 200 -- for x,y,z on
    z = 300 -- your robot
    direction = ATAN2(x, y)
    p1 = POS(x, y, z, 0, 0, direction, 'n') --r orientation component
    MOVE TO p1                                --of POS equals angle
END p_atan2                                 --returned by ATAN2(100,200)
```

### A.1.24 ATTACH Statement

**Purpose:** Gives the KAREL program control of motion for the robot arm and auxiliary and extended axes

**Syntax :** ATTACH

**Details:**

- Used with the RELEASE statement. If motion control is not currently released from program control, the ATTACH statement has no effect.
- If the teach pendant is still enabled, execution of the KAREL program is delayed until the teach pendant is disabled. The task status will show a hold of "attach done."
- Stopped motions can only be resumed following execution of the ATTACH statement.

**See Also:** RELEASE Statement, [Chapter 8 MOTION](#), for more information on motion control, [Appendix E](#), “Syntax Diagrams,” for additional syntax information.

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.1.25 ATT\_WINDOW\_D Built-In Procedure**

**Purpose:** Attach a window to the screen on a display device

**Syntax :** ATT\_WINDOW\_D(window\_name, disp\_dev\_nam, row, col, screen\_name, status)

Input/Output Parameters :

[in] window\_name :STRING

[in] disp\_dev\_nam :STRING

[in] row :INTEGER

[in] col :INTEGER

[out] screen\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

#### **Details:**

- Causes data in the specified window to be displayed or attached to the screen currently active on the specified display device.

- *window\_name* must be a previously defined window.

- *disp\_dev\_nam* must be one of the display devices already defined:

'CRT' CRT Device

'TP' Teach Pendant Device

- *row* and *col* indicate the position in the screen. Row 1 indicates the top row; col 1 indicates the left-most column. The entire window must be visible in the screen where positioned. For example, if the screen is 24 rows by 80 columns (as defined by its associated display device) and the window is 2 rows by 80 columns, *row* must be in the range 1-23; *col* must be 1.

- The name of the active screen is returned in *screen\_name*. This can be used to detach the window later.

- It is an error if the window is already attached to the screen.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

### A.1.26 ATT\_WINDOW\_S Built-In Procedure

**Purpose:** Attach a window to a screen

**Syntax :** ATT\_WINDOW\_S(window\_name, screen\_name, row, col, status)

Input/Output Parameters :

[in] window\_name :STRING

[in] screen\_name :STRING

[in] row :INTEGER

[in] col :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- Causes data in the specified window to be displayed or attached to the specified screen at a specified row and column.
- *window\_name* and *screen\_name* must be previously defined window and screen names.
- *row* and *col* indicate the position in the screen. Row 1 indicates the top row; col 1 indicates the left-most column. The entire window must be visible in the screen as positioned. For example, if the screen is 24 rows by 80 columns (as defined by its associated display device) and the window is 2 rows by 80 columns, row must be in the range 1-23; col must be 1.
- If the screen is currently active, the data will immediately be displayed on the device. Otherwise, there is no change in the displayed data.
- It is an error if the window is already attached to the screen.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** [Section 7.9](#), "User Interface Tips," DET\_WINDOW Built-In

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### A.1.27 AVL\_POS\_NUM Built-In Procedure

**Purpose:** Returns the first available position number in a teach pendant program

**Syntax :** AVL\_POS\_NUM(open\_id, pos\_num, status)

Input/Output Parameters :

[in] open\_id :INTEGER

[out] pos\_num : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :TPE

**Details:**

- *open\_id* specifies the opened teach pendant program. A program must be opened before calling this built-in.
- *pos\_num* is set to the first available position number.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

## **A.2 - B - KAREL LANGUAGE DESCRIPTION**

### **A.2.1 BOOLEAN Data Type**

**Purpose:** Defines a variable, function return type, or routine parameter as a BOOLEAN data type

**Syntax :** BOOLEAN

**Details:**

- The BOOLEAN data type represents the BOOLEAN predefined constants TRUE, FALSE, ON, and OFF.

[Table A-10](#) lists some examples of valid and invalid BOOLEAN values used to represent the Boolean predefined constants.

**Table A-10. Valid and Invalid BOOLEAN Values**

VALID	INVALID	REASON
TRUE	T	Must use entire word
ON	1	Cannot use INTEGER values

- TRUE and FALSE typically represent logical flags, and ON and OFF typically represent signal states. TRUE and ON are equivalent, as are FALSE and OFF.
- Valid BOOLEAN operators are
  - AND, OR, and NOT
  - Relational operators ( $>$ ,  $\geq$ ,  $=$ ,  $\neq$ ,  $<$ , and  $\leq$ )
- The following have BOOLEAN values:
  - BOOLEAN constants, whether predefined or user-defined (for example, ON is a predefined constant)
  - BOOLEAN variables and BOOLEAN fields in a structure
  - ARRAY OF BOOLEAN elements
  - Values returned by BOOLEAN functions, whether user-defined or built-in (for example, IN\_RANGE(pos\_var))
  - Values resulting from expressions that use relational or BOOLEAN operators (for example,  $x > 5.0$ )
  - Values of digital ports (for example, DIN[2])
- Only BOOLEAN expressions can be assigned to BOOLEAN variables, returned from BOOLEAN function routines, or passed as arguments to BOOLEAN parameters.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.3, "Saving Data to the Default Device" \(SAVE\\_VR.KL\)](#)

[Section B.5, "Using Register Built-ins" \(REG\\_EX.KL\)](#)

[Section B.7, "Listing Files and Programs and Manipulating Strings" \(LIST\\_EX.KL\)](#)

[Section B.9 , "Using the File and Device Built-ins" \(FILE\\_EX.KL\)](#)

[Section B.10 , "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.12 , "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.14](#) , "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL)

[Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

## A.2.2 BYNAME Built-In Function

**Purpose:** Allows a KAREL program to pass a variable, whose name is contained in a STRING, as a parameter to a KAREL routine. This means the programmer does not have to determine the variable name during program creation and translation.

**Syntax :** BYNAME (prog\_name, var\_name, entry)

Input/Output Parameters :

[in] prog\_name :STRING

[in] var\_name :STRING

[in,out] entry :INTEGER

%ENVIRONMENT Group :system

### Details:

- This built-in can be used only to pass a parameter to a KAREL routine.
- *entry* returns the entry number in the variable data table where *var\_name* is located. This variable does not need to be initialized and should not be modified.
- *prog\_name* specifies the name of the program that contains the specified variable. If *prog\_name* is equal to " (double quotes), then the routine defaults to the task name being executed.
- *var\_name* must refer to a static, program variable.
- If *var\_name* does not contain a valid variable name or if the variable is not of the type expected as a routine parameter, the program is aborted.
- System variables cannot be passed using BYNAME.
- The PATH data type cannot be passed using BYNAME. However, a user-defined type that is a PATH can be used instead.

**Example:** Refer to [Section B.2](#) , "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

## A.2.3 BYTE Data Type

**Purpose:** Defines a variable as a BYTE data type

**Syntax :** BYTE

**Details:**

- BYTE has a range of ( $0 \leq n \geq 255$ ). No uninitialized checking is done on bytes.
- BYTES are allowed only within an array or within a structure.
- BYTES can be assigned to SHORTs and INTEGERs, and SHORTs and INTEGERs can be assigned to BYTES. An assigned value outside the BYTE range will be detected during execution and cause the program to abort.

**Example:** The following example defines an array of BYTE and a structure containing BYTES.

**BYTE Data Type**

```
PROGRAM byte_ex
%NOLOCKGROUP
  TYPE
    mystruct = STRUCTURE
      param1: BYTE
      param2: BYTE
      param3: SHORT
    ENDSTRUCTURE
  VAR
    array_byte: ARRAY[10] OF BYTE
    myvar: mystruct
  BEGIN
    array_byte[1] = 254
    myvar.param1 = array_byte[1]
  END byte_ex
```

#### A.2.4 BYTES\_AHEAD Built-In Procedure

**Purpose:** Returns the number of bytes of input data presently in the read-ahead buffer for a KAREL file. Allows KAREL programs to check instantly if data has been received from a serial port and is available to be read by the program. BYTES\_AHEAD is also supported on socket messaging and pipes.

**Syntax :** BYTES\_AHEAD(file\_id, n\_bytes, status)

Input/Output Parameters :

[in] file\_id :FILE

[out] n\_bytes :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :FLBT

**Details:**

- *file\_id* specifies the file that was opened.
- The *file\_id* must be opened with the ATR\_READAHD attribute set greater than zero.
- *n\_byte* is the number of bytes in the read\_ahead buffer.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.
- A non-zero status will be returned for non-serial devices such as files.

**See Also:** [Section 7.2.1](#), “File Attributes”

**Example:** The following example will clear Port 2 (FLPY:) from any bytes still remaining to be read.

**BYTES\_AHEAD Built-In Procedure**

```

ROUTINE purge_port
VAR
    s1          : STRING[1]
    n_try       : INTEGER
    n_bytes     : INTEGER
    stat        : INTEGER
BEGIN
    stat=SET_PORT_ATR (port_2, ATR_READAHD, 1) -- sets FLPY: to have a read
                                                -- ahead buffer of 128 bytes
    OPEN FILE fi('RO', 'rdahd.tst')
    REPEAT
        BYTES_AHEAD (fi, n_bytes, stat)
            --Get number of bytes ready
            --to be read
        if (n_bytes = 0) then --if there are no bytes then set stat
            stat = 282
        endif
        if (n_bytes >= 1_) then --there are bytes to be read
            read fi(s1::1)      --read in one byte at a time
            stat=io_status (fi) --get the status of the read operation
        endif
        UNTIL stat <> 0           --continue until no more bytes are left
    END purge_port
    BEGIN
        -- main program text here
    END bytes_ahd

```

### A.2.5 BYTES\_LEFT Built-In Function

**Purpose:** Returns the number of bytes remaining in the current input data record

**Syntax :** BYTES\_LEFT(file\_id)

Function Return Type :INTEGER

Input/Output Parameters :

[in] file\_id :FILE

%ENVIRONMENT Group :FLBT

**Details:**

- *file\_id* specifies the file that was opened.
- If no read or write operations have been done or the last operation was a READ file\_id (CR), a zero is returned.
- If *file\_id* does not correspond to an opened file or one of the pre-defined “files” opened to the respective CRT/KB, teach pendant, and vision windows, the program is aborted.

**Note** An infeed character (LF) is created when the ENTER key is pressed, and is counted by BYTES\_LEFT.

- This function will return a non-zero value only when data is input from a keyboard (teach pendant or CRT/KB), not from files or ports.



**Warning**

This function is used exclusively for reading from a window to determine if more data has been entered. Do not use this function with any other file device. Otherwise, you could injure personnel or damage equipment.

**See Also:** [Section 7.9.1](#) , "User Menu on the Teach Pendant,"[Section 7.9.2](#) , "User Menu on the CRT/KB"

**Example:** The following example reads the first number, **qd\_field** , and then uses BYTES\_LEFT to determine if the user entered any additional numbers. If so, these numbers are then read.

#### BYTES\_LEFT Built-In Function

```
PROGRAM p_bytesleft
%NOLOCKGROUP
%ENVIRONMENT flbt
CONST
```

```

default_1 = 0
default_2 = -1

VAR rqd_field, opt_field_1, opt_field_2: INTEGER
BEGIN
    WRITE('Enter integer field(s): ')
    READ(rqd_field)
    IF BYTES_LEFT(TPDISPLAY) > 0 THEN
        READ(opt_field_1)
    ELSE
        opt_field_1 = default_1
    ENDIF
    IF BYTES_LEFT(TPDISPLAY) > 0 THEN
        READ(opt_field_2)
    ELSE
        opt_field_2 = default_2
    ENDIF
END p_bytesleft

```

## **A.3 - C - KAREL LANGUAGE DESCRIPTION**

### **A.3.1 CALL\_PROG Built-In Procedure**

**Purpose:** Allows a KAREL program to call an external KAREL or teach pendant program. This means that the programmer does not have to determine the program to be called until run time.

**Syntax :** CALL\_PROG(prog\_name, prog\_index)

Input/Output Parameters :

[in] prog\_name :STRING

[in,out] prog\_index :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *prog\_name* is the name of the program to be executed, in the current calling task.
- *prog\_index* returns the entry number in the program table where *prog\_name* is located. This variable does not need to be initialized and should not be modified.
- CALL\_PROG cannot be used to run internal or external routines.

**See Also:** CURR\_PROG and CALL\_PROGLIN Built-In Functions

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

### **A.3.2 CALL\_PROGLIN Built-In Procedure**

**Purpose:** Allows a KAREL program to call an external KAREL or teach pendant program, beginning at a specified line. This means that the programmer does not need to know, at creation and translation, what program will be called. The programmer can decide this at run time.

**Syntax :** CALL\_PROGLIN(prog\_name, prog\_line, prog\_index, pause\_entry)

Input/Output Parameters :

[in] prog\_name :STRING

[in] prog\_line :INTEGER

[in,out] prog\_index :INTEGER

[in] pause\_entry :BOOLEAN

%ENVIRONMENT Group :BYNAM

**Details:**

- *prog\_name* is the name of the program to be executed, in the current calling task.
- *prog\_line* specifies the line at which to begin execution for a teach pendant program. 0 or 1 is used for the beginning of the program.
- KAREL programs always execute at the beginning of the program.
- *prog\_index* returns the entry number in the program table where *prog\_name* is located. This variable does not need to be initialized and should not be modified.
- *pause\_entry* specifies whether to pause program execution upon entry of the program.
- CALL\_PROGLIN cannot be used to run internal or external routines.

**See Also:** CURR\_PROG and CALL\_PROG Built-In Function

**Example:** Refer to [Section B.5](#), "Using Register Built-ins" (REG\_EX.KL), for a detailed program example.

### **A.3.3 CANCEL Action**

**Purpose:** Terminates any motion in progress

**Syntax :** CANCEL <GROUP[n{,n}]>

**Details:**

- Cancels a motion currently in progress or pending (but not stopped) for one or more groups.
- CANCEL does not cancel motions that are already stopped. To cancel a motion that is already stopped, use the CNCL\_STP\_MTN built-in routine.
- If the group clause is not present, all groups for which the task has control (when the condition is defined) will be canceled. In particular, if the program containing the condition handler definition contains the %NOLOCKGROUP directive, the CANCEL action will not cancel motion in any group.
- If a motion that is canceled and is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are canceled.
- The robot and auxiliary or extended axes decelerate smoothly to a stop. The remainder of the motion is canceled.
- Canceled motions are treated as completed and cannot be resumed.
- The CANCEL action in a global condition handler also cancels any pending motions.
- The CANCEL action in a local condition handler cancels only the motion in progress, permitting any pending motions to start.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**Example:** The following example uses a local condition handler to cancel only the current motion in progress.

**CANCEL Action**

```
MOVE ALONG some_path,
WHEN AT NODE[n] DO
    CANCEL
ENDMOVE
```

### A.3.4 CANCEL Statement

**Purpose:** Terminates any motion in progress.

**Syntax :** CANCEL <GROUP[n{,n}]>

**Details:**

- Cancels a motion currently in progress or pending (but not stopped) for one or more groups.
- CANCEL does not cancel motions that are already stopped. To cancel a motion that is already stopped, use the CNCL\_STP\_MTN built-in routine.
- If the group clause is not present, all groups for which the task has control will be canceled. In particular, if the program using the CANCEL statement contains the %NOLOCKGROUP directive, the CANCEL statement will not cancel motion in any group.
- If a motion that is canceled is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are canceled.
- The robot and auxiliary axes decelerate smoothly to a stop. The remainder of the motion is canceled.
- Canceled motions are treated as completed and cannot be resumed.
- CANCEL does not affect stopped motions. Stopped motions can be resumed.
- If an interrupt routine executes a CANCEL statement and the interrupted statement was a motion statement, when the interrupted program resumes, execution normally resumes with the statement following the motion statement.
- CANCEL might not work as expected if it is used in a routine called by a condition handler. The motion might already be put on the stopped motion queue before the routine is called. Use a CANCEL action directly in the condition handler to be sure the motion is canceled.
- Motion cannot be cancelled for a different task.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for additional syntax information

**Example:** The following example cancels the current motion if DIN[1] is ON.

**CANCEL Statement**

```
MOVE ALONG some_path NOWAIT
IF DIN[1] THEN
    WRITE ('Motion canceled',CR)
    CANCEL
ENDIF
```

### **A.3.5 CANCEL FILE Statement**

**Purpose:** Cancels a READ or WRITE statement that is in progress.

**Syntax :** CANCEL FILE [file\_var]

where:

file\_var :a FILE variable

**Details:**

- Used to cancel input or output on a specified file
- The built-in function IO\_STATUS can be used to determine if a CANCEL FILE operation was successful or, if it failed to determine the reason for the failure.

**See Also:** IO\_STATUS Built-In Function, [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#) , [Appendix E](#), “Syntax Diagrams,” for additional syntax information

**Example:** The following example reads an integer, but cancels the read if the F1 key is pressed.

#### **CANCEL FILE Statement**

```
PROGRAM can_file_ex

%ENVIRONMENT FLBT
%ENVIRONMENT UIF
%NOLOCKGROUP

VAR
    int_var: INTEGER

ROUTINE cancel_read
BEGIN
    CANCEL FILE TPDISPLAY
END cancel_read

BEGIN
    CONDITION[1]:
        WHEN TPIN[ky_f1]+ DO
            cancel_read
        ENABLE CONDITION[1]
    ENDCONDITION

    ENABLE CONDITION[1]
    REPEAT
        -- Read an integer, but cancel if F1 pressed
        CLR_IO_STAT(TPDISPLAY)
```

```
    WRITE(CR, 'Enter an integer: ')
    READ(int_var)
    UNTIL FALSE

end can_file_ex
```

### **A.3.6 CHECK\_DICT Built-In Procedure**

**Purpose:** Checks the specified dictionary for a specified element

**Syntax :** CHECK\_DICT(dict\_name, element\_no, status)

Input/Output Parameters :

[in] dict\_name :STRING

[in] element\_no :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *dict\_name* is the name of the dictionary to check.
- *element\_no* is the element number within the dictionary.
- *status* explains the status of the attempted operation. If not equal to 0, then the element could not be found.

**See Also:** ADD\_DICT, READ\_DICT, WRITE\_DICT, REMOVE\_DICT Built-In Procedures. Refer to the program example for the DISCTRL\_LIST Built-In Procedure and [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### **A.3.7 CHECK\_EPOS Built-In Procedure**

**Purpose:** Checks that the specified position is valid and that no motion errors will be generated when moving to this position

**Syntax :** CHECK\_EPOS (eposn, uframe, utool, status <, group\_no>)

Input/Output Parameters :

[in] eposn :XYZWPREXT  
 [in] uframe :POSITION  
 [in] utool :POSITION  
 [out] status :INTEGER  
 [in] group\_no :INTEGER  
 %ENVIRONMENT Group :PBCORE

**Details:**

- *eposn* is the XYZWPREXT position to be checked.
- *uframe* specifies the uframe position to use with *eposn*.
- *utool* specifies the utool position to use with *eposn*.
- *status* explains the status of the check. If the position is reachable, the status will be 0.
- *group\_no* is optional, but if specified will be the group number for *eposn*. If not specified the default group of the program is used.

**See Also:** GET\_POS\_FRM

**Example:** Refer to Section B.7 "Generating and Moving Along a Hexagon Path" (GEN\_HEX.KL)

**A.3.8 CHECK\_NAME Built-In Procedure**

**Purpose:** Checks a specified file or program name for illegal characters.

**Syntax :** CHECK\_NAME (name\_spec, status)

Input/Output Parameters :

[in] name\_spec :STRING  
 [out] status :INTEGER  
 %ENVIRONMENT Group :FDEV

**Details:**

- Name\_spec specifies the string to check for illegal characters. The string can be the file name or program name. It should not include the extension of the file or the program. This built-in does not handle special system names such as \*SYSTEM\*.

### A.3.9 CHR Built-In Function

**Purpose:** Returns the character that corresponds to a numeric code

**Syntax :** CHR (code)

Function Return Type :STRING

Input/Output Parameters :

[in] code :INTEGER

%ENVIRONMENT Group :SYSTEM

**Details:**

- *code* represents the numeric code of the character for either the ASCII, Graphic, or Multinational character set.
- Returns a single character string that is assigned the value of *code* .

**See Also:** [Appendix D, "ASCII Character Codes"](#)

**Example:** Refer to the following sections for detailed program examples:

[Section B.4, "Standard Routines" \(ROUT\\_EX.KL\)](#)

[Section B.5, "Using Register Built-ins" \(REG\\_EX.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.13, "Using the DISCTRL\\_ALPHA Built-in" \(DCALP\\_EX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

### A.3.10 CLEAR Built-In Procedure

**Purpose:** Clears the specified program and/or variables from memory

**Syntax :** CLEAR(file\_spec, status)

Input/Output Parameters :

[in] file\_spec :STRING

[out] status :INTEGER  
 %ENVIRONMENT Group :PBCORE

**Details:**

- *file\_spec* specifies the program name and type of data to clear. The following types are valid:  
 no ext :KAREL or Teach Pendant program and variables.TP :Teach Pendant program.PC :KAREL program.VR :KAREL variables
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** The following example clears a KAREL program, clears the variables for a program, and clears a teach pendant program.

**CLEAR Built-In Procedure**

```
-- Clear KAREL program
CLEAR('test1.pc', status)

-- Clear KAREL variables
CLEAR('testvars.vr', status)

-- Clear Teach Pendant program
CLEAR('prg1.tp', status)
```

**A.3.11 CLEAR\_SEMA Built-In Procedure**

**Purpose:** Clear the indicated semaphore by setting the count to zero

**Syntax :** CLEAR\_SEMA(semaphore\_no)

Input/Output Parameters :

[in] semaphore\_no :INTEGER  
 %ENVIRONMENT Group :MULTI

**Details:**

- The semaphore indicated by *semaphore\_no* is cleared.
- *semaphore\_no* must be in the range of 1 to the number of semaphores defined on the controller.
- All semaphores are cleared at COLD start. It is good practice to clear a semaphore prior to using it. Before several tasks begin sharing a semaphore, one and only one of these task, should clear the semaphore.

**See Also:** POST\_SEMA, PEND\_SEMA Built-In Procedures, SEMA\_COUNT Built-In Function, examples in Chapter 14, "Multi-Tasking"

### **A.3.12 CLOSE FILE Statement**

**Purpose:** Breaks the association between a FILE variable and a data file or communication port

**Syntax :** CLOSE FILE file\_var

where:

file\_var :a FILE variable

**Details:**

- *file\_var* must be a static variable that was used in the OPEN FILE statement.
- Any buffered data associated with the *file\_var* is written to the file or port.
- The built-in function IO\_STATUS will always return zero.

**See Also:** IO\_STATUS Built-In Function, [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#) , [Appendix E](#) , “Syntax Diagrams,” for additional syntax information

**Example:** Refer to [Section B.12](#) , "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### **A.3.13 CLOSE HAND Statement**

**Purpose:** Causes the specified hand to close

**Syntax :** CLOSE HAND hand\_num

where:

hand\_num :an INTEGER expression

**Details:**

- The actual effect of the statement depends on how the HAND signals are set up in I/O system.
- The valid range of values for *hand\_num* is 1-2. Otherwise, the program is aborted with an error.
- The statement has no effect if the value of *hand\_num* is in range but the hand is not connected.
- The program is aborted with an error if the value of *hand\_num* is in range but the HAND signal represented by that value has not been assigned.

**See Also:** [Chapter 14 INPUT/OUTPUT SYSTEM](#), for more information on hand signals, [Appendix E](#), "Syntax Diagrams," for additional syntax information

**Example:** The following example moves the robot to the first position and closes the hand specified by `hand_num`.

### CLOSE HAND Statement

```
MOVE TO p1
CLOSE HAND hand_num
```

### A.3.14 CLOSE\_TPE Built-In Procedure

**Purpose:** Closes the specified teach pendant program

**Syntax :** CLOSE\_TPE(open\_id, status)

Input/Output Parameters :

[in] open\_id :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *open\_id* indicates the teach pendant program to close. All teach pendant programs that are opened must be closed before they can be executed. Any unclosed programs remain opened until the KAREL program which opened it is aborted or runs to completion.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

**See Also:** OPEN\_TPE Built-In Procedure

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

### A.3.15 CLR\_IO\_STAT Built-In Procedure

**Purpose:** Clear the results of the last operation on the file argument

**Syntax :** CLR\_IO\_STAT(file\_id)

Input/Output Parameters :

[in] file\_id :FILE  
%ENVIRONMENT Group :PBCORE

**Details:**

- Causes the last operation result on *file\_id* , which is returned by IO\_STATUS, to be cleared to zero.

**See Also:** I/O-STATUS Built-In Function

**Example:** Refer to [Section B.12](#) , "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### **A.3.16 CLR\_PORT\_SIM Built-In Procedure**

**Purpose:** Sets the specified port to be unsimulated

**Syntax :** CLR\_PORT\_SIM(port\_type, port\_no, status)

Input/Output Parameters :

[in] port\_type :INTEGER

[in] port\_no :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :iosetup

**Details:**

- *port\_type* specifies the code for the type of port to unsimulate. Codes are defined in FR:KLIOTYPS.KL.
- *port\_no* specifies the port number to unsimulate.
- *status* is returned with zero if parameters are valid and the simulation of the specified port is cleared.

**See Also:** GET\_PORT\_SIM, SET\_PORT\_SIM Built-In Procedures

### **A.3.17 CLR\_POS\_REG Built-In Procedure**

**Purpose:** Removes all data for the specified group in the specified position register

**Syntax :** CLR\_POS\_REG(register\_no, group\_no, status)

Input/Output Parameters :

[in] register\_no :INTEGER  
 [in] group\_no :INTEGER  
 [out] status :INTEGER  
 %ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the register number whose data should be cleared.
- If *group\_no* is zero, data for all groups is cleared.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** SET\_POS\_REG Built-In Procedure, GET\_POS\_REG Built-In Function

**Example:** The following example clears the first 100 position registers.

**CLR\_POS\_REG Built-In Procedure**

```
FOR register_no = 1 to 100 DO
    CLR_POS_REG(register_no, 0, status)
ENDFOR
```

### A.3.18 %CMOSVARS Translator Directive

**Purpose:** Specifies the default storage for KAREL variables is permanent memory

**Syntax :** %CMOSVARS

**Details:**

- If %CMOSVARS is specified in the program, then all static variables by default will be created in permanent memory.
- If %CMOSVARS is not specified, then all static variables by default will be created in temporary memory.
- If a program specifies %CMOSVARS, but not all static variables need to be created in permanent memory, the IN DRAM clause can be used on selected variables.

**See Also:** Chapter 1.3.1, "Memory," IN DRAM Clause

**Example:** Refer to the following sections for detailed program examples:

[Section B.10 , "Using Dynamic Display Built-ins" \(DCLST\\_EX.KL\)](#)

[Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

### A.3.19 CNC\_DYN\_DISB Built-In Procedure

**Purpose:** Cancels the dynamic display based on the value of a BOOLEAN variable in a specified window.

**Syntax :** CNC\_DYN\_DISB (b\_var, window\_name, status)

Input/Output Parameters :

[in] b\_var :BOOLEAN

[in] window\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *b\_var* is the boolean variable whose dynamic display is to be canceled.
- *window\_name* must be a previously defined window name. See [Section 7.9.1](#). and [Section 7.9.2](#) for predefined window names.
- If there is more than one display active for this variable in this window, all the displays are canceled.
- *status* returns an error if there is no dynamic display active specifying this variable and window. If not equal to 0, then an error occurred.

**See Also:** INI\_DYN\_DISB Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL)

[Section B.11](#), "Manipulating Values of Dynamically Displayed Variables" (CHG\_DATA.KL)

### A.3.20 CNC\_DYN\_DISE Built-In Procedure

**Purpose:** Cancels the dynamic display based on the value of an INTEGER variable in a specified window.

**Syntax :** CNC\_DYN\_DISE (e\_var, window\_name, status)

Input/Output Parameters :

[in] e\_var :INTEGER

[in] window\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *e\_var* is the integer variable whose dynamic display is to be canceled.
- Refer to the CNC\_DYN\_DISB built-in procedure for a description of the other parameters listed above.

**See Also:** INI\_DYN\_DISE Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.11 , "Manipulating Values of Dynamically Displayed Variables" \(CHG\\_DATA.KL\)](#)

### **A.3.21 CNC\_DYN\_DISI Built-In Procedure**

**Purpose:** Cancels the dynamic display of an INTEGER variable in a specified window.

**Syntax :** CNC\_DYN\_DISI(int\_var, window\_name, status)

Input/Output Parameters :

[in] int\_var :INTEGER

[in] window\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *int\_var* is the integer variable whose dynamic display is to be canceled.
- Refer to the CNC\_DYN\_DISB built-in procedure for a description of the other parameters listed above.

**See Also:** INI\_DYN\_DISI Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.11, "Manipulating Values of Dynamically Displayed Variables" \(CHG\\_DATA.KL\)](#)

### **A.3.22 CNC\_DYN\_DISP Built-In Procedure**

**Purpose:** Cancels the dynamic display based on the value of a port in a specified window.

**Syntax :** CNC\_DYN\_DISP(port\_type, port\_no, window\_name, status)

Input/Output Parameters :

[in] port\_type :INTEGER

[in] port\_no :INTEGER

[in] window\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *port\_type* and *port\_no* are integer values specifying the port whose dynamic display is to be canceled.
- Refer to the CNC\_DYN\_DISB built-in procedure for a description of the other parameters listed above.

**See Also:** INI\_DYN\_DISP Built-In Procedure for information on *port\_type* codes.

**Example:** Refer to the following sections for detailed program examples:

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.11, "Manipulating Values of Dynamically Displayed Variables" \(CHG\\_DATA.KL\)](#)

### **A.3.23 CNC\_DYN\_DISR Built-In Procedure**

**Purpose:** Cancels the dynamic display of a REAL number variable in a specified window.

**Syntax :** CNC\_DYN\_DISR(real\_var, window\_name, status)

Input/Output Parameters :

[in] real\_var :REAL

[in] window\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *real\_var* is the REAL variable whose dynamic display is to be canceled.
- Refer to the CNC\_DYN\_DISB built-in procedure for a description of the other parameters listed above.

**See Also:** INI\_DYN\_DISR Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.11, "Manipulating Values of Dynamically Displayed Variables" \(CHG\\_DATA.KL\)](#)

### A.3.24 CNC\_DYN\_DISS Built-In Procedure

**Purpose:** Cancels the dynamic display of a STRING variable in a specified window.

**Syntax :** CNC\_DYN\_DISS(str\_var, window\_name, status)

Input/Output Parameters :

[in] str\_var :STRING

[in] window\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *str\_var* is the STRING variable whose dynamic display is to be canceled.

- Refer to the CNC\_DYN\_DISB built-in procedure for a description of the other parameters listed above.

**See Also:** INI\_DYN\_DISS Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.11, "Manipulating Values of Dynamically Displayed Variables" \(CHG\\_DATA.KL\)](#)

### **A.3.25 CNCL\_STP\_MTN Built-In Procedure**

**Purpose:** Cancels all stopped motions

**Syntax :** CNCL\_STP\_MTN

%ENVIRONMENT Group :motn

- All stopped motions will be canceled for all groups that the program controls.
- The statements following the motion statements will be executed.
- CNCL\_STP\_MTN will have no effect if no motions are currently stopped.
- Motion cannot be cancelled for a different task.



#### **Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**Example:** The following example will cancel all stopped motions for all groups that the program controls after an emergency stop has occurred.

#### **CNCL\_STP\_MTN Built-In Procedure**

```
ROUTINE e_stop_hdlr
  BEGIN
    CNCL_STP_MTN
  END e_stop_hdlr

  CONDITION[100] :
    WHEN ERROR[estop] DO
      UNPAUSE
```

```

ENABLE CONDITION[100]
e_stop_hndlr
END CONDITION
ENABLE CONDITION[100]

```

### A.3.26 CNV\_CONF\_STR Built-In Procedure

**Purpose:** Converts the specified CONFIG into a STRING

**Syntax :** CNV\_CONF\_STR(source, target)

Input/Output Parameters :

[in] source :CONFIG

[out] target :STRING

%ENVIRONMENT Group :STRNG

**Details:**

- *target* receives the STRING form of the configuration specified by *source* .
- *target* must be long enough to accept a valid configuration string for the robot arm attached to the controller. Otherwise, the program will be aborted with an error.

Using a length of 25 is generally adequate because the longest configuration string of any robot is 25 characters long.

**See Also:** CNV\_STR\_CONF Built-In Procedure

**Example:** The following example converts the configuration from position **posn** into a STRING and puts it into **config\_string** . The string is then displayed on the screen.

### **CNV\_CONF\_STR Built-In Procedure**

```

CNV_CONF_STR(posn.pos_config, config_string)
WRITE('Configuration of posn: ', config_string, cr)

```

### A.3.27 CNV\_INT\_STR Built-In Procedure

**Purpose:** Formats the specified INTEGER into a STRING

**Syntax :** CNV\_INT\_STR(source, length, base, target)

Input/Output Parameters :

[in] source :INTEGER expression  
[in] length :INTEGER expression  
[in] base :INTEGER expression  
[out] target :STRING expression  
%ENVIRONMENT Group :PBCORE

**Details:**

- *source* is the INTEGER to be formatted into a STRING.
- *length* specifies the minimum length of the *target*. The actual length of *target* may be greater if required to contain the contents of *source* and at least one leading blank.
- *base* indicates the number system in which the number is to be represented. *base* must be in the range 2-16 or 0 (zero) indicating base 10.
- If the values of *length* or *base* are invalid, *target* is returned uninitialized.
- If *target* is not declared long enough to contain *source* and at least one leading blank, it is returned with one blank and the rest of its declared length filled with “\*”.

**See Also:** CNV\_STR\_INT Built-In Procedure

**Example:** Refer to the following section for detailed program examples:

[Section B.7](#) , "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

### A.3.28 CNV\_JPOS\_REL Built-In Procedure

**Purpose:** Allows a KAREL program to examine individual joint angles as REAL values

**Syntax :** CNV\_JPOS\_REL(jointpos, real\_array, status)

Input/Output Parameters :

[in] joint\_pos :JOINTPOS  
[out] real\_array :ARRAY [num\_joints] OF REAL  
[out] status :INTEGER  
%ENVIRONMENT Group :SYSTEM

**Details:**

- *joint\_pos* is one of the KAREL joint position data types: JOINTPOS, or JOINTPOS1 through JOINTPOS9.
- *num\_joints* can be smaller than the number of joints in the system. A value of nine can be used if the actual number of joints is unknown. Joint number one will be stored in *real\_array* element number one, etc. Excess array elements will be ignored.
- The measurement of the *real\_array* elements is in degrees.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CNV\_REL\_JPOS Built-In Procedure

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

### A.3.29 CNV\_REAL\_STR Built-In Procedure

**Purpose:** Formats the specified REAL value into a STRING

**Syntax :** CNV\_REAL\_STR(source, length, num\_digits, target)

Input/Output Parameters :

[in] source :REAL expression  
 [in] length :INTEGER expression  
 [in] num\_digits :INTEGER expression  
 [out] target :STRING  
 %ENVIRONMENT Group :STRNG

**Details:**

- *source* is the REAL value to be formatted.
- *length* specifies the minimum length of the *target*. The actual length of *target* may be greater if required to contain the contents of *source* and at least one leading blank.
- *num\_digits* specifies the number of digits displayed to the right of the decimal point. If *num\_digits* is a negative number, *source* will be formatted in scientific notation (where the ABS(*num\_digits*) represents the number of digits to the right of the decimal point.) If *num\_digits* is 0, the decimal point is suppressed.
- If *length* or *num\_digits* are invalid, *target* is returned uninitialized.
- If the declared length of *target* is not large enough to contain *source* with one leading blank, *target* is returned with one leading blank and the rest of its declared length filled with “\*”s (asterisks).

**See Also:** CNV\_STR\_REAL Built-In Procedure

**Example:** The following example converts the REAL number in **cur\_volts** into a STRING and puts it into **volt\_string**. The minimum length of **cur\_volts** is specified to be seven characters with two characters after the decimal point. The contents of **volt\_string** is then displayed on the screen.

#### CNV\_REAL\_STR Built-In Procedure

```
cur_volts = AIN[2]
CNV_REAL_STR(cur_volts, 7, 2, volt_string)
WRITE('Voltage=',volt_string,CR)
```

### A.3.30 CNV\_REL\_JPOS Built-In Procedure

**Purpose:** Allows a KAREL program to manipulate individual angles of a joint position

**Syntax :** CNV\_REL\_JPOS(real\_array, joint\_pos, status)

Input/Output Parameters :

[in] real\_array :ARRAY [num\_joints] OF REAL

[out] joint\_pos :JOINTPOS

[out] status :INTEGER

%ENVIRONMENT Group :SYSTEM

#### Details:

- *real\_array* must have a declared size, equal to or greater than, the number of joints in the system. A value of nine can be used for *num\_joints*, if the actual number of joints is unknown. Array element number one will be stored in joint number one, and so forth. Excess array elements will be ignored. If the array is not large enough the program will abort with an invalid argument error.
- If any of the elements of *real\_array* that correspond to a joint angle are uninitialized, the program will be paused with an uninitialized variable error.
- The measurement of the *real\_array* elements is degrees.
- *joint\_pos* is one of the KAREL joint position types: JOINTPOS, or JOINTPOS1 through JOINTPOS9.
- *joint\_pos* receives the joint position form of *real\_array*.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** Refer to the following sections for detailed program examples:

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.8, "Generating and Moving Along a Hexagon Path" \(GEN\\_HEX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

### **A.3.31 CNV\_STR\_CONF Built-In Procedure**

**Purpose:** Converts the specified configuration string into a CONFIG data type

**Syntax :** CNV\_STR\_CONF(source, target, status)

Input/Output Parameters :

[in] source :STRING

[out] target :CONFIG

[out] status :INTEGER

%ENVIRONMENT Group :STRNG

**Details:**

- *target* receives the CONFIG form of the configuration string specified by *source* .
- *source* must be a valid configuration string for the robot arm attached to the controller.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CNV\_CONF\_STR Built-In Procedure

**Example:** The following example sets the configuration of position **posn** to the configuration specified by **config\_string** and then moves the TCP to that position.

### **CNV\_STR\_CONF Built-In Procedure**

```
CNV_STR_CONF(config_string, posn.pos_config, status)
MOVE TO posn
```

### **A.3.32 CNV\_STR\_INT Built-In Procedure**

**Purpose:** Converts the specified STRING into an INTEGER

**Syntax :** CNV\_STR\_INT(source, target)

Input/Output Parameters :

[in] source :STRING

[out] target :INTEGER  
 %ENVIRONMENT Group :PBCORE

**Details:**

- *source* is converted into an INTEGER and stored in *target* .
- If *source* does not contain a valid representation of an INTEGER, *target* is set uninitialized.

**See Also:** CNV\_INT\_STR Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#) , "Copying Path Variables" (CPY\_PTH.KL)

[Section B.12](#) , "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

### **A.3.33 CNV\_STR\_REAL Built-In Procedure**

**Purpose:** Converts the specified STRING into a REAL

**Syntax :** CNV\_STR\_REAL(source, target)

Input/Output Parameters :

[in] source :STRING

[out] target :REAL

%ENVIRONMENT Group :PBCORE

**Details:**

- Converts *source* to a REAL number and stores the result in *target* .
- If *source* is not a valid decimal representation of a REAL number, *target* will be set uninitialized. *source* may contain scientific notation of the form *nn.nnEsnn* where *s* is a + or - sign.

**See Also:** CNV\_REAL\_STR Built-In Procedure

**Example:** The following example converts the STRING **str** into a REAL and puts it into **rate** .

#### **CNV\_STR\_REAL Built-In Procedure**

```
REPEAT
  WRITE('Enter rate: ')
  READ(str)
  CNV_STR_REAL(str, rate)
```

---

```
UNTIL NOT UNINIT(rate)
```

### A.3.34 CNV\_STR\_TIME Built-In Procedure

**Purpose:** Converts a string representation of time to an integer representation of time.

**Syntax :** CNV\_STR\_TIME(source, target)

Input/Output Parameters :

[in] source :STRING

[out] target :INTEGER

%ENVIRONMENT Group :TIM

**Details:**

- The size of the string parameter, *source* , is STRING[20].
- *source* must be entered using “DD-MMM-YYYY HH:MM:SS” format. The seconds specifier, “SS,” is optional. A value of zero (0) is used if seconds is not specified. If *source* is invalid, *target* will be set to 0.
- *target* can be used with the SET\_TIME Built-In Procedure to reset the time on the system. If *target* is 0, the time on the system will not be changed.

**See Also:** SET\_TIME Built-In Procedure

**Example:** The following example converts the STRING variable **str\_time** , input by the user in “DD-MMM-YYYY HH:MM:SS” format, to the INTEGER representation of time **int\_time** using the CNV\_STR\_TIME procedure. SET\_TIME is then used to set the time within the KAREL system to the time specified by **int\_time** .

### **CNV\_STR\_TIME Built-In Procedure**

```
WRITE('Enter the new time : ')
READ(str_time)
CNV_STR_TIME(str_time,int_time)
SET_TIME(int_time)
```

### A.3.35 CNV\_TIME\_STR Built-In Procedure

**Purpose:** Converts an INTEGER representation of time to a STRING

**Syntax :** CNV\_TIME\_STR(source, target)

Input/Output Parameters :

[in] source :INTEGER

[out] target :STRING

%ENVIRONMENT Group :TIM

**Details:**

- The GET\_TIME Built-In Procedure is used to determine the INTEGER representation of time. CNV\_TIME\_STR is used to convert *source* to *target*, which will be displayed in "DD-MMM-YYY HH:MM:" format.

**See Also:** GET\_TIME Built-In Procedure

**Example:** Refer to [Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL), for a detailed program example.

### A.3.36 %COMMENT Translator Directive

**Purpose:** Specifies a comment of up to 16 characters

**Syntax :** %COMMENT = 'ssssssssssssss'

where sssssssssssss = space

**Details:**

- The comment can be up to 16 characters long.
- During load time, the comment will be stored as a program attribute and can be displayed on the teach pendant or CRT/KB.
- %COMMENT must be used after the PROGRAM statement, but before any CONST, TYPE, or VAR sections.

**See Also:** SET\_ATTR\_PRG and GET\_ATTR\_PRG Built-In Procedures

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

[Section B.3](#), "Saving Data to the Default Device" (SAVE\_VR.KL)

[Section B.5](#), "Using Register Built-ins" (REG\_EX.KL)

[Section B.6](#), "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL)

[Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL)

[Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

[Section B.13](#), "Using the DISCTRL\_ALPHA Built-in" (DCALP\_EX.KL)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

### **A.3.37 COMMON\_ASSOC Data Type**

**Purpose:** Defines a variable or structure field as a COMMON\_ASSOC data type

**Syntax :** COMMON\_ASSOC

**Details:**

- COMMON\_ASSOC consists of a record containing standard associated data common for all motion groups. It contains the following predefined fields, all INTEGERS:
  - SEGTERMTYPE :termination type
  - SEGDECELTOL :deceleration tolerance
  - SEGRELACCEL :not implemented
  - SEGTIMESHFT :not implemented
- Variables and fields of structures can be declared as COMMON\_ASSOC.
- Subfields of this structure can be accessed and set using the usual structure field notation.
- Variables and fields declared COMMON\_ASSOC can be:
  - Passed as parameters.
  - Written to and read from unformatted files.
  - Assigned to one another.
- Each subfield of a COMMON\_ASSOC variable or structure field can be passed as a parameter to a routine, but is always passed by value.

**See Also:** [Section 8.4.7](#) , "Path Motion," for default values, [Section 2.1.6](#) , "Predefined Identifiers"

**Example:** Refer to [Section B.2](#) , "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

### A.3.38 CONDITION...ENDCONDITION Statement

**Purpose:** Defines a global condition handler

**Syntax :** CONDITION[cond\_hand\_no]: [with\_list]

WHEN cond\_list DO action\_list

{WHEN cond\_list DO action\_list}

ENDCONDITION

**Details:**

- *cond\_hand\_no* specifies the number associated with the condition handler and must be in the range of 1-1000. The program is aborted with an error if it is outside this range.
- If a condition handler with the specified number already exists, the old one is replaced with the new one.
- The optional [with\_list] can be used to specify condition handler qualifiers. See the WITH clause for more information.
- All of the conditions listed in a single WHEN clause must be satisfied simultaneously for the condition handler to be triggered.
- Multiple conditions must all be separated by the AND operator or the OR operator. Mixing of AND and OR is not allowed.
- The actions listed after DO are to be taken when the corresponding conditions of a WHEN clause are satisfied simultaneously.
- Multiple actions are separated by a comma or on a new line.
- Calls to function routines are not allowed in a CONDITION statement.
- The condition handler is initially disabled and is disabled again whenever it is triggered. Use the ENABLE statement or action, specifying the condition handler number, to enable it.
- Use the DISABLE statement or action to deactivate a condition handler.
- The condition handler remains defined and can subsequently be reactivated by the ENABLE statement or action.
- The PURGE statement can be used to delete the definition of a condition handler.
- Condition handlers are known only to the task which defines them. Two different tasks can use the same *cond\_hand\_no* even though they specify different conditions.

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , Appendix E, “Syntax Diagrams,” for additional syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.6](#) , "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

### **A.3.39 CONFIG Data Type**

**Purpose:** Defines a variable or structure field as a CONFIG data type

**Syntax :** CONFIG

**Details:**

- CONFIG defines a variable or structure field as a highly compact structure consisting of fields defining a robot configuration.
- CONFIG contains the following predefined fields:
  - CFG\_TURN\_NO1 :INTEGER
  - CFG\_TURN\_NO2 :INTEGER
  - CFG\_TURN\_NO3 :INTEGER
  - CFG\_FLIP :BOOLEAN
  - CFG\_LEFT :BOOLEAN
  - CFG\_UP :BOOLEAN
  - CFG\_FRONT :BOOLEAN
- Variables and fields of structures can be declared as CONFIG.
- Subfields of CONFIG data type can be accessed and set using the usual structure field notation.
- Variables and fields declared as CONFIG can be
  - Assigned to one another.
  - Passed as parameters.
  - Written to and read from unformatted files.
- Each subfield of a CONFIG variable or structure field can be passed as a parameter to a routine, but is always passed by value.
- A CONFIG field is part of every POSITION and XYZWPR variable and field.
- An attempt to assign a value to a CONFIG subfield that is too large for the field results in an abort error.

**Example:** The following example shows how subfields of the CONFIG structure can be accessed and set using the usual structure.field notation.

**CONFIG Data Type**

```

VAR
    config_var1  config_var2:  CONFIG
    pos_var:    POSITION
    seam_path:   PATH
    i:        INTEGER

BEGIN
    config_var1 = pos_var.config_data
    config_var1 = config_var2
    config_var1.cfg_turn_no1 = 0
    IF pos_var.pos_config_data.cfg_flip THEN...
    FOR i = 1 TO PATH_LEN(seam_path) DO
        seam_path[i].node_pos.pos_config = config_ar1
    ENDFOR

```

**A.3.40 CONNECT TIMER Statement**

**Purpose:** Causes an INTEGER variable to start being updated as a millisecond clock

**Syntax :** CONNECT TIMER TO *clock\_var*

where:

*clock\_var* :a static, user-defined INTEGER variable

**Details:**

- *clock\_var* is presently incremented by the value of the system variable \$SCR.\$COND\_TIME every \$SCR.\$COND\_TIME milliseconds as long as the program is running or paused and continues until the program disconnects the timer, ends, or aborts. For example, if \$SCR.\$COND\_TIM E=32 then *clock\_var* will be incremented by 32 every 32 milliseconds.
- You should initialize *clock\_var* before using the CONNECT TIMER statement to ensure a proper starting value.
- If the variable is uninitialized, it will remain so for a short period of time (up to 32 milliseconds) and then it will be set to a very large negative value (-2.0E31 + 32 milliseconds) and incremented from that value.
- The program can reset the *clock\_var* to any value while it is connected.
- A *clock\_var* initialized at zero wraps around from approximately two billion to approximately minus two billion after about 23 days.
- If *clock\_var* is a system variable or a local variable in a routine, the program cannot be translated.

**Note** If two CONNECT TIMER statements using the same variable, are executed in two different tasks, the timer will advance twice as fast. For example, the timer will be incremented by 2 \* \$SCR.\$COND\_TIME every \$SCR.\$COND\_TIME ms. However, this does not occur if two or more CONNECT TIMER statements using the same variable, are executed in the same task.

**See Also:** Appendix D, “Syntax Diagrams,” for additional syntax information, DISCONNECT TIMER Statement

**Example:** Refer to the following sections for detailed program examples:

[Section B.8](#) , "Generating and Moving Along a Hexagon Path" (GEN\_HEX.KL)

[Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

### **A.3.41 CONTINUE Action**

---

**Purpose:** Continues execution of a paused task

**Syntax :** CONTINUE <PROGRAM[n]>

**Details:**

- The CONTINUE action will not resume stopped motions.
- If program execution is paused, the CONTINUE action will continue program execution.
- The CONTINUE action can be followed by the clause PROGRAM[n], where n is the task number to be continued. Use GET\_TSK\_INFO to get a task number for a specified task name.
- A task can be in an interrupt routine when CONTINUE is executed. However, you should be aware of the following circumstances because CONTINUE only affects the current interrupt level, and interrupt levels of a task might be independently paused or running.
  - If the interrupt routine and the task are both paused, CONTINUE will continue the interrupt routine but the task will remain paused.
  - If the interrupt routine is running and the task is paused, CONTINUE will appear to have no effect because it will try to continue the running interrupt routine.
  - If the interrupt routine is paused and the task is running, CONTINUE will continue the interrupt routine.

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.3.42 CONTINUE Condition

**Purpose:** Condition that is satisfied when program execution is continued

**Syntax :** CONTINUE <PROGRAM[n]>

**Details:**

- The CONTINUE condition monitors program execution.

If program execution is paused, the CONTINUE action, issuing CONTINUE from the CRT/KB or a CYCLE START from the operator panel, will continue program execution and satisfy the CONTINUE condition.

- The CONTINUE condition can be followed by the clause PROGRAM[n], where n is the task number to be continued. Use GET\_TSK\_INFO to get the task number of a specified task name.

**Example:** In the following example, program execution is being monitored. When the program is continued, a digital output will be turned on.

#### **CONTINUE Condition**

```
CONDITION[1] :  
    WHEN CONTINUE DO DOUT[1] = ON  
ENDCONDITION
```

### A.3.43 CONT\_TASK Built-In Procedure

**Purpose:** Continues the specified task

**Syntax :** CONT\_TASK(task\_name, status)

Input/Output Parameters :

[in] task\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :MULTI

**Details:**

- *task\_name* is the name of the task to be continued. If the task was not paused, an error is returned in *status*.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

- A task can be in an interrupt routine when CONT\_TASK is executed. However, you should be aware of the following circumstances because CONT\_TASK only affects the current interrupt level, and interrupt levels of a task might be independently paused or running.
  - If the interrupt routine and the task are both paused, CONT\_TASK will continue the interrupt routine but the task will remain paused.
  - If the interrupt routine is running and the task is paused, CONT\_TASK will appear to have no effect because it will try to continue the running interrupt routine.
  - If the interrupt routine is paused and the task is running, CONT\_TASK will continue the interrupt routine.

**See Also:** RUN\_TASK, ABORT\_TASK, PAUSE\_TASK Built-In Procedures, [Chapter 15 MULTI-TASKING](#)

**Example:** The following example prompts the user for the task name and continues the task execution. Refer to [Chapter 15 MULTI-TASKING](#), for more examples.

#### **CONT\_TASK Built-In Procedure**

```
PROGRAM cont_task_ex
  %ENVIRONMENT MULTI
  VAR
    task_str: STRING[12]
    status: INTEGER
  BEGIN
    WRITE('Enter task name to continue: ')
    READ(task_str)
    CONT_TASK(task_str, status)
  END cont_task_ex
```

#### **A.3.44 COPY\_FILE Built-In Procedure**

**Purpose:** Copies the contents of one file to another with the overwrite option

**Syntax :** COPY\_FILE(from\_file, to\_file, overwrite\_sw, nowait\_sw, status)

Input/Output Parameters :

[in] from\_file :STRING

[in] to\_file :STRING

[in] overwrite\_sw :BOOLEAN

[in] nowait\_sw :BOOLEAN

[out] status :INTEGER

%ENVIRONMENT Group :FDEV

**Details:**

- *from\_file* specifies the device, name, and type of the file from which to copy. *from\_file* can be specified using the wildcard (\*) character. If no device is specified, the default device is used. You must specify both a name and type. However, these can be a wildcard (\*) character.
- *to\_file* specifies the device, name, and type of the file to which to copy. *to\_file* can be specified using the wildcard (\*) character. If no device is specified, the default device is used.
- *overwrite\_sw* specifies that the file(s) should be overwritten if they exist.
- If *nowait\_sw* is TRUE, execution of the program continues while the command is executing. If it is FALSE, the program stops, including condition handlers, until the operation is complete. If you have time critical condition handlers in the program, put them in another program that executes as a separate task.
- If the program is aborted during the copy, the copy will completed before aborting.
- If the device you are copying to becomes full during the copy, an error will be returned.

**Note** *nowait\_sw* is not available in this release and should be set to FALSE.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** RENAME\_FILE, DELETE\_FILE Built-In Procedures

**Example:** Refer to [Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL), for a detailed program example.

### A.3.45 COPY\_PATH Built-In Procedure

**Purpose:** Copies a complete path, part of a path, or a path in reverse node order (including associated data), to another identical type path variable.

**Syntax :** COPY\_PATH (source\_path, start\_node, end\_node, dest\_path, status)

Input/Output Parameters :

[in] source\_path :PATH

[in] start\_node :INTEGER

[in] end\_node :INTEGER

[in] dest\_path :PATH

[out] status :INTEGER

%ENVIRONMENT Group :pathop

**Details:**

- *source\_path* specifies the source path to copy from. This path can be a standard path or a user defined path.
- *start\_node* specifies the number of the first node to copy. A value of 0 will copy the complete path, including header information. The *start\_node* number must be between 0 and the highest node number in the source path. Otherwise, error status will be returned.
- *end\_node* specifies the number of the last node to copy. A value of 0 will copy the complete path, including header information. The *end\_node* number must be between 0 and the highest node number of the source path. Otherwise, error status will be returned.
- *dest\_path* specifies the destination path to copy to. This path can be a standard path or a user defined path. However, the *dest\_path* type must be identical to the *source\_path* type. If they are not identical, an error status will be returned.
- *status* of 0 is returned if the parameters are valid and the COPY\_PATH operation was successful. Non-zero status indicates the COPY\_PATH operation was unsuccessful.

**Note** To copy a complete path from one path variable to another identical path variable, set the *start\_node* and *end\_node* parameters to 0 (zero).

An example of a **partial path** copy to a destination path.

Executing the COPY\_PATH(P1, 2, 5, P2) command will copy node 2 through node 5 (inclusive) of path P1 to node 1 through 4 of Path P2, provided the path length of P1 is greater than or equal to 5. The destination path P2 will become a 4 node path. The original destination path is completely overwritten.

An example of a **source path copy in reverse order** to a destination path.

Executing the COPY\_PATH(P1, 5, 2, P2) command will copy node 5 through node 2 (inclusive) of path P1 to node 1 through 4 of Path P2, provided the path length of P1 is greater than or equal to 5. The destination path P2 will become a 4 node path. The original destination path is completely overwritten.

Specifically, the above command will copy node 5 of P1 to node 1 of P2, node 4 of P1 to node 2 of P2, and so forth (including the common and group associated data for each node). Because of the reverse node-to-node copy of associated data, the trajectory of the destination path might not represent the expected reverse trajectory of the source path. This is caused by the change in relative position of the segmotype and segtermtype contained in the associated data.

**Warning**

**When you execute a reverse node copy operation, the associated data of the source path can cause an unexpected reverse path trajectory in the destination path. Be sure personnel and equipment are out of the way before you test the destination path. Otherwise, you could damage equipment or injure personnel.**

**Example:** Refer to [Section B.2 , "Copying Path Variables "](#) (CPY\_PTH.KL), for a detailed program example.

### **A.3.46 COPY\_QUEUE Built-In Procedure**

**Purpose:** Copies one or more consecutive entries from a queue into an array of integers. The entries are not removed but are copied, starting with the oldest and proceeding to the newest, or until the output array, or integers, are full. A parameter specifies the number of entries at the head of the list (oldest entries) to be skipped.

**Syntax :** COPY\_QUEUE(queue, queue\_data, sequence\_no, n\_skip, out\_data, n\_got, status)

Input/Output Parameters :

[in] queue\_t :QUEUE\_TYPE

[in] queue\_data :ARRAY OF INTEGER

[in] n\_skip :INTEGER

[in] sequence\_no :integer

[out] out\_data :ARRAY OF INTEGER

[out] n\_got :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBQMGR

**Details:**

- *queue\_t* specifies the queue variable for the queue from which the values are to be read.
- *queue\_data* specifies the array variable for the queue from which the values are to be read.
- *sequence\_no* specifies the sequence number of the oldest entry to be copied. If the *sequence\_no* is zero, the starting point for the copy is determined by the *n\_skip* parameter.

- *n\_skip* specifies the number of oldest entries to be skipped. A value of zero indicates to return the oldest entries.
- *out\_data* is an integer array into which the values are to be copied; the size of the array is the maximum number of values returned.
- *n\_got* is returned with the number of entries returned. This will be one of the following:
  - Zero if there are *n\_skip* or fewer entries in the queue.
  - (*queue\_to n\_entries\_skip*) if this is less than ARRAY\_LEN(*out\_data*)
  - ARRAY\_LEN(*out\_data*) if this is less than or equal to *queue.n\_entries - n\_skip*
- *status* is returned with zero

**See Also:** APPEND\_QUEUE, DELETE\_QUEUE, INSERT\_QUEUE Built-In Procedures, [Section 15.8](#), "Using Queues for Task Communication"

**Example:** The following example gets one “page” of a job queue and calls a routine, disp\_queue, to display this. If there are no entries for the page, the routine returns FALSE; otherwise the routine returns TRUE.

#### COPY\_QUEUE Built-In Procedure

```

PROGRAM copy_queue_x
%environment PBQMGR
VAR
  job_queue FROM global_vars: QUEUE_TYPE
  job_data FROM global_vars: ARRAY[100] OF INTEGER

ROUTINE disp_queue(data: ARRAY OF INTEGER;
                   n_disp: INTEGER) FROM disp_prog

ROUTINE disp_page(data_array: ARRAY OF INTEGER;
                  page_no: INTEGER): BOOLEAN

VAR
  status: INTEGER
  n_got: INTEGER

BEGIN
  COPY_QUEUE(job_queue, job_data,
             (page_no - 1) * ARRAY_LEN(data_array), 0,
             data_array, n_got, status)
  IF (n_got = 0) THEN
    RETURN (FALSE)
  ELSE
    disp_queue(data_array, n_got)
    RETURN (TRUE)
  ENDIF

```

```
END disp_page  
  
BEGIN  
  
END copy_queue_x
```

### **A.3.47 COPY\_TPE Built-In Procedure**

**Purpose:** Copies one teach pendant program to another teach pendant program.

**Syntax :** COPY\_TPE(from\_prog, to\_prog, overwrite\_sw, status)

Input/Output Parameters :

```
[in] from_prog :STRING  
  
[in] to_prog :STRING  
  
[in] overwrite_sw :BOOLEAN  
  
[out] status :INTEGER  
  
%ENVIRONMENT Group :TPE
```

**Details:**

- *from\_prog* specifies the teach pendant program name, without the .tp extension, to be copied.
- *to\_prog* specifies the new teach pendant program name, without the .tp extension, that *from\_prog* will be copied to.
- *overwrite\_sw*, if set to TRUE, will automatically overwrite the *to\_prog* if it already exists and it is not currently selected. If set to FALSE, the *to\_prog* will not be overwritten if it already exists.
- *status* explains the status of the attempted operation. If not equal to 0, the copy did not occur.

**See Also:** CREATE\_TPE Built-in Procedure

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

### **A.3.48 COS Built-In Function**

**Purpose:** Returns the REAL cosine of the REAL angle argument, specified in degrees

**Syntax :** COS(angle) Function Return Type :REAL

Input/Output Parameters :

[in] angle :REAL expression

%ENVIRONMENT Group :SYSTEM

**Details:**

- *angle* is an angle specified in the range of  $\pm 18000$  degrees. Otherwise, the program will be aborted with an error.

**Example:** Refer to [Section B.8](#), "Generating and Moving Along a Hexagon Path" (GEN\_HEX.KL), for a detailed program example.

### **A.3.49 CR Input/Output Item**

---

**Purpose:** Can be used as a data item in a READ or WRITE statement to specify a carriage return

**Syntax :** CR

**Details:**

- When CR is used as a data item in a READ statement, it specifies that any remaining data in the current input line is to be ignored.

The next data item will be read from the start of the next input line.

- When CR is used as a data item in a WRITE statement, it specifies that subsequent output to the same file will appear on a new line.

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for additional syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.3](#) , "Saving Data to the Default Device" (SAVE\_VR.KL)

[Section B.4](#) , "Standard Routines" (ROUT\_EX.KL)

[Section B.5](#) , "Using Register Built-ins" (REG\_EX.KL)

[Section B.6](#) , "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.7](#) , "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

[Section B.8](#) , "Generating and Moving Along a Hexagon Path" (GEN\_HEX.KL)

[Section B.9](#) , "Using the File and Device Built-ins" (FILE\_EX.KL)

[Section B.10 , "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.12 , "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.13 , "Using the DISCTRL\\_ALPHA Built-in" \(DCALP\\_EX.KL\)](#)

[Section B.14 , "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

[Section B.1 , "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

### **A.3.50 CREATE\_TPE Built-In Procedure**

**Purpose:** Creates a teach pendant program of the specified name

**Syntax :** CREATE\_TPE(prog\_name, prog\_type, status)

Input/Output Parameters :

[in] prog\_name :STRING

[in] prog\_type :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :TPE

**Details:**

- *prog\_name* specifies the name of the program to be created.
- *prog\_type* specifies the type of the program to be created. The following constants are valid for program type: PT\_MNE\_UNDEF :TPE program of undefined sub type PT\_MNE\_JOB :TPE job PT\_MNE\_PROC :TPE process PT\_MNE\_MACRO :TPE macro
- *status* explains the status of the attempted operation. If it is not equal to 0, then an error occurred. Some of the possible errors are as follows:

7015 Specified program exist

9030 Program name is NULL

9031 Remove num from top of Program name

9032 Remove space from Program name

9036 Memory is not enough

9038 Invalid character in program name

- The program is created to reference all motion groups on the system. The program is created without any comment or any other program attributes. Once the program is created, SET\_ATTR\_PRG can be used to specify program attributes.

**See Also:** SET\_ATTR\_PRG Built-In Procedure

### **A.3.51 CREATE\_VAR Built-In Procedure**

**Purpose:** Creates the specified KAREL variable

**Syntax :** CREATE\_VAR(var\_prog\_nam, var\_nam, typ\_prog\_nam, type\_nam, group\_num, inner\_dim, mid\_dim, outer\_dim, status, <mem\_pool>)

Input/Output Parameters :

[in] var\_prog\_nam :STRING

[in] var\_nam :STRING

[in] typ\_prog\_nam :STRING

[in] type\_nam :STRING

[in] group\_num :INTEGER

[in] inner\_dim :INTEGER

[in] mid\_dim :INTEGER

[in] outer\_dim :INTEGER

[out] status :INTEGER

[in] mem\_pool :INTEGER

%ENVIRONMENT Group :MEMO

#### **Details:**

- *var\_prog\_nam* specifies the program name that the variable should be created in. If *var\_prog\_nam* is '', the default, which is the name of the program currently executing, is used.
- *var\_nam* specifies the variable name that will be created.
- If a variable is to be created as a user-defined type, the user-defined type must already be created in the system. *typ\_prog\_nam* specifies the program name of the user-defined type. If *typ\_prog\_nam* is '', the default, which is the name of the program currently executing, is used.

- *type\_nam* specifies the type name of the variable to be created. The following type names are valid:

'ARRAY OF BYTE'

'ARRAY OF SHORT'

'BOOLEAN'

'CAM\_SETUP'

'COMMON\_ASSOC'

'CONFIG'

'FILE'

'GROUP\_ASSOC'

'INTEGER'

'JOINTPOS'

'JOINTPOS1'

'JOINTPOS2'

'JOINTPOS3'

'JOINTPOS4'

'JOINTPOS5'

'JOINTPOS6'

'JOINTPOS7'

'JOINTPOS8'

'JOINTPOS9'

'MODEL'

'POSITION'

'REAL'

'STRING[n]', where n is the string length; the default is 12 if not specified.

'VECTOR'

'VIS\_PROCESS'

'XYZWPR'

'XYZWPREXT'

Any other type names are considered user-defined types.

- *group\_num* specifies the group number to be used for positional data types.
- *inner\_dim* specifies the dimensions of the innermost array. For example, *inner\_dim* = 30 for ARRAY[10,20,30] OF INTEGER. *inner\_dim* should be set to 0 if the variable is not an array.
- *mid\_dim* specifies the dimensions of the middle array. For example, *mid\_dim* = 20 for ARRAY[10,20,30] OF INTEGER. *mid\_dim* should be set to 0 if the variable is not a 2-D array.
- *outer\_dim* specifies the dimensions of the outermost array. For example, *outer\_dim* = 10 for ARRAY[10,20,30] OF INTEGER. *outer\_dim* should be set to 0 if the variable is not a 3-D array.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.
- *mem\_pool* is an optional parameter that specifies the memory pool from which the variable is created. If not specified, then the variable is created in DRAM which is temporary memory. The DRAM variable must be recreated at every power up and the value is always reset to uninitialized.
- If *mem\_pool* = -1, then the variable is created in CMOS RAM which is permanent memory.

**See Also:** CLEAR, RENAME\_VAR Built-In Procedures

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

### **A.3.52 %CRTDEVICE**

**Purpose:** Specifies that the CRT/KB device is the default device

**Syntax :** %CRTDEVICE

**Details:**

- Specifies that the INPUT/OUTPUT window will be the default in the READ and WRITE statements instead of the TPDISPLAY window.

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example showing how to use this device.

### A.3.53 CURJPOS Built-In Function

**Purpose:** Returns the current joint position of the tool center point (TCP) for the specified group of axes, even if one of the axes is in an overtravel

**Syntax :** CURJPOS(axes\_lim\_mask, ovr\_trv\_mask <,group\_no>)

Function Return Type :JOINTPOS

Input/Output Parameters :

[out] axes\_lim\_mask :INTEGER

[out] ovr\_trv\_mask :INTEGER

[in] group\_no :INTEGER

%ENVIRONMENT Group :SYSTEM

**Details:**

- If *group\_no* is omitted, the default group for the program is assumed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.
- *axes\_lim\_mask* specifies which axes are outside the axis limits.
- *ovr\_trv\_mask* specifies which axes are in overtravel.

**Note** *axis\_limit\_mask* and *ovr\_trv\_mask* are not available in this release and can be set to 0.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** CURPOS Built-In Function, [Chapter 8 MOTION](#)

**Example:** The following example gets the current joint position of the robot.

#### CURJPOS Built-In Function

```
PROGRAM getpos
VAR
    jnt: JOINTPOS
```

```
BEGIN
jnt=CURJPOS( 0 , 0 )
END getpos
```

### A.3.54 CURPOS Built-In Function

**Purpose:** Returns the current Cartesian position of the tool center point (TCP) for the specified group of axes even if one of the axes is in an overtravel

**Syntax :** CURPOS(axis\_limit\_mask, ovr\_trv\_mask <,group\_no>)

Function Return Type :XYZWPREXT

Input/Output Parameters :

[out] axis\_limit\_mask :INTEGER

[out] ovr\_trv\_mask :INTEGER

[in] group\_no :INTEGER

%ENVIRONMENT Group :SYSTEM

**Details:**

- If *group\_no* is omitted, the default group for the program is assumed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.
- The group must be kinematic.
- Returns the current position of the tool center point (TCP) relative to the current value of the system variable \$UFRAME for the specified group.
- *axis\_limit\_mask* specifies which axes are outside the axis limits.
- *ovr\_trv\_mask* specifies which axes are in overtravel.

**Note** *axis\_limit\_mask* and *ovr\_trv\_mask* are not available in this release and will be ignored if set.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Chapter 8 MOTION](#)

**Example:** Refer to [Section B.5](#), "Using Register Built-ins," for a detailed program example.

[Section B.5](#), "Using Register Built-ins" (REG\_EX.KL)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

### **A.3.55 CURR\_PROG Built-In Function**

**Purpose:** Returns the name of the program currently being executed

**Syntax :** CURR\_PROG

Function Return Type :STRING[12]

%ENVIRONMENT Group :BYNAM

**Details:**

- The variable assigned to CURR\_PROG must be declared with a string variable length  $\geq 12$

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

## **A.4 - D - KAREL LANGUAGE DESCRIPTION**

### **A.4.1 DAQ\_CHECKP Built-In Procedure**

**Purpose:** To check the status of a pipe and the number of bytes available to be read from the pipe.

**Syntax :** DAQ\_CHECKP(pipe\_num, pipe\_stat, bytes\_avail)

Input/Output Parameters :

[in] pipe\_num :INTEGER

[out] pipe\_stat :INTEGER

[out] bytes\_avail :INTEGER

**Details:**

- *pipe\_num* is the number of the pipe (1 - 5) to check.

- *pipe\_stat* is the status of the pipe returned. The status is a combination of the following flags:
  - DAQ\_PIPREG is when the pipe is registered (value = 1).
  - DAQ\_ACTIVE is when the pipe is active, i.e., has been started (value = 2).
  - DAQ\_CREATD is when the pipe is created (value = 4).
  - DAQ\_SNAPSH is when the pipe is in snapshot mode (value = 8).
  - DAQ\_1STRD is when the pipe has been read for the first time (value = 16).
  - DAQ\_OVERFLOW is when the pipe is overflowed (value = 32).
  - DAQ\_FLUSH is when the pipe is being flushed (value = 64).
- *bytes\_avail* is the number of bytes that are available to be read from the pipe.

#### **DAQ\_CHECKP Built-In Procedure**

The *pipe\_stat* returned parameter can be AND'ed with the above flag constants to determine whether the pipe is registered, is active, and so forth. For example, you must check to see if the pipe is active before writing to it.

#### **DAQ\_CHECKP Built-In Procedure**

The DAQ\_OVERFLOW flag will never be set for the task that writes to the pipe when it calls DAQ\_CHECKP. This flag applies only to tasks that read from the pipe.

**See Also:** DAQ\_WRITE Built-In.

**Example:** Refer to the DAQWRITE example in the built-in function DAQ\_WRITE.

**Note** This built-in is only available when DAQ or data monitor options are loaded.

#### **A.4.2 DAQ\_REGPIPE Built-In Procedure**

**Purpose:** To register a pipe for use in KAREL.

**Syntax :** DAQ\_REGPIPE(pipe\_num, mem\_type, pipe\_size, prog\_name, var\_name, pipe\_name, stream\_size, and status)

Input/Output Parameters :

[in] pipe\_num :INTEGER

[in] mem\_type :INTEGER

[in] pipe\_size :INTEGER  
[in] prog\_name :STRING  
[in] var\_name :STRING  
[in] pipe\_name :STRING  
[in] stream\_size :INTEGER  
[out] status :INTEGER

**Details:**

- *pipe\_num* is the number of the pipe (1-5) to be registered.
- *mem\_type* allows you to allocate the memory to be used for the pipe. The following constants can be used:
  - DAQ\_DRAM allows you to allocate DRAM memory.
  - DAQ\_CMOS allows you to allocate CMOS memory.
- *pipe\_size* is the size of the pipe, is expressed as the number of data records that it can hold. The data record size itself is determined by the data type of *var\_name*.
- *prog\_name* is the name of the program containing the variable to be used for writing to the pipe. If passed as an empty string, the name of the current program is used.
- *var\_name* is the name of the variable that defines the data type to be used for writing to the pipe. Once registered, you can write any variable of this data type to the pipe.
- *pipe\_name* is the name of the pipe file. For example, if the pipe name is passed as 'foo.dat', the pipe will be accessible using the file string 'PIP:FOO.DAT'. A unique file name with an extension is required even if the pipe is being used only for sending to the PC.
- *stream\_size* is the number of records to automatically stream to an output file, if the pipe is started as a streamed pipe. A single write of the specified variable constitutes a single record in the pipe. If stream size is set to zero, the pipe will not automatically stream records to a file device; all data will be kept in the pipe until the pipe is read. Use *stream\_size* to help optimize network loading when the pipe is used to send data to the PC. If it is zero or one, the monitoring task will send each data record as soon as it is seen in the pipe. If the number is two or more, the monitor will wait until there are that many data records in the pipe before sending them all to the PC. In this manner, the overhead of sending network packets can be minimized. Data will not stay in the pipe longer than the time specified by the FlushTime argument supplied with the FRCPipe.StartMonitor Method.
- *status* is the status of the attempted operation. If not 0, then an error occurred and the pipe was not registered.

**See Also:** DAQ\_UNREG Built-In.

**DAQ\_REGPIPE Built-In Procedure**

Pipes must be registered before they can be started and to which data is written. The registration operation tells the system how to configure the pipe when it is to be used. After it is registered, a pipe is configured to accept the writing of a certain amount of data per record, as governed by the size of the specified variable. In order to change the configuration of a pipe, the pipe must first be unregistered using DAQ\_UNREG, and then re-registered.

**Example:** The following example registers KAREL pipe 1 to write a variable in the program.

**DAQ\_REGPIPE Built-In Procedure**

```

PROGRAM DAQREG
%ENVIRONMENT DAQ
CONST
    er_abort = 2
VAR
    status: INTEGER
    datavar: INTEGER
BEGIN
    -- Register pipe 1 DRAM as kldaq.dat
    -- It can hold 100 copies of the datavar variable
    -- before the pipe overflows
    DAQ_REGPIPE(1, DAQ_DRAM, 100, '', 'datavar', &
                'kldaq.dat', 0, status)
    IF status<>0 THEN
        POST_ERR(status, ' ', 0, er_abort)
    ENDIF
END DAQREG

```

**Note** This built-in is only available when DAQ or data monitor options are loaded.

**A.4.3 DAQ\_START Built-In Procedure**

**Purpose:** To activate a KAREL pipe for writing.

**Syntax :** DAQ\_START(pipe\_num, pipe\_mode, stream\_dev, status)

Input/Output Parameters :

[in] pipe\_num :INTEGER

[in] pipe\_mode :INTEGER

[in] stream\_dev :STRING

[out] status :INTEGER

**Details:**

- *pipe\_num* is the number of the pipe (1 - 5) to be started. The pipe must have been previously registered
- *pipe\_mode* is the output mode to be used for the pipe. The following constants are used:
  - DAQ\_SNAPSHT is the snapshot mode (each read of the pipe will result in all of the pipe's contents).
  - DAQ\_STREAM is the stream mode (each read from the same pipe file will result in data written since the previous read).
- *stream\_dev* is the device to which records will be automatically streamed. This parameter is ignored if the stream size was set to 0 during registration.
- *status* is the status of the attempted operation. If not 0, then an error occurred and the pipe was not unregistered.

**See Also:** DAQ\_REGPIPE Built-In and DAQ\_STOP Built-In,

**DAQ\_START Built-In Procedure**

This built-in call can be made either from the same task/program as the writing task, or from a separate activate/deactivate task. The writing task can lie dormant until the pipe is started, at which point it begins to write data.

**DAQ\_START Built-In Procedure**

A pipe is automatically started when a PC application issues the FRCPipe.StartMonitor method. In this case, there is no need for the KAREL application to call DAQ\_START to activate the pipe..

**DAQ\_START Built-In Procedure**

Starting and stopping a pipe is tracked using a reference counting scheme. That is, any combination of two DAQ\_START and FRCPipe.StartMonitor calls requires any comb

**Example:** The following example starts KAREL pipe 1 in streaming mode.

**DAQ\_START Built-In Procedure**

```
PROGRAM PIPONOFF
%ENVIRONMENT DAQ
CONST
    er_abort = 2
```

```

VAR
    status: INTEGER
    tpinput: STRING[1]
BEGIN
    -- prompt to turn on pipe
    WRITE('Press 1 to start pipe')
    READ (tpinput)
    IF tpinput = '1' THEN
        -- start pipe 1
        DAQ_START(1, DAQ_STREAM, 'RD:', status)
        IF status<>0 THEN
            POST_ERR(status, ' ', 0, er_abort)
        ELSE
            -- prompt to turn off pipe
            WRITE('Press any key to stop pipe')
            READ (tpinput)
            -- stop pipe 1
            DAQ_STOP(1, FALSE, status)
            IF status<>0 THEN
                POST_ERR(status, ' ', 0, er_abort)
            ENDIF
        ENDIF
    ENDIF
END PIPONOFF

```

**Note** This built-in is only available when DAQ or data monitor options are loaded.

#### A.4.4 DAQ\_STOP Built-In Procedure

**Purpose:** To stop a KAREL pipe for writing.

**Syntax :** DAQ\_STOP(pipe\_num, force\_off, status)

Input/Output Parameters :

[in] pipe\_num :INTEGER

[in] force\_off :BOOLEAN

[out] status :INTEGER

**Details:**

- *pipe\_num* is the number of the pipe (1 - 5) to be stopped.

- *force\_off* occurs if TRUE force the pipe to be turned off, even if another application made a start request on the pipe. If set FALSE, if all start requests have been accounted for with stop requests, the pipe is turned off, else it remains on.
- *status* is the status of the attempted operation. If not 0, then an error occurred and the pipe was not stopped.

**See Also:** DAQ\_START Built-In.

#### **DAQ\_STOP Built-In Procedure**

The start/stop mechanism on each pipe works on a reference count. The pipe is started on the first start request, and each subsequent start request is counted. If a stop request is received for the pipe, the count is decremented.

#### **DAQ\_STOP Built-In Procedure**

If the pipe is not forced off, and the count is not zero, the pipe stays on. By setting the *force\_off* flag to TRUE, the pipe is turned off regardless of the count. The count is reset.

#### **DAQ\_STOP Built-In Procedure**

FRCPipe.StopMonitor method issued by a PC application is equivalent to a call to DAQ\_STOP.

**Example:** Refer to the PIPONOFF example in the built-in function DAQ\_START.

**Note** This built-in is only available when DAQ or data monitor options are loaded.

### **A.4.5 DAQ\_UNREG Built-In Procedure**

**Purpose:** To unregister a previously-registered KAREL pipe, so that it may be used for other data.

**Syntax :** DAQ\_UNREG(pipe\_num, status)

Input/Output Parameters :

[in] pipe\_num :INTEGER

[out] status :INTEGER

**Details:**

- *pipe\_num* is the number of the pipe (1 - 5) to be unregistered.
- *status* is the status of the attempted operation. If not 0, then an error occurred and the pipe was not unregistered.

**See Also:** DAQ\_REGPIPE Built-In.

#### **DAQ\_UNREG Built-In Procedure**

Unregistering a pipe allows the pipe to be re-configured for a different data size, pipe size, pipe name, and so forth. You must un-register the pipe before re-registering using DAQ\_REGPIPE.

**Example:** The following example unregisters KAREL pipe 1.

#### **DAQ\_UNREG Built-In Procedure**

```
PROGRAM DAQUNREG
%ENVIRONMENT DAQ
CONST
    er_abort = 2
VAR
    status: INTEGER
BEGIN
    -- unregister pipe 1
    DAQ_UNREG(1, status)
    IF status<>0 THEN
        POST_ERR(status, ' ', 0, er_abort)
    ENDIF
END DAQUNREG
```

**Note** This built-in is only available when DAQ or data monitor options are loaded.

#### **A.4.6 DAQ\_WRITE Built-In Procedure**

**Purpose:** To write data to a KAREL pipe.

**Syntax :** DAQ\_WRITE(pipe\_num, prog\_name, var\_name, status)

Input/Output Parameters :

[in] pipe\_num :INTEGER

[in] prog\_name :STRING

[in] var\_name :STRING

[out] status :INTEGER

**Details:**

- *pipe\_num* is the number of the pipe (1 - 5) to which data is written.

- *prog\_name* is the name of the program containing the variable to be written. If passed as an empty string, the name of the current program is used.
- *var\_name* is the name of the variable to be written.
- *status* is the status of the attempted operation. If not 0, then an error occurred and the data was not written.

**See Also:** DAQ\_REGPIPE and DAQ\_CHECKP.

### **DAQ\_WRITE Built-In Procedure**

You do not have to use the same variable for writing data to the pipe that was used to register the pipe. The only requirement is that the data type of the variable written matches the type of the variable used to register the pipe.

### **DAQ\_WRITE Built-In Procedure**

If a PC application is monitoring the pipe, each call to DAQ\_WRITE will result in an FRCPipe\_Receive Event.

**Example:** The following example registers KAREL pipe 2 and writes to it when the pipe is active.

### **DAQ\_WRITE Built-In Procedure**

```

PROGRAM DAQWRITE
%ENVIRONMENT DAQ
%ENVIRONMENT SYSDEF
CONST
    er_abort = 2
TYPE
    daq_data_t = STRUCTURE
        count: INTEGER
        dataval: INTEGER
    ENDSTRUCTURE
VAR
    status: INTEGER
    pipestat: INTEGER
    numbytes: INTEGER
    datavar: daq_data_t
BEGIN
    -- register 10KB pipe 2 in DRAM as kldaq.dat
    DAQ_REGPIPE(2, DAQ_DRAM, 100, '', 'datavar', &
                'kldaq.dat', 1, status)
    IF status<>0 THEN
        POST_ERR(status, ' ', 0, er_abort)
    ENDIF

    -- use DAQ_CHECKP to monitor status of pipe
    DAQ_CHECKP(2, pipestat, numbytes)

```

```

datavar.count = 0
WHILE (pipestat AND DAQ_PIPREG) > 0 DO -- do while registered
    -- update data variable
    datavar.count = datavar.count + 1
    datavar.dataval = $FAST_CLOCK
    -- check if pipe is active
    IF (pipestat AND DAQ_ACTIVE) > 0 THEN
        -- write to pipe
        DAQ_WRITE(2, '', datavar, status)
        IF status<>0 THEN
            POST_ERR(status, ' ', 0, er_abort)
        ENDIF
    ENDIF
    -- put in delay to reduce loading
    DELAY(200)
    DAQ_CHECKP(2, pipestat, numbytes)
ENDWHILE
END DAQWRITE

```

**Note** This built-in is only available when DAQ or data monitor options are loaded.

#### A.4.7 %DEFGROUP Translator Directive

**Purpose:** Specifies the default motion group to be used by the translator

**Syntax :** %DEFGROUP = n

**Details:**

- n is the number of the motion group.
- The range is 1 to the number of groups on the controller.
- If %DEFGROUP is not specified, group 1 is used.



#### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

### A.4.8 DEF\_SCREEN Built-In Procedure

**Purpose:** Defines a screen

**Syntax :** DEF\_SCREEN(screen\_name, disp\_dev\_name, status)

Input/Output Parameters :

[in] screen\_name :STRING

[in] disp\_dev\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- Define a screen, associated with a specified display device, to which windows could be attached and be activated (displayed).
- *screen\_name* must be a unique, valid name (string), one to four characters long.
- *disp\_dev\_name* must be one of the display devices already defined, otherwise an error is returned. The following are the predefined display devices:

'TP' Teach Pendant Device 'CRT' CRT/KB Device

- *status* explains the status of the attempted operation. (If not equal to 0, then an error occurred.)

**See Also:** ACT\_SCREEN Built-In Procedure

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### A.4.9 DEF\_WINDOW Built-In Procedure

**Purpose:** Define a window

**Syntax :** DEF\_WINDOW(window\_name, n\_rows, n\_cols, options, status)

Input/Output Parameters :

[in] window\_name :STRING

[in] n\_rows :INTEGER

[in] n\_cols :INTEGER

[in] options :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- Define a window that can be attached subsequently to a screen, have files opened to it, be written or have input echoed to it, and have information dynamically displayed in it.
- *window\_name* must be a valid name string, one to four characters long, and must not duplicate a window with the same name.
- *n\_rows* and *n\_cols* specify the size of the window in standard-sized characters. Any line containing double-wide or double-wide-double-high characters will contain only half this many characters. The first row and column begin at 1.
- *options* must be one of the following:
  - 0 :No option
  - wd\_com\_cursr :Common cursor
  - wd\_scrolled :Vertical scrolling
  - wd\_com\_cursr + wd\_scrolled :Common cursor + Vertical scrolling
- If common cursor is specified, wherever a write leaves the cursor is where the next write will go, regardless of the file variable used. Also, any display attributes set for any file variable associated with this window will apply to all file variables associated with the window. If this is not specified, the cursor position and display attributes (except character size attributes, which always apply to the current line of a window) are maintained separately for each file variable open to the window. The common-cursor attribute is useful for windows that can be written to by more than one task and where these writes are to appear end-to-end. An example might be a log display.
- If vertical scrolling is specified and a line-feed, new-line, or index-down character is received and the cursor is in the bottom line of the window, all lines except the top line are moved up and the bottom line is cleared. If an index-up character is written, all lines except the bottom line are moved down and the top line is cleared. If this is not specified, the bottom or top line is cleared, but the rest of the window is unaffected.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** ATT\_WINDOW\_D, ATT\_WINDOW\_S Built-In Procedures

### A.4.10 %DELAY Translator Directive

**Purpose:** Sets the amount of time program execution will be delayed every 250 milliseconds. Each program is delayed 8ms every 250ms by default. This allows the CPU to perform other functions such as servicing the CRT/KB and Teach Pendant user interfaces. %DELAY provides a way to change from the default and allow more CPU for system tasks such as user interface.

**Syntax :** %DELAY = n

**Details:**

- *n* is the delay time in milliseconds.
- The default delay time is 8 ms, if no DELAY is specified
- If *n* is set to 0, the program will attempt to use 100% of the available CPU time. This could result in the teach pendant and CRT/KB becoming inoperative since their priority is lower. A delay of 0 is acceptable if the program will be waiting for motion or I/O.
- While one program is being displayed, other programs are prohibited from executing. Interrupt routines (routines called from condition handlers) will also be delayed.
- Very large delay values will severely inhibit the running of all programs.
- To delay one program in favor of another, use the DELAY Statement instead of %DELAY.

### A.4.11 DELAY Statement

**Purpose:** Causes execution of the program to be suspended for a specified number of milliseconds

**Syntax :** DELAY time\_in\_ms

where:

time\_in\_ms :an INTEGER expression

**Details:**

- If motion is active at the time of the delay, the motion continues.
- *time\_in\_ms* is the time in milliseconds. The actual delay will be from zero to \$SCR.\$cond\_time milliseconds less than the rounded time.
- A time specification of zero has no effect.
- If a program is paused while a delay is in progress, the delay will continue to be timed.
- If the delay time in a paused program expires while the program is still paused, the program, upon resuming and with no further delay, will continue execution with the statement following the delay. Otherwise, upon resumption, the program will finish the delay time before continuing execution.

- Aborting a program, or issuing RUN from the CRT/KB when a program is paused, terminates any delays in progress.
- While a program is awaiting expiration of a delay, the KCL> SHOW TASK command will show a hold of DELAY.
- A time value greater than one day or less than zero will cause the program to be aborted with an error.

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for additional syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.11](#), "Manipulating Values of Dynamically Displayed Variables" (CHG\_DATA.KL)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

#### **A.4.12 DELETE\_FILE Built-In Procedure**

**Purpose:** Deletes the specified file

**Syntax :** DELETE\_FILE(file\_spec, nowait\_sw, status)

Input/Output Parameters :

[in] file\_spec :STRING

[in] nowait\_sw :BOOLEAN

[out] status :INTEGER

%ENVIRONMENT Group :FDEV

**Details:**

- *file\_spec* specifies the device, name, and type of the file to delete. *file\_spec* can be specified using the wildcard (\*) character. If no device name is specified, the default device is used.
- If *nowait\_sw* is TRUE, execution of the program continues while the command is executing. If it is FALSE, the program stops, including condition handlers, until the operation is complete. If you have time critical condition handlers in the program, put them in another program that executes as a separate task.

**Note** *nowait\_sw* is not available in this release and should be set to FALSE.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** COPY\_FILE, RENAME\_FILE Built-In Procedures

**Example:** Refer to [Section B.3](#) , "Saving Data to the Default Device" (SAVE\_VRS.KL), for a detailed program example.

### **A.4.13 DELETE\_NODE Built-In Procedure**

**Purpose:** Deletes a path node from a PATH

**Syntax :** DELETE\_NODE(path\_var, node\_num, status)

Input/Output Parameters :

[in] path\_var :PATH

[in] node\_num :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PATHOP

**Details:**

- *node\_num* specifies the node to be deleted from the PATH specified by *path\_var* .
- All nodes past the deleted node will be renumbered.
- *node\_num* must be in the range from one to PATH\_LEN(*path\_var*). If it is outside this range, the status is returned with an error.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** APPEND\_NODE, INSERT\_NODE Built-In Procedures

**Example:** Refer to [Section B.2](#) , "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

### **A.4.14 DELETE\_QUEUE Built-In Procedure**

**Purpose:** Deletes an entry from a queue

**Syntax :** DELETE\_QUEUE(sequence\_no, queue, queue\_data, status)

Input/Output Parameters :

[in] sequence\_no :INTEGER

[in,out] queue\_t :QUEUE\_TYPE

[in,out] queue\_data :ARRAY OF INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBQMGR

**Details:**

- Use COPY\_QUEUE to get a list of the sequence numbers.
- *sequence\_no* specifies the sequence number of the entry to be deleted. Use COPY\_QUEUE to get a list of the sequence numbers.
- *queue\_t* specifies the queue variable for the queue.
- *queue\_data* specifies the array used to hold the data in the queue. The length of this array determines the maximum number of entries in the queue.
- *status* returns 61003, “Bad sequence no,” if the specified sequence number is not in the queue.

**See Also:** APPEND\_QUEUE, COPY\_QUEUE, INSERT\_QUEUE Built-In Procedures, [Section 15.8](#), "Using Queues for Task Communication"

#### **A.4.15 DEL\_INST\_TPE Built-In Procedure**

**Purpose:** Deletes the specified instruction in the specified teach pendant program

**Syntax :** DEL\_INST\_TPE(open\_id, lin\_num, status)

Input/Output Parameters :

[in] open\_id :INTEGER

[in] lin\_num :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :TPE

**Details:**

- *open\_id* specifies the opened teach pendant program. A program must be opened with read/write access, using the OPEN\_TPE built-in, before calling the DEL\_INST\_TPE built-in.
- *lin\_num* specifies the line number of the instruction to be deleted.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

**See Also:** CREATE\_TPE, CLOSE\_TPE, COPY\_TPE, OPEN\_TPE, SELECT\_TPE Built-In Procedures

#### A.4.16 DET\_WINDOW Built-In Procedure

**Purpose:** Detach a window from a screen

**Syntax :** DET\_WINDOW(window\_name, screen\_name, status)

Input/Output Parameters :

[in] window\_name :STRING

[in] screen\_name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- Removes the specified window from the specified screen.
- *window\_name* and *screen\_name* must be valid and already defined.
- The areas of other window(s) hidden by this window are redisplayed. Any area occupied by this window and not by any other window is cleared.
- An error occurs if the window is not attached to the screen.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** DEF\_WINDOW, ATT\_WINDOW\_S, ATT\_WINDOW\_D Built-In Procedures

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

#### A.4.17 DISABLE CONDITION Action

**Purpose:** Used within a condition handler to disable the specified condition handler

**Syntax :** DISABLE CONDITION [cond\_hand\_no]

where:

cond\_hand\_no :an INTEGER expression

**Details:**

- If the condition handler is not defined, DISABLE CONDITION has no effect.

- If the condition handler is defined but not currently enabled, DISABLE CONDITION has no effect.
- When a condition handler is disabled, its conditions are not tested. Thus, if it is activated again, the conditions must be satisfied after the activation.
- Use the ENABLE CONDITION statement or action to reactivate a condition handler that has been disabled.
- *cond\_hand\_no* must be in the range of 1-1000. Otherwise, the program will be aborted with an error.

**See Also:** Chapter 6, “Condition Handlers,” for more information on using DISABLE CONDITION in condition handlers

**Example:** The following example disables condition handler number 2 when condition number 1 is triggered.

#### DISABLE CONDITION Action

```
CONDITION[1] :
  WHEN EVENT[1] DO
    DISABLE CONDITION[2]
  ENDCONDITION
```

#### A.4.18 DISABLE CONDITION Statement

**Purpose:** Disables the specified condition handler

**Syntax :** DISABLE CONDITION [cond\_hand\_no]

where:

cond\_hand\_no :an INTEGER expression

#### Details:

- If the condition handler is not defined, DISABLE CONDITION has no effect.
- If the condition handler is defined but not currently enabled, DISABLE CONDITION has no effect.
- When a condition handler is disabled, its conditions are not tested. Thus, if it is activated again, the conditions must be satisfied after the activation.
- Use the ENABLE CONDITION statement or action to reactivate a condition handler that has been disabled.
- *cond\_hand\_no* must be in the range of 1-1000. Otherwise, the program will be aborted with an error.

**See Also:** [Chapter 6 CONDITION HANDLERS](#), for more information on using DISABLE CONDITION in condition handlers, [Appendix E](#), “Syntax Diagrams,” for additional syntax information

**Example:** The following example allows the operator to choose whether or not to see **count**.

### DISABLE CONDITION Statement

```
PROGRAM p_disable
VAR
    count      : INTEGER
    answer     : STRING[1]

ROUTINE showcount
BEGIN
    WRITE ('count = ',count::10,CR)
END showcount

BEGIN
    CONDITION[1]:
        WHEN EVENT[1] DO          -- Condition[1] shows count
            showcount
        ENABLE CONDITION[1]
    ENDCONDITON

    ENABLE CONDITION[1]
    count = 0
    WRITE ('do you want to see count?')
    READ (answer,CR)

    IF answer = 'n'
        THEN DISABLE CONDITION[1] -- Disables condition[1]
    ENDIF           -- Count will not be shown

    FOR count = 1 TO 13 DO
        SIGNAL EVENT[1]
    ENDFOR

END p_disable
```

### A.4.19 DISCONNECT TIMER Statement

**Purpose:** Stops updating a clock variable previously connected as a timer

**Syntax :** DISCONNECT TIMER timer\_var

where:

timer\_var :a static, user-defined INTEGER variable

**Details:**

- If *timer\_var* is not currently connected as a timer, the DISCONNECT TIMER statement has no effect.
- If *timer\_var* is a system or local variable, the program will not be translated.

**See Also:** [Appendix E](#), “Syntax Diagrams,” for additional syntax information, CONNECT TIMER Statement

**Example:** The following example moves the TCP to the initial POSITION variable **p1** , sets the INTEGER variable **timevar** to 0 and connects the timer. After moving to the destination position **p2** , the timer is disconnected.

#### **DISCONNECT TIMER Statement**

```
MOVE TO p1
    timevar = 0
    CONNECT TIMER TO timevar

MOVE TO p2
    DISCONNECT TIMER timevar
```

#### **A.4.20 DISCTRL\_ALPH Built\_In Procedure**

**Purpose:** Displays and controls alphanumeric string entry in a specified window.

**Syntax :** DISCTRL\_ALPH(window\_name, row, col, str, dict\_name, dict\_ele, term\_char, status)

Input/Output Parameters :

[in] window\_name :STRING

[in] row :INTEGER

[in] col :INTEGER

[in,out] str :STRING

[in] dict\_name :STRING

[in] dict\_ele :INTEGER

[out] term\_char :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *window\_name* identifies the window where the *str* is currently displayed. See also Section 7.9.1, "USER Menu on the Teach Pendant", or Section 7.9.2, "USER Menu on the CRT/KB," for a listing of windows that may be used for *window\_name*.
- *row* specifies the row number where the *str* is displayed.
- *col* specifies the column number where the *str* is displayed.
- *str* specifies the KAREL string to be modified, which is currently displayed on the *window\_name* at position *row* and *col*.
- *dict\_name* specifies the dictionary that contains the words that can be entered. *dict\_name* can also be set to one of the following predefined values.

'PROG' :program name entry

'COMM' :comment entry

- *dict\_ele* specifies the dictionary element number for the words. *dict\_ele* can contain a maximum of 5 lines with no "&new\_line" accepted on the last line. See the example below.
- If a predefined value for *dict\_name* is used, then *dict\_ele* is ignored.
- *term\_char* receives a code indicating the character that terminated the menu. The code for key terminating conditions are defined in the include file FR:KLEVKEYS.KL. The following predefined constants are keys that are normally returned:

ky\_enter

ky\_prev

ky\_new\_menu

- DISCTRL\_ALPH will display and control string entry from the teach pendant device. To display and control string entry from the CRT/KB device, you must create an INTEGER variable, *device\_stat*, and set it to *crt\_panel*. To set control to the teach pendant device, set *device\_stat* to *tp\_panel*. Refer to the example below.
- *status* explains the status of an attempted operation. If not equal to 0, then an error occurred.

**Note** DISCTRL\_ALPH will only display and control string entry if the USER or USER2 menu is the selected menu. Therefore, use FORCE\_SPMENU(*device\_stat*, SPI\_TPUSER, 1) before calling DISCTRL\_ALPH to force the USER menu.

**See Also:** ACT\_SCREEN, DISCTRL\_LIST Built-In Procedures

**Example:** Refer to [Section B.13](#), "Using the DISCTRL\_ALPHA Built-in" (DCLAP\_EX.KL), for a detailed program example.

#### A.4.21 DISCTRL\_FORM Built\_In Procedure

**Purpose:** Displays and controls a form on the teach pendant or CRT/KB screen

**Syntax :** DISCTRL\_FORM(dict\_name, ele\_number, value\_array, inact\_array, change\_array, term\_mask, def\_item, term\_char, status)

Input/Output Parameters :

[in] dict\_name : STRING

[in] ele\_number : INTEGER

[in] value\_array : ARRAY OF STRING

[in] inactive\_array : ARRAY OF BOOLEAN

[out] change\_array : ARRAY OF BOOLEAN

[in] term\_mask : INTEGER

[in,out] def\_item : INTEGER

[out] term\_char : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :PBcore

**Details:**

- *dict\_name* is the four-character name of the dictionary containing the form.
- *ele\_number* is the element number of the form.
- *value\_array* is an array of variable names that corresponds to each edit or display only data item in the form. Each variable name can be specified as a '[prog\_name]var\_name'.
  - *[prog\_name]* is the name of the program that contains the specified variable. If [prog\_name] is not specified, the current program being executed is used. '\*SYSTEM\*' should be used for system variables.
  - *var\_name* must refer to a static, global program variable.
  - *var\_name* can contain node numbers, field names, and/or subscripts.
  - *var\_name* can also specify a port variable with index. For example, 'DIN[1]'.
- *inactive\_array* is an array of booleans that corresponds to each item in the form.
  - Each boolean defaults to FALSE, indicating it is active.

- You can set any boolean to TRUE which will make that item inactive and non-selectable.
- The array size can be greater than or less than the number of items in the form.
- If an *inactive\_array* is not used, then an array size of 1 can be used. The array does not need to be initialized.
- *change\_array* is an array of booleans that corresponds to each edit or display only data item in the form.
  - If the corresponding value is set, then the boolean will be set to TRUE, otherwise it is set to FALSE. You do not need to initialize the array.
  - The array size can be greater than or less than the number of data items in the form.
  - If *change\_array* is not used, an array size of 1 can be used.
- *term\_mask* is a bit-wise mask indicating conditions that will terminate the form. This should be an OR of the constants defined in the include file klevkmsk.kl.

*kc\_func\_key* — Function keys

*kc\_enter\_key* — Enter and Return keys

*kc\_prev\_key* — PREV key

If either a selectable item or a new menu is selected, the form will always terminate, regardless of *term\_mask*.

- For version 6.20 and 6.21, *def\_item* receives the item you want to be highlighted when the form is entered. *def\_item* returns the item that was currently highlighted when the termination character was pressed.
- For version 6.22 and later, *def\_item* receives the item you want to be highlighted when the form is entered. *def\_item* is continuously updated while the form is displayed and contains the number of the item that is currently highlighted
- *term\_char* receives a code indicating the character or other condition that terminated the form. The codes for key terminating conditions are defined in the include file klevkeys.kl. Keys normally returned are pre-defined constants as follows:

*ky\_undef* — No termination character was pressed

*ky\_select* — A selectable item was selected

*ky\_new\_menu* — A new menu was selected

*ky\_f1* — Function key 1 was selected

*ky\_f2* — Function key 2 was selected

*ky\_f3* — Function key 3 was selected

ky\_f4 — Function key 4 was selected

ky\_f5 — Function key 5 was selected

ky\_f6 — Function key 6 was selected

ky\_f7 — Function key 7 was selected

ky\_f8 — Function key 8 was selected

ky\_f9 — Function key 9 was selected

ky\_f10 — Function key 10 was selected

- DISCTRL\_FORM will display the form on the teach pendant device. To display the form on the CRT/KB device, you must create an INTEGER variable, *device\_stat*, and set it to *crt\_panel*. To set control to the teach pendant device, set *device\_stat* to *tp\_panel*.
- *status* explains the status of the attempted operation. If *status* returns a value other than 0, an error has occurred.

**Note** DISCTRL\_FORM will only display the form if the USER2 menu is the selected menu. Therefore, use FORCE\_SPMENU(*device\_stat*, SPI\_TPUSER2, 1) before calling DISCTRL\_FORM to force the USER2 menu.

See Also: [Chapter 10 DICTIONARIES AND FORMS](#), for more details and examples.

#### A.4.22 DISCTRL\_LIST Built-In Procedure

**Purpose:** Displays and controls cursor movement and selection in a list in a specified window

**Syntax :** DISCTRL\_LIST(file\_var, display\_data, list\_data, action, status)

Input/Output Parameters :

[in] file\_var :FILE

[in,out] display\_data :DISP\_DAT\_T

[in] list\_data :ARRAY OF STRING

[in] action :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *file\_var* must be opened to the window where the list data is to appear.
- *display\_data* is used to display the list. Refer to the DISP\_DAT\_T data type for details.
- *list\_data* contains the list of data to display.
- *action* must be one of the following:
  - dc\_disp : Positions cursor as defined in display\_data
  - dc\_up : Moves cursor up one row
  - dc\_dn : Moves cursor down one row
  - dc\_lf : Moves cursor left one field
  - dc\_rt : Moves cursor right one field
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.
- Using DISCTRL\_FORM is the preferred method for displaying and controlling information in a window.

**See Also:** DISCTRL\_FORM Built-In Procedure, [Section 7.9.1](#) , "User Menu on the Teach Pendant," [Section 7.9.2](#) , "User Menu on the CRT/KB," [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

**Caution**

The input parameters are not checked for validity. You must make sure the input parameters are valid; otherwise, the built-in might not work properly.

#### A.4.23 DISCTRL\_PLMN Built-In Procedure

**Purpose:** Creates and controls cursor movement and selection in a pull-up menu

**Syntax :** DISCTRL\_PLMN(dict\_name, element\_no, ftn\_key\_no, def\_item, term\_char, status)

Input/Output Parameters :

[in] dict\_name :STRING

[in] element\_no :INTEGER

[in] ftn\_key\_num :INTEGER  
 [in,out] def\_item :INTEGER  
 [out] term\_char :INTEGER  
 [out] status :INTEGER  
 %ENVIRONMENT Group : UIF

**Details:**

- The menu data in the dictionary consists of a list of enumerated values that are displayed and selected from a pull-up menu on the teach pendant device. A maximum of 9 values should be used. Each value is a string of up to 12 characters.

A sequence of consecutive dictionary elements, starting with *element\_no*, define the values. Each value must be put in a separate element, and must not end with &new\_line. The characters are assigned the numeric values 1..9 in sequence. The last dictionary element must be "".

- dict\_name* specifies the name of the dictionary that contains the menu data.
- element\_no* is the element number of the first menu item within the dictionary.
- ftn\_key\_num* is the function key where the pull-up menu should be displayed.
- def\_item* is the item that should be highlighted when the menu is entered. 1 specifies the first item. On return, *def\_item* is the item that was currently highlighted when the termination character was pressed.
- term\_char* receives a code indicating the character that terminated the menu. The codes for key terminating conditions are defined in the include file FROM:KLEVKEYS.KL. Keys normally returned are pre-defined constants as follows:

ky\_enter — A menu item was selected

ky\_prev — A menu item was not selected

ky\_new\_menu — A new menu was selected

ky\_f1

ky\_f2

ky\_f3

ky\_f4

ky\_f5

- status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** In this example, dictionary file TPEXAMEG.TX is loaded as 'EXAM' on the controller. TPPLMN.KL calls DISCTRL\_PLMN to display and process the pull-up menu above function key 3.

### **DISCTRL\_PLMN Built-In Procedure**

```
-----  
TPEXAMEG.TX  
-----  
  
$subwin_menu  
"Option 1"  
$  
"Option 2"  
$  
"Option 3"  
$  
"Option 4"  
$  
"Option 5"  
$  
"....."  
  
-----  
TPPLMN.KL  
-----  
  
PROGRAM tpplmn  
  
%ENVIRONMENT uif  
  
VAR  
    def_item: INTEGER  
    term_char: INTEGER  
    status: INTEGER  
  
BEGIN  
    def_item = 1  
    DISCTRL_PLMN('EXAM', 0, 3, def_item, term_char, status)  
    IF term_char = ky_enter THEN  
        WRITE (CR, def_item, ' was selected')  
    ENDIF  
END tpplmn
```

### **A.4.24 DISCTRL\_SBMN Built-In Procedure**

**Purpose:** Creates and controls cursor movement and selection in a sub-window menu

**Syntax :** DISCTRL\_SBMN(dict\_name, element\_no, def\_item, term\_char, status)

Input/Output Parameters :

[in] dict\_name :STRING

[in] element\_no :INTEGER

[in,out] def\_item :INTEGER

[out] term\_char :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group : UIF

#### Details:

- The menu data in the dictionary consists of a list of enumerated values that are displayed and selected from the 'subm' subwindow on the Teach Pendant device. There can be up to 5 subwindow pages, for a maximum of 35 values. Each value is a string of up to 16 characters. If 4 or less enumerated values are used, then each string can be up to 40 characters.

A sequence of consecutive dictionary elements, starting with *element\_no* , define the values. Each value must be put in a separate element, and must not end with &new\_line. The characters are assigned the numeric values 1..35 in sequence. The last dictionary element must be "".

- *dict\_name* specifies the name of the dictionary that contains the menu data.
- *element\_no* is the element number of the first menu item within the dictionary.
- *def\_item* is the item that should be highlighted when the menu is entered. 1 specifies the first item. On return, *def\_item* is the item that was currently highlighted when the termination character was pressed.
- *term\_char* receives a code indicating the character that terminated the menu. The codes for key terminating conditions are defined in the include file FROM:KLEVKEYS.KL. Keys normally returned are pre-defined constants as follows:

ky\_enter — A menu item was selected

ky\_prev — A menu item was not selected

ky\_new\_menu — A new menu was selected

ky\_f1

ky\_f2

ky\_f3

ky\_f4

ky\_f5

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** In this example, dictionary file TPEXAMEG.TX is loaded as 'EXAM' on the controller. TPSBMN.KL calls DISCTRL\_SBMN to display and process the subwindow menu.

### **DISCTRL\_SBMN Built-In Procedure**

---

TPEXAMEG.TX

---

\$subwin\_menu

"Red"

\$

"Blue"

\$

"Green"

\$

"Yellow"

\$

"Brown"

\$

"Pink"

\$

"Mauve"

\$

"Black"

\$

"Lime"

\$

"Lemon"

\$

"Beige"

\$

"Blue"

\$

"Green"

\$

"Yellow"

\$

"Brown"

\$

"\a"

---

TPSBMN.KL

---

```

PROGRAM tpsbmn
%ENVIRONMENT uif

VAR
    def_item: INTEGER
    term_char: INTEGER
    status: INTEGER
BEGIN
    def_item = 1
    DISCTRL_SBMN('EXAM', 0, def_item, term_char, status)
    IF term_char = ky_enter THEN
        WRITE (CR, def_item, ' was selected')
    ENDIF
END tpsbmn

```

#### A.4.25 DISCTRL\_TBL Built-In Procedure

**Purpose:** Displays and controls a table on the teach pendant

**Syntax :** DISCTRL\_TBL(dict\_name, ele\_number, num\_rows, num\_columns, col\_data, inact\_array, change\_array, def\_item, term\_char, term\_mask, value\_array, attach\_wind, status)

Input/Output Parameters :

[in] dict\_name :STRING

[in] ele\_number :INTEGER

[in] num\_rows :INTEGER

[in] num\_columns :INTEGER

[in] col\_data :ARRAY OF COL\_DESC\_T

[in] inact\_array :ARRAY OF BOOLEAN

[out] change\_array :ARRAY OF BOOLEAN

[in,out] def\_item :INTEGER

[out] term\_char :INTEGER

[in] term\_mask :INTEGER

[in] value\_array :ARRAY OF STRING

[in] attach\_wind :BOOLEAN  
[out] status :INTEGER  
%ENVIRONMENT Group : UIF

**Details:**

- DISCTRL\_TBL is similar to the INIT\_TBL and ACT\_TBL Built-In routines and should be used if no special processing needs to be done with each keystroke.
- *dict\_name* is the four-character name of the dictionary containing the table header.
- *ele\_number* is the element number of the table header.
- *num\_rows* is the number of rows in the table.
- *num\_columns* is the number of columns in the table.
- *col\_data* is an array of column descriptor structures, one for each column in the table. For a complete description, refer to the INIT\_TBL Built-In routine in this appendix.
- *inact\_array* is an array of booleans that corresponds to each column in the table.
  - You can set each boolean to TRUE which will make that column inactive. This means the you cannot move the cursor to this column.
  - The array size can be less than or greater than the number of items in the table.
  - If *inact\_array* is not used, then an array size of 1 can be used, and the array does not need to be initialized.
- *change\_array* is a two dimensional array of BOOLEANS that corresponds to formatted data items in the table.
  - If the corresponding value is set, then the boolean will be set to TRUE, otherwise it is set to FALSE. You do not need to initialize the array.
  - The array size can be less than or greater than the number of data items in the table.
  - If *change\_array* is not used, then an array size of 1 can be used.
- *def\_item* is the row containing the item you want to be highlighted when the table is entered. On return, *def\_item* is the row containing the item that was currently highlighted when the termination character was pressed.
- *term\_char* receives a code indicating the character or other condition that terminated the table. The codes for key terminating conditions are defined in the include file FROM:KLEVKEYS.KL. Keys normally returned are pre-defined constants as follows:

ky\_undef — No termination character was pressed

ky\_select — A selectable item as selected

ky\_new\_menu — A new menu was selected

ky\_f1 — Function key 1 was selected

ky\_f2 — Function key 2 was selected

ky\_f3 — Function key 3 was selected

ky\_f4 — Function key 4 was selected

ky\_f5 — Function key 5 was selected

ky\_f6 — Function key 6 was selected

ky\_f7 — Function key 7 was selected

ky\_f8 — Function key 8 was selected

ky\_f9 — Function key 9 was selected

ky\_f10 — Function key 10 was selected

- *term\_mask* is a bit-wise mask indicating conditions that will terminate the request. This should be an OR of the constants defined in the include file FROM:KLEVKMSK.KL.

kc\_display — Displayable keys

kc\_func\_key — Function keys

kc\_keypad — Key-pad and Edit keys

kc\_enter\_key — Enter and Return keys

kc\_delete — Delete and Backspace keys

kc\_lr\_arw — Left and Right Arrow keys

kc\_ud\_arw — Up and Down Arrow keys

kc\_other — Other keys (such as Prev)

- *value\_array* is an array of variable names that corresponds to each column of data item in the table. Each variable name can be specified as '[prog\_name]var\_name'.

— *[prog\_name]* specifies the name of the program that contains the specified variable. If [prog\_name] is not specified, then the current program being executed is used.

— *var\_name* must refer to a static, global program variable.

— *var\_name* can contain node numbers, field names, and/or subscripts.

- *attach\_wind* should be set to 1 if the table manager window needs to be attached to the display device. If it is already attached, this parameter can be set to 0.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** Refer to the INIT\_TBL Built-In routine for an example of setting up the dictionary text and initializing the parameters.

#### **A.4.26 DISMOUNT\_DEV Built-In Procedure**

**Purpose:** Dismounts the specified device.

**Syntax :** DISMOUNT\_DEV (device, status)

Input/Output Parameters :

[in] device :STRING

[out] status :INTEGER

%ENVIRONMENT Group :FDEV

**Details:**

- *device* specifies the device to be dismounted.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** MOUNT\_DEV, FORMAT\_DEV Built-In Procedures

**Example:** Refer to [Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL), for a detailed program example.

#### **A.4.27 DISP\_DAT\_T Data Type**

**Purpose:** Defines data type for use in DISCTRL\_LIST Built-In

**Syntax :**

disp\_dat\_t = STRUCTURE

  win\_start : ARRAY [4] OF SHORT

  win\_end : ARRAY [4] OF SHORT

  curr\_win : SHORT

  cursor\_row : SHORT

```
lins_per_pg : SHORT  
curs_st_col : ARRAY [10] OF SHORT  
curs_en_col : ARRAY [10] OF SHORT  
curr_field : SHORT  
last_field : SHORT  
curr_it_num : SHORT  
sob_it_num : SHORT  
eob_it_num : SHORT  
last_it_num : SHORT  
menu_id : SHORT  
ENDSTRUCTURE
```

**Details:**

- *disp\_dat\_t* can be used to display a list in four different windows. The list can contain up to 10 fields. Left and right arrows move between fields. Up and down arrows move within a field.
- *win\_start* is the starting row for each window.
- *win\_end* is the ending row for each window.
- *curr\_win* defines the window to display. The count begins at zero (0 will display the first window).
- *cursor\_row* is the current cursor row.
- *lins\_per\_pg* is the number of lines per page for paging up and down.
- *curs\_st\_col* is the cursor starting column for each field. The range is 0-39 for the teach pendant.
- *curs\_en\_col* is the cursor ending column for each field. The range is 0-39 for the teach pendant.
- *curr\_field* is the current field in which the cursor is located. The count begins at zero (0 will set the cursor to the first field).
- *last\_field* is the last field in the list.
- *curr\_it\_num* is the item number the cursor is on.
- *sob\_it\_num* is the item number of the first item in the array.
- *eob\_it\_num* is the item number of the last item in the array.
- *last\_it\_num* is the item number of the last item in the list.
- *menu\_id* is the current menu identifier. Not implemented. May be left uninitialized.

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLIST\_EX.KL), for a detailed program example.

## A.5 - E - KAREL LANGUAGE DESCRIPTION

### A.5.1 ENABLE CONDITION Action

**Purpose:** Enables the specified condition handler

**Syntax :** ENABLE CONDITION [cond\_hand\_no]

where:

cond\_hand\_no :an INTEGER expression

**Details:**

- ENABLE CONDITION has no effect when
  - The condition handler is not defined
  - The condition handler is defined but is already enabled
- *cond\_hand\_no* must be in the range of 1-1000. Otherwise, the program will be aborted with an error.
- When a condition handler is enabled, its conditions are tested each time the condition handler is scanned. If the conditions are satisfied, the corresponding actions are performed and the condition handler is deactivated. Issue an ENABLE CONDITION statement or action to reactivate it.
- Use the DISABLE CONDITION statement or action to deactivate a condition handler that has been enabled.
- Condition handlers are known only to the task which defines them. One task cannot enable another tasks condition.

**See Also:** DISABLE CONDITION Action, [Chapter 6 CONDITION HANDLERS](#)

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.5.2 ENABLE CONDITION Statement

**Purpose:** Enables the specified condition handler

**Syntax :** ENABLE CONDITION [cond\_hand\_no]

where:

`cond_hand_no` :an INTEGER expression

**Details:**

- ENABLE CONDITION has no effect when
  - The condition handler is not defined
  - The condition handler is defined but is already enabled
- `cond_hand_no` must be in the range of 1-1000. Otherwise, the program will be aborted with an error.
- When a condition handler is enabled, its conditions are tested each time the condition handler is scanned. If the conditions are satisfied, the corresponding actions are performed and the condition handler is deactivated. Issue an ENABLE CONDITION statement or action to reactivate it.
- Use the DISABLE CONDITION statement or action to deactivate a condition handler that has been enabled.
- Condition handlers are known only to the task which defines them. One task cannot enable another tasks condition.

**See Also:** DISABLE CONDITION Statement, [Chapter 6 CONDITION HANDLERS](#) , Appendix E, “Syntax Diagrams,” for additional syntax information

**Example:** Refer to the following sections for detailed program examples.

[Section B.6](#) , "Path Variables and Condition Handlers Program" (PTH\_MOV.KL)

[Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

### **A.5.3 %ENVIRONMENT Translator Directive**

**Purpose:** Loads environment file.

**Syntax :** %ENVIRONMENT path\_name

- Used by the off-line translator to specify that the binary file, `path_name.ev`, should be loaded. Environment files contain definitions for predefined constants, ports, types, system variables, and built-ins.
- All .EV files are loaded upon installation of the controller software. Therefore, the controller’s translator will ignore %ENVIRONMENT statements since it already has the .EV files loaded.
- `path_name` can be one of the following:
  - BYNAM

- CTDEF (allows program access to CRT/KB system variables)
  - ERRS
  - FDEV
  - FLBT
  - IOSETUP
  - KCLOP
  - MEMO
  - MIR
  - MOTN
  - MULTI
  - PATHOP
  - PBCORE
  - PBQMGR
  - REGOPE
  - STRNG
  - SYSDEF (allows program access to most system variables)
  - SYSTEM
  - TIM
  - TPE
  - TRANS
  - UIF
  - VECTR
- If no %ENVIRONMENT statements are specified in your KAREL program, the off-line translator will load all the .EV files specified in TRMNEG.TX. The translator must be able to find these files in the current directory or in one of the PATH directories.
  - If at least one %ENVIRONMENT statement is specified, the off-line translator will only load the files you specify in your KAREL program. Specifying your own %ENVIRONMENT statements will reduce the amount of memory required to translate and will be faster, especially if you do not require system variables since SYSDEF.EV is the largest file.
  - SYSTEM.EV and PBCORE.EV are automatically loaded by the translator and should not be specified in your KAREL program. The off-line translator will print the message "Continuing without system defined symbols" if it cannot find SYSTEM.EV. Do not ignore this message. Make sure the SYSTEM.EV file is loaded.

**Example:** Refer to the following sections for detailed program examples:

[Section B.3, "Saving Data to the Default Device" \(SAVE\\_VR.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

#### **A.5.4 ERR\_DATA Built-In Procedure**

**Purpose:** Reads the requested error from the error history and returns the error

**Syntax :** ERR\_DATA(seq\_num, error\_code, error\_string, cause\_code, cause\_string, time\_int, severity, prog\_nam)

Input/Output Parameters :

[in,out] seq\_num :INTEGER

[out] error\_code :INTEGER

[out] error\_string :STRING

[out] cause\_code :INTEGER

[out] cause\_string :STRING

[out] time\_int :INTEGER

[out] severity :INTEGER

[out] prog\_nam :STRING

%ENVIRONMENT Group :ERRS

- *seq\_num* is the sequence number of the previous error requested. *seq\_num* should be set to 0 if the oldest error in the history is desired. *seq\_num* should be set to MAXINT if the most recent error is desired.
- *seq\_num* is set to the sequence number of the error that is returned.
  - If the initial value of *seq\_num* is greater than the sequence number of the newest error in the log, *seq\_num* is returned as zero and no other data is returned.
  - If the initial value of *seq\_num* is less than the sequence number of the oldest error in the log, the oldest error is returned.
- *error\_code* returns the error code and *error\_string* returns the error message. *error\_string* must be at least 40 characters long or the program will abort with an error.

- *cause\_code* returns the reason code if it exists and *cause\_string* returns the message. *cause\_string* must be at least 40 characters long or the program will abort with an error.
- *error\_code* and *cause\_code* are in the following format:

ffccc (decimal)

where ff represents the facility code of the error.

ccc represents the error code within the specified facility.

Refer to Chapter 6, "Condition Handlers," for the error facility codes.

- *time\_int* returns the time that *error\_code* was posted. The time is in encoded format, and CNV\_TIME\_STR Built-In should be used to get the date-and-time string.
- *severity* returns one of the following *error\_codes*: 0 :WARNING1 :PAUSE2 :ABORT
- If the error occurs in the execution of a program, *prog\_nam* specifies the name of the program in which the error occurred.
- If the error is posted by POST\_ERR, or if the error is not associated with a particular program (e.g., E-STOP), *prog\_nam* is returned as ‘ “ ” ’.
- Calling ERR\_DATA immediately after POST\_ERR may not return the error just posted since POST\_ERR returns before the error is actually in the error log.

**See Also:** POST\_ERR Built-In Procedure

### **A.5.5 ERROR Condition**

**Purpose:** Specifies an error as a condition

**Syntax :** ERROR[n]

where:

n :an INTEGER expression or asterisk (\*)

**Details:**

- If *n* is an INTEGER, it represents an error code number. The condition is satisfied when the specified error occurs.
- If *n* is an asterisk (\*), it represents a wildcard. The condition is satisfied when any error occurs.
- The condition is an event condition, meaning it is satisfied only for the scan performed when the error was detected. The error is not remembered on subsequent scans.

**See Also:** [Chapter 6 CONDITION HANDLERS](#), for more information on using conditions. The appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual* for a list of all error codes

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.5.6 EVAL Clause**

**Purpose:** Allows expressions to be evaluated in a condition handler definition

**Syntax :** EVAL(expression)

where:

expression :a valid KAREL expression

**Details:**

- *expression* is evaluated when the condition handler is defined, rather than dynamically during scanning.
- *expression* can be any valid expression that does not contain a function call.

**See Also:** [Chapter 6 CONDITION HANDLERS](#), for more information on using conditions

**Example:** The following example uses a local condition handler to move to the position **far\_pos** until AIN[ **force** ] is greater than the evaluated expression (10 \* **f\_scale** ).

#### **EVAL Clause**

```
WRITE ('Enter force scale: ')
READ (f_scale)
MOVE TO far_pos,
    UNTIL AIN[force] > EVAL(10 * f_scale)
ENDMOVE
```

### **A.5.7 EVENT Condition**

**Purpose:** Specifies the number of an event that satisfies a condition when a SIGNAL EVENT statement or action with that event number is executed

**Syntax :** EVENT[event\_no]

where:

event\_no :is an INTEGER expression

**Details:**

- Events can be used as user-defined event codes that become TRUE when signaled.
- The SIGNAL EVENT statement or action is used to signal that an event has occurred.
- *event\_no* must be in the range of -32768 to 32767.

**See Also:** SIGNAL EVENT Action, and CONDITION or SIGNAL EVENT Statement

**Example:** Refer to [Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

## A.5.8 EXP Built-In Function

**Purpose:** Returns a REAL value equal to e (approximately 2.71828) raised to the power specified by a REAL argument

**Syntax :** EXP(x)

Function Return Type :REAL

Input/Output Parameters :

[in] x :REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- EXP returns e (base of the natural logarithm) raised to the power *x* .
- *x* must be less than 80. Otherwise, the program will be paused with an error.

**Example:** The following example uses the EXP Built-In to evaluate the exponent of the expression **(-6.44 + timevar/(timevar + 20))** .

### **EXP Built-In Function**

```
WRITE (CR, 'Enter time needed for move: ')
READ (timevar)

distance = timevar *
          EXP(-6.44 + timevar/(timevar + 20))

WRITE (CR, CR, 'Distance for move:', distance::10::3)
```

## A.6 - F - KAREL LANGUAGE DESCRIPTION

### A.6.1 FILE Data Type

**Purpose:** Defines a variable as FILE data type

**Syntax :** file

**Details:**

- FILE allows you to declare a static variable as a file.
- You must use a FILE variable in OPEN FILE, READ, WRITE, CANCEL FILE, and CLOSE FILE statements.
- You can pass a FILE variable as a parameter to a routine.
- Several built-in routines require a FILE variable as a parameter, such as BYTES\_LEFT, CLR\_IO\_STAT, GET\_FILE\_POS, IO\_STATUS, SET\_FILE\_POS.
- FILE variables have these restrictions:
  - FILE variables must be a static variable.
  - FILE variables are never saved.
  - FILE variables cannot be function return values.
  - FILE types are not allowed in structures, but are allowed in arrays.
  - No other use of this variable data type, including assignment to one another, is permitted.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2 , "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.12 , "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

### A.6.2 FILE\_LIST Built-In Procedure

**Purpose:** Generates a list of files with the specified name and type on the specified device.

**Syntax:** FILE\_LIST(file\_spec, n\_skip, format, ary\_nam, n\_files, status)

Input/Output Parameters :

[in] file\_spec :STRING

[in] n\_skip :INTEGER

[in] format :INTEGER  
[out] ary\_nam :ARRAY of STRING  
[out] n\_files :INTEGER  
[out] status :INTEGER  
%ENVIRONMENT Group :BYNAM

**Details:**

- *file\_spec* specifies the device, name, and type of the list of files to be found. *file\_spec* can be specified using the wildcard (\*) character.
- *n\_skip* is used when more files exist than the declared length of *ary\_nam*. Set *n\_skip* to 0 the first time you use FILE\_LIST. If *ary\_nam* is completely filled with variable names, copy the array to another ARRAY of STRINGS and execute the FILE\_LIST again with *n\_skip* equal to *n\_files*. The second call to FILE\_LIST will skip the files found in the first pass and only locate the remaining files.
- *format* specifies the format of the file name and file type. The following values are valid for *format* :

1 **file\_name** only, no blanks 2 **file\_type** only, no blanks3 **file\_name.file\_type** , no blanks4 **filename.ext size date time** The total length is 40 characters.

- The **file\_name** starts with character 1.
- The **file\_type** (extension) starts with character 10.
- The **size** starts with character 21.
- The **date** starts with character 26.
- The **time** starts with character 36.

**Date and time** are only returned if the device supports time stamping; otherwise just the filename.ext size is stored.

- *ary\_nam* is an ARRAY of STRINGS to store the file names. If the string length of *ary\_nam* is not large enough to store the formatted information, an error will be returned.
- *n\_files* is the number of files stored in *ary\_name* .
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** VAR\_LIST, PROG\_LIST Built-In Procedures

**Example:** Refer to [Section B.7](#) , "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL), for a detailed program example.

### A.6.3 FOR...ENDFOR Statement

**Purpose:** Looping construct based on an INTEGER counter

**Syntax :** FOR count = initial || TO | DOWNT0 || final

DO {stmt} ENDFOR

where:

[in]count :INTEGER variable

[in]initial :INTEGER expression

[in]final :INTEGER expression

[in]stmt :executable KAREL statement

**Details:**

- Initially, *count* is set to the value of *initial* and *final* is evaluated. For each iteration, *count* is compared to *final*.
- If TO is used, *count* is incremented for each loop iteration.
- If DOWNT0 is used, *count* is decremented for each loop iteration.
- If *count* is greater than *final* using TO, *stmt* is never executed.
- If *count* is less than *final* using DOWNT0, *stmt* is never executed on the first iteration.
- If the comparison does not fail on the first iteration, the FOR loop will be executed for the number of times that equals ABS(*final - initial*) + 1.
- If *final = initial*, the loop is executed once.
- initial* is evaluated prior to entering the loop. Therefore, changing the values of *initial* and *final* during loop execution has no effect on the number of iterations performed.
- The value of *count* on exit from the loop is uninitialized.
- Never issue a GO TO statement in a FOR loop. If a GO TO statement causes the program to exit a FOR loop, the program might be aborted with a “Run time stack overflow” error.
- Never include a GO TO label in a FOR loop. Entering a FOR loop by a GO TO statement usually causes the program to be aborted with a “Run time stack underflow” error when the ENDFOR statement is encountered.
- The program will not be translated if *count* is a system variable or ARRAY element.

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for additional syntax information.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.7, "Listing Files and Programs and Manipulating Strings" \(LIST\\_EX.KL\)](#)

[Section B.11, "Manipulating Values of Dynamically Displayed Variables" \(CHG\\_DATA.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

#### **A.6.4 FORCE\_SPMENU Built-In Procedure**

**Purpose:** Forces the display of the specified menu

**Syntax :** FORCE\_SPMENU(device\_code, spmenu\_id, screen\_no)

Input/Output Parameters :

[in] device\_code :INTEGER

[in] spmenu\_id :INTEGER

[in] screen\_no :INTEGER

%ENVIRONMENT Group :pbcore

**Details:**

- *device\_code* specifies the device and should be one of the following predefined constants:

tp\_panel Teach pendant device

crt\_panel CRT device

- *spmenu\_id* and *screen\_no* specify the menu to force. The predefined constants beginning with SPI\_ define the *spmenu\_id* and the predefined constants beginning with SCR\_ define the *screen\_no*. If no SCR\_ is listed, use 1.

SPI\_TPHINTS — UTILITIES Hints

SPI TPPRGADJ — UTILITIES Prog Adjust

SPI TPMIRROR — UTILITIES Mirror Image

SPI\_TPSHIFT — UTILITIES Program Shift  
SPI\_TPTSTRUN — TEST CYCLE  
SPI TPMANUAL, SCR\_MACMAN — MANUAL Macros  
SPI\_TPOTREL — MANUAL OT Release  
SPI\_TPALARMM, SCR\_ALM\_ALL — ALARM Alarm Log  
SPI\_TPALARMM, SCR\_ALM\_MOT — ALARM Motion Log  
SPI\_TPALARMM, SCR\_ALM\_SYS — ALARM System Log  
SPI\_TPALARMM, SCR\_ALM\_APPL — ALARM Appl Log  
SPI\_TPDIGIO — I/O Digital  
SPI\_TPANAIO — I/O Analog  
SPI\_TPGRPIO — I/O Group  
SPI\_TPROBIO — I/O Robot  
SPI\_TPUOPIO — I/O UOP  
SPI\_TPSOPIO — I/O SOP  
SPI\_TPPLCIO — I/O PLC  
SPI\_TPSETGEN — SETUP General  
SPI\_TPFRAM — SETUP Frames  
SPI TPPORT — SETUP Port Init  
SPI TPMMACRO, SCR\_MACSETUP — SETUP Macro  
SPI\_TPREFPOS — SETUP Ref Position  
SPI TPPWORD — SETUP Passwords  
SPI\_TPHCOMM — SETUP Host Comm  
SPI\_TPSYRSR — SETUP RSR/PNS  
SPI\_TPFILS — FILE  
SPI\_TPSTATUS, SCR\_AXIS — STATUS Axis

SPI\_TPMEMORY — STATUS Memory  
SPI\_TPVERSN — STATUS Version ID  
SPI TPPRGSTS — STATUS Program  
SPI\_TPSFTY — STATUS Safety Signals  
SPI\_TPUSER — USER  
SPI\_TPSELECT — SELECT  
SPI\_TPTCH — EDIT  
SPI\_TPREGIS, SCR\_NUMREG — DATA Registers  
SPI\_SFMPREG, SCR\_POSREG — DATA Position Reg  
SPI\_TPSYSV, SCR\_NUMVAR — DATA KAREL Vars  
SPI\_TPSYSV, SCR\_POSVAR — DATA KAREL Posns  
SPI\_TPPOSN — POSITION  
SPI\_TPSYSV, SCR\_CLOCK — SYSTEM Clock  
SPI\_TPSYSV, SCR\_SYSVAR — SYSTEM Variables  
SPI TPMASCAL — SYSTEM Master/Cal  
SPI\_TPBRKCTR — SYSTEM Brake Cntrl  
SPI\_TPAXLM — SYSTEM Axis Limits  
SPI\_CRTKCL, SCR\_KCL — KCL> (crt\_panel only)  
SPI\_CRTKCL, SCR\_CRT — KAREL EDITOR (crt\_panel only)  
SPI\_TPUSER2 — Menu for form/table managers

**See Also:** ACT\_SCREEN Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.4](#) , "Standard Routines" (ROUT\_EX.KL)

[Section B.5](#) , "Using Register Built-ins" (REG\_EX.KL)

[Section B.12](#) , "Dictionary Files" (DCLISTEG.UTX)

[Section B.13](#) , "Using the DISCTRL\_ALPHA Built-in" (DCALP\_EX.KL)

[Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

## **A.6.5 FORMAT\_DEV Built-In Procedure**

**Purpose:** Deletes any existing information and records a directory and other internal information on the specified device.

**Syntax :** FORMAT\_DEV(device, volume\_name, nowait\_sw, status)

Input/Output Parameters :

[in] device :STRING

[in] volume\_name :STRING

[in] nowait\_sw :BOOLEAN

[out] status :INTEGER

%ENVIRONMENT Group :FDEV

**Details:**

- *device* specifies the device to initialize.
- *volume\_name* acts as a label for a particular unit of storage media. *volume\_name* can be a maximum of 11 characters and will be truncated to 11 characters if more are specified.
- If *nowait\_sw* is TRUE, execution of the program continues while the command is executing. If it is FALSE, the program stops, including condition handlers, until the operation is complete. If you have time critical condition handlers in the program, put them in another program that executes as a separate task.

**Note** *nowait\_sw* is not available in this release and should be set to FALSE.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** MOUNT\_DEV, DISMOUNT\_DEV Built-In Procedures

**Example:** Refer to [Section B.9](#) , "Using the File and Device Built-ins" (FILE\_EX.KL), for a detailed program example.

## A.6.6 FRAME Built-In Function

**Purpose:** Returns a frame with a POSITION data type representing the transformation to the coordinate frame specified by three (or four) POSITION arguments.

**Syntax :** FRAME(pos1, pos2, pos3 <,pos4>)

Function Return Type :Position

Input/Output Parameters :

[in]pos1 :POSITION

[in]pos2 :POSITION

[in]pos3 :POSITION

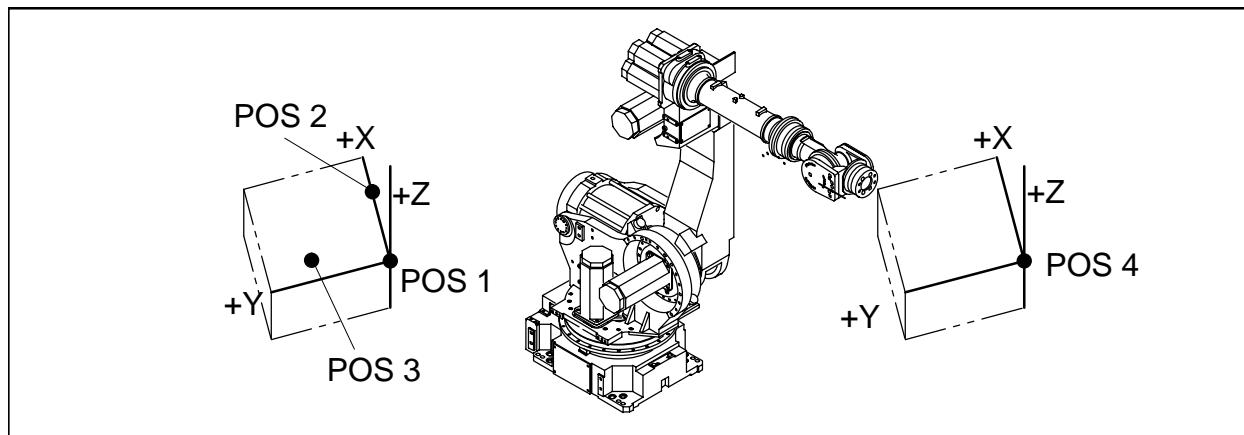
[in]pos4 :POSITION

%ENVIRONMENT Group :SYSTEM

### Details:

- The returned value is computed as follows:
  - *pos1* is assumed to be the origin unless a *pos4* argument is supplied. See [Figure A-1](#) .
  - If *pos4* is supplied, the origin is shifted to *pos4* , and the new coordinate frame retains the same orientation in space as the first coordinate frame. See [Figure A-1](#) .
  - The x-axis is parallel to a line from *pos1* to *pos2* .
  - The xy-plane is defined to be that plane containing *pos1* , *pos2* , and *pos3* , with *pos3* in the positive half of the plane.
  - The y-axis is perpendicular to the x-axis and in the xy-plane.
  - The z-axis is through *pos1* and perpendicular to the xy-plane. The positive direction is determined by the right hand rule.
  - The configuration of the result is set to that of *pos1* , or *pos4* if it is supplied.
- *pos1* and *pos2* arguments must be at least 10 millimeters apart and *pos3* must be at least 10 millimeters away from the line connecting *pos1* and *pos2* .

If either condition is not met, the program is paused with an error.

**Figure A-1. FRAME Built-In Function**

**Example:** The following example allows the operator to set a frame to a pallet so that a palletizing routine will be able to move the TCP along the x, y, z direction in the pallet's coordinate frame.

### FRAME Built-In Function

```

WRITE('Teach corner_1, corner_2, corner_3',CR)
RELEASE --Allows operator to turn on teach pendant
          --and teach positions

ATTACH --Returns motion control to program
$UFRAME = FRAME (corner_1, corner_2, corner_3)

```

### A.6.7 FROM Clause

**Purpose:** Indicates a variable or routine that is external to the program, allowing data and/or routines to be shared among programs

**Syntax :** FROM prog\_name

where:

prog\_name : any KAREL program identifier

**Details:**

- The FROM clause can be part of a type, variable, or routine declaration.
- The type, variable, or routine belongs to the program specified by *prog\_name* .

- In a FROM clause, *prog\_name* can be the name of any program, including the program in which the type, variable, or routine is declared.
- If the FROM clause is used in a routine declaration and is called during program execution, the body of the declaration must appear in the specified program and that program must be loaded.
- The FROM clause cannot be used when declaring variables in the declaration section of a routine.

**Example:** Refer to the following sections for detailed program examples:

[Section B.6](#), "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.7](#), "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

[Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL)

[Section B.11](#), "Manipulating Values of Dynamically Displayed Variables" (CHG\_DATA.KL)

[Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

## **A.7 - G - KAREL LANGUAGE DESCRIPTION**

### **A.7.1 GET\_ATTR\_PRG Built-In Procedure**

**Purpose:** Gets attribute data from the specified teach pendant or KAREL program

**Syntax :** GET\_ATTR\_PRG(program\_name, attr\_number, int\_value, string\_value, status)

Input/Output Parameters :

[in] program\_name :STRING

[in] attr\_number :INTEGER

[out] int\_value :INTEGER

[out] string\_value :STRING

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *program\_name* specifies the program from which to get attribute.

- *attr\_number* is the attribute whose value is to be returned. The following attributes are valid:

AT\_PROG\_TYPE : Program type

AT\_PROG\_NAME : Program name (String[12])

AT\_OWNER : Owner (String[8])

AT\_COMMENT : Comment (String[16])

AT\_PROG\_SIZE : Size of program

AT\_ALLC\_SIZE : Size of allocated memory

AT\_NUM\_LINE : Number of lines

AT\_CRE\_TIME : Created (loaded) time

AT\_MDFY\_TIME : Modified time

AT\_SRC\_NAME : Source file ( or original file ) name (String[128])

AT\_SRC\_VRSN : Source file versionA

T\_DEF\_GROUP : Default motion groups (for task attribute)

AT\_PROTECT : Protection code; 1 :Protection OFF ; 2 :Protection ON

AT\_STK\_SIZE : Stack size (for task attribute)

AT\_TASK\_PRI : Task priority (for task attribute)

AT\_DURATION : Time slice duration (for task attribute)

AT\_BUSY\_OFF : Busy lamp off (for task attribute)

AT\_IGNR\_ABRT : Ignore abort request (for task attribute)

AT\_IGNR\_PAUS : Ignore pause request (for task attribute)

AT\_CONTROL : Control code (for task attribute)

- The program type returned for AT\_PROG\_TYPE will be one of the following constants:

PT\_KRLPRG : Karel program

PT\_MNE\_UNDEF : Teach pendant program of undefined sub type

PT\_MNE\_JOB : Teach pendant job

PT\_MNE\_PROC : Teach pendant process

PT\_MNE\_MACRO : Teach pendant macro

- If the attribute data is a number, it is returned in *int\_value* and *string\_value* is not modified.
- If the attribute data is a string, it is returned in *string\_value* and *int\_value* is not modified.
- *status* explains the status of the attempted operation. If it is not equal to 0, then an error has occurred. Some of the errors which could occur are:

7073 The program specified in *program\_name* does not exist

17027 *string\_value* is not large enough to contain the attribute string. The value has been truncated to fit.

17033 *attr\_number* has an illegal value

**See Also:** SET\_ATTR\_PRG, GET\_TSK\_INFO, SET\_TSK\_ATTR Built-In Procedures

## A.7.2 GET\_FILE\_POS Built-In Function

**Purpose:** Returns the current file position (where the next READ or WRITE operation will take place) in the specified file

**Syntax :** GET\_FILE\_POS(file\_id)

Function Return Type :INTEGER

Input/Output Parameters :

[in] file\_id :FILE

%ENVIRONMENT Group :FLBT

**Details:**

- GET\_FILE\_POS returns the number of bytes before the next byte to be read or written in the file.
- Line terminators are counted in the value returned.
- The file associated with *file\_id* must be open. Otherwise, the program is aborted with an error.
- If the file associated with *file\_id* is open for read-only, it cannot be on the FROM or RAM disks as a compressed file.

**Warning**

**GET\_FILE\_POS is only supported for files opened on the RAM Disk device. Do not use GET\_FILE\_POS on another device; otherwise, you could injure personnel and damage equipment.**

**Note** GET\_FILE\_POS is not supported for files on the floppy disk.

**Example:** The following example opens the **filepos.dt** data file, stores the positions in **my\_path** in a file, and builds a directory to access them.

**GET\_FILE\_POS Built-In Function**

```
OPEN FILE file_id ('RW','filepos.dt')

FOR i = 1 TO PATH_LEN(my_path) DO
    temp_pos = my_path[i].node_pos
    pos_dir[i] = GET_FILE_POS(file_id)
    WRITE file_id (temp_pos)
ENDFOR
```

**A.7.3 GET\_JPOS\_REG Built-In Function**

**Purpose:** Gets a JOINTPOS value from the specified register

**Syntax :** GET\_JPOS\_REG(register\_no, status <,group\_no>)

Function Return Type :REGOPE

Input/Output Parameters :

[in] register\_no :INTEGER

[out] status :INTEGER

[in] group\_no :INTEGER

%ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the position register to get.
- If *group\_no* is omitted, the default group for the program is assumed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.

- GET\_JPOS\_REG returns the position in JOINTPOS format. Use POS\_REG\_TYPE to determine the position representation.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** GET\_POS\_REG, SET\_JPOS\_REG, SET\_POS\_REG Built-in Procedures

**Example:** Refer to [Section B.5](#), "Using Register Built-ins" (REG\_EX.KL) for a detailed program example.

#### A.7.4 GET\_JPOS\_TPE Built-In Function

**Purpose:** Gets a JOINTPOS value from the specified position in the specified teach pendant program

**Syntax :** GET\_JPOS\_TPE(open\_id, position\_no, status <, group\_no>)

Function Return Type :JOINTPOS

Input/Output Parameters :

[in] open\_id :INTEGER

[in] position\_no :INTEGER

[out] status :INTEGER

[in] group\_no :INTEGER

%ENVIRONMENT Group :PBCORE

##### **Details:**

- *open\_id* specifies the teach pendant program. A program must be opened before calling this built-in.
- *position\_no* specifies the position in the program to get.
- If *group\_no* is omitted, the default group for the program is assumed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.
- No conversion is done for the position representation. The position data must be in JOINTPOS format. If the stored position is not in JOINTPOS, an error status is returned. Use GET\_POS\_TYP to get the position representation.
- If the specified position in the program is uninitialized, the returned JOINTPOS value is uninitialized and the status is set to 17038, "Uninitialized TPE position".
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

**See Also:** SET\_JPOS\_TPE, GET\_POS\_TPE, SET\_POS\_TPE Built-ins

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TPE.KL), for a detailed program example.

### A.7.5 GET\_PORT\_ASG Built-in Procedure

**Purpose:** Allows a KAREL program to determine the physical port(s) to which a specified logical port is assigned.

**Syntax :** GET\_PORT\_ASG(log\_port\_type, log\_port\_no, rack\_no, slot\_no, phy\_port\_type, phy\_port\_no, n\_ports, status)

Input/Output Parameters :

[in] log\_port\_type :INTEGER

[in] log\_port\_no :INTEGER

[out] rack\_no :INTEGER

[out] slot\_no :INTEGER

[out] phy\_port\_type :INTEGER

[out] phy\_port\_no :INTEGER

[out] n\_ports :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :IOSETUP

#### Details:

- *log\_port\_type* specifies the code for the type of port whose assignment is being accessed. Codes are defined in FR:KLIOTYPS.KL.
- *log\_port\_no* specifies the number of the port whose assignment is being accessed.
- *rack\_no* is returned with the rack containing the port module. For process I/O boards, memory-image, and dummy ports, this is zero; for Allen-Bradley ports, this is 16.
- *phy\_port\_type* is returned with the type of port assigned to. Often this will be the same as *log\_port\_type*. Exceptions are if *log\_port\_type* is a group type (io\_gpin or io\_gpout) or a port is assigned to memory-image or dummy ports.
- *phy\_port\_no* is returned with the number of the port assigned to. If *log\_port\_type* is a group, this is the port number for the least-significant bit of the group.

- *n\_ports* is returned with the number of physical ports assigned to the logical port. This will be 1 in all cases except when *log\_port\_type* is a group type. In this case, *n\_ports* indicates the number of bits in the group.
- *status* is returned with zero if the parameters are valid and the specified port is assigned. Otherwise, it is returned with an error code.

**Example:** The following example returns to the caller the module rack and slot number, *port\_number*, and number of bits assigned to a specified group input port. A boolean is returned indicating whether the port is assigned to a DIN port. If the port is not assigned, a non-zero status is returned.

### GET\_PORT\_ASG Built-In Procedure

```

PROGRAM getasgprog
  %ENVIRONMENT IOSETUP
  %INCLUDE FR:\kliotyps

  ROUTINE get_gin_asg(gin_port_no: INTEGER;
                      rack_no: INTEGER;
                      slot_no: INTEGER;
                      frst_port_no: INTEGER;
                      n_ports: INTEGER;
                      asgd_to_din: BOOLEAN): INTEGER

  VAR
    phy_port_typ: INTEGER
    status: INTEGER

  BEGIN
    GET_PORT_ASG(io_gpin, gin_port_no, rack_no, slot_no,
                 phy_port_typ, frst_port_no, n_ports, status)
    IF status <> 0 THEN
      RETURN (status)
    ENDIF
    asgd_to_din = (phy_port_typ = io_din)
  END get_gin_asg

  BEGIN
  END getasgprog

```

### A.7.6 GET\_PORT\_ATR Built-In Function

**Purpose:** Gets an attribute from the specified port

**Syntax :** GET\_PORT\_ATR(*port\_id*, *atr\_type*, *atr\_value*)

Function Return Type :INTEGER

Input/Output Parameters :

[in] port\_id :INTEGER

[in] atr\_type :INTEGER

[out] atr\_value :INTEGER

%ENVIRONMENT Group :FLBT

**Details:**

- *port\_id* specifies which port is to be queried. Use one of the following predefined constants:

port\_1

port\_2

port\_3

port\_4

port\_5

- *atr\_type* specifies the attribute whose current setting is to be returned. Use one of the following predefined constants:

atr\_readahd :Read ahead buffer

atr\_baud :Baud rate

atr\_parity :Parity

atr\_sbts :Stop bit

atr\_dbts :Data length

atr\_xonoff :Xon/Xoff

atr\_eol :End of line

atr\_modem :Modem line

- *atr\_value* receives the current value for the specified attribute.

- GET\_PORT\_ATR returns the status of this action to the port.

**See Also:** SET\_PORT\_ATR Built-In Function, [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#)

**Example:** The following example sets up the port to a desired configuration, if it is not already set to the specified configuration.

### GET\_PORT\_ATR Built-In Function

```
PROGRAM port_atr
%ENVIRONMENT FLBT
VAR
    stat:    INTEGER
    atr_value: INTEGER

BEGIN
-- sets read ahead buffer to desired value, if not already correct
    stat=GET_PORT_ATR(port_2,atr_readahd,atr_value)
    IF(atr_value <> 2) THEN
        stat=SET_PORT_ATR(port_2,atr_readahd,2) --set to 256 bytes
    ENDIF
-- sets the baud rate to 9600, if not already set
    stat=GET_PORT_ATR(port_2,atr_baud,atr_value)
    IF(atr_value <> BAUD_9600) THEN
        stat=SET_PORT_ATR(port_2,atr_baud,baud_9600)
    ENDIF
-- sets parity to even, if not already set
    stat=GET_PORT_ATR(port_2,atr_parity,atr_value)
    IF(atr_value <> PARITY_EVEN) THEN
        stat=SET_PORT_ATR(port_2,atr_parity,PARITY_EVEN)
    ENDIF
-- sets the stop bit to 1, if not already set
    stat=GET_PORT_ATR(port_2,atr_sbts,atr_value)
    IF(atr_value <> SBITS_1) THEN
        stat=SET_PORT_ATR(port_2,atr_sbts,SBITS_1)
    ENDIF
-- sets the data bit to 5, if not already set
    stat=GET_PORT_ATR(port_2,atr_dbts,atr_value)
    IF(atr_value <> DBITS_5) THEN
        stat=SET_PORT_ATR(port_2,atr_dbts,DBITS_5)
    ENDIF
-- sets xonoff to not used, if not already set
    stat=GET_PORT_ATR(port_2,atr_xonoff,atr_value)
    IF(atr_value <> xf_not_used) THEN
        stat=SET_PORT_ATR(port_2,atr_xonoff,xf_not_used)
    ENDIF
-- sets end of line marker, if not already set
    stat=GET_PORT_ATR(port_2,atr_eol,atr_value)
    IF(atr_value <> 65) THEN
        stat=SET_PORT_ATR(port_2,atr_eol,65)
    ENDIF
END port_atr
```

### A.7.7 GET\_PORT\_CMT Built-In Procedure

**Purpose:** Allows a KAREL program to determine the comment that is set for a specified logical port

**Syntax :** GET\_PORT\_CMT(port\_type, port\_no, comment\_str, status)

Input/Output Parameters :

[in] port\_type :INTEGER

[in] port\_no :INTEGER

[out] comment\_str :STRING

[out] status :INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port whose comment is being returned. Codes are defined in FR:KLIOTYPS.KL.
- *port\_no* specifies the port number whose comment is being set.
- *comment\_str* is returned with the comment for the specified port. This should be declared as a STRING with a length of at least 16 characters.
- *status* is returned with zero if the parameters are valid and the comment is returned for the specified port.

**See Also:** GET\_PORT\_VAL, GET\_PORT\_MOD, SET\_PORT\_CMT, SET\_PORT\_VAL, SET\_PORT\_MOD Built-in Procedures.

### A.7.8 GET\_PORT\_MOD Built-In Procedure

**Purpose:** Allows a KAREL program to determine what special port modes are set for a specified logical port

**Syntax :** GET\_PORT\_MOD(port\_type, port\_no, mode\_mask, status)

Input/Output Parameters :

[in] port\_type :INTEGER

[in] port\_no :INTEGER

[out] mode\_mask :INTEGER

[out] status :INTEGER  
 %ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port whose mode is being returned. Codes are defined in FR:KLIOTYPS.KL.
- *port\_no* specifies the port number whose mode is being set.
- *mode\_mask* is returned with a mask specifying which modes are turned on. The following modes are defined:

1 :reverse mode

Sense of the port is reversed; if the port is set to TRUE, the physical output is set to FALSE. If the port is set to FALSE, the physical output is set to TRUE. If a physical input is TRUE, when the port is read, FALSE is returned. If a physical input is FALSE, when the port is read, TRUE is returned.

2 :complementary mode

The logical port is assigned to two physical ports whose values are complementary. In this case, *port\_no* must be an odd number. If port n is set to TRUE, then port n is set to TRUE and port n + 1 is set to FALSE. If port n is set to FALSE, then port n is set to FALSE and port n + 1 is set to TRUE. This is effective only for output ports.

- *status* is returned with zero if the parameters are valid and the specified mode is returned for the specified port.

**Example:** The following example gets the mode(s) for a specified port.

**GET\_PORT\_MOD\_Built-In Procedure**

```
PROGRAM getmodprog
%ENVIRONMENT IOSETUP
%INCLUDE FR:\kliotyps
ROUTINE get_mode( port_type:  INTEGER;
                  port_no:    INTEGER;
                  reverse:    BOOLEAN;
                  complementary: BOOLEAN):  INTEGER

VAR
  mode:    INTEGER
  status:  INTEGER

BEGIN
  GET_PORT_MOD(port_type, port_no, mode, status)

  IF (status <>0) THEN
    RETURN (status)
```

```

ENDIF

IF (mode AND 1) <> 0 THEN
    reverse = TRUE
ELSE
    reverse = FALSE
ENDIF

IF (mode AND 2) <> 0 THEN
    complementary = TRUE
ELSE
    complementary = FALSE
ENDIF

RETURN (status)
END get_mode

BEGIN
END getmodprog

```

### A.7.9 GET\_PORT\_SIM Built-In Procedure

**Purpose:** Gets port simulation status

**Syntax :** GET\_PORT\_SIM(port\_type, port\_no, simulated, status)

Input/Output Parameters:

[in] port\_type :INTEGER

[in] port\_no :INTEGER

[out] simulated :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port to get. Codes are defined in FRS:KLIOTYPS.KL.
- *port\_no* specifies the number of the port whose simulation status is being returned.
- *simulated* returns TRUE if the port is being simulated, FALSE otherwise.
- *status* is returned with zero if the port is valid.

**See Also:** GET\_PORT\_MOD, SET\_PORT\_SIM, SET\_PORT\_MOD Built-in Procedures.

### A.7.10 GET\_PORT\_VAL Built-In Procedure

**Purpose:** Allows a KAREL program to determine the current value of a specified logical port

**Syntax :** GET\_PORT\_VAL(*port\_type*, *port\_no*, *value*, *status*)

Input/Output Parameters :

[in] *port\_type* :INTEGER

[in] *port\_no* :INTEGER

[out] *value* :STRING

[out] *status* :INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port whose comment is being returned. Codes are defined in FR:KLIOTYPS.KL.
- *port\_no* specifies the port number whose comment is being set.
- *value* is returned with the current value (status) of the specified port. For BOOLEAN port types, (i.e. DIN), this will be 0 = OFF, or 1 = ON.
- *status* is returned with zero if the parameters are valid and the comment is returned for the specified port.

**See Also:** GET\_PORT\_CMT, GET\_PORT\_MOD, SET\_PORT\_CMT, SET\_PORT\_VAL, SET\_PORT\_MOD Built-in Procedures.

### A.7.11 GET\_POS\_FRM Built-In Procedure

**Purpose:** Gets the uframe number and utool number of the specified position in the specified teach pendant program.

**Syntax :** GET\_POS\_FRM(*open\_id*, *position\_no*, *gnum*, *ufram\_no*, *utool\_no*, *status*)

Input/Output Parameters :

[in] *open\_id* :INTEGER

[in] position\_no :INTEGER  
 [in] gnum :INTEGER  
 [out] ufram\_no :INTEGER  
 [out] utool\_no :INTEGER  
 [out] status :INTEGER  
 %ENVIRONMENT Group :pbcore

**Details:**

- *open\_id* specifies the opened teach pendant program. A program must be opened before calling this built-in.
- *position\_no* specifies the position in the teach pendant program.
- *gnum* specifies the group number of position.
- *ufram\_no* is returned with the frame number of position\_no.
- *utool\_no* is returned with the tool number of position\_no.
- If the specified position, *position\_no*, is uninitialized, the *status* is set to 17038, "Uninitialized TPE position."
- *status* indicates the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** GET\_POS\_TYP, CHECK\_EPOS.

**A.7.12 GET\_POS\_REG Built-In Function**

**Purpose:** Gets an XYZWPR value from the specified register

**Syntax :** GET\_POS\_REG(register\_no, status <,group\_no>)

Function Return Type :XYZWPREXT

Input/Output Parameters:

[in] register\_no :INTEGER  
 [out] status :INTEGER  
 [in] group\_no :INTEGER  
 %ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the position register to get.
- If *group\_no* is omitted, the default group for the program is assumed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.
- GET\_POS\_REG returns the position in XYZWPREXT format. Use POS\_REG\_TYPE to determine the position representation.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** GET\_JPOS\_REG, SET\_JPOS\_REG, SET\_POS\_REG, GET\_REG Built-in Procedures.

**Example:** Refer to [Section B.5 , "Using Register Built-ins" \(REG\\_EX.KL\)](#), for a detailed program example.

### A.7.13 GET\_POS\_TPE Built-In Function

**Purpose:** Gets an XYZWPREXT value from the specified position in the specified teach pendant program

**Syntax :** GET\_POS\_TPE(open\_id, position\_no, status <, group\_no>)

Function Return Type :XYZWPREXT

Input/Output Parameters:

[in] open\_id : INTEGER

[in] position\_no : INTEGER

[out] status : INTEGER

[in] group\_no : INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *open\_id* specifies the opened teach pendant program. A program must be opened before calling this built-in.
- *position\_no* specifies the position in the program to get.
- No conversion is done for the position representation. The positional data must be in XYZWPR or XYZWPREXT, otherwise, an error status is returned. Use GET\_POS\_TYP to get the position representation.

- If the specified position in the program is uninitialized, the returned XYZWPR value is uninitialized and status is set to 17038, "Uninitialized TPE Position."
- If *group\_no* is omitted, the default group for the program is assumed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

**See Also:** GET\_JPOS\_TPE, SET\_JPOS\_TPE, SET\_POS\_TPE, GET\_POS\_TYP Built-in Procedures.

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

### **A.7.14 GET\_POS\_TYP Built-In Procedure**

**Purpose:** Gets the position representation of the specified position in the specified teach pendant program

**Syntax :** GET\_POS\_TYP(open\_id, position\_no, group\_no, posn\_typ, num\_axs, status)

Input/Output Parameters:

[in] open\_id :INTEGER

[in] position\_no :INTEGER

[in] group\_no :INTEGER

[out] posn\_typ :INTEGER

[out] num\_axs :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

#### **Details:**

- *open\_id* specifies the opened teach pendant program. A program must be opened before calling this built-in.
- *position\_no* specifies the position in the program.
- *group\_no* specifies the group number.
- Position type is returned by *posn\_typ*. *posn\_typ* is defined as follows:  
2 :XYZWPR  
6 :XYZWPREXT9  
9 :JOINTPOS

- If it is in joint position, the number of the axis in the representation is returned by *num\_axs* .
- If the specified position in the program is uninitialized, then a status is set to 17038, "Uninitialized TPE Position."
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

**Example:** Refer to [Section B.14](#) , "Applying Offsets to a Copied Teach Pendant Program" (CPY\_T.KL), for a detailed program example.

### A.7.15 GET\_PREG\_CMT Built-In-Procedure

**Purpose:** To retrieve the comment information of a KAREL position register based on a given register number.

**Syntax:** GET\_PREG\_CMT (register\_no, comment\_string, status)

Input/Output Parameters:

[in] register\_no: INTEGER

[out] comment\_string: STRING

[out] status: INTEGER

%ENVIRONMENT group: REGOPE

**Details:**

- Register\_no specifies which position register to retrieve the comments from. The comment of the given position register is returned in the comment\_string.

### A.7.16 GET\_QUEUE Built-In Procedure

**Purpose:** Retrieves the specified oldest entry from a queue

**Syntax :** GET\_QUEUE(queue, queue\_data, value, status, sequence\_no)

Input/Output Parameters:

[in,out] queue\_t :QUEUE\_TYPE

[in,out] queue\_data :ARRAY OF INTEGER

[out] value :INTEGER

[out] sequence\_no :INTEGER  
 [out] status :INTEGER  
 %ENVIRONMENT Group :PBQMGR

**Details:**

- *queue\_t* specifies the queue variable for the queue from which the value is to be obtained.
- *queue\_data* specifies the array variable with the queue data.
- *value* is returned with the oldest entry obtained from the queue.
- *sequence\_no* is returned with the sequence number of the returned entry.
- *status* is returned with the zero if an entry is successfully obtained from the queue. Otherwise, a value of 61002, “Queue is empty,” is returned.

**See Also:** MODIFY\_QUEUE Built-In Procedure, [Section 15.8](#), "Using Queues for Task Communication

**Example:** In the following example the routine **get\_nxt\_err** returns the oldest entry from the error queue, or zero if the queue is empty.

**GET\_QUEUE Built-In Procedure**

```
PROGRAM get_queue_x
  %environment PBQMGR
  VAR
    error_queue FROM global_vars: QUEUE_TYPE
    error_data FROM global_vars: ARRAY[100] OF INTEGER

    ROUTINE get_nxt_err: INTEGER
    VAR
      status: INTEGER
      value: INTEGER
      sequence_no: INTEGER

    BEGIN
      GET_QUEUE(error_queue, error_data, value, sequence_no, status)
      IF (status = 0) THEN
        RETURN (value)
      ELSE
        RETURN (0)
      ENDIF
    END get_nxt_err
    BEGIN
    END get_queue_x
```

### A.7.17 GET\_REG Built-In Procedure

**Purpose:** Gets an INTEGER or REAL value from the specified register

**Syntax :** GET\_REG(register\_no, real\_flag, int\_value, real\_value, status)

Input/Output Parameters:

[in] register\_no :INTEGER

[out] real\_flag :BOOLEAN

[out] int\_value :INTEGER

[out] real\_value :REAL

[out] status :INTEGER

%ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the register to get.
- *real\_flag* is set to TRUE and *real\_value* to the register content if the specified register has a real value. Otherwise, *real\_flag* is set to FALSE and *int\_value* is set to the contents of the register.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** Refer to [Section B.5 , "Using Register Built-ins"](#) (REG\_EX.KL), for a detailed program example.

### A.7.18 GET\_REG\_CMT

**Purose:** To retrieve the comment information of a KAREL register based on a given register number.

**Syntax:** GET\_REG\_CMT (register\_no, comment\_string, status)

Input/Output Parameters:

[in] register\_no: INTEGER

[out] comment\_string: STRING

[out] status: INTEGER

%ENVIRONMENT group: REGOPE

**Details:**

- Register\_no specifies which register to retrieve the comments from. The comment of the given register is returned in comment\_string.

### A.7.19 GET\_TIME Built-In Procedure

**Purpose:** Retrieves the current time (in integer representation) from within the KAREL system

**Syntax :** GET\_TIME(i)

Input/Output Parameters:

[out] i :INTEGER

%ENVIRONMENT Group :TIM

**Details:**

- *i* holds the INTEGER representation of the current time stored in the KAREL system. This value is represented in 32-bit INTEGER format as follows:

**Table A-11. INTEGER Representation of Current Time**

31–25	24–21	20–16
year	month	day
15–11	10–5	4–0
hour	minute	second

- The contents of the individual fields are as follows:

— DATE:

Bits 31-25 — Year since 1980

Bits 24-21 — Month (1-12)

Bits 20-16 — Day of the month

— TIME:

Bits 15-11 — Number of hours (0-23)

Bits 10-5 — Number of minutes (0-59)

Bits 4-0 — Number of 2-second increments (0-29)

- INTEGER values can be compared to determine if one time is more recent than another.
- Use the CNV\_TIME\_STR built-in procedure to convert the INTEGER into the “DD-MMM-YYY HH:MM:SS” STRING format.

**See Also:** CNV\_TIME\_STR Built-In Procedure

**Example:** Refer to [Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL), for a detailed program example.

## A.7.20 GET\_TPE\_CMT Built-in Procedure

**Purpose:** This built-in provides the ability for a KAREL program to read the comment associated with a specified position in a teach pendant program.

**Syntax :** GET\_TPE\_CMT(open\_id, pos\_no, comment, status)

Input/Output Parameters:

[in] open\_id :INTEGER

[in] pos\_no :INTEGER

[out] comment :STRING

[out] status :INTEGER

%ENVIRONMENT Group :TPE

**Details:**

- *open\_id* specifies the open\_id returned from a previous call to OPEN\_TPE.
- *pos\_no* specifies the number of the position in the TPP program to get a comment from.
- *comment* is associated with specified positions and is returned with a zero length string if the position has no comment. If the string variable is too short for the comment, an error is returned and the string is not changed.
- *status* indicates zero if the operation was successful, otherwise an error code will be displayed.

**See Also:** SET\_TPE\_CMT and OPEN\_TPE for more Built-in Procedures.

### **A.7.21 GET\_TPE\_PRM Built-in Procedure**

**Purpose:** Gets the values of the parameters when parameters are passed in a TPE CALL or MACRO instruction.

**Syntax :** GET\_TPE\_PRM(param\_no, data\_type, int\_value, real\_value, str\_value, status)

Input/Output Parameters:

[in] param\_no :INTEGER

[out] data\_type :INTEGER

[out] int\_value :INTEGER

[out] real\_value :REAL

[out] str\_value :STRING

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *param\_no* indicates the number of the parameter. There can be at most ten parameters.
- *data\_type* indicates the data type for the parameter, as follows:
  - 1 : INTEGER
  - 2 : REAL
  - 3 : STRING
- *int\_value* is the value of the parameter if the *data\_type* is INTEGER.
- *real\_value* is the value of the parameter if the *data\_type* is REAL.
- *str\_value* is the value of the parameter if the *data\_type* is STRING.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.
- If the parameter designated by *param\_no* does not exist, a status of 17042 is returned, which is the error message: "ROUT-042 WARN TPE parameters do not exist." If this error is returned, confirm the *param\_no* and the parameter in the CALL or MACRO command in the main TPE program.

**See Also:** *FANUC Robotics SYSTEM R-J3iB Controller Application-Specific Setup and Operations Manual*, for information on using parameters in teach pendant CALL or MACRO instructions.

**Example:** The following example shows the implementation of a macro (Send Event) with CALL parameters that are retrieved by a KAREL program that uses the GET\_TPE\_PRM built-in.

### GET\_TPE\_PRM Built-In Procedure

Macro table entry for the Send Event macro:  
 109 [Send Event] [SENDEVNT]--[ 0 ]

Teach pendant program, TEST1.TP, which uses the Send Event macro:

```

1: ! Send Event 7
2: ! Wait for PC answer
3: ! Answer in REG 5
4: Send Event(7,1,5)
5: IF R[5]<9999,JMP LBL[10]
6: ! Error in macro
7: !
8: LBL[10]
```

Teach pendant program SENDEVNT.TP, which implements the Send Event macro by calling the GESNDEVT KAREL program and passing the CALL parameters from Send Event:

```

1: !Send Event Macro
2: CALL GESNDEVT(AR[1],AR[2],AR[3])
```

Snippet of the KAREL program GESNDEVT.KL, which gets the parameter information using the GET\_TPE\_PRM built-in:

```

PROGRAM GESNDEVT
  .
  .
BEGIN
  -- Send Event(event_no [,wait_sw [,status_reg]] )

  -- get parameter 1 (mandatory parameter)
  Get_tpe_prm(1, data_type, event_no,real_value,string_value,status)
  IF status<>0 THEN -- 17042 "ROUT-042 TPE parameters do not exist"
    POST_ERR(status, '', 0, er_abort)
  ELSE
    IF data_type <> PARM_INTEGER THEN -- make sure parm is an integer
      POST_ERR(er_pceventer, '1', 0, er_abort)
    ELSE
      IF (event_no < MIN_EVENT) OR (event_no > MAX_EVENT) THEN
        POST_ERR(er_illevent, '', 0, er_abort)
      ENDIF
    ENDIF
  ENDIF
```

```

-- get second parameter (optional)
Get_tpe_prm(2, data_type, wait_sw,real_value,string_value,status)
IF status<>0 THEN
    IF status = ER17042 THEN -- "ROUT-142 Parameter doesn't exist"
        wait_sw = 0 -- DEFAULT no wait
    ELSE
        POST_ERR(status, '', 0, er_warn) -- other error
    ENDIF
    .
.
```

## **A.7.22 GET\_TSK\_INFO Built-In Procedure**

**Purpose:** Get the value of the specified task attribute

**Syntax :** GET\_TSK\_INFO(task\_name, task\_no, attribute, value\_int, value\_str, status)

Input/Output Parameters:

[in,out] task\_name :STRING

[in,out] task\_no :INTEGER

[in] attribute :INTEGER

[out] value\_int :INTEGER

[out] value\_str :STRING

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *task\_name* is the name of the task of interest. *task\_name* is used as input only if *task\_no* is uninitialized or set to 0, otherwise, *task\_name* is considered an output parameter.
- *task\_no* is the task number of interest. If *task\_no* is uninitialized or set to 0, it is returned as an output parameter.
- *attribute* is the task attribute whose value is to be returned. It will be returned in *value\_int* unless otherwise specified. The following attributes are valid:

TSK\_HOLDCOND : Task hold conditions

TSK\_LINENUM : Current executing line number

TSK\_LOCKGRP : Locked group  
TSK\_MCTL : Motion controlled groups  
TSK\_NOABORT : Ignore abort request  
TSK\_NOBUSY : Busy lamp off  
TSK\_NOPAUSE : Ignore pause request  
TSK\_NUMCLDS : Number of child tasks  
TSK\_PARENT : Parent task number  
TSK\_PAUSESFT : Pause on shift release  
TSK\_PRIORITY : Task priority  
TSK\_PROGNAME : Current program name returned in value\_str  
TSK\_PROGTYPE : Program type - refer to description below  
TSK\_ROUTNAME : Current routine name returned in value\_str  
TSK\_STACK : Stack size  
TSK\_STATUS : Task status — refer to description below  
TSK\_STEP : Single step task  
TSK\_TIMESLIC : Time slice duration in ms  
TSK TPMOTION : TP motion enable  
TSK\_TRACE : Trace enable  
TSK\_TRACELEN : Length of trace array

- TSK\_STATUS is the task status: The return values are:
  - PG\_RUNACCEPT : Run request has been accepted
  - PG\_ABORTING : Abort has been accepted
  - PG\_RUNNING : Task is running
  - PG\_PAUSED : Task is paused
  - PG\_ABORTED : Task is aborted

- TSK\_PROGTYPE is the program type. The return values are:

PG\_NOT\_EXEC : Program has not been executed yet

PG\_MNEMONIC : Teach pendant program is or was executing

PG\_AR\_KAREL : KAREL program is or was executing

- *status* explains the status of the attempted operation. If it is not equal to 0, then an error occurred.

**See Also:** [Chapter 15 MULTI-TASKING](#)

**Example:** See examples in [Chapter 15 MULTI-TASKING](#)

### A.7.23 GET\_VAR Built-In Procedure

**Purpose:** Allows a KAREL program to retrieve the value of a specified variable

**Syntax :** GET\_VAR(entry, prog\_name, var\_name, value, status)

Input/Output Parameters:

[in,out] entry :INTEGER

[in] prog\_name :STRING

[in] var\_name :STRING

[out] value :Any valid KAREL data type except PATH, VIS\_PROCESS, and MODEL

[out] status :INTEGER

%ENVIRONMENT Group :SYSTEM

**Details:**

- *entry* returns the entry number in the variable data table of *var\_name* in the device directory where *var\_name* is located. This variable should not be modified.
- *prog\_name* specifies the name of the program that contains the specified variable. If *prog\_name* is blank, it will default to the current task name being executed. Set the *prog\_name* to ‘\*SYSTEM\*’ to get a system variable.
- *var\_name* must refer to a static, program variable.
- *var\_name* can contain node numbers, field names, and/or subscripts.
- If both *var\_name* and *value* are ARRAYS, the number of elements copied will equal the size of the smaller of the two arrays.

- If both *var\_name* and *value* are STRINGS, the number of characters copied will equal the size of the smaller of the two strings.
- If both *var\_name* and *value* are STRUCTUREs of the same type, *value* will be an exact copy of *var\_name*.
- *value* is the value of *var\_name*.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.
- If the value of *var\_name* is uninitialized, then *value* will be set to uninitialized and *status* will be set to 12311.

**See Also:** SET\_VAR Built-In Procedure



### Caution

Using GET\_VAR to modify system variables could cause unexpected results.

**Example:** The following example displays two programs, **util\_prog** and **task**. The program **util\_prog** uses a FOR loop to increment the value of the INTEGER variable **num\_of\_parts**. **util\_prog** also assigns values to the ARRAY **part\_array**. The program **task** uses two GET\_VAR statements to retrieve the values of **num\_of\_parts** and **part\_array[3]**. The value of **num\_of\_parts** is assigned to the INTEGER variable **count** and **part\_array[3]** is assigned to the STRING variable **part\_name**. The last GET\_VAR statement places the value of **count** into another INTEGER variable **newcount**.

### GET\_VAR Built-In Procedure

```
PROGRAM util_prog

VAR
    j, num_of_parts : INTEGER
    part_array      : ARRAY[5] OF STRING[10]

BEGIN
    num_of_parts = 0

    FOR j = 1 to 20 DO
        num_of_parts = num_of_parts + 1
    ENDFOR

    part_array[1] = 10
    part_array[2] = 20
    part_array[3] = 30
    part_array[4] = 40
    part_array[5] = 50

END util_prog
```

```

PROGRAM task

VAR
    entry, status      : INTEGER
    count, new_count  : INTEGER
    part_name         : STRING[20]

BEGIN
    GET_VAR(entry, 'util_prog', 'part_array[3]', part_name, status)
    WRITE('Part Name is Now....>', part_name, cr)

    GET_VAR(entry, 'util_prog', 'num_of_parts', count, status)
    WRITE('COUNT Now Equals....>', count, cr)

    GET_VAR(entry, 'task', 'count', new_count, status)

END task

```

## **A.7.24 GO TO Statement**

**Purpose:** Transfers control to a specified statement

**Syntax :** || GO TO | GOTO || stmnt\_label

where:

stmnt\_label : A valid KAREL identifier

**Details:**

- *stmnt\_label* must be defined in the same routine or program body as the GO TO statement.
- Label identifiers are followed by double colons (::). Executable statements may or may not follow on the same line.
- GOTO should only be used in special circumstances where normal control structures such as WHILE, REPEAT, and FOR loops would be awkward or difficult to implement.

**See Also:** [Section 2.1.5, “Labels,”](#) for more information on rules for labels, [Appendix E, “Syntax Diagrams,”](#) for additional syntax information

**Example:** The following example moves the TCP from one position to another depending on the status of DIN[1].

### **GO TO Statement**

```

BEGIN
    IF NOT DIN[1] THEN MOVE TO p1

```

```
ELSE GO TO end_it
ENDIF

IF NOT DIN[1] THEN MOVE TO p2
ELSE GO TO end_it
ENDIF

END_IT::
```

### A.7.25 GROUP\_ASSOC Data Type

**Purpose:** Declares a variable or structure field as a GROUP\_ASSOC data type

**Syntax :** GROUP\_ASSOC <IN GROUP[n]>

**Details:**

- GROUP\_ASSOC consists of a record containing the standard associated data for a motion group. It contains the following predefined fields, all INTEGERS except for SEGBREAK, which is a BOOLEAN:
  - SEGRELSPEED : percentage of nominal speed
  - SEGTYPE : motion type
  - SEGORIENTYPE: orientation control mode
  - SEGBREAK : not implemented
- Variables and fields of structures can be declared GROUP\_ASSOC.
- Subfields of this structure can be accessed and set using the usual structure field notation.
- Variables and fields declared GROUP\_ASSOC can be:
  - Passed as parameters.
  - Written to and read from unformatted files.
  - Assigned to one another.
- Each subfield of a GROUP\_ASSOC variable or structure field can be passed as a parameter to a routine, but is always passed by value.
- The keyword GROUP\_ASSOC can be followed by a clause IN GROUP[n] to specify the group to which the data applies. If it is not present, it is assumed that the data is to apply to the default group specified by the %DEFCGROUP directive.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Section 8.4.7](#), "Path Motion," for default values

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

## **A.8 - H - KAREL LANGUAGE DESCRIPTION**

### **A.8.1 HOLD Action**

**Purpose:** Causes the current motion to be held and prevents subsequent motions from starting

**Syntax :** HOLD <GROUP[n,{,n}]>

**Details:**

- Any motion in progress is held. Robot and auxiliary or extended axes decelerate to a stop.
- An attempted motion after a HOLD is executed is also held. HOLD cannot be overridden by a condition handler which issues a motion.
- HOLD is released using the UNHOLD statement or action.
- If the group clause is not present, all groups for which the task has control (when the condition is defined) will be canceled.
- If a motion that is held is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are held.
- Motion cannot be held for a different task.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Chapter 8 MOTION](#), for more information on starting and stopping motions

**Example:** The following example uses a local condition handler to move along the path *pathvar* but stops the motion before node 3 using the HOLD action.

### HOLD Action

```
MOVE ALONG pathvar,  
WHEN TIME 200 BEFORE NODE[ 3 ] DO  
    HOLD  
ENDMOVE
```

## A.8.2 HOLD Statement

**Purpose:** Causes the current motion to be held and prevents subsequent motions from starting

**Syntax :** HOLD <GROUP[n{,n}]>

**Details:**

- Any motion in progress is held. Robot and auxiliary or extended axes decelerate to a stop.
- An attempted motion after a HOLD is executed is also held. HOLD cannot be overridden by a condition handler which issues a motion.
- HOLD is released using the UNHOLD statement or action.
- All held motions are canceled if a RELEASE statement is executed while motion is held.
- If the group clause is not present, all groups for which the task has control will be canceled.
- If a motion that is stopped, resumed, canceled, or held is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are stopped, resumed, canceled, or held.
- Motion cannot be held for a different task.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Chapter 8 MOTION](#), for more information on starting and stopping motions, [Appendix E, “Syntax Diagrams,”](#) for additional syntax information

**Example:** The following example initiates a move along the path *pathvar* but stops the motion until the F1 key TPIN[1] on the teach pendant is pressed.

**HOLD Statement**

```

MOVE ALONG path_var NOWAIT
    HOLD
    WRITE ('Press F1 on teach pendant to resume motion')
    WAIT FOR TPIN[129]+
    UNHOLD

```

**A.9 - I - KAREL LANGUAGE DESCRIPTION****A.9.1 IF ... ENDIF Statement**

**Purpose:** Executes a sequence of statements if a BOOLEAN expression is TRUE; an alternate sequence can be executed if the condition is FALSE.

**Syntax :** IF *bool\_exp* THEN

{ *true\_stmnt* } < ELSE

{ *false\_stmnt* } >ENDIF

where:

*bool\_exp* : BOOLEAN

*true\_stmnt* : An executable KAREL statement

*false\_stmnt* : An executable KAREL statement

**Details:**

- If *bool\_exp* evaluates to TRUE, the statements contained in the *true\_stmnt* are executed. Execution then continues with the first statement after the ENDIF.
- If *bool\_exp* evaluates to FALSE and no ELSE clause is specified, execution skips directly to the first statement after the ENDIF.
- If *bool\_exp* evaluates to FALSE and an ELSE clause is specified, the statements contained in the *false\_stmnt* are executed. Execution then continues with the first statement after the ENDIF.
- IF statements can be nested in either *true\_stmnt* or *false\_stmnt*.

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for additional syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.3](#), "Saving Data to the Default Device" (SAVE\_VR.KL)

[Section B.5](#), "Using Register Built-ins" (REG\_EX.KL)

[Section B.6](#), "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.7](#), "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

[Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL)

[Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL)

[Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

[Section B.13](#), "Using the DISCTRL\_ALPHA Built-in" (DCALP\_EX.KL)

[Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

## **A.9.2 IN Clause**

**Purpose:** Specifies where a variable will be created

**Syntax :** IN (CMOS | DRAM)

**Details:**

- The IN clause can be part of a variable declaration. It should be specified before the FROM clause.
- IN *CMOS* specifies the variable will be created in permanent memory.
- IN *DRAM* specifies the variable will be created in temporary memory.
- If the IN clause is not specified all variables are created in temporary memory; unless the %CMOSVARS directive is specified, in which case all variables will be created in permanent memory.
- The IN clause cannot be used when declaring variables in the declaration section of a routine.

**See Also:** [Section 1.4.1](#), "Memory," %CMOSVARS Translator Directive

**Example:** Refer to the following sections for detailed program examples:

In DRAM, [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

In CMOS, [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL) or [Section B.11](#), "Manipulating Values of Dynamically Displayed Variables" (CHG\_DATA.KL)

### A.9.3 %INCLUDE Translator Directive

**Purpose:** Inserts other files in a program at translation time.

**Syntax :** %INCLUDE file\_spec

**Details:**

- *file\_spec* is the name of the file to include. It has the following details:
  - The file name specified must be no longer than 12 characters.
  - The file type defaults to .KL, and so it does not appear in the directive.
- The %INCLUDE directive must appear on a line by itself.
- The specified files usually contain declarations, such as CONST or VAR declarations. However, they can contain any portion of a program including executable statements and even other %INCLUDE directives.
- Included files can themselves include other files up to a maximum depth of three nested included files. There is no limit on the total number of included files.
- When the KAREL language translator encounters a %INCLUDE directive during translation of a file, it begins translating the included file just as though it were part of the original file. When the entire file has been included, the translator resumes with the original file.
- Some examples in Appendix A reference the following include files:

%INCLUDE FR:\klevkmsk

%INCLUDE FR:\klevkeys

%INCLUDE FR:\klevccdf

%INCLUDE FR:\kliotyps

These files contain constants that can be used in your KAREL programs. If you are translating on the controller, you can include them directly from the FROM disk.

The include files are also available on the OLPC disks, and are copied to the hard disk as part of the installation process.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.13, "Using the DISCTRL\\_ALPHA Built-in" \(DCALP\\_EX.KL\)](#)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

#### A.9.4 INDEX Built-In Function

**Purpose:** Returns the index for the first character of the first occurrence of a specified STRING argument in another specified STRING argument. If the argument is not found, a 0 value is returned.

**Syntax :** INDEX(main, find)

Function Return Type :INTEGER

Input/Output Parameters:

[in] main :STRING

[in] find :STRING

%ENVIRONMENT Group :SYSTEM

**Details:**

- The returned value is the index position in *main* corresponding to the first character of the first occurrence of *find* or 0 if *find* does not occur in *main*.

**Example:** The following example uses the INDEX built-in function to look for the first occurrence of the string “Old” in **part\_desc**.

#### **INDEX Built-In Function**

```
class_key = 'Old'
part_desc = 'Refurbished Old Part'

IF INDEX(part_desc, class_key) > 0 THEN
    in_class = TRUE
ENDIF
```

#### A.9.5INI\_DYN\_DISB Built-In Procedure

**Purpose:** Initiates the dynamic display of a BOOLEAN variable. This procedure displays elements of a STRING ARRAY depending of the current value of the BOOLEAN variable.

**Syntax :**INI\_DYN\_DISB (b\_var, window\_name, field\_width, attr\_mask, char\_size, row, col, interval, strings, status)

Input/Output Parameters :

[in] b\_var :BOOLEAN  
 [in] window\_name :STRING  
 [in] field\_width :INTEGER  
 [in] attr\_mask :INTEGER  
 [in] char\_size :INTEGER  
 [in] row :INTEGER  
 [in] col :INTEGER  
 [in] interval :INTEGER  
 [in] strings :ARRAY OF STRING  
 [out] status :INTEGER  
 %ENVIRONMENT Group :UIF

**Details:**

- The dynamic display is initiated based on the value of *b\_var* . If *b\_var* is FALSE, *strings[1]* is displayed; if *b\_var* is TRUE, *strings[2]* is displayed. If *b\_var* is uninitialized, a string of \*'s is displayed. Both *b\_var* and *strings* must be static (not local) variables.
- *window\_name* must be a previously defined window name. See [Section 7.9.1](#) . and [Section 7.9.2](#) for predefined window names.
- If *field\_width* is non-zero, the display is extended with blanks if the element of *strings[n]* is shorter than this specified width. The area is cleared when the dynamic display is canceled.
- *attr\_mask* is a bit-wise mask that indicates character display attributes. This should be one of the following constants:

0 :Normal  
 1 :Bold (Supported only on the CRT)  
 2 :Blink (Supported only on the CRT)  
 4 :Underline  
 8 :Reverse video

- To have multiple display attributes, use the OR operator to combine the constant attribute values together. For example, to have the text displayed as bold and underlined use 1 OR 4.

- *char\_size* specifies whether data is to be displayed in normal, double-wide, or double-high, double-wide sizes. This should be one of the following constants:
  - 0 :Normal
  - 1 :Double-wide (Supported only on the CRT)
  - 2 :Double-high, double-wide
- *row* and *col* specify the location in the window in which the data is to be displayed.
- *interval* indicates the minimum time interval, in milliseconds, between updates of the display. This must be greater than zero. The actual time might be greater since the task that formats the display runs at a low priority.
- *strings[n]* contains the text that will be displayed.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CNC\_DYN\_DISB built-in procedure

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

#### A.9.6 INI\_DYN\_DISE Built-In Procedure

**Purpose:** Initiates the dynamic display of an INTEGER variable. This procedure displays elements of a STRING ARRAY depending of the current value of the INTEGER variable.

**Syntax :** INI\_DYN\_DISE (e\_var, window\_name, field\_width, attr\_mask, char\_size, row, col, interval, strings, status)

Input/Output Parameters :

[in] e\_var :INTEGER

[in] window\_name :STRING

[in] field\_width :INTEGER

[in] attr\_mask :INTEGER

[in] char\_size :INTEGER

[in] row :INTEGER

[in] col :INTEGER

[in] interval :INTEGER

[in] strings :ARRAY OF STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- The dynamic display is initiated based on the value of *e\_var*. If *e\_var* has a value of n, *strings[n+1]* is displayed; if *e\_var* has a negative value, or a value greater than or equal to the length of the array of *strings*, a string of '??'s is displayed. Both *e\_var* and *string s* must be static (not local) variables.
- Refer to the INI\_DYN\_DISB built-in procedure for a description of the other parameters listed above.

**See Also:** CNC\_DYN\_DISE built-in procedure

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

### **A.9.7 INI\_DYN\_DISI Built-In Procedure**

**Purpose:** Initiate the dynamic display of an INTEGER variable in a specified window.

**Syntax :** INI\_DYN\_DISI(i\_var, window\_name, field\_width, attr\_mask, char\_size, row, col, interval, buffer\_size, format, status)

Input/Output Parameters:

[in] i\_var :INTEGER

[in] window\_name :STRING

[in] field\_width :INTEGER

[in] attr\_mask :INTEGER

[in] char\_size :INTEGER

[in] row :INTEGER

[in] col :INTEGER

[in] interval :INTEGER

[in] buffer\_size :INTEGER

[in] format :STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *i\_var* is the integer whose dynamic display is to be initiated.
- If *field\_width* is non-zero, the display is extended with blanks if *i\_var* is shorter than this specified width. The area is cleared when the dynamic display is canceled.
- *buffer\_size* is not implemented.
- *format* is used to print out the variable. This can be passed as a literal enclosed in single quotes. The format string begins with a % and ends with a conversion character. Between the % and the conversion character there can be, in order:
  - Flags (in any order), which modify the specification:
    - : specifies left adjustment of this field.
    - + : specifies that the number will always be printed with a sign.
    - 0 specifies padding a numeric field width with leading zeroes.
  - A number that specifies the minimum field width. The converted argument will be printed in a field at least this wide. If necessary it will be padded on the left (or right, if left adjustment is called for) to make up the field width.
  - A period, which separates the field width from the precision.
  - A number, the precision, that specifies the maximum number of characters to be printed from a string, or the number of digits after the decimal point of a floating-point value, or the minimum number of digits for an integer.

The format specifier must contain one of the conversion characters in [Table A-12](#).

**Table A-12. Conversion Characters**

Character	Argument Type; Printed As
d	INTEGER; decimal number
o	INTEGER; unsigned octal notation (without a leading zero).
x,X	INTEGER; unsigned hexadecimal notation (without a leading 0x or 0X), using abcdef or ABCDEF for 10, ..., 15.

**Table A-12. Conversion Characters (Cont'd)**

Character	Argument Type; Printed As
u	INTEGER; unsigned decimal notation.
s	STRING; print characters from the string until end of string or the number of characters given by the precision.
f	REAL; decimal notation of the form [-]mmm.ddddd, where the number of d's is given by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
e,E	REAL; decimal notation of the form [-]m.ddddde+xx or [-]m.dddddE+xx, where the number of d's is given by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
g,G	REAL; %e or %E is used if the exponent is less than -4 or greater than or equal to the precision; otherwise %f is used. Trailing zeros and a trailing decimal pointer are not printed.
%	no argument is converted; print a %.

- Refer to the INI\_DYN\_DISP built-in procedure for a description of the other parameters listed above.

**See Also:** CNC\_DYN\_DISI, DEF\_WINDOW Built-In Procedure

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

### **A.9.8 INI\_DYN\_DISP Built-In Procedure**

**Purpose:** Initiates the dynamic display of a value of a port in a specified window, based on the port type and port number.

**Syntax :** INI\_DYN\_DISP (port\_type, port\_no, window\_name, field\_width, attr\_mask, char\_size, row, col, interval, strings, status)

Input/Output Parameters :

[in] port\_type :INTEGER

[in] port\_no :INTEGER  
[in] window\_name :STRING  
[in] field\_width :INTEGER  
[in] attr\_mask :INTEGER  
[in] char\_size :INTEGER  
[in] row :INTEGER  
[in] col :INTEGER  
[in] interval :INTEGER  
[in] strings :ARRAY OF STRING  
[out] status :INTEGER

**Details:**

- *port\_type* specifies the type of port to be displayed. Codes are defined in FROM: KLIOTYPS.KL.
  - If the *port\_type* is a BOOLEAN port (e.g., DIN), If the is FALSE, strings[1] is displayed; If variable is TRUE, strings[2] is displayed.
  - If the *port\_type* is an INTEGER port (e.g., GIN), if the value of the port is n, *strings[n+1 ]* will be displayed. If the value of the port is greater than or equal to the length of the array of strings, a string of '??'s is displayed.
- *port\_no* specifies the port number to be displayed.
- Refer to the INI\_DYN\_DISP built-in procedure for a description of other parameters listed above.

**See Also:** CNC\_DYN\_DISP Built-In procedure

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

### **A.9.9 INI\_DYN\_DISR Built-In Procedure**

**Purpose:** Initiates the dynamic display of a REAL variable in a specified window.

**Syntax :** INI\_DYN\_DISR(r\_var, window\_name, field\_width, attr\_mask, char\_size, row, col, interval, buffer\_size, format, status)

Input/Output Parameters:

[in] r\_var :REAL  
 [in] window\_name :STRING  
 [in] field\_width :INTEGER  
 [in] attr\_mask :INTEGER  
 [in] char\_size :INTEGER  
 [in] row :INTEGER  
 [in] col :INTEGER  
 [in] interval :INTEGER  
 [in] buffer\_size :INTEGER  
 [in] format :STRING  
 [out] status :INTEGER  
 %ENVIRONMENT Group :UIF

**Details:**

- *r\_var* is the REAL variable whose dynamic display is to be initiated.
- If *field\_width* is non-zero, the display is extended with blanks if *r\_var* is shorter than this specified width. The area is cleared when the dynamic display is canceled.
- Refer to the INI\_DYN\_DISI built-in procedure for a description of other parameters listed above.

**See Also:** CNC\_DYN\_DISR Built-In Procedure

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

## **A.9.10 INI\_DYN\_DISS Built-In Procedure**

**Purpose:** Initiates the dynamic display of a STRING variable in a specified window.

**Syntax :** INI\_DYN\_DISS(s\_var, window\_name, field\_width, attr\_mask, char\_size, row, col, interval, buffer\_size, format, status)

Input/Output Parameters:

[in] s\_var :STRING

[in] window\_name :STRING  
[in] field\_width :INTEGER  
[in] attr\_mask :INTEGER  
[in] char\_size :INTEGER  
[in] row :INTEGER  
[in] col :INTEGER  
[in] interval :INTEGER  
[in] buffer\_size :INTEGER  
[in] format :STRING  
[out] status :INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *s\_var* is the STRING variable whose dynamic display is to be initiated.
- If *field\_width* is non-zero, the display is extended with blanks if *s\_var* is shorter than this specified width. The area is cleared when the dynamic display is canceled.
- Refer to the INI\_DYN\_DISI built-in procedure for a description of other parameters listed above.

**See Also:** CNC\_DYN\_DISS,INI\_DYN\_DISI Built-In Procedures

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

### A.9.11 INIT\_QUEUE Built-In Procedure

**Purpose:** Sets a queue variable entry to have no entries in the queue

**Syntax :** INIT\_QUEUE(queue)

Input/Output Parameters:

[out] queue\_t :QUEUE\_TYPE

%ENVIRONMENT Group : PBQMGR

**Details:**

- queue\_t is the queue to be initialized

**See Also:** GET\_QUEUE, MODIFY\_QUEUE Built-In Procedures, QUEUE\_TYPE Data Type, [Section 15.8, "Using Queues for Task Communication"](#)

**Example:** The following example initializes a queue called job\_queue.

**INIT\_QUEUE Built-In Procedure**

```
PROGRAM init_queue_x
%environment PBQMGR
VAR
    job_queue FROM globals: QUEUE_TYPE
BEGIN
    INIT_QUEUE( job_queue )
END init_queue_x
```

**A.9.12 INIT\_TBL Built-In Procedure**

**Purpose:** Initializes a table on the teach pendant

**Syntax :** INIT\_TBL(dict\_name, ele\_number, num\_rows, num\_columns, col\_data, inact\_array, change\_array, value\_array, vptr\_array, table\_data, status)

Input/Output Parameters:

[in] dict\_name :STRING

[in] ele\_number :INTEGER

[in] num\_rows :INTEGER

[in] num\_columns :INTEGER

[in] col\_data :ARRAY OF COL\_DESC\_T

[in] inact\_array :ARRAY OF BOOLEAN

[in] change\_array :ARRAY OF ARRAY OF BOOLEAN

[in] value\_array :ARRAY OF STRING

[out] vptr\_array :ARRAY OF ARRAY OF INTEGER

[in,out] table\_data :XWORK\_T

[out] status :INTEGER  
%ENVIRONMENT Group :UIF

**Details:**

- INIT\_TBL must be called before using the ACT\_TBL built-in. INIT\_TBL does not need to be called if using the DISCTRL\_TBL built-in.
- The INIT\_TBL and ACT\_TBL built-in routines should only be used instead of DISCTRL\_TBL if special processing needs to be done with each keystroke or if function key processing needs to be done without exiting the table menu.
- *dict\_name* is the four-character name of the dictionary containing the table header.
- *ele\_number* is the element number of the table header.
- *num\_rows* is the number of rows in the table.
- *num\_columns* is the number of columns in the table.
- *col\_data* is an array of column descriptor structures, one for each column in the table. It contains the following fields:
  - *item\_type* : Data type of values in this column. The following data type constants are defined:

TPX\_INT\_ITEM — Integer type

TPX\_REL\_ITEM — Real type

TPX\_FKY\_ITEM — Function key enumeration type

TPX\_SUB\_ITEM — Subwindow enumeration type

TPX\_KST\_ITEM — KAREL string type

TPX\_KSL\_ITEM — KAREL string label type (can select, not edit)

TPX\_KBL\_ITEM — KAREL boolean type

TPX\_BYT\_ITEM — Byte type

TPX\_SHT\_ITEM — Short type

TPX\_PBL\_ITEM — Port boolean type

TPX\_PIN\_ITEM — Port integer type

- *start\_col* : Starting character column (1..40) of the display field for this data column.
- *field\_width* : Width of the display field for this data column.

- *num\_ele* : Dictionary element used to display values for certain data types. The format of the dictionary elements for these data types are as follows:
  - TPX\_FKY\_ITEM: The enumerated values are placed on function key labels. There can be up to 2 pages of function key labels, for a maximum of 10 labels. Each label is a string of up to 8 characters. However, the last character of a label which is followed by another label should be left blank or the two labels will run together.
  - A single dictionary element defines all of the label values. Each value must be put on a separate line using &new\_line. The values are assigned to the function keys F1..F5, F6..F10 and the numeric values 1..10 in sequence. Unlabeled function keys should be left blank. If there are any labels on the second function key page, F6..F10, the labels for keys 5 and 10 must have the character “>” in column 8. If there are no labels on keys F6..F10, lines do not have to be specified for any key label after the last non-blank label.

**Example:**

```
$ example_fkey_label_c
  " " &new_line
  "F2" &new_line
  "F3" &new_line
  "F4" &new_line
  "F5 >" &new_line
  "F6" &new_line
  "F7" &new_line
  " " &new_line
  " " &new_line
  " >"
```

- -- TPX\_SUB\_ITEM: The enumerated values are selected from a subwindow on the display device. There can be up to 5 subwindow pages, for a maximum of 35 values. Each value is a string of up to 16 characters.
- A sequence of consecutive dictionary elements, starting with enum\_dict, define the values. Each value must be put in a separate element, and must not end with &new\_line. The character are assigned the numeric values 1..35 in sequence. The last dictionary element must be "\a".

**Example:**

```
$ example_sub_win_enum_c
  "Red"
  $
  "Blue"
  $
  "Green"
  $
  "Yellow"
  $
  "\a"
```

- TPX\_KBL\_ITEM, TPX\_PBL\_ITEM: The “true” and “false” values are placed on function key labels F4 and F5, in that order. Each label is a string of up to 8 characters. However, the last character of the “true” label should be left blank or the two labels will run together.
- A single dictionary element the label values. Each value must be put on a separate line using &new\_line, with the “false” value first.

**Example:**

```
$ example_boolean_c
    "OFF" &new_line
    "ON"
```

- *enum\_dict* : Dictionary name used to display data types TPX\_FKY\_ITEM, TPX\_SUB\_ITEM, TPX\_KBL\_ITEM, or TPX\_PBL\_ITEM
- *format\_spec* : Format string is used to print out the data value. The format string contains a format specifier. The format string can also contain any desired characters before or after the format specifier. The format specifier itself begins with a % and ends with a conversion character. Between the % and the conversion character there may be, in order:
  - Flags (in any order), which modify the specification:
    - : specifies left adjustment of this field.
    - + : specifies that the number will always be printed with a sign.
    - space : if the first character is not a sign, a space will be prefixed.
    - 0 : specifies padding a numeric field width with leading zeroes.
  - A number that specifies the minimum field width. The converted argument will be printed in a field at least this wide. If necessary it will be padded on the left (or right, if left adjustment is called for) to make up the field width.
  - A period, which separates the field width from the precision.
  - A number, the precision, that specifies the maximum number of characters to be printed from a string, or the number of digits after the decimal point of a floating-point value, or the minimum number of digits for an integer.
- The format specifier must contain one of the conversion characters in the following table:

**Table A-13. Conversion Characters**

Character	Argument Type; Printed As
d	INTEGER; decimal number.
o	INTEGER; unsigned octal notation (without a leading zero).
x,X	INTEGER; unsigned hexadecimal notation (without a leading 0x or 0X), using abcdef or ABCDEF for 10, ..., 15.
u	INTEGER; unsigned decimal notation.
s	STRING; print characters from the string until end of string or the number of characters given by the precision.
f	REAL; decimal notation of the form [-]mmm.ddddd, where the number of d's is given by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
e,E	REAL; decimal notation of the form [-]m.ddddde+xx or [-]m.dddddE+xx, where the number of d's is given by the precision. The default precision is 6; a precision of 0
g,G	REAL; %e or %E is used if the exponent is less than -4 or greater than or equal to the precision; otherwise %f is used. Trailing zeros and a trailing decimal pointer are not printed.
%	no argument is converted; print a %.

**Example:** "%d" or "%-10s"

The format specifiers which can be used with the data types specified in the item\_type field in *col\_data* are as follows:

TPX\_INT\_ITEM %d, %o, %x, %X, %u

TPX\_REL\_ITEM %f, %e, %E, %g, %G

TPX\_FKY\_ITEM %s

TPX\_SUB\_ITEM %s

TPX\_KST\_ITEM %s

TPX\_KSL\_ITEM %s

TPX\_KBL\_ITEM %s

TPX\_BYT\_ITEM %d, %o, %x, %X, %u, %c

TPX\_SHT\_ITEM %d, %o, %x, %X, %u

TPX\_PBL\_ITEM %s

TPX\_PIN\_ITEM %d, %o, %x, %X, %u

— *max\_integer* : Maximum value if data type is TPX\_INT\_ITEM, TPX\_BYT\_ITEM, or TPX\_SHT\_ITEM.

— *min\_integer* : Minimum value if data type is TPX\_INT\_ITEM, TPX\_BYT\_ITEM, or TPX\_SHT\_ITEM.

— *max\_real* : Maximum value for reals.

— *min\_real* : Minimum value for reals.

— *clear\_flag* : If data type is TPX\_KST\_ITEM, 1 causes the field to be cleared before entering characters and 0 causes it not to be cleared.

— *lower\_case* : If data type is TPX\_KST\_ITEM, 1 allows the characters to be input to the string in upper or lower case and 0 restricts them to upper case.

- *inact\_array* is an array of booleans that corresponds to each column in the table.
  - You can set each boolean to TRUE which will make that column inactive. This means the column cannot be cursored to.
  - The array size can be less than or greater than the number of items in the table.
  - If *inact\_array* is not used, then an array size of 1 can be used, and the array does not need to be initialized.
- *change\_array* is a two dimensional array of booleans that corresponds to formatted data item in the table.
  - If the corresponding value is set, then the boolean will be set to TRUE, otherwise it is set to FALSE. You do not need to initialize the array.
  - The array size can be less than or greater than the number of data items in the table.
  - If *change\_array* is not used, then an array size of 1 can be used.
- *value\_array* is an array of variable names that correspond to the columns of data in the table. Each variable name can be specified as '[*prog\_name*]*var\_name*'.
  - [*prog\_name*] specifies the name of the program that contains the specified variable. If [*prog\_name*] is not specified, then the current program being executed is used.
  - *var\_name* must refer to a static, global program variable.
  - *var\_name* can contain node numbers, field names, and/or subscripts.

- Each of these named variables must be a KAREL array of length *num\_rows*. Its data type and values should be consistent with the value of the *item\_type* field in *col\_data* for the corresponding column, as follows:
  - TPX\_INT\_ITEM: ARRAY OF INTEGER containing the desired values.
  - TPX\_REL\_ITEM: ARRAY OF REAL containing the desired values.
  - TPX\_FKY\_ITEM: ARRAY OF INTEGER with values referring to items in the dictionary element specified in the *enum\_ele* field in *col\_data*. There can be at most 2 function key pages, or 10 possible function key enumeration values.
  - TPX\_SUB\_ITEM: ARRAY OF INTEGER with values referring to items in the dictionary element specified in the *enum\_ele* field in *col\_data*. There can be at most 28 subwindow enumeration values.
  - TPX\_KST\_ITEM: ARRAY OF STRING containing the desired values.
  - TPX\_KSL\_ITEM: ARRAY OF STRING containing the desired values. These values cannot be edited by the user. If one is selected, ACT\_TBL will return.
  - TPX\_KBL\_ITEM: ARRAY OF BOOLEAN containing the desired values. The dictionary element specified by the *enum\_ele* field in *col\_data* should have exactly two elements, with the false item first and the true item second.
  - TPX\_BYT\_ITEM: ARRAY OF BYTE containing the desired values.
  - TPX\_SHT\_ITEM: ARRAY OF SHORT containing the desired values.
  - TPX\_PBL\_ITEM: ARRAY OF STRING containing the names of the ports, for example “DIN[5]”.
  - TPX\_PIN\_ITEM: ARRAY OF STRING containing the names of the ports, for example “GOUT[3]”.
  - TPX\_BYT\_ITEM: ARRAY OF BYTE containing the desired values.
  - TPX\_SHT\_ITEM: ARRAY OF SHORT containing the desired values.
  - TPX\_PBL\_ITEM: ARRAY OF STRING containing the names of the ports, for example “DIN[5]”.
  - TPX\_PIN\_ITEM: ARRAY OF STRING containing the names of the ports, for example “GOUT[3]”.
- *vptr\_array* is an array of integers that corresponds to each variable name in *value\_array*. **Do not change this data; it is used internally.**
- *table\_data* is used to display and control the table. **Do not change this data; it is used internally.**
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** In this example, TPXTABEG.TX is loaded as ‘XTAB’ on the controller. TPEXTBL calls INIT\_TBL to initialize a table with five columns and four rows. It calls ACT\_TBL in a loop to read and process each key pressed.

#### INIT\_TBL Built-In Procedure

---

TPXTABEG.TX

```
-----  
$title  
&reverse "DATA Test Schedule" &standard &new_line  
"E1: " &new_line  
" W(mm) TEST C(%%) G(123456) COLOR"  
^1  
?2  
  
$function_keys  
"f1" &new_line  
"f2" &new_line  
"f3" &new_line  
"f4" &new_line  
" HELP >" &new_line  
"f6" &new_line  
"f7" &new_line  
"f8" &new_line  
"f9" &new_line  
"f10 >"  
$help_text "Help text goes here...  
  
"$enum1  
" " &new_line  
" " &new_line  
"TRUE" &new_line  
"FALSE" &new_line  
"  
  
$enum2  
"Red"  
$  
"Blue"  
$  
"Green"  
$  
"Yellow"  
$  
"Brown"  
$  
"Pink"  
$  
"Mauve"  
$  
"Black"  
$  
"....."  
-----
```

```
TPEXTBL.KL
-----
PROGRAM tpextbl

%ENVIRONMENT uif
%INCLUDE FROM:\klevccdf
%INCLUDE FROM:\klevkeysVAR
dict_name: STRING[ 6 ]
ele_number: INTEGER
num_rows: INTEGER
num_columns: INTEGER
col_data: ARRAY[ 5 ] OF COL_DESC_T
inact_array: ARRAY[ 5 ] OF BOOLEAN
change_array: ARRAY[ 4,5 ] OF BOOLEAN
value_array: ARRAY[ 5 ] OF STRING[ 26 ]
vptr_array: ARRAY[ 4,5 ] OF INTEGER
table_data: XWORK_T
status: INTEGER
action: INTEGER
def_item: INTEGER
term_char: INTEGER
attach_sw: BOOLEAN
save_action: INTEGER
done: BOOLEAN
value1: ARRAY[ 4 ] OF INTEGER
value2: ARRAY[ 4 ] OF INTEGER
value3: ARRAY[ 4 ] OF REAL
value4: ARRAY[ 4 ] OF STRING[ 10 ]
value5: ARRAY[ 4 ] OF INTEGER

BEGIN
def_item = 1
value_array[1] = 'value1'
value_array[2] = 'value2'
value_array[3] = 'value3'
value_array[4] = 'value4'
value_array[5] = 'value5'

value1[1] = 21
value1[2] = 16
value1[3] = 1
value1[4] = 4

value2[1] = 3
value2[2] = 2
value2[3] = 3
value2[4] = 2
```

```
value3[1] = -13
value3[2] = 4.1
value3[3] = 23.9
value3[4] = -41

value4[1] = 'XXX---'
value4[2] = '--X-X-'
value4[3] = 'XXX-XX'
value4[4] = '-X-X--'

value5[1] = 1
value5[2] = 1
value5[3] = 2
value5[4] = 3

inact_array[1] = FALSE
inact_array[2] = FALSE
inact_array[3] = FALSE
inact_array[4] = FALSE
inact_array[5] = FALSE

col_data[1].item_type = TPX_INT_ITEM
col_data[1].start_col = 6
col_data[1].field_width = 4
col_data[1].format_spec = '%3d'
col_data[1].max_integer = 99
col_data[1].min_integer = -99

col_data[2].item_type = TPX_FKY_ITEM
col_data[2].start_col = 12
col_data[2].field_width = 5
col_data[2].format_spec = '%s'
col_data[2].enum_ele = 3 -- enum1 element number
col_data[2].enum_dict = 'XTAB'

col_data[3].item_type = TPX_REL_ITEM
col_data[3].start_col = 18
col_data[3].field_width = 5
col_data[3].format_spec = '%3.1f'

col_data[4].item_type = TPX_KST_ITEM
col_data[4].start_col = 26
col_data[4].field_width = 6
col_data[4].format_spec = '%s'

col_data[5].item_type = TPX_SUB_ITEM
```

```

col_data[5].start_col = 34
col_data[5].field_width = 6
col_data[5].format_spec = '%s'
col_data[5].enum_ele = 4 -- enum2 element number
col_data[5].enum_dict = 'XTAB'

dict_name = 'XTAB'
ele_number = 0 -- title element number
num_rows = 4
num_columns = 5
def_item = 1
attach_sw = TRUE

INIT_TBL(dict_name, ele_number, num_rows, num_columns, col_data,
         inact_array, change_array, value_array, vptr_array,
         table_data, status)
IF status <> 0 THEN
    WRITE('INIT_TBL status = ', status, CR);
ELSE
    def_item = 1
    -- Initial display of table
    ACT_TBL(ky_disp_updt, def_item, table_data, term_char,
            attach_sw, status)
    IF status <> 0 THEN
        WRITE(CR, 'ACT_TBL status = ', status)
    ENDIF
ENDIF

IF status = 0 THEN
    -- Loop until a termination key is selected.
    done = FALSE
    action = ky_reissue -- read new key
    WHILE NOT done DO
        -- Read new key, act on it, and return it
        ACT_TBL(action, def_item, table_data, term_char,
                attach_sw, status)
        save_action = action
        action = ky_reissue -- read new key

        -- Debug only
        WRITE TPERROR (CHR(cc_home) + CHR(cc_clear_win))

        -- Process termination keys.
        SELECT (term_char) OF
            CASE (ky_select, ky_new_menu):
                done = TRUE;
            CASE (ky_f1):
                -- Perform F1

```

```
SET_CURSOR(TPERROR, 1, 1, status)
WRITE TPERROR ('F1 pressed')

CASE (ky_f2):
    -- Perform F2
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F2 pressed')

CASE (ky_f3):
    -- Perform F3
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F3 pressed')

CASE (ky_f4):
    -- Perform F4
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F4 pressed')

CASE (ky_f5):
    -- Perform F5 Help
    action = ky_help

CASE (ky_f6):
    -- Perform F6
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F6 pressed')

CASE (ky_f7):
    -- Perform F7
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F7 pressed')

CASE (ky_f8):
    -- Perform F8
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F8 pressed')

CASE (ky_f9):
    -- Perform F9
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F9 pressed')

CASE (ky_f10):
    -- Perform F10
    SET_CURSOR(TPERROR, 1, 1, status)
    WRITE TPERROR ('F10 pressed')

CASE (ky_undef):
    -- Process special keys.
    SELECT (save_action) OF
        CASE (ky_f1_s):
            -- Perform Shift F1
            SET_CURSOR(TPERROR, 1, 1, status)
            WRITE TPERROR ('F1 shifted pressed')
        ELSE:
            ENDSELECT
    ELSE:
```

```

        action = term_char -- act on this key
    ENDSELECT
ENDWHILE

    IF term_char <> ky_new_menu THEN
        -- Cancel the dynamic display
        ACT_TBL(ky_cancel, def_item, table_data, term_char,
                attach_sw, status)
    ENDIF
ENDIF

END tpextbl

```

### **A.9.13 IN\_RANGE Built-In Function**

**Purpose:** Returns a BOOLEAN value indicating whether or not the specified position argument can be reached by a group of axes

**Syntax :** IN\_RANGE(posn)

Function Return Type :BOOLEAN

Input/Output Parameters:

[in] posn : XYZWPREXT

%ENVIRONMENT Group :SYSTEM

**Details:**

- The returned value is TRUE if *posn* is within the work envelope of the group of axes; otherwise, FALSE is returned.
- The current \$UFRAME and \$UTOOL are applied to *posn*.

**See Also:** CHECK\_EPROS Built-in procedure, [Chapter 8 MOTION](#), Section 4.1.2, "Group Motion"

**Example:** The following example checks to see if the new position is in the work envelope before moving the TCP to it.

#### **IN\_RANGE Built-In Function**

```

IF IN_RANGE(pallet : part_slot) THEN
    WITH $UFRAME = pallet MOVE TO part_slot
ELSE WRITE('I can't get there!',CR)
ENDIF

```

### A.9.14 INSERT\_NODE Built-In Procedure

**Purpose:** Inserts an uninitialized node in the specified PATH argument preceding the specified path node number

**Syntax :** INSERT\_NODE(path\_var, node\_num, status)

Input/Output Parameters:

[in] path\_var :PATH

[in] node\_num :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PATHOP

**Details:**

- *node\_num* specifies the index number of the path node before which the new uninitialized node is to be inserted.
- The new node can be assigned values by directly referencing its NODEDATA structure.
- All nodes following the inserted node are renumbered.
- Valid *node\_num* values are in the range  $node\_num \Rightarrow 1$  and  $node\_num \leqslant PATH\_LEN(path\_var)$ .
- If *node\_num* is not a valid node number, status is returned with an error.
- If the program does not have enough RAM for an INSERT\_NODE request, an error will occur.
- If the program is paused, the INSERT\_NODE request is **NOT** retried.

**See Also:** DELETE\_NODE, APPEND\_NODE Built-in Procedures

**Example:** In the following example, the PATH\_LEN built-in is used to set the variable length equal to the number of nodes in **path\_var**. INSERT\_NODE inserts a new path node after the last node in **path\_var**.

#### **INSERT\_NODE Built-In Procedure**

```
length = PATH_LEN(path_var)
INSERT_NODE(path_var, length, status)
```

### A.9.15 INSERT\_QUEUE Built-In Procedure

**Purpose:** Inserts an entry into a queue if the queue is not full

**Syntax :** INSERT\_QUEUE(value, sequence\_no, queue, queue\_data, status)

Input/Output Parameters:

[in] value :INTEGER

[in] sequence\_no :INTEGER

[in,out] queue\_t :QUEUE\_TYPE

[in,out] queue\_data :ARRAY OF INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBQMGR

**Details:**

- *value* specifies the value to be inserted into the queue, *queue\_t*.
- *sequence\_no* specifies the sequence number of the entry before which the new entry is to be inserted.
- *queue\_t* specifies the queue variable for the queue.
- *queue\_data* specifies the array used to hold the data in the queue. The length of this array determines the maximum number of entries in the queue.
- *status* is returned with 61002, "Queue is full," if there is no room for the entry in the queue, with 61003, "Bad sequence no," if the specified sequence number is not in the queue.

**See Also:** MODIFY\_QUEUE, APPEND\_QUEUE, DELETE\_QUEUE Built-In Procedures, [Section 15.8](#), "Using Queues for Task Communication"

**Example:** In the following example, the routine **ins\_in\_queue** adds an entry (**value**) to a queue (**queue\_t** and **queue\_data**) following the specified entry **sequence\_no**; it returns TRUE if this was successful; otherwise it returns FALSE.

#### **INSERT\_QUEUE Built-In Procedure**

```
PROGRAM ins_queue_x
%environment PBQMGR
ROUTINE ins_in_queue(value: INTEGER;
                      sequence_no: INTEGER;
                      queue_t: QUEUE_TYPE;
```

```

queue_data: ARRAY OF INTEGER): BOOLEAN

VAR
    status: INTEGER

BEGIN
    INSERT_QUEUE(value, sequence_no, queue_t, queue_data, status)
    return (status = 0)
END ins_in_queue
BEGIN
END ins_queue_x

```

### A.9.16 INTEGER Data Type

**Purpose:** Defines a variable, function return type, or routine parameter as INTEGER data type

**Syntax :** INTEGER

**Details:**

- An INTEGER variable or parameter can assume whole number values in the range -2147483648 through +2147483646.
- INTEGER literals consist of a series of digits, optionally preceded by a plus or minus sign. They cannot contain decimal points, commas, spaces, dollar signs (\$), or other punctuation characters. (See [Table A-14](#) )

**Table A-14. Valid and Invalid INTEGER Literals**

Valid	Invalid	Reason
1	1.5	Decimal point not allowed (must be a whole number)
-2500450	-2,500,450	Commas not allowed
+65	+6 5	Spaces not allowed

- If an INTEGER argument is passed to a routine where a REAL parameter is expected, it is treated as a REAL and passed by value.
- Only INTEGER expressions can be assigned to INTEGER variables, returned from INTEGER function routines, or passed as arguments to INTEGER parameters.
- Valid INTEGER operators are:
  - Arithmetic operators (+, -, \*, /, DIV, MOD)

- Relational operators ( $>$ ,  $\geq$ ,  $=$ ,  $\neq$ ,  $<$ ,  $\leq$ )
- Bitwise operations (AND, OR, NOT)

**See Also:** [Chapter 5 ROUTINES](#) , for more information on passing by value, [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#) , for more information on format specifiers

**Example:** Refer to [Appendix B](#) for detailed program examples.

### A.9.17 INV Built-In Function

**Purpose:** Used in coordinate frame transformations with the relative position operator (:) to determine the coordinate values of a POSITION in a frame that differs from the frame in which that POSITION was recorded

**Syntax :** INV(pos) Function Return Type :POSITION

Input/Output Parameters:

[in] pos :POSITION

%ENVIRONMENT Group :SYSTEM

**Details:**

- The returned value is the inverse of the *pos* argument.
- The configuration of the returned POSITION will be that of the *pos* argument.

**Example:** The following example uses the INV built-in to determine the POSITION of **part\_pos** with reference to the coordinate frame that has **rack\_pos** as its origin. Both **part\_pos** and **rack\_pos** were originally taught and recorded in User Frame. The robot is then instructed to move to that position.

#### **INV Built-In Function**

```
PROGRAM p_inv
  VAR
    rack_pos, part_pos, p1 : POSITION
  BEGIN
    p1 = INV(rack_pos):part_pos
    MOVE TO p1
  END p_inv
```

### A.9.18 IO\_MOD\_TYPE Built-In Procedure

**Purpose:** Allows a KAREL program to determine the type of module in a specified rack/slot

**Syntax :** IO\_MOD\_TYPE(rack\_no, slot\_no, mod\_type, status)

Input/Output Parameters:

[in] rack\_no :INTEGER

[in] slot\_no :INTEGER

[out] mod\_type :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *rack\_no* is the rack containing the port module. For process I/O boards, this is zero; for Allen-Bradley and Genius ports, this is 16.
- *slot\_no* is the slot containing the port module. For process I/O boards, this is the position of the board in the SLC-2 chain.
- *mod\_type* is the module type.

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- *status* is returned with zero if the parameters are valid and there is a module or board with the specified rack/slot number as follows:

**Example:** The following example returns to the caller the module in the specified rack and slot number.

#### **IO\_MOD\_TYPE Built-In Procedure**

```
PROGRAM iomodtype
%ENVIRONMENT IOSETUP
ROUTINE get_mod_type(rack_no: INTEGER;
                      slot_no: INTEGER;
                      mod_type: INTEGER): INTEGER
VAR
  status: INTEGER
BEGIN
```

```

    IO_MOD_TYPE(rack_no, slot_no, mod_type, status)
    RETURN (status)
END get_mod_type
BEGIN
END iomodtype

```

### **A.9.19 IO\_STATUS Built-In Function**

**Purpose:** Returns an INTEGER value indicating the success or type of failure of the last operation on the file argument

**Syntax :** IO\_STATUS(file\_id)

Function Return Type :INTEGER

Input/Output Parameters:

[in] file\_id :FILE

%ENVIRONMENT Group :PBCORE

**Details:**

- IO\_STATUS can be used after an OPEN FILE, READ, WRITE, CANCEL FILE, or CLOSE FILE statement. Depending on the results of the operation, it will return 0 if successful or one of the errors listed in the *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual*. Some of the common errors are shown in [Table A-15](#).

**Table A-15. IO\_STATUS Errors**

0	Last operation on specified file was successful
2021	End of file for RAM disk device
10006	End of file for floppy device
12311	Uninitialized variable
12324	Illegal open mode string
12325	Illegal file string

**Table A-15. IO\_STATUS Errors (Cont'd)**

12326	File var is already used
12327	Open file failed
12328	File is not opened
12329	Cannot write the variable
12330	Write file failed
12331	Cannot read the variable
12332	Read data is too short
12333	Illegal ASCII string for read
12334	Read file failed
12335	Cannot open pre_defined file
12336	Cannot close pre_defined file
12338	Close file failed
12347	Read I/O value failed
12348	Write I/O value failed
12358	Timeout at read request
12359	Read request is nested
12367	Bad base in format

- Use READ file\_id(cr) to clear any IO\_STATUS error.
- If *file\_id* does not correspond to an opened file or one of the pre-defined “files” opened to the respective CRT/KB, teach pendant, and vision windows, the program is aborted with an error.

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLIST\_EX.KL), for a detailed program example.

## A.10 - J - KAREL LANGUAGE DESCRIPTION

### A.10.1 J\_IN\_RANGE Built-In Function

**Purpose:** Returns a BOOLEAN value indicating whether or not the specified joint position argument can be reached by a group of axes

**Syntax :** J\_IN\_RANGE(posn)

Function Return Type :BOOLEAN

Input/Output Parameters:

[in] posn :JOINTPOS

%ENVIRONMENT Group :SYSTEM

**Details:**

- The returned value is TRUE if *posn* is within the work envelope; otherwise, FALSE is returned.

**See Also:** IN\_RANGE Built-in Function, CHECK\_EPROS Built-in procedure

### A.10.2 JOINTPOS Data Type

**Purpose:** Defines a variable, function return type, or routine parameter as JOINTPOS data type.

**Syntax :** JOINTPOS<n> <IN GROUP[m]>

**Details:**

- A JOINTPOS consists of a REAL representation of the position of each axis of the group, expressed in degrees or millimeters (mm).
- n* specifies the number of axes, with 9 as the default. The size in bytes is  $4 + 4 * n$ .
- A JOINTPOS may be followed by IN GROUP[m], where m indicates the motion group with which the data is to be used. The default is the group specified by the %DEFGROUP directive or 1.
- CNV\_REL\_JPOS and CNV\_JPOS\_REL Built-ins can be used to access the real values.

- A JOINTPOS can be assigned to other positional types. Note that some motion groups, for example single axis positioners, have no XYZWPR representation. If you attempt to assign a JOINTPOS to a XYZWPR or POSITION type for such a group, a run-time error will result.

**Example:** Refer to the following sections for detailed program examples:

[Section B.5, "Using Register Built-ins" \(REG\\_EX.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.8, "Generating and Moving Along a Hexagon Path" \(GEN\\_HEX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

### **A.10.3 JOINT2POS Built-In Function**

**Purpose:** This routine is used to convert joint angles (*in\_jnt*) to a Cartesian position (*out\_pos*) by calling the forward kinematics routine.

**Syntax :** JOINT2POS (*in\_jnt* - Joint angles can be converted to Cartesian, uframe, utool, config\_ref, *out\_pos*, *wjnt\_cfg*, *ext\_ang*, and *status*).

Input/Output Parameters:

[in] *in\_jnt* :Jointpos

[in] *uframe* :POSITION

[in] *utool* :POSITION

[in] *config\_ref* :INTEGER

[out] *out\_pos* :POSITION

[out] *wjnt\_cfg* :CONFIG

[out] *ext\_ang* :ARRAY OF REAL

[out] *status* :INTEGER

%ENVIRONMENT Group :MOTN

#### **Details:**

- The input *in\_jnt* is defined as the joint angles to be converted to the Cartesian position.
- The input *uframe* is the user frame for the Cartesian position.

- The input *utool* is defined as the corresponding tool frame.
- The input *config\_ref* is an integer representing the type of solution desired. The values listed below are valid. Also, the pre-defined constants in the parentheses can be used and the values can be added as required. One example includes: *config\_ref* = HALF\_SOLN + CONFIG\_TCP.
  - 0 :(FULL\_SOLN) = Default
  - 1 :(HALF\_SOLN) = Wrist joint (xyz456). This value does not calculate/use wpr.
  - 2 :(CONFIG\_TCP) = The Wrist Joint Config (up/down) is based on the fixed wrist.
  - 4 :(APPROX\_SOLN) = Approximate solution. This value reduce calculation time for some robots.
  - 8 :(NO\_TURNS) = Ignore wrist turn numbers. Use the closest path for joints 4, 5 and 6 (uses ref\_jnt).
  - 16 :(NO\_M\_TURNS) = Ignore major axis (J1 only) turn number. Use the closest path.
- The output *out\_pos* is the Cartesian position corresponding to the input joint angles.
- The output *wjnt\_cfg* is the wrist joint configuration. The value will be output when *config\_ref* corresponds to HALF\_SOLN.
- The output *ext\_ang* contains the values of the joint angles for the extended axes if they exist.
- The output *status* explains the status of the attempted operation. If it is not equal to 0, then an error has occurred.

## **A.11 - K - KAREL LANGUAGE DESCRIPTION**

### **A.11.1 KCL Built-In Procedure**

**Purpose:** Sends the KCL command specified by the STRING argument to KCL for execution.

**Syntax :** KCL (command, status)

**Input/Output Parameters :**

[in] command :STRING

[out] status :INTEGER

%ENVIRONMENT Group :kclop

**Details:**

- *command* must contain a valid KCL command.
- *command* cannot exceed 126 characters.

- Program execution waits until execution of the KCL command is completed or until an error is detected.
- All KCL commands are performed as if they were entered at the command level, with the exception of destructive commands, such as CLEAR ALL, for which no confirmation is required.
- *status* indicates whether the command was executed successfully.
- If a KCL command file is being executed and \$STOP\_ON\_ERR is FALSE, the KCL built-in will continue to run to completion. The first error detected will be returned or a 0 if no errors occurred.

**See Also:** KCL\_NO\_WAIT, KCL\_STATUS Built-In Procedures

**Example:** The following example will show programs and wait until finished. Status will be the outcome of this operation.

#### KCL Built-In Procedure

```
PROGRAM kcl_test
VAR
    command :STRING[20]
    status :INTEGER

BEGIN
    command = 'SHOW PROGRAMS'
    KCL (command, status)
END kcl_test
```

**Example:** Refer to [Example Program for Display Only Data Items](#) for another example.

#### A.11.2 KCL\_NO\_WAIT Built-In Procedure

**Purpose:** Sends the KCL command specified by the STRING argument to KCL for execution, but does not wait for completion of the command before continuing program execution.

**Syntax :** KCL\_NO\_WAIT (command, status)

Input/Output Parameters :

[in] command :STRING

[out] status :INTEGER

%ENVIRONMENT Group :kclop

**Details:**

- *command* must contain a valid KCL command.

- *status* indicates whether KCL accepted the command.
- Program execution waits until KCL accepts the command or an error is detected.

**See Also:** KCL, KCL\_STATUS Built-In Procedures

**Example:** The following example will load a program, but will not wait for the program to be loaded before returning. Status will indicate if the command was accepted or not.

#### KCL\_NO\_WAIT Built-In Procedure

```
PROGRAM kcl_test
VAR
    command :STRING[ 20 ]
    status :INTEGER

BEGIN
    command = 'Load prog test_1'
    KCL_NO_WAIT (command, status)
    delay 5000
    status = KCL_STATUS
END kcl_test
```

#### A.11.3 KCL\_STATUS Built-In Procedure

**Purpose:** Returns the status of the last executed command from either KCL or KCL\_NO\_WAIT built-in procedures.

**Syntax :** KCL\_STATUS

Function Return Type :INTEGER

%ENVIRONMENT Group :kclop

##### Details:

- Returns the *status* of the last executed command from the KCL or KCL\_NO\_WAIT built-ins.
- Program execution waits until KCL can return the status.

**See Also:** KCL\_NO\_WAIT, KCL Built-In Procedures

## A.12 - L - KAREL LANGUAGE DESCRIPTION

### A.12.1 LN Built-In Function

**Purpose:** Returns the natural logarithm of a specified REAL argument

**Syntax :** LN(x)

Function Return Type :REAL

Input/Output Parameters:

[in] x : REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- The returned value is the natural logarithm of  $x$  .
- $x$  must be greater than zero. Otherwise, the program will be aborted with an error.

**Example:** The following example returns the natural logarithm of the input variable **a** and assigns it to the variable **b** .

#### **LN Built-In Function**

```
WRITE(CR, CR, 'enter a number =')
READ(a, CR)
b = LN(a)
```

### A.12.2 LOAD Built-In Procedure

**Purpose:** Loads the specified file

**Syntax :** LOAD (file\_spec, option\_sw, status)

Input/Output Parameters:

[in] file\_spec :STRING

[in] option\_sw :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *file\_spec* specifies the device, name, and type of the file to load. The following types are valid:
  - .TP Teach pendant program
  - .PC KAREL program
  - .VR KAREL variables
  - .SV KAREL system variables
  - .IO I/O configuration data
  - no ext KAREL program and variables
- *option\_sw* specifies the type of options to be done during loading.

The following value is valid for .TP files:

- 1 If the program already exists, then it overwrites the program. If option\_sw is not 1 and the program exists, an error will be returned.

The following value is valid for .SV files:

- 1 Converts system variables.

- *option\_sw* is ignored for all other types.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.7, "Listing Files and Programs and Manipulating Strings" \(LIST\\_EX.KL\)](#)

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

### **A.12.3 LOAD\_STATUS Built-In Procedure**

**Purpose:** Determines whether the specified KAREL program and its variables are loaded into memory

**Syntax :** LOAD\_STATUS(prog\_name, loaded, initialized)

Input/Output Parameters:

[in] prog\_name :STRING

[out] loaded :BOOLEAN  
[out] initialized :BOOLEAN  
%ENVIRONMENT Group :PBCORE

**Details:**

- *prog\_name* must be a program and cannot be a routine.
- *loaded* returns a value of TRUE if *prog\_name* is currently loaded into memory. FALSE is returned if *prog\_name* is not loaded.
- *initialized* returns a value of TRUE if any variable within *prog\_name* has been initialized. FALSE is returned if all variables within *prog\_name* are uninitialized.
- If either *loaded* or *initialized* is FALSE, use the LOAD built-in procedure to load *prog\_name* and its variables.

**Example:** Refer to the following sections for detailed program examples:

[Section B.7](#), "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

[Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL)

#### **A.12.4 LOCK\_GROUP Built-In Procedure**

**Purpose:** Locks motion control for the specified group of axes

**Syntax :** LOCK\_GROUP(group\_mask, status)

Input/Output Parameters:

[in] group\_mask : INTEGER  
[out] status : INTEGER  
%ENVIRONMENT Group :MULTI

**Details:**

- *group\_mask* specifies the group of axes to lock for the running task. The group numbers must be in the range of 1 to the total number of groups defined on the controller.
- The *group\_mask* is specified by setting the bit(s) for the desired group(s).

**Table A-16. Group\_mask Setting**

GROUP	DECIMAL	BIT
Group 1	1	1
Group 2	2	2
Group 3	4	3

To specify multiple groups select the decimal values, shown in [Table A-16](#), which correspond to the desired groups. Then connect them together using the OR operator. For example to specify groups 1, 3, enter "1 OR 4".

- Motion control is gained for the specified motion groups.
- If one or more of the groups cannot be locked, then an error is returned, and any available groups will be locked.
- Moving a group automatically locks the group if it has not been previously locked by another task.
- If a task tries to move a group that is already locked by another task, it will be paused.
- *status* explains the status of the attempted operation. If not equal to 0, an error occurred.

**Note** Do not use more than one motion group in a KAREL program. If you need to use more than one motion group, you must use a teach pendant program.



#### Warning

**Do not run a KAREL program that includes more than one motion group. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**Example:** The following example unlocks group 1, 2, and 3, and then locks group 3. Refer to [Chapter 15 MULTI-TASKING](#), for more examples.

#### **LOCK\_GROUP Built-In Procedure**

```
%ENVIRONMENT MOTN
%ENVIRONMENT MULTI

VAR
    status: INTEGER

BEGIN
    REPEAT
        -- Unlock groups 1, 2, and 3
```

```
UNLOCK_GROUP(1 OR 2 OR 4, status)
IF status = 17040 THEN
    CNCL_STP_MTN      -- or RESUME
ENDIF
DELAY 500
UNTIL status = 0

-- Lock only group 3
LOCK_GROUP(4, status)

END lock_grp_ex
```

### A.12.5 %LOCKGROUP Translator Directive

**Purpose:** Specifies the motion group(s) to be locked when calling this program or a routine from this program.

**Syntax :** %LOCKGROUP = n, n ,...

**Details:**

- *n* is the number of the motion group to be locked.
- The range of *n* is 1 to the number of groups on the controller.
- When the program or routine is called, the task will attempt to get motion control for all the specified groups if it does not have them locked already. The task will pause if it cannot get motion control.
- If %LOCKGROUP is not specified, all groups will be locked.
- The %NOLOCKGROUP directive can be specified if no groups should be locked.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** %NOLOCKGROUP Directive, LOCK\_GROUP, UNLOCK\_GROUP Built-In Procedures

## A.13 - M - KAREL LANGUAGE DESCRIPTION

### A.13.1 MIRROR Built-In Function

**Purpose:** Determines the mirror image of a specified position variable.

**Syntax :** MIRROR (old\_pos, mirror\_frame, orientation\_flag)

Function Return Type: XYZWPREXT

Input/Output Parameters :

[in] old\_pos :POSITION

[in] mirror\_frame :POSITION

[in] orient\_flag :BOOLEAN

%ENVIRONMENT Group :MIR

**Details:**

- *old\_pos* and *mirror\_frame* must both be defined relative to the same user frame.
- *old\_pos* specifies the value whose mirror image is to be generated.
- *mirror\_frame* specifies the value across whose xz\_plane the image is to be generated.
- If *orient\_flag* is TRUE, both the orientation and location component of *old\_pos* will be mirrored. If FALSE, only the location is mirrored and the orientation of the new mirror-image position is the same as that of *old\_pos*.
- The returned mirrored position is not guaranteed to be a reachable position, since the mirrored position can be outside of the robot's work envelope.

**See Also:** The appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual*, chapter on "Advanced Functions"

**Example:** The following example gets the current position of the robot, creates a mirror frame, and generates a mirrored position which is mirrored about the y axis.

#### MIRROR Built-In Function

```
PROGRAM mir_exam
VAR
    cur_pos:    XYZWPREXT
    org_pos:    POSITION
    mir_pos:    XYZWPREXT
    mir_posa:   POSITION
```

```
pos_frame: XYZWPREXT
frame: POSITION
orient_flag: BOOLEAN

BEGIN
cur_pos = curpos(0,0) -- Get the current position of the robot

cur_pos.x = 1000.00 -- Create a new position which (1000,0,300,w,p,r)
cur_pos.y = 0.0
cur_pos.z = 300.00

move to cur_pos -- The robot is now at a know position:
--(1000,0,300,w,p,r) where (w,p,r) have not
--changed from the original position.

pos_frame = curpos(0,0) -- Create a frame used to mirror about.

pos_frame.w = 0 -- By setting (w,p,r) to 0, the x-z plane of
pos_frame.p = 0 -- pos_frame will be parallel to the world's x-z
pos_frame.r = 0 -- plane. pos_frame now set to (1000,0,300,0,0,0)

frame = pos_frame -- Convert the mirror frame to a POSITION type.

cur_pos.y = 200 -- Move 200mm in the y direction.
move to cur_pos -- Current position is (1000,200,300,w,p,r)

org_pos = cur_pos -- Convert org_pos to a POSITION type.

orient_flag = FALSE -- Send Mirror current position: (1000, 200, 300,
-- w,p,r), and mirror frame: (1000,0,300,0,0,0).
-- Mirrors about the y axis without mirroring the
-- orientation (w,p,r).

mir_pos = mirror(org_pos, frame, orient_flag)
-- mir_pos is the mirrored position: (1000, -200,
-- 300, w, p, r).
-- The orientation is the same as org_pos.

orient_flag = TRUE -- The mirrored position includes mirroring of
-- the tool orientation.

mir_posa = mirror(org_pos, frame, orient_flag)
-- mir_posa is the mirrored position where Normal
-- Orient, & Approach vectors have been mirrored.
end mir_exam
```

### A.13.2 MODIFY\_QUEUE Built-In Procedure

**Purpose:** Replaces the value of an entry of a queue.

**Syntax :** MODIFY\_QUEUE(value, sequence\_no, queue\_t, queue\_data, status)

Input/Output Parameters:

[in] value :INTEGER

[in] sequence\_no :INTEGER

[in,out] queue\_t :QUEUE\_TYPE

[in,out] queue\_data :ARRAY OF INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBQMGR

**Details:**

- *value* specifies the value to be inserted into the queue.
- *sequence\_no* specifies the sequence number of the entry whose value is to be modified
- *queue\_t* specifies the queue variable for the queue
- *queue\_data* specifies the array used to hold the data in the queue. The length of this array determines the maximum number of entries in the queue.
- *status* is returned with 61003, “Bad sequence no,” if the specified sequence number is not in the queue.

**See Also:** COPY\_QUEUE, GET\_QUEUE, DELETE\_QUEUE Built-In Procedures[Section 15.8](#), "Using Queues for Task Communication"

**Example:** In the following example, the routine update\_queue replaces the value of the specified entry ( **sequence\_no** ); of a queue ( **queue** and **queue\_data** ) with a new value ( **value** ).

#### **MODIFY\_QUEUE Built-In Procedure**

```
PROGRAM mod_queue_x
%ENVIRONMENT PBQMGR
ROUTINE update_queue(value: INTEGER;
                      sequence_no: INTEGER;
                      queue_t: QUEUE_TYPE;
                      queue_data: ARRAY OF INTEGER)
VAR
    status: INTEGER
```

```

BEGIN
MODIFY_QUEUE(value, sequence_no, queue_t, queue_data, status)
return
END update_queue
BEGIN
END mod_queue_x

```

### A.13.3 MOTION\_CTL Built-In Function

**Purpose:** Determines whether the KAREL program has motion control for the specified group of axes

**Syntax :** MOTION\_CTL<(group\_mask)>

Function Return Type :BOOLEAN

Input/Output Parameters:

[in] group\_mask :INTEGER

%ENVIRONMENT Group :MOTN

**Details:**

- If *group\_mask* is omitted, the default group mask for the program is assumed.
- The default *group\_mask* is determined by the %LOCKGROUP and %NOLOCKGROUP directives.
- The *group\_mask* is specified by setting the bit(s) for the desired group(s).

Table A-17. Group\_mask Setting

GROUP	DECIMAL	BIT
Group 1	1	1
Group 2	2	2
Group 3	4	3

To specify multiple groups select the decimal values, shown in [Table A-17](#), which correspond to the desired groups. Then connect them together using the OR operator. For example to specify groups 1, 3, enter "1 OR 4".

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

- Returns TRUE if the KAREL program has motion control for the specified group of axes.

**A.13.4 MOUNT\_DEV Built-In Procedure**

**Purpose:** Mounts the specified device

**Syntax :** MOUNT\_DEV (device, status)

Input/Output Parameters:

[in] device : STRING

[out] status :INTEGER

%ENVIRONMENT Group :FDEV

**Details:**

- *device* specifies the device to be mounted.
- *status* explains the status of the attempted operation. If it is not equal to 0, then an error occurred.

**See Also:** DISMOUNT\_DEV and FORMAT\_DEV

**Example:** Refer to [Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL), for a detailed program example.

**A.13.5 MOVE ABOUT Statement**

**Purpose:** Moves the TCP to a destination an angular distance about a specified vector from the current TCP position

**Syntax :** < WITH clause >

MOVE ABOUT vect BY angle

< NOWAIT > <,

cond\_handler

{cond\_handler}

ENDMOVE >

where:

WITH\_clause : Described under “WITH clause”

vect : VECTOR expression

angle : a REAL expression

NOWAIT : Described under “NOWAIT clause”

cond\_handler : a local condition handler

#### Details:

- *angle* is measured in degrees.
- The location of the destination will be the same as that of the current position when the move is completed.
- If \$MOTYPE is linear, the location of the TCP remains fixed during the move.
- The shortest distance for the move is always used. For example, if the angle is > 180 degrees (or < -180), the actual motion will be in the opposite direction from what you might expect.



#### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** Local condition handlers, composed of WHEN and UNTIL clauses, [Chapter 6 CONDITION HANDLERS](#), [Appendix E](#), “Syntax Diagrams,” for additional syntax information, NOWAIT, WHEN, WITH, UNTIL Clauses

**Example:** Initially, the following example moves the TCP to a desired position, defines a vector in the positive x direction ( **direction** ), and defines **angle** to be 30°. The TCP is then rotated about the **direction** vector by **angle** .

#### MOVE ABOUT Statement

```
$MOTYPE = JOINT  
MOVE TO tool_pos
```

```

direction.x = 1
direction.y = 0
direction.z = 0

angle = 30

WITH $SPEED = 200 MOVE ABOUT direction BY angle

```

### **A.13.6 MOVE ALONG Statement**

**Purpose:** Moves the TCP (and, optionally, auxiliary axes) continuously along the nodes of a PATH.

**Syntax :** < WITH clause >

```

MOVE ALONG path_var <[start_node<..end_node]>
<NOWAIT> < ,
cond_handler
{cond_handler}
ENDMOVE >

```

where:

WITH clause : Described under “WITH Clause”

path\_var : a PATH variable

start\_node : an INTEGER expression

end\_node : an INTEGER expression

NOWAIT : Described under “NOWAIT Clause”

cond\_handler : a local condition handler

**Details:**

- If *start\_node* is not present, the TCP (and, optionally, auxiliary axes) moves to the first node of the PATH, then to each successive node until the end of the PATH is reached.
- If only *start\_node* is present, the TCP (and, optionally, auxiliary axes) moves to the specified *start\_node*, then to each successive node until the end of the PATH is reached.

- If a range of nodes is specified with *start\_node...end\_node*, the TCP (and, optionally, auxiliary axes) moves to the specified *start\_node*, then to each successive node until the specified *end\_node* is reached.
- *start\_node* and *end\_node* must be in the range from 1 to the length of the PATH. If, during program execution, one of these values is less than 1, the program will be aborted. If one of these values is greater than the actual length of the PATH, the program will be paused.
- The standard associated data values for each node are applied to the motion segment whose destination is the corresponding node.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** Local condition handlers, composed of WHEN and UNTIL clauses, [Chapter 6 CONDITION HANDLERS](#), [Appendix E](#), “Syntax Diagrams,” for additional syntax information, NOWAIT, WHEN, WITH, UNTIL Clauses

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

[Section B.6](#), "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

### **A.13.7 MOVE AWAY Statement**

**Purpose:** Moves the TCP away from its current position using a REAL value offset, measured in millimeters along the negative z-axis of the tool coordinate system.

**Syntax :** <WITH\_clause>

MOVE AWAY distance

<NOWAIT><,

cond\_handler

{ cond\_handler }

ENDMOVE >

where:

WITH\_clause : Described under “WITH Clause”

distance : a REAL expression

NOWAIT : Described under “NOWAIT Clause”

cond\_handler : a local condition handler

#### Details:

- *distance* designates the offset distance, in millimeters, that the TCP is to move from the current TCP position.
- The direction of displacement is determined by the sign of the specified *distance* and the tool orientation at the starting point.
- If the distance is positive, displacement will be in the negative z direction in the coordinate frame of the tool. Otherwise it is in the positive z direction.
- The tool orientation at the end of the move will be the same as at the start. It will be constant during the move only if \$MOTYPE is specified as linear.



#### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** Local condition handlers, composed of WHEN and UNTIL clauses, [Chapter 6 CONDITION HANDLERS](#), [Appendix E](#), “Syntax Diagrams,” for additional syntax information, NOWAIT, WHEN, WITH, UNTIL Clauses

**Example:** The following example sets \$MOTYPE to JOINT and moves the TCP to the position **start\_pos**. Next the TCP moves away -100 millimeters which brings the tool closer to the surface. Moving the TCP away 100 millimeters brings the tool farther away from the surface.

#### MOVE AWAY Statement

```
$MOTYPE = JOINT          -- start_pos is located
      MOVE TO start_pos   -- 100 mm away from a
                           -- surface. Tool is
                           -- perpendicular to
                           -- surface at start_pos.
      distance = 100.0
```

```
MOVE AWAY -distance  
MOVE AWAY distance
```

### **A.13.8 MOVE AXIS Statement**

**Purpose:** Moves a specified robot or auxiliary axis a distance specified in degrees or millimeters

**Syntax :** < WITH\_clause >

```
MOVE AXIS axis_no BY distance
```

```
< NOWAIT > < ,
```

```
cond_handler
```

```
{ cond_handler }
```

```
ENDMOVE >
```

where:

WITH\_clause : Described under “WITH Clause”

axis\_no : an INTEGER expression

distance : a REAL expression

NOWAIT : Described under “NOWAIT Clause”

cond\_handler : a local condition handler

**Details:**

- *axis\_no* indicates the robot or auxiliary axis to move.
- Robot axes are numbered from one to the number of axes on the robot; auxiliary axes are numbered from one more than the last robot axis to the last auxiliary axis.
- *distance* designates the distance to move. The units of distance are degrees for rotational axes and millimeters for linear (prismatic) axes.
- If an emergency stop occurs during a MOVE AXIS motion, a new destination is computed using the current position at the time the motion is resumed. The original distance is used in the computation, meaning the axis will not end up at the position it was originally moving to before the emergency stop occurred.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Appendix E](#), “Syntax Diagrams,” for additional syntax information, NOWAIT, WHEN, WITH, UNTIL Clauses

**See Also:** NOWAIT Clause, Appendix A, “KAREL Language Alphabetical Description,” WHEN Clause and UNTIL Clause, Appendix A, “KAREL Language Alphabetical Description,” WITH Clause, Appendix A, “KAREL Language Alphabetical Description,” [Appendix E](#), “Syntax Diagrams,” for additional syntax information

**Example:** The following example moves each axis individually 45°.

**MOVE AXIS Statement**

```
degrees = 45
```

```
FOR i = 1 TO 5 DO
    MOVE AXIS i BY degrees
ENDFOR
```

**A.13.9 MOVE\_FILE Built-In Procedure**

**Purpose:** Moves the specified file from one memory file device to another

**Syntax :** MOVE\_FILE (file\_spec, status)

Input/Output Parameters :

[in] file\_spec : string

[out] status : integer

%ENVIRONMENT Group :FDEV

**Details:**

- *file\_spec* specifies the device, name, and type of the file to be moved. The file should exist on the FROM or RAM disks.
- If *file\_spec* is a file on the FROM disk, the file is moved to the RAM disk, and vice versa.

- The wildcard character (\*) can be used to replace the entire file name, the first part of the file name, the last part of the file name, or both the first and last parts of the file name. The file type can also use the wildcard in the same manner. If file\_spec specifies multiple files, then they are all moved to the other disk.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** In the following example, all .KL files are moved from the RAM disk to the FROM disk.

#### **MOVE\_FILE Built-In Procedure**

```
PROGRAM move_files
%NOLOCKGROUP
%ENVIRONMENT FDEV
VAR
    status: INTEGER
BEGIN
    MOVE_FILE('RD:\*.KL', status)
    IF status <> 0 THEN
        POST_ERR(status, '', 0, 0)
    ENDIF
END move_files
```

#### **A.13.10 MOVE NEAR Statement**

**Purpose:** Moves the TCP to a destination near the specified POSITION by the distance offset, which is measured along the negative z-axis of the POSITION

**Syntax :** < WITH\_clause >

MOVE NEAR posn BY distance

< NOWAIT > < ,

cond\_handler

{ cond\_handler }

ENDMOVE >

where:

WITH\_clause : Described under “WITH Clause”

posn : a POSITION variable

distance : a REAL expression

NOWAIT : Described under “NOWAIT Clause”

cond\_handler : a local condition handler

**Details:**

- *distance* designates the offset from the POSITION *posn* to move to in millimeters.
- The direction of the offset is determined by the sign of *distance* and the orientation of the tool at *posn*.
- If *distance* is positive, the displacement will be along the negative z-axis of *posn*. Otherwise, the displacement will be along the positive z-axis.
- The orientation of the final POSITION will be the same as that specified in *posn*.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** Local condition handlers, composed of WHEN and UNTIL clauses, [Chapter 6 CONDITION HANDLERS](#), [Appendix E](#), “Syntax Diagrams,” for additional syntax information, NOWAIT, WHEN, WITH, UNTIL Clauses

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.13.11 MOVE RELATIVE Statement**

**Purpose:** Moves the TCP from its present location by a distance specified as a VECTOR or POSITION, in \$UFRAME coordinates

**Syntax :** <WITH\_clause>

MOVE RELATIVE distance

<NOWAIT><,

cond\_handler

{ cond\_handler }

ENDMOVE >

where:

WITH\_clause : Described under “WITH Clause”

distance : a VECTOR or POSITION expression

NOWAIT : Described under “NOWAIT Clause”

cond\_handler : a local condition handler

#### Details:

- The *TCP* is moved the specified distance in x, y, and z directions of the default or specified \$UFRAME.
- If a VECTOR is used, the orientation of the *TCP* at the destination will be the same as that of the *TCP* at the current position, when the move is complete.
- If a POSITION is used, the orientation of the *TCP* at the destination will be computed by premultiplying the orientation from the distance position to the current orientation of the current position.



#### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** Local condition handlers, composed of WHEN and UNTIL clauses, [Chapter 6 CONDITION HANDLERS](#), [Appendix E](#), “Syntax Diagrams,” for additional syntax information, NOWAIT Clause

**Example:** The following example sets \$MOTYPE to JOINT and uses the MOVE TO statement to move the TCP to position **start\_pos**. The VECTOR variable **direction** is set to the x, y, and z values of 300, 0, 0. The MOVE RELATIVE statement moves the TCP from **start\_pos** by the value of **direction**.

#### MOVE RELATIVE Statement

```
$MOTYPE = JOINT
MOVE TO start_pos
direction.x = 300
direction.y = 0
direction.z = 0
MOVE RELATIVE direction
```

### A.13.12 MOVE TO Statement

**Purpose:** Initiates motion of the robot TCP to a specified POSITION or PATH node

**Syntax :** < WITH\_clause >

MOVE TO || posn | p\_var[n] || < VIA\_clause >

< NOWAIT >,

cond\_handler

{cond\_handler}

ENDMOVE >

where:

WITH\_clause : Described under “WITH clause”

posn : a positional expression

p\_var : a PATH

n : an INTEGER

VIA\_clause : Described under “VIA Clause”

NOWAIT : Described under “NOWAIT Clause”

cond\_handler : a local condition handler

#### Details:

- If the destination is a PATH variable, *n* specifies the node within *p\_var* that is the destination of the motion.

Any other fields, including the standard associated data fields, do not affect the motion.

- A *positional expression* can be a POSITION, XYZWPR, XYZWPREXT or JOINTPOS.



#### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** Local condition handlers, composed of WHEN and UNTIL Clauses,[Chapter 6 CONDITION HANDLERS](#), [Appendix E](#), “Syntax Diagrams,” for additional syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.6](#), "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.8](#), "Generating and Moving Along a Hexagon Path" (GEN\_HEX.KL)

### **A.13.13 MSG\_CONNECT Built-In Procedure**

**Purpose:** Connect a client or server port to another computer for use in Socket Messaging.

**Syntax :** MSG\_CONNECT (tag, status)

Input/Output Parameters :

[in] tag :STRING

[out] status :INTEGER

%ENVIRONMENT Group :FLBT

**Details:**

- Tag is the name of a client port (C1:-C8) or server port (S1:S8).
- Status explains the status of the attempted operation. If it is not equal to 0, then an error occurred.

**See Also:** Socket Messaging in the *FANUC Robotics SYSTEM R-J3iB Controller Internet Options Setup and Operations Manual*.

**Example:** The following example connects to S8: and reads messages. The messages are displayed on the teach pendant screen.

#### **MSG\_CONNECT Built-In Procedure**

```
PROGRAM tcperv8
```

```
VAR
    file_var : FILE
    tmp_int : INTEGER
    tmp_int1 : INTEGER
    tmp_str : string [128]
    tmp_str1 : string [128]
    status : integer
    entry : integer
```

```

BEGIN

    SET_FILE_ATR (file_var, ATR_IA)
    -- Set up S8 server tag
    DISMOUNT_DEV('S8:',status)
    MOUNT_DEV('S8:',status)
    write (' Mount Status = ',status,cr)
    status = 0
    IF status = 0 THEN
        -- Connect the tag
        write ('Connecting ..',cr)
        MSG_CONNECT ('S8:',status)
        write ('Connect Status = ',status,cr)
    IF status < > 0 THEN
        MSG_DISCO('S8:',status)
        write (' Connecting..',cr)
        MSG_CONNECT('S8:',status)
        write (' Connect Status = ',status,cr)
    ENDIF
    IF status = 0 THEN
        -- OPEN S8:
        write ('Opening',cr)
        OPEN FILE file_var ('rw','S8:')
        status = io_status(file_var)
        FOR tmp_int 1 TO 1000 DO
            write ('Reading',cr)
            BYTES_AHEAD(file_var, entry, status)
            -- Read 10 bytes
            READ file_var (tmp_str::10)
            status = i/o_status(file_var)
            --Write 10 bytes
            write (tmp_str::10,cr)
            status = io_status(file_var)
        ENDFOR
        CLOSE FILE file_var
        write ('Disconnecting..',cr)
        MSG_DISCO('S8:',status)
        write ('Done.',cr)
    ENDIF
ENDIF
END tcpserv8

```

#### **A.13.14 MSG\_DISCO Built-In Procedure**

**Purpose:** Disconnect a client or server port from another computer.

**Syntax :** MSG\_DISCO (tag, status)

Input/Output Parameters :

[in] tag :STRING

[out] status :INTEGER

%ENVIRONMENT Group :FLBT

**Details:**

- Tag is the name of a client port (C1:-C8) or server port (S1:S8).
- Status explains the status of the attempted operation. If it is not equal to 0, then an error occurred.

**See Also:** Socket Messaging in the *FANUC Robotics SYSTEM R-J3iB Controller Internet Options Setup and Operations Manual*.

**Example:** Refer to MSG\_CONNECT Built-In Procedure for more examples.

### **A.13.15 MSG\_PING**

**Syntax :** MSG\_PING (host name, status)

Input/Output Parameters :

[in] host name :STRING

[out] status :INTEGER

%ENVIRONMENT Group :FLBT

**Details:**

- Host name is the name of the host to perform the check on. An entry for the host has to be present in the host entry tables (or the DNS option loaded and configured on the robot).
- Status explains the status of the attempted operation. If it is not equal to 0, then an error occurred.

**See Also:** Ping in the *FANUC Robotics SYSTEM R-J3iB Controller Internet Options Setup and Operations Manual*.

**Example:** The following example performs a PING check on the hostname "fido". It writes the results on the teach pendant.

#### **MSG\_PING Built-In Procedure**

PROGRAM pingtest

```

VAR
  Tmp_int  : INTEGER
  Status   : integer

BEGIN
  WRITE('pinging..',cr)
  MSG_PING('fido',status)
  WRITE('ping Status = ',status,cr)
END pingtest

```

## **A.14 - N - KAREL LANGUAGE DESCRIPTION**

### **A.14.1 NOABORT Action**

**Purpose:** Prevents program execution from aborting when an external error occurs

**Details:**

- The NOABORT action usually corresponds to an ERROR[n].
- If the program is aborted by itself (i.e., executing an ABORT statement, run time error), the NOABORT action will be ignored and program execution will be aborted.

**Example:** The following example uses a global condition handler to test for error number 11038, "Pulse Mismatch." If this error occurs, the NOABORT action will prevent program execution from being aborted.

#### **NOABORT Action**

```

PROGRAM noabort_ex

%NOLOCKGROUP

BEGIN

  --Pulse Mismatch condition handler
  CONDITION[801]:
    WHEN ERROR[11038] DO
      NOABORT
    ENDCONDITION

    ENABLE CONDITION[801]

END noabort_ex

```

### **A.14.2 %NOABORT Translator Directive**

**Purpose:** Specifies a mask for aborting

**Syntax :** %NOABORT = ERROR + COMMAND

**Details:**

- ERROR and COMMAND are defined as follows:

ERROR : ignore abort error severity  
COMMAND : ignore abort command

- Any combination of ERROR and COMMAND can be specified.
- If the program is aborted by itself (for example, executing an ABORT statement, run-time error), the %NOABORT directive will be ignored and program execution will be aborted.
- This directive is only effective for programs with %NOLOCKGROUP. If the program has motion control, the %NOABORT directive will be ignored and program execution will be aborted.

### **A.14.3 %NOBUSYLAMP Translator Directive**

**Purpose:** Specifies that the busy lamp will be OFF during execution.

**Syntax:** %NOBUSYLAMP

**Details:**

- The busy lamp can be set during task execution by the SET\_TSK\_ATTR built-in.

### **A.14.4 NODE\_SIZE Built-In Function**

**Purpose:** Returns the size (in bytes) of a PATH node

**Syntax :** NODE\_SIZE(path\_var)

Function Return Type :INTEGER

Input/Output Parameters:

[in] path\_var : PATH

%ENVIRONMENT Group :PATHOP

**Details:**

- The returned value is the size of an individual PATH node, including the positional data type size and any associated data.
- The returned value can be used to calculate file positions for random access to nodes in files.

**Example:** The following example program reads a path, while overlapping reads with preceding moves. The routine **read\_header** reads the path header and prepares for reading of nodes. The routine **read\_node** reads a path node.

### NODE\_SIZE Built-In Function

```

PROGRAM read_and_mov
VAR my_path: PATH
    path_base: INTEGER
    node_size: INTEGER
    max_node_no: INTEGER
    i: INTEGER
    file_var: FILE
ROUTINE read_header

BEGIN
    READ file_var(my_path[0])
    IF IO_STATUS(file_var) <> 0 THEN
        WRITE('HEADER READ ERROR:',IO_STATUS(file_var),cr)
        ABORT
    ENDIF
    max_node_no = PATH_LEN(my_path)
    node_size = NODE_SIZE(my_path)
    path_base = GET_FILE_POS(file_var)
END read_header

ROUTINE read_node(node_no: INTEGER)
--
VAR status: INTEGER
BEGIN
    SET_FILE_POS(file_var, path_base+(node_no-1)*node_size, status)
    READ file_var(my_path[node_no])
END read_node

BEGIN
    SET_FILE_ATR(file_var, atr_uf)
    OPEN FILE F1('RO','PATHFILE.DT')
    read_header
    FOR i = 1 TO max_node_no DO
        read_node(i)
        MOVE TO my_path[i] NOWAIT
    ENDFOR
    CLOSE FILE file_var
END read_and_mov

```

### A.14.5 %NOLOCKGROUP Translator Directive

**Purpose:** Specifies that motion groups do not need to be locked when calling this program, or a routine defined in this program.

**Syntax :** %NOLOCKGROUP

**Details:**

- When the program or routine is called, the task will not attempt to get motion control.
- If %NOLOCKGROUP is not specified, all groups will be locked when the program or routine is called, and the task will attempt to get motion control. The task will pause if it cannot get motion control.
- The task will keep motion control while it is executing the program or routine. When it exits the program or routine, the task automatically unlocks all the motion groups.
- If the task contains executing or stopped motion, then task execution is held until the motion is completed. Stopped motion must be resumed and completed or cancelled.
- If a program that has motion control calls a program with the %NOLOCKGROUP Directive or a routine defined in such a program, the program will keep motion control even though it is not needed.
- The UNLOCK\_GROUP built-in routine can be used to release control.
- If a motion statement is encountered in a program that has the %NOLOCKGROUP Directive, the task will attempt to get motion control for all the required groups if it does not already have it. The task will pause if it cannot get motion control.



**Caution**

Many of the fields in the \$GROUP system variable are initialized to a set of default values when a KAREL task is started, see [KAREL Motion Initialization](#). When %NOLOCKGROUP is specified, this initialization does not occur. Therefore, when a motion is issued the current values of these fields are used. This could cause unexpected motion.

#### KAREL Motion Initialization

```
$GROUP[n].$MOTYPE      = JOINT
$GROUP[n].$TERMTYPE     = FINE
$GROUP[n].$SEGTERMTYPE  = FINE
$GROUP[n].$DECELTOL    = 0
$GROUP[n].$USE_CONFIG   = TRUE
$GROUP[n].$ORIENT_TYPE  = RSWORLD
$GROUP[n].$SPEED        = 300.0
$GROUP[n].$ROTSPEED     = 500.0  ($MRR_GRP[n].$ROTSPEEDLIM x 57.29577951)
$GROUP[n].$CONTAXISVEL = 0.0
```

`$GROUP[n].$SEG_TIME = 0`



### Warning

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** %LOCKGROUP Translator Directive, LOCK\_GROUP, UNLOCK\_GROUP Built-In Procedures

**Example:** Refer to the following sections for detailed program examples:

[Section B.3](#), "Saving Data to the Default Device" (SAVE\_VR.KL)

[Section B.5](#), "Using Register Built-ins" (REG\_EX.KL)

[Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL)

[Section B.11](#), "Manipulating Values of Dynamically Displayed Variables" (CHG\_DATA.KL)

[Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

[Section B.13](#), "Using the DISCTRL\_ALPHA Built-in" (DCALP\_EX.KL)

## A.14.6 NOMESSAGE Action

**Purpose:** Suppresses the display and logging of error messages

**Syntax :** NOMESSAGE

**Details:**

- Display and logging of the error messages are suppressed only for the error number specified in the corresponding condition.
- Use a wildcard (\*) to suppress all messages.
- Abort error messages still will be displayed and logged even if NOMESSAGE is used.

**Example:** Refer to [Section B.1](#) , "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.14.7 NOPAUSE Action

**Purpose:** Resumes program execution if the program was paused, or prevents program execution from pausing

**Syntax :** NOPAUSE

**Details:**

- The NOPAUSE action usually corresponds to an ERROR[n] or PAUSE condition.
- The program will be resumed, even if it was paused before the error.
- If the program is paused by itself, the NOPAUSE action will be ignored and program execution will be paused.

**Example:** The following example uses a global condition handler to test for error number 12311. If this error occurs, the NOPAUSE action will prevent program execution from being paused and the NOMESSAGE action will suppress the error message normally displayed for error number 12311. This will allow the routine **uninit\_error** to be executed without interruption.

#### NOPAUSE Action

```

ROUTINE uninit_error
BEGIN
    WRITE ('Uninitialized operand',CR)
    WRITE ('Use KCL> SET VAR to initialize operand',CR)
    WRITE ('Press Resume at Test/Run screen to ',cr)
    WRITE ('continue program',cr)
    PAUSE --pauses program (undoes NOPAUSE action)
END uninit_error

CONDITION[1]:
WHEN ERROR[12311] DO
    NOPAUSE, NOMESSAGE, uninit_error
ENDCONDITION

```

### A.14.8 %NOPAUSE Translator Directive

**Purpose:** Specifies a mask for pausing

**Syntax :** %NOPAUSE = ERROR + COMMAND + TPENABLE

**Details:**

- The bits for the mask are as follows:

```

ERROR : ignore pause error severity
COMMAND : ignore pause command

```

TPENABLE : ignore paused request when TP enabled

- Any combination of ERROR, COMMAND, and TPENABLE can be specified.
- If the program is paused by itself, the %NOPAUSE directive will be ignored and program execution will be paused.
- This directive is only effective for programs with %NOLOCKGROUP. If the program has motion control, the %NOPAUSE Directive will be ignored and program execution will be paused.

### **A.14.9 %NOPAUSESHFT Translator Directive**

**Purpose:** Specifies that the task is not paused if shift key is released.

**Syntax :** %NOPAUSESHFT

**Details:**

- This attribute can be set during task execution by the SET\_TSK\_ATTR built-in routine.

### **A.14.10 NOWAIT Clause**

**Purpose:** Allows program execution to overlap with motion or a pulse

**Syntax :** NOWAIT

**Details:**

- If NOWAIT is included in a motion statement, the next statement will be executed at the same time motion begins.
- NOWAIT follows the motion specification of a MOVE statement and the VIA clause but precedes any condition handler clauses.
- If NOWAIT is not included, the next statement will be executed when the motion is completed or canceled.
- A NOWAIT motion will be canceled at the time the CANCEL action or statement is executed.

**See Also:** PULSE Statement, MOVE Statements Syntax Diagrams, [Appendix E “Syntax Diagrams”](#)

**Example:** In the following example, the NOWAIT clause is used so that all statements will be executed at the same time.

#### **NOWAIT Clause**

```
PULSE DOUT[2] FOR 50 NOWAIT
```

```
MOVE TO p1 NOWAIT
```

```
DOUT[1] = ON
```

## A.15 - O - KAREL LANGUAGE DESCRIPTION

### A.15.1 OPEN FILE Statement

**Purpose:** Associates a data file or communication port with a file variable

**Syntax :** OPEN FILE file\_var ( usage\_string, file\_string)

where:

file\_var : FILE

usage\_string : a STRING

file\_string : a STRING

**Details:**

- *file\_var* must be a static variable not already in use by another OPEN FILE statement.
- The *usage\_string* is composed of the following:

‘RO’ :Read only

‘RW’ :Read write

‘AP’ :Append

‘UD’ :Update

- The *file\_string* identifies a data file name and type, a window or keyboard, or a communication port.
- The SET\_FILE\_ATR built-in routine can be used to set a file’s attributes.
- When a program is aborted or exits normally, any opened files are closed. Files are not closed when a program is paused.
- Use the IO\_STATUS built-in function to verify if the open file operation was successful.

**See Also:** IO\_STATUS Built-In Function, SET\_FILE\_ATR Built-In Procedure, [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#) , [Chapter 9 FILE SYSTEM](#) , [Appendix E](#), “Syntax Diagrams” for more syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

[Section B.12 , "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

### A.15.2 OPEN HAND Statement

**Purpose:** Opens a hand on the robot

**Syntax :** OPEN HAND hand\_num

where:

hand\_num : an INTEGER expression

**Details:**

- The actual effect of the statement depends on how the HAND signals are set up. Refer to Chapter 13, “Input/Output System.”
- *hand\_num* must be a value in the range 1-2. Otherwise, the program is aborted with an error.
- The statement has no effect if the value of *hand\_num* is in range but the hand is not connected.
- If the value of **hand\_num** is in range but the HAND signal represented by that value has not been assigned, the program is aborted with an error.

**See Also:** Appendix D, “Syntax Diagrams” for more syntax information

**Example:** The following example moves the TCP to the position **p2** and opens the hand of the robot specified by the INTEGER variable **hand\_num**.

#### **OPEN HAND Statement**

```
MOVE TO p2
OPEN HAND hand_num
```

### A.15.3 OPEN\_TPE Built-In Procedure

**Purpose:** Opens the specified teach pendant program

**Syntax :** OPEN\_TPE(prog\_name, open\_mode, reject\_mode, open\_id, status)

Input/Output Parameters:

[in] prog\_name :STRING

[in] open\_mode :INTEGER

[in] reject\_mode :INTEGER

[out] open\_id :INTEGER  
[out] status :INTEGER  
%ENVIRONMENT Group :PBCORE

**Details:**

- *prog\_name* specifies the name of the teach pendant program to be opened. *prog\_name* must be in all capital letters.
- *prog\_name* must be closed, using CLOSE\_TPE, before *prog\_name* can be executed.
- *open\_mode* determines the access code to the program. The access codes are defined as follows:

0 : none

TPE\_RDACC : Read Access

TPE\_RWACC : Read/Write Access

- *reject\_mode* determines the reject code to the program. The program that has been with a reject code cannot be opened by another program. The reject codes are defined as follows:

TPE\_NOREJ : none

TPE\_RDREJ : Read Reject

TPE\_WRTREJ : Write Reject

TPE\_RWREJ : Read/Write Reject

TPE\_ALLREJ : All Reject

- *open\_id* indicates the id number of the opened program.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.
- All open teach pendant programs are closed automatically when the KAREL program is aborted or exits normally.

**See Also:** CREATE\_TPE Built-In Procedure, COPY\_TPE Built-In Procedure, AVL\_POS\_NUM Built-In Procedure

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

### A.15.4 ORD Built-In Function

**Purpose:** Returns the numeric ASCII code corresponding to the character in the STRING argument that is referenced by the index argument

**Syntax :** ORD(str, str\_index)

Function Return Type :INTEGER

Input/Output Parameters:

[in] str :STRING

[in] str\_index :INTEGER

%ENVIRONMENT Group :SYSTEM

**Details:**

- The returned value represents the ASCII numeric code of the specified character.
- *str\_index* specifies the indexed position of a character in the argument *str*. A value of 1 indicates the first character.
- If *str\_index* is less than one or greater than the current length of *str*, the program is paused with an error.

**See Also:** [Appendix D](#), “Character Codes”

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### A.15.5 ORIENT Built-In Function

**Purpose:** Returns a unit VECTOR representing the y-axis (orient vector) of the specified POSITION argument

**Syntax :** ORIENT(posn)

Function Return Type :VECTOR

Input/Output Parameters:

[in] posn : POSITION

%ENVIRONMENT Group :VECTR

**Details:**

- Instead of using this built-in, you can directly access the Orient Vector of a POSITION.
- The returned value is the orient vector of *posn*.
- The orient vector is the positive y-direction in the tool coordinate frame.

**Example:** The following example initially moves the TCP to the POSITION **start\_pos**. The VECTOR **pos\_vector** is then set to the value of the orient vector for **start\_pos**. The MOVE ABOUT statement moves the TCP about **pos\_vector** by 45°.

**ORIENT Built-In Function**

```
MOVE TO start_pos  
  
pos_vector = ORIENT (start_pos)  
MOVE ABOUT pos_vector BY 45
```

## A.16 - P - KAREL LANGUAGE DESCRIPTION

### A.16.1 PATH Data Type

**Purpose:** Defines a variable or routine parameter as PATH data type

**Syntax :** PATH

**Details:**

- A PATH is a varying length list of elements called path nodes, numbered from 1 to the number of nodes in the PATH.
- No valid operators are defined for use with PATH variables.
- A PATH variable is indexed (or subscripted) as if it were an ARRAY variable. For example, *tool\_track[1]* refers to the first node of a PATH called *tool\_track*.
- An uninitialized PATH has a length of zero.
- PATH variables cannot be declared local to routines and cannot be returned from functions.
- Only PATH expressions can be assigned to PATH variables or passed as arguments to PATH parameters.
- A PATH variable can specify a data structure constituting the data for each path node.
- A PATH variable can specify a data structure constituting the path header. This can be used to specify the UFRAME and/or UTOOL to be used with recording or moving along the path. It can also specify an axis group whose current position defines a table-top coordinate frame with respect to which the robot data is recorded and moved.

- A PATH can be declared with either, neither, or both of the following clauses following the word PATH:
  - NODEDATA = node\_struct\_name, specifying the data structure constituting a path node.
  - PATHHEADER = header\_struct\_name, specifying the structure constituting the path header.

If both fields are present, they can appear in either order and are separated by a comma and optionally a new line.

- If NODEDATA is not specified, it defaults to the STD\_PTH\_NODE structure described in Appendix A.
- If PATHHEADER is not specified, there is no (user-accessible) path header.
- An element of the PATHHEADER structure can be referenced with the syntax path\_var\_name.header\_field\_name.
- An element of a NODEDATA structure can be referenced with the syntax path\_var\_name[node\_no].node\_field\_name.
- The path header structure can be copied from one path to another with the path\_var1 = path\_var2 statement.
- The path node structure can be copied from one node to another with the path\_var[2] = path\_var[1] statement.
- A path can be passed as an argument to a routine as long as the PATHHEADER and NODEDATA types match. A path that is passed as an argument to a built-in routine can be of any type.
- A path node can be passed as an argument to a routine as long as the routine parameter is the same type as the NODEDATA structure.
- If the data structure specified for NODEDATA in a path includes more than one position data type for the same group, only the first for that group will be used in move statements specifying the path.
- PATHs provide the ability to specify motion groups to be used for local condition handlers.
- A path can be declared with a NODEDATA structure having no position type elements. This can be a useful way of maintaining a list structure. Such a path can not be used in a MOVE statement.

**See Also:** APPEND\_NODE, DELETE\_NODE, INSERT\_NODE Built-In Procedures, PATH\_LEN, NODE\_SIZE Built-In Functions

**Example:** The following example shows different declarations of PATH variables.

### PATH Data Type

TYPE

```

node_struct = STRUCTURE
    node_posn: XYZWPR IN GROUP[1]
    node_data: GROUP_ASSOC IN GROUP[1]
    aux_posn: JOINTPOS IN GROUP[2]
    common_data: COMMON_ASSOC
  
```

```

weld_time: INTEGER
weld_current: INTEGER
ENDSTRUCTURE

std_pth_node = STRUCTURE -- This type is predefined
node_pos: POSITION IN GROUP[1]
group_data: GROUP_ASSOC IN GROUP[1]
common_data: COMMON_ASSOC
ENDSTRUCTURE

hdr_struct = STRUCTURE
uframe1: POSITION
utool: POSITION
speed: REAL
ENDSTRUCTURE

VAR
path_1a: PATH PATHHEADER = hdr_struct, NODEDATA = node_struct
path_1b: PATH NODEDATA = node_struct, PATHHEADER = hdr_struct
path_2: PATH NODEDATA = node_struct -- no header
path_3: PATH -- equivalent to PATH NODEDATA = std_pth_node
path_4: PATH PATHHEADER = hdr_struct -- std_pth_node

```

The following example shows how an element of a NODEDATA structure can be referenced.

### PATH Data Type

```

-- Using declaration for path_1a:

-- Using NODEDATA fields:

path_1a[1].node_posn = CURPOS(0, 0)
cnt_dn_time = path_1a[node_no].weld_time
path_1a[1].node_data.SEGRELSPEED = new_value
path_1a[1].common_data.SEGTERMTYPE = new_value

-- Using PATHHEADER fields:

path_1a.utool = tool_1
WITH $UFRAME = path_1a.uframe, $SPEED = path_1a.speed
MOVE ALONG path_1a

```

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

### **A.16.2 PATH\_LEN Built-In Function**

**Purpose:** Returns the number of nodes in the PATH argument

**Syntax :** PATH\_LEN(path\_nam)

Function Return Type : INTEGER

Input/Output Parameters :

[in] path\_nam : PATH

%ENVIRONMENT Group :PBCORE

**Details:**

- The returned value corresponds to the number of nodes in the PATH variable argument.
- Calling PATH\_LEN with an uninitialized PATH returns a value of zero.

**See Also:** COPY\_PATH Built-in

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

### **A.16.3 PAUSE Action**

**Purpose:** Suspends execution of a running task

**Syntax :** PAUSE <PROGRAM[n]>

**Details:**

- The PAUSE action pauses task execution in the following manner:
  - Any motion already initiated continues until completed.
  - Files are left open.
  - All connected timers continue being incremented.
  - All PULSE statements in execution continue execution.

- Sensing of conditions specified in condition handlers continues.
- Any Actions, except routine call actions, are completed. Routine call actions are performed when the program is resumed.
- The PAUSE action can be followed by the clause PROGRAM[n], where n is the task number to be paused.
- Use GET\_TSK\_INFO to find a task number.

**See Also:** UNPAUSE Action

#### **A.16.4 PAUSE Condition**

**Purpose:** Monitors the pausing of program execution

**Syntax :** PAUSE < PROGRAM [n] >

**Details:**

- The PAUSE condition is satisfied when a program is paused, for example, by an error, a PAUSE Statement, or the PAUSE Action.
- If one of the actions corresponding to a PAUSE condition is a routine call, it is necessary to specify a NOPAUSE action to allow execution of the routine.

Also, the routine being called needs to include a PAUSE statement so the system can handle completely the cause of the original pause.

- The PAUSE condition can be followed by the clause PROGRAM[n], where n is the task number to be paused.
- Use GET\_TSK\_INFO to find a task number.

**Example:** The following example scans for the PAUSE condition in a global condition handler. If this condition is satisfied, DOUT[1] will be turned on. The CONTINUE action continues program execution; ENABLE reenables the condition handler.

##### **PAUSE Condition**

```
CONDITION[1] :  
    WHEN PAUSE DO  
        DOUT[1] = TRUE  
        CONTINUE  
        ENABLE CONDITION[1]  
    ENDCONDITION
```

### **A.16.5 PAUSE Statement**

**Purpose:** Suspends execution of a KAREL program

**Syntax :** PAUSE < PROGRAM [n] >

**Details:**

- The PAUSE statement pauses program execution in the following manner:
  - Any motion already initiated continues until completed.
  - Files are left open.
  - All connected timers continue being incremented.
  - All PULSE statements in execution continue execution.
  - Sensing of conditions specified in condition handlers continues.
  - Any actions, except routine call actions, are completed. Routine call actions are performed when the program is resumed.
- The PAUSE statement can be followed by the clause PROGRAM[n], where n is the task number to be paused.
- Use GET\_TSK\_INFO to find a task number.

**See Also:** [Appendix E, “Syntax Diagrams,”](#) for more syntax information

**Example:** If DIN[1] is TRUE, the following example pauses the KAREL program using the PAUSE statement. The message, “Program is paused. Press RESUME function key to continue” will be displayed on the CRT/KB screen.

#### **PAUSE Statement**

```
PROGRAM p_pause

BEGIN
  IF DIN[1] THEN
    WRITE ('Program is Paused. ')
    WRITE ('Press RESUME function key to continue', CR)
    PAUSE
  ENDIF
END p_pause
```

## A.16.6 PAUSE\_TASK Built-In Procedure

**Purpose:** Pauses the specified executing task

**Syntax :** PAUSE\_TASK(task\_name, force\_sw, stop\_mtn\_sw, status)

Input/Output Parameters:

[in] task\_name :STRING

[in] force\_sw :BOOLEAN

[in] stop\_mtn\_sw :BOOLEAN

[out] status :INTEGER

%ENVIRONMENT Group :MULTI

### Details:

- *task\_name* is the name of the task to be paused. If task name is '\*ALL\*', all executing tasks are paused except the tasks that have the "ignore pause request" attribute set.
- *force\_sw* specifies whether a task should be paused even if the task has the "ignore pause request" attribute set. This parameter is ignored if *task\_name* is '\*ALL\*'.
- *stop\_mtn\_sw* specifies whether all motion groups belonging to the specified task are stopped.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** RUN\_TASK, CONT\_TASK, ABORT\_TASK Built-In Procedures, [Chapter 15 MULTI-TASKING](#)

**Example:** The following example pauses the user-specified task and stops any motion. Refer to [Chapter 15 MULTI-TASKING](#), for more examples.

### PAUSE\_TASK Built-In Procedure

```
PROGRAM pause_ex

%ENVIRONMENT MULTI

VAR
    task_str: STRING[12]
    status   : INTEGER

BEGIN
```

```

    WRITE('Enter task name to pause:')
    READ(task_str)
    PAUSE_TASK(task_str, TRUE, TRUE, status)

END pause_ex

```

### **A.16.7 PEND\_SEMA Built-In Procedure**

**Purpose:** Suspends execution of the task until either the value of the semaphore is greater than zero or max\_time expires

**Syntax :** PEND\_SEMA(semaphore\_no, max\_time, time\_out)

Input/Output Parameters:

- [in] semaphore\_no :INTEGER
- [in] max\_time :INTEGER
- [out] time\_out :BOOLEAN

%ENVIRONMENT Group :MULTI

**Details:**

- PEND\_SEMA decrements the value of the semaphore.
- *semaphore\_no* specifies the semaphore number to use.
- *semaphore\_no* must be in the range of 1 to the number of semaphores defined on the controller.
- *max\_time* specifies the expiration time, in milliseconds. A *max\_time* value of -1 indicates to wait forever, if necessary.
- On continuation, *time\_out* is set TRUE if *max\_time* expired without the semaphore becoming nonzero, otherwise it is set FALSE.

**See Also:** POST\_SEMA, CLEAR\_SEMA Built-In Procedures, SEMA\_COUNT Built-In Function, [Chapter 15 MULTI-TASKING](#)

**Example:** See examples in [Chapter 15 MULTI-TASKING](#)

### **A.16.8 PIPE\_CONFIG Built-In Procedure**

**Purpose:** Configure a pipe for special use.

**Syntax :** pipe\_config(pipe\_name, cmos\_flag, n\_sectors, record\_size, form\_dict, form\_ele, status)

Input/Output Parameters :

[in] pipe\_name :STRING  
[in] cmos\_flag :BOOLEAN  
[in] n\_sectors :INTEGER  
[in] record\_size :INTEGER  
[in] form\_dict :STRING  
[in] form\_ele :INTEGER  
[out] status :INTEGER  
%ENVIRONMENT Group :FLBT

**Details:**

- pipe\_name is the name of the pipe file. If the file does not exist it will be created with this operation.
- CMOS\_flag if set to TRUE will put the pipe data in CMOS. By default pipe data is in DRAM.
- n\_sectors number of 1024 byte sectors to allocate to the pipe. The default is 8.
- record\_size the size of a binary record in a pipe. If set to 0 the pipe is treated as ASCII. If a pipe is binary and will be printed as a formatted data then this must be set to the record length.
- form\_dict is the name of the dictionary containing formatting information.
- form\_ele is the element number in form\_dict containing the formatting information.
- status explains the status of the attempted operation. If it is not equal to 0, then an error occurred.

**See Also:** For further information see "PIP: Device" in [Section 9.2.3](#) .

### **A.16.9 POP\_KEY\_RD Built-In Procedure**

**Purpose:** Resumes key input from a keyboard device

**Syntax :** POP\_KEY\_RD(key\_dev\_name, pop\_index, status)

Input/Output Parameters:

[in] key\_dev\_name :STRING  
[in] pop\_index :INTEGER

[out] status :INTEGER  
 %ENVIRONMENT Group :PBCORE

**Details:**

- Resumes all suspended read requests on the specified keyboard device.
- If there were no read requests active when suspended, this operation will not resume any inputs. This is not an error.
- *key\_dev\_name* must be one of the keyboard devices already defined:

'TPKB' :Teach Pendant Keyboard Device

'CRKB' :CRT Keyboard Device

- *pop\_id* is returned from PUSH\_KEY\_RD and should be used to re-activate the read requests.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** PUSH\_KEY\_RD, READ\_KB Built-in Procedures

**Example:** Refer to the example for the READ\_KB Built-In Routine.

**A.16.10 Port\_Id Action**

**Purpose:** Sets the value of a port array element to the result of an expression

**Syntax :** port\_id[n] = expression

where:

port\_id :an output port array

n :an INTEGER

expression :a variable, constant, or EVAL clause

**Details:**

- The value of *expression* is assigned to the port array element referenced by *n* .
- The port array must be an output port array that can be written to by a KAREL program. Refer to Chapter 2, “Language Elements.”
- *expression* can be a user-defined, static variable, a system variable that can be read by a KAREL program, any constant, or an EVAL clause.

- If *expression* is a variable, the value used is the current value of the variable at the time the action is taken, not when the condition handler is defined.
- If *expression* is an EVAL clause, it is evaluated when the condition handler is defined and that value is assigned when the action is taken.
- The expression must be of the same type as *port\_id*.
- You cannot assign a port array element to a port array element directly.
- If the expression is a variable that is uninitialized when the condition handler is enabled, the program will be aborted with an error.

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#) , Relational Conditions, Appendix A, “KAREL Language Alphabetical Description”

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.16.11 Port\_Id Condition**

**Purpose:** Monitors a digital port signal

**Syntax :** <NOT> port\_id[n] < + | - >

where:

port\_id : a port array

n : an INTEGER

**Details:**

- *n* specifies the port array signal to be monitored.
- *port\_id* must be one of the predefined BOOLEAN port array identifiers with read access. Refer to Chapter 2, “Language Elements.”
- For event conditions, only the + or - alternatives are used.
- For state conditions, only the NOT alternative is used.

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#) , Relational Conditions, Appendix A, “KAREL Language Alphabetical Description”

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.16.12 POS Built-In Function

**Purpose:** Returns an XYZWPR composed of the specified location arguments (x,y,z), orientation arguments (w,p,r), and configuration argument (c)

**Syntax :** POS(x, y, z, w, p, r, c)

Function Return Type : XYZWPR

Input/Output Parameters:

[in] x, y, z, w, p, and r :REAL

[in] c :CONFIG

%ENVIRONMENT Group :SYStem

**Details:**

- *c* must be a valid configuration for the robot attached to the controller. CNV\_STR\_CONF can be used to convert a string to a CONFIG variable.
- *x*, *y*, and *z* are the Cartesian values of the location (in millimeters). Each argument must be in the range  $\pm 10000000$  mm ( $\pm 10$  km). Otherwise, the program is paused with an error.
- *w*, *p*, and *r* are the yaw, pitch, and roll values of the orientation (in degrees). Each argument must be in the range  $\pm 180$  degrees. Otherwise, the program is paused with an error.

**See Also:** [Chapter 8 MOTION](#)

**Example:** The following example uses the POS Built-In to designate numerically the POSITION next\_pos and then moves the TCP to that position.

#### **POS Built-In Function**

```
CNV_STR_CONF( 'n' , config_var , status )
next_pos = POS(100,-400.25,0.5,10,-45,30,config_var)
MOVE TO next_pos
```

### A.16.13 POS2JOINT Built-In Function

**Purpose:** This routine is used to convert Cartesian positions (in\_pos) to joint angles (out\_jnt) by calling the inverse kinematics routine.

**Syntax :** POS2JOINT (in\_pos, uframe, utool, config\_ref, wjnt\_cfg, ext\_ang, out\_jnt, and status).

Input/Output Parameters:

```
[in] ref_jnt :Jointpos  
[in] in_pos :POSITION  
[in] uframe :POSITION  
[in] utool :POSITION  
[in] config_ref :INTEGER  
[in] wjnt_cfg :CONFIG  
[in] ext_ang :ARRAY OF REAL  
[out] out_jnt :JOINTPOS  
[out] status :INTEGER  
%ENVIRONMENT Group :MOTN
```

**Details:**

- The input *ref\_jnt* are the reference joint angles that represent the robot's position just before moving to the current position.
- The input *in\_pos* is the robot Cartesian position to be converted to joint angles.
- The input *uframe* is the user frame for the Cartesian position.
- The input *utool* is the corresponding tool frame.
- The input *config\_ref* is an integer representing the type of solution desired. The values listed below are valid. Also, the pre-defined constants in the parentheses can be used and the values can be added as required. One example includes: *config\_ref* = HALF\_SOLN + CONFIG\_TCP.
  - 0 :(FULL\_SOLN) = Default
  - 1 :(HALF\_SOLN) = Wrist joint (XYZ456). This does not calculate/use WPR.
  - 2 :(CONFIG\_TCP) = The Wrist Joint Config (up/down) is based on the fixed wrist.
  - 4 :(APPROX\_SOLN) = Approximate solution. Reduce calculation time for some robots.
  - 8 :(NO\_TURNS) = Ignore wrist turn numbers. Use the closest path for joints 4, 5 and 6 (uses *ref\_jnt*).
  - 16 :(NO\_M\_TURNS) = Ignore major axis (J1 only) turn number. Use the closest path.
- The input *wjnt\_cfg* is the wrist joint configuration. This value must be input when *config\_ref* corresponds to HALF\_SOLN.
- The input *ext\_ang* contains the values of the joint angles for the extended axes if they exist.
- The output *out\_jnt* are the joint angles that correspond to the Cartesian position

- The output *status* explains the status of the attempted operation. If it is not equal to 0, then an error has occurred.

### **A.16.14 POS\_REG\_TYPE Built-In Procedure**

**Purpose:** Returns the position representation of the specified position register

**Syntax :** POS\_REG\_TYPE (register\_no, group\_no, posn\_type, num\_axes, status)

Input/Output Parameters :

[in] register : INTEGER

[in] group\_no : INTEGER

[out] posn\_type : INTEGER

[out] num\_axes : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the position register.
- If *group\_no* is omitted, the default group for the program is assumed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.
- *posn\_type* returns the position type. *posn\_type* is defined as follows:
  - 1 :POSITION
  - 2 :XYZWPR
  - 6 :XYZWPREXT
  - 9 :JOINTPOS
- *num\_axes* returns number of axes in the representation if the position type is a JOINTPOS. If the position type is an XYZWPREXT, only the number of extended axes is returned by *num\_axes*.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** GET\_POS\_REG, GET\_JPOS\_REG, SET\_POS\_REG, SET\_JPOS\_REG Built-in Procedures

**Example:** The following example determines the position type in the register and uses the appropriate built-in to get data.

**POS\_REG\_TYPE Built-In Procedure**

```
PROGRAM get_reg_data
%NOLOCKGROUP
%ENVIRONMENT REGOPEN

VAR
    entry: INTEGER
    group_no: INTEGER
    jpos: JOINTPOS
    maxpregnum: integer
    num_axes: INTEGER
    posn_type: INTEGER
    register_no: INTEGER
    status: INTEGER
    xyz: XYZWPR
    xyzext: XYZWPREXTBEGIN
    group_no = 1

    GET_VAR(entry, '*POSREG*', '$MAXPREGNUM', maxpregnum, status)

    -- Loop for each register
    FOR register_no = 1 to 10 DO

        -- Get the position register type
        POS_REG_TYPE(register_no, group_no, posn_type, num_axes, status)

        -- Get the position register
        WRITE('PR[', register_no, '] of type ', posn_type, CR)
        SELECT posn_type OF
            CASE (2):
                xyz = GET_POS_REG(register_no, status)
            CASE (6):
                xyzext = GET_POS_REG(register_no, status)
            CASE (9):
                jpos = GET_JPOS_REG(register_no, status)
            ELSE:
                ENDSELECT
        ENDFOR
    END get_reg_data
```

## A.16.15 POSITION Data Type

**Purpose:** Defines a variable, function return type, or routine parameter as POSITION data type

**Syntax :** POSITION <IN GROUP[n]>

**Details:**

- A POSITION consists of a matrix defining the normal, orient, approach, and location vectors and a component specifying a configuration string, for a total of 56 bytes.
- The configuration string indicates the joint placements and multiple turns that describe the configuration of the robot when it is at a particular position.
- A POSITION is always referenced with respect to a specific coordinate frame.
- The POSITION data type can be used to represent a frame of reference in which case the configuration component is ignored.
- Coordinate frame transformations can be done using the relative position operator (:).
- A POSITION can be assigned to other positional types.
- Valid POSITION operators are the
  - Relative position (:) operator
  - Approximately equal (>=<) operator
- A POSITION can be followed by IN GROUP[n], where n indicates the motion group with which the data is to be used. The default is the group specified by the %DEFGROUP directive, or 1.
- Components of POSITION variables can be accessed or set as if they were defined as follows:

### POSITION Data Type

```

POSITION = STRUCTURE
    NORMAL: VECTOR          -- read-only
    ORIENT: VECTOR          -- read-only
    APPROACH: VECTOR         -- read-only
    LOCATION: VECTOR         -- read-write
    CONFIG_DATA: CONFIG      -- read-write
ENDSTRUCTURE
  
```

**See Also:** [Chapter 8 MOTION](#), POS, UNPOS Built-In Functions

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.16.16 POST\_ERR Built-In Procedure

**Purpose:** Posts the error code and reason code to the error reporting system to display and keep history of the errors

**Syntax:** POST\_ERR(error\_code, parameter, cause\_code, severity)

Input/Output Parameters:

[in] error\_code :INTEGER

[in] parameter :STRING

[in] cause\_code :INTEGER

[in] severity :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *error\_code* is the error to be posted.
- *parameter* will be included in *error\_code*'s message if %s is specified in the dictionary text. If not necessary, then enter the null string.
- *cause\_code* is the reason for the error. 0 can be used if no cause is applicable.
- *error\_code* and *cause\_code* are in the following format:  
ffccc (decimal)

where

**ff** represents the facility code of the error. specified facility.

**ccc** represents the error code within the

- *severity* is defined as follows:

0 : WARNING, no change in task execution

1 : PAUSE, all tasks and stop all motion all motion

2 : ABORT, all tasks and cancel

**See Also:** ERR\_DATA Built-In Procedure, the appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual*, "Error Codes"

**Example:** Refer to [Section B.13](#), "Using the DISCTRL\_ALPHA Built-in" (DCALP\_EX.KL), for a detailed program example.

### **A.16.17 POST\_SEMA Built-In Procedure**

**Purpose:** Add one to the value of the indicated semaphore

**Syntax :** POST\_SEMA(semaphore\_no)

Input/Output Parameters:

[in] semaphore\_no : INTEGER

%ENVIRONMENT Group : MULTI

**Details:**

- The semaphore indicated by *semaphore\_no* is incremented by one.
- *semaphore\_no* must be in the range of 1 to the number of semaphores defined on the controller.

**See Also:** PEND\_SEMA, CLEAR\_SEMA Built-In Procedures, SEMA\_COUNT Built-In Function, [Chapter 15 MULTI-TASKING](#),

**Example:** See examples in [Chapter 15 MULTI-TASKING](#).

### **A.16.18 PRINT\_FILE Built-In Procedure**

**Purpose:** Prints the contents of an ASCII file to a serial printer

**Syntax :** PRINT\_FILE(file\_spec, nowait\_sw, status)

Input/Output Parameters:

[in] file\_spec : STRING

[in] nowait\_sw : BOOLEAN

[out] status : INTEGER

%ENVIRONMENT Group : FDEV

**Details:**

- *file\_spec* specifies the device, name, and type of the file to print.
- If *nowait\_sw* is TRUE, execution of the program continues while the command is executing. If it is FALSE, the program stops, including condition handlers, until the operation has completed. If you have time critical condition handlers in your program, put them in another program that executes as a separate task.

**Note** *nowait\_sw* is not available in this release and should be set to FALSE.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

## **A.16.19 %PRIORITY Translator Directive**

**Purpose:** Specifies task priority

**Syntax :** %PRIORITY = n

**Details:**

- *n* is the priority and is defined as follows:  
1 to 89 : lower than motion, higher than user interface  
90 to 99 : lower than user interface
- The lower the value, the higher the task priority.
- The default priority is 50. Refer to [Section 15.4, "Task Scheduling"](#) for more information on how the specified priority is converted into the system priority.
- The priority can be set during task execution by the SET\_TSK\_ATTR Built-In routine.

**Example:** Usually an error handling task pends on an error and when an error occurs, it processes the error recovery as soon as possible. In this case, the error handling task might need to have a higher priority than other tasks, so “n” should be less than 50.

## **%PRIORITY Translator Directive**

```
%PRIORITY = 49
```

## **A.16.20 PROG\_LIST Built-In Procedure**

**Purpose:** Returns a list of program names.

**Syntax :** prog\_list(prog\_name, prog\_type, n\_skip, format, ary\_name, n\_progs <,f\_index>)

**Input/Output Parameters :**

[in] prog\_name :STRING

[in] prog\_type :INTEGER

[in] n\_skip :INTEGER

[in] format :INTEGER

[out] ary\_name :ARRAY of string  
 [out] n\_progs :INTEGER  
 [out] status :INTEGER  
 [in,out] f\_index :INTEGER  
 %ENVIRONMENT Group :BYNAM

**Details:**

- *prog\_name* specifies the name of the program(s) to be returned in *ary\_name*. *prog\_name* may use the wildcard (\*) character, to indicate that all programs matching the *prog\_type* should be returned in *ary\_name*.
- *prog\_type* specifies the type of programs to be retrieved. The valid types are:
  - 1 :VR - programs which contain only variables
  - 2 :JB, PR, MR, TP3 :JB - job programs only
  - 4 :PR - process programs only
  - 5 :MR - macro programs only
  - 6 :PC - KAREL programs only
  - 7 :all programs VR, JB, PR, MR, TP, PC
  - 8 :all programs except VR
- *n\_skip* is used when more programs exist than the declared length of *ary\_name*. Set *n\_skip* to 0 the first time you use PROG\_LIST. If *ary\_name* is completely filled with program names, copy the array to another ARRAY of STRINGS and execute PROG\_LIST again with *n\_skip* equal to *n\_skip* + *n\_progs*. The call to PROG\_LIST will then skip the programs found in the previous passes and locate only the remaining programs.
- *format* specifies the format of the program name. The following values are valid for *format* :
  - 1 :program name only, no blanks
  - 2 :'program name program type'  
total length = 15 characters
- *prog\_name* = 12 characters followed by a space
- *prog\_type* = 2 characters
- *ary\_name* is an ARRAY of STRING used to store the program names.

- *n\_progs* is the number of variables stored in the *ary\_name* .
- *status* will return zero if successful.
- *f\_index* is an optional parameter for fast indexing. If you specify *prog\_name* as a complex wildcard (anything other than the straight \*), then you should use this parameter. The first call to PROG\_LIST set *f\_index* and *n\_skip* both to zero. *f\_index* will then be used internally to quickly find the next *prog\_name*. DO NOT change *f\_index* once a listing for a particular *prog\_name* has begun.

**See Also:** VAR\_LIST Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.7, "Listing Files and Programs and Manipulating Strings" \(LIST\\_EX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

## **A.16.21 PROGRAM Statement**

**Purpose:** Identifies the program name in a KAREL source program

**Syntax :** PROGRAM *prog\_name*

where:

*prog\_name* : a valid KAREL identifier

**Details:**

- It must be the first statement (other than comments) in a program.
- The identifier used to name a program cannot be used in the program for any other purpose, such as to identify a variable or constant.
- *prog\_name* must also appear in the END statement that marks the end of the executable section of the program.
- The program name can be used to call the program as a procedure routine from within a program in the same way routine names are used to call procedure routines.

**Example:** Refer to [Appendix B, "KAREL Example Programs,"](#) for more detailed examples of how to use the PROGRAM Statement.

## A.16.22 PULSE Action

**Purpose:** Pulses a digital output port for a specified number of milliseconds

**Syntax :** PULSE DOUT[port\_no] FOR time\_in\_ms

where:

port\_no : an INTEGER variable or literal

time\_in\_ms : an INTEGER

**Details:**

- *port\_no* must be a valid digital output port number.
- *time\_in\_ms* specifies the duration of the pulse in milliseconds.
- If *time\_in\_ms* duration is zero, no pulse will occur. Otherwise, the period is rounded up to the next multiple of 8 milliseconds.
- A pulse always turns on the port at the start of the pulse and turns off the port at the end of the pulse.
- If the port is “normally on,” negative pulses can be accomplished by setting the port to reversed polarity, or by executing the following sequence:  
DOUT[n] = FALSE  
DELAY x  
DOUT[n] = TRUE
- NOWAIT is not allowed in a PULSE action.
- If the program is paused while a pulse is in progress, the pulse will end at the correct time.
- If the program is aborted while a pulse is in progress, the port stays in whatever state it was in when the abort occurred.
- If *time\_in\_ms* is negative or greater than 86,400,000 (24 hours), the program is aborted with an error.

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#)

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

## A.16.23 PULSE Statement

**Purpose:** Pulses a digital output port for a specified number of milliseconds.

**Syntax :** PULSE DOUT[port\_no] FOR time\_in\_ms < NOWAIT >

where:

port\_no : an INTEGER variable or literal

time\_in\_ms : an INTEGER

**Details:**

- *port\_no* must be a valid digital output port number.
- *time\_in\_ms* specifies the duration of the pulse in milliseconds.
- If *time\_in\_ms* duration is zero, no pulse will occur. Otherwise, the period is rounded up to the next multiple of 8 milliseconds.

The actual duration of the pulse will be from zero to 8 milliseconds less than the rounded value.

For example, if 100 is specified, it is rounded up to 104 (the next multiple of 8) milliseconds. The actual duration will be from 96 to 104 milliseconds.

- A pulse always turns on the port at the start of the pulse and turns off the port at the end of the pulse.
- If the port is “normally on,” negative pulses can be accomplished by setting the port to reversed polarity, or by executing the following sequence:  
DOUT[n] = FALSE  
DELAY x  
DOUT[n] = TRUE
- If NOWAIT is specified in a PULSE statement, the next KAREL statement will be executed concurrently with the pulse.
- If NOWAIT is not specified in a PULSE statement, the next KAREL statement will not be executed until the pulse is completed.

**See Also:** [Appendix E](#), “Syntax Diagrams” for more syntax information

**Example:** In the following example a digital output is pulsed, followed by the pulsing of a second digital output. Because NOWAIT is specified, **DOUT[start\_air]** will be executed before **DOUT[5]** is completed.

**PULSE Statement**

```
PULSE DOUT[5] FOR (seconds * 1000) NOWAIT
PULSE DOUT[start_air] FOR 50 NOWAIT
```

### A.16.24 PURGE CONDITION Statement

**Purpose:** Deletes the definition of a condition handler from the system

**Syntax :** PURGE CONDITION[cond\_hand\_no]

where:

cond\_hand\_no : an INTEGER expression

**Details:**

- The statement has no effect if there is no condition handler defined with the specified number.
- The PURGE CONDITION Statement is used only to purge global condition handlers.
- The PURGE CONDITION Statement will purge enabled conditions.
- If a condition handler with the specified number was previously defined, it must be purged before it is replaced with a new one.

**See Also:** ENABLE CONDITION Statement[Chapter 6 CONDITION HANDLERS](#) , Appendix E, “Syntax Diagrams” for more syntax information

**Example:** In the following example, if the BOOLEAN variable **ignore\_cond** is TRUE, the global condition handler, CONDITION[1], will be purged using the PURGE statement; otherwise CONDITION[1] is enabled.

#### **PURGE CONDITION Statement**

```
IF ignore_cond THEN
    PURGE CONDITION[ 1 ]
ELSE
    ENABLE CONDITION[ 1 ]
ENDIF
```

### A.16.25 PURGE\_DEV Built-In Procedure

**Purpose:** Purges the specified memory file device by freeing any used blocks that are no longer needed

**Syntax :** PURGE\_DEV (device, status)

Input/Output Parameters :

[in] device : STRING

[out] status : INTEGER

%ENVIRONMENT Group :FDEV

**Details:**

- *device* specifies the memory file device to purge. *device* should be set to 'FR:' for FROM disk, 'RD:' for RAM disk, or 'MF:' for both disks.
- The purge operation is only necessary when the device does not have enough memory to perform an operation. The 'FR:' device will return 85001 if the FROM disk is full. The 'RD:' device will return 85020 if the RAM disk is full.
- The purge operation will erase file blocks that were previously used, but no longer needed. These are called garbage blocks. The FROM disk may contain many garbage blocks if files are deleted or overwritten. The RAM disk does not normally contain garbage blocks, but they can occur when power is removed during a file copy.
- The VOL\_SPACE built-in can be used to determine the number of garbage blocks on the FROM disk. Hardware limitations may reduce the number of blocks actually freed.
- The device must be mounted and no files can be open on the device or an error will be returned.
- *status* explains the status of the attempted operation. If not equal to 0 then an error occurred. 85023 is returned if no errors occurred, but no blocks were purged.

**Example:** Return to [Section B.9](#), "Using the File and Device Built-Ins" (FILE\_EX.KL), for a more detailed program example.

### A.16.26 PUSH\_KEY\_RD Built-In Procedure

**Purpose:** Suspend key input from a keyboard device

**Syntax :** PUSH\_KEY\_RD(key\_dev\_name, key\_mask, pop\_index, status)

Input/Output Parameters:

[in] key\_dev\_name :STRING

[in] key\_mask :INTEGER

[out] pop\_index :INTEGER

[out] status :INTEGER  
%ENVIRONMENT Group :PBCORE

**Details:**

- Suspends all read requests on the specified keyboard device that uses (either as accept\_mask or term\_mask) any of the specified key classes.
- If there are no read requests active, a null set of inputs is recorded as suspended. This is not an error.
- *key\_dev\_name* must be one of the keyboard devices already defined:

'TPKB' :Teach Pendant Keyboard Device

'CRKB' :CRT Keyboard Device

- *key\_mask* is a bit-wise mask indicating the classes of characters that will be suspended. This should be an OR of the constants defined in the include file klevkmsk.kl.

kc\_display :Displayable keys

kc\_func\_key :Function keys

kc\_keypad :Keypad and Edit keys

kc\_enter\_key :Enter and Return keys

kc\_delete :Delete and Backspace keys

kc\_lr\_arw :Left and Right Arrow keys

kc\_ud\_arw :Up and Down Arrow keys

kc\_other :Other keys (such as Prev)

- *pop\_id* is returned and should be used in a call to POP\_KEY\_RD to re-activate the read requests.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** POP\_KEY\_RD Built-In Procedure

**Example:** Refer to the READ\_KB Built-In Procedure for an example.

## A.17 - Q - KAREL LANGUAGE DESCRIPTION

### A.17.1 QUEUE\_TYPE Data Type

**Purpose:** Defines the data type for use in QUEUE built-in routines

**Syntax :** queue\_type = STRUCTURE

n\_entries : INTEGER

sequence\_no : INTEGER

head : INTEGER

tail : INTEGER

ENDSTRUCTURE

**Details:**

- *queue\_type* is used to initialize and maintain queue data for the QUEUE built-in routines. **Do not change this data; it is used internally.**

**See Also:** APPEND\_QUEUE, DELETE\_QUEUE, INSERT\_QUEUE, COPY\_QUEUE, GET\_QUEUE, INIT\_QUEUE, MODIFY\_QUEUE Built-In Procedures

## A.18 - R - KAREL LANGUAGE DESCRIPTION

### A.18.1 READ Statement

**Purpose:** Reads data from a serial I/O device or file

**Syntax :** READ <file\_var> (data\_item {,data\_item})

where:

file\_var : a FILE variable

data\_item : a variable identifier and its optional format specifiers or the reserved word CR

**Details:**

- If *file\_var* is not specified in a READ statement the default TPDISPLAY is used. %CRTDEVICE directive will change the default to INPUT.
- If *file\_var* is specified, it must be one of the input devices (INPUT, CRTPROMPT, TPDISPLAY, TPPROMPT) or a variable that was set in the OPEN FILE statement.
- If *file\_var* attribute was set with the UF option, data is transmitted into the specified variables in binary form. Otherwise, data is transmitted as ASCII text.
- *data\_item* can be a system variable that has RW access or a user-defined variable.
- When the READ statement is executed, data is read beginning with the next nonblank input character and ending with the last character before the next blank, end of line, or end of file for all input types except STRING.
- If *data\_item* is of type ARRAY, a subscript must be provided.
- If *data\_item* is of type PATH, you can specify that the entire path be read, a specific node be read ([n]), or a range of nodes be read ([n .. m]).
- Optional format specifiers can be used to control the amount of data read for each *data\_item*. The effect of format specifiers depends on the data type of the item being read and on whether the data is in text (ASCII) or binary (unformatted) form.
- The reserved word CR, which can be used as a data item, specifies that any remaining data in the current input line is to be ignored. The next data item will be read from the start of the next input line.
- If reading from a file and any errors occur during input, the variable being read and all subsequent variables up to CR in the data list are set uninitialized.
- If *file\_var* is a window device and any errors occur during input, an error message is displayed indicating the bad data item and you are prompted to enter a replacement for the invalid data item and to reenter all subsequent items.
- Use IO\_STATUS (*file\_var*) to determine if the read operation was successful.

**Note** Read CR should never be used in unformatted mode.

**See Also:** [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#), for more information on the READ format specifiers, [IO\\_STATUS Built-In Function](#), [Appendix E, “Syntax Diagrams,”](#) for more syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.13, "Using the DISCTRL\\_ALPHA Built-in" \(DCALP\\_EX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

## **A.18.2 READ\_DICT Built-In Procedure**

**Purpose:** Reads information from a dictionary

**Syntax :** READ\_DICT(dict\_name, element\_no, ksta, first\_line, last\_line, status)

Input/Output Parameters:

[in] dict\_name : STRING

[in] element\_no : INTEGER

[out] ksta : ARRAY OF STRING

[in] first\_line : INTEGER

[out] last\_line : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *dict\_name* specifies the name of the dictionary from which to read.
- *element\_no* specifies the element number to read. This element number is designated with a \$ in the dictionary file.
- *ksta* is a KAREL STRING ARRAY used to store the information being read from the dictionary text file.
- If *ksta* is too small to store all the data, then the data is truncated and status is set to 33008, "Dictionary Element Truncated."
- *first\_line* indicates the array element of *ksta*, at which to begin storing the information.
- *last\_line* returns a value indicating the last element used in the *ksta* array.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred reading the element from the dictionary file.
- &new\_line is the only reserved attribute code that can be read from dictionary text files using READ\_DICT. The READ\_DICT Built-In ignores all other reserved attribute codes.

**See Also:** ADD\_DICT, WRITE\_DICT, REMOVE\_DICT Built-In Procedures. Refer to the program example for the DISCTRL\_LIST Built-In Procedure. [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### A.18.3 READ\_DICT\_V Built-In-Procedure

**Purpose:** Reads information from a dictionary with formatted variables

**Syntax :** READ\_DICT\_V(dict\_name, element\_no, value\_array, ksta, status)

Input/Output Parameters:

[in] dict\_name : STRING

[in] element\_no : INTEGER

[in] value\_array : ARRAY OF STRING

[out] ksta : ARRAY OF STRING

[out] status : INTEGER

%ENVIRONMENT Group :UIF

#### Details:

- *dict\_name* specifies the name of the dictionary from which to read.
- *element\_no* specifies the element number to read. This number is designated with a \$ in the dictionary file.
- *value\_array* is an array of variable names that corresponds to each formatted data item in the dictionary text. Each variable name can be specified as '[prog\_name]var\_name'.
  - *[prog\_name]* specifies the name of the program that contains the specified variable. If not specified, then the current program being executed is used.

- *var\_name* must refer to a static variable.
- *var\_name* may contain node numbers, field names, and/or subscripts.
- *ksta* is a KAREL STRING ARRAY used to store the information that is being read from the dictionary text file.
- If *ksta* is too small to store all the data, then the data is truncated and status is set to 33008, "Dictionary Element Truncated."
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred reading the element from the dictionary file.
- &new\_line is the only reserved attribute code that can be read from dictionary text files using READ\_DICT\_V. The READ\_DICT\_V Built-In ignores all other reserved attribute codes.

**See Also:** WRITE\_DICT\_V Built-In Procedure, [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** In the following example, **TPTASKEG.TX** contains dictionary text information which will display a system variable. This information is the first element in the dictionary. Element numbers start at 0. **util\_prog** uses READ\_DICT\_V to read in the text and display it on the teach pendant.

#### READ\_DICT\_V Built-In Procedure

```
-----
TPTASKEG.TX
-----
$ "Maximum number of tasks = %d"
-----
UTILITY PROGRAM:
-----
PROGRAM util_prog
%ENVIRONMENT uif
VAR
  ksta: ARRAY[1] OF STRING[40]
  status: INTEGER
  value_array: ARRAY[1] OF STRING[30]
BEGIN
  value_array[1] = '[*system*].$scr.$maxnumtask'
  ADD_DICT('TPTASKEG', 'TASK', dp_default, dp_open, status)
  READ_DICT_V('TASK', 0, value_array, ksta, status)
  WRITE(ksta[i], cr)
END util_prog
```

### **A.18.4 READ\_KB Built-In Procedure**

**Purpose:** Read from a keyboard device and wait for completion

**Syntax :** READ\_KB(file\_var, buffer, buffer\_size, accept\_mask, term\_mask, time\_out, init\_data, n\_chars\_got, term\_char, status)

Input/Output Parameters:

[in] file\_var : FILE

[out] buffer : STRING

[in] buffer\_size : INTEGER

[in] accept\_mask : INTEGER

[in] time\_out : INTEGER

[in] term\_mask : INTEGER

[in] init\_data : STRING

[out] n\_chars\_got : INTEGER

[out] term\_char : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- Causes data from specified classes of characters to be stored in a user-supplied buffer until a termination condition is met or the buffer is full. Returns to the caller when the read is terminated.
- If you use READ\_KB for the CRT/KB, you will get "raw" CRT characters returned. To get teach pendant equivalent key codes, you must perform the following function:  
tp\_key = \$CRT\_KEY\_TBL[crt\_key + 1]

This mapping allows you to use common software between the CRT/KB and teach pendant devices.

- *file\_var* must be open to a keyboard-device. If *file\_var* is also associated with a window, the characters are echoed to the window.
- The characters are stored in *buffer*, up to a maximum of *buffer\_size* or the size of the string, whichever is smaller.
- *accept\_mask* is a bit-wise mask indicating the classes of characters that will be accepted as input. This should be an OR of the constants defined in the include file klevkmsk.kl.

kc\_display :Displayable keys

kc\_func\_key :Function keys

kc\_keypad :Key-pad and Edit keys

kc\_enter\_key :Enter and Return keys

kc\_delete :Delete and Backspace keys

kc\_lr\_arw :Left and Right Arrow keys

kc\_ud\_arw :Up and Down Arrow keys

kc\_other :Other keys (such as Prev)

- It is reasonable for *accept\_mask* to be zero; this means that no characters are accepted as input. This is used when waiting for a single key that will be returned as the *term\_char*. In this case, *buffer\_size* would be zero.
- If *accept\_mask* includes displayable characters, the following characters, if accepted, have the following meanings:
  - Delete characters - If the cursor is not in the first position of the field, the character to the left of the cursor is deleted.
  - Left and right arrows - Position the cursor one character to the left or right from its present position, assuming it is not already in the first or last position already.
  - Up and down arrows - Fetch input previously entered in reads to the same file.
- *term\_mask* is a bit-wise mask indicating conditions which will terminate the request. This should be an OR of the constants defined in the include file klevkmsk.kl.

kc\_display :Displayable keys

kc\_func\_key :Function keys

kc\_keypad :Key-pad and Edit keys

kc\_enter\_key :Enter and Return keys

kc\_delete :Delete and Backspace keys

kc\_lr\_arw :Left and Right Arrow keys

kc\_ud\_arw :Up and Down Arrow keys

kc\_other :Other keys (such as Prev)

- *time\_out* specifies the time, in milliseconds, after which the input operation will be automatically canceled. A value of -1 implies no timeout.
- *init\_data\_p* points to a string which is displayed as the initial value of the input field. This must not be longer than *buffer\_size*.
- *n\_chars\_got* is set to the number of characters in the input buffer when the read is terminated.
- *term\_char* receives a code indicating the character or other condition that terminated the form. The codes for key terminating conditions are defined in the include file klevkeys.kl. Keys normally returned are pre-defined constants as follows:

ky\_up\_arw

ky\_dn\_arw

ky\_rt\_arw

ky\_lf\_arw

ky\_enter

ky\_prev

ky\_f1

ky\_f2

ky\_f3

ky\_f4

ky\_f5

ky\_next

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

The following example suspends any teach pendant reads, uses READ\_KB to read a single key, and then resumes any suspended reads.

### READ\_KB Built-In Procedure

```
PROGRAM readkb

%NOLOCKGROUP
%ENVIRONMENT flbt
%ENVIRONMENT uif
%INCLUDE FR:eklevkmsk

VAR
    file_var: FILE
    key: INTEGER
    n_chars_got: INTEGER
    pop_index: INTEGER
    status: INTEGER
    str: STRING[1]

BEGIN
    -- Suspend any outstanding TP Keyboard reads
    PUSH_KEY_RD('TPKB', 255, pop_index, status)
    IF (status = 0) THEN
        WRITE (CR, 'pop_index is ', pop_index)
    ELSE
        WRITE (CR, 'PUSH_KEY_RD status is ', status)
    ENDIF

    -- Open a file to TP Keyboard with PASALL and FIELD attributes
    -- and NOECHO
    SET_FILE_ATR(file_var, ATR_PASSALL)
    SET_FILE_ATR(file_var, ATR_FIELD)
    OPEN FILE file_var ('RW', 'KB:TPKB')

    -- Read a single key from the TP Keyboard
```

```

READ_KB(file_var, str, 1, 0, kc_display+kc_func_key+kc_keypad+
        kc_enter_key+kc_lr_arw+kc_ud_arw+kc_other, 0, '',
        n_chars_got, key, status)
IF (status = 0) THEN
    WRITE (CR, 'key is ', key, ', n_chars_got = ', n_chars_got)
ELSE
    WRITE (CR, 'READ_KB status is ', status)
ENDIF

CLOSE FILE file_var

-- Resume any outstanding TP Keyboard reads
POP_KEY_RD('TPKB', pop_index, status)
IF (status <> 0) THEN
    WRITE (CR, 'POP_KEY_RD status is ', status)
ENDIF

END readkb

```

### **A.18.5 REAL Data Type**

**Purpose:** Defines a variable, function return type, or routine parameter as a REAL data type with a numeric value that includes a decimal point and a fractional part, or numbers expressed in scientific notation

**Syntax :** REAL

**Details:**

- REAL variables and expressions can have values in the range of -3.4028236E+38 through -1.175494E-38, 0.0, and from +1.175494E-38 through +3.4028236E+38, with approximately seven decimal digits of significance. Otherwise, the program will be aborted with the “Real overflow” error.
- The decimal point is mandatory when defining a REAL constant or literal (except when using scientific notation). The decimal point is not mandatory when defining a REAL variable as long as it was declared as REAL.
- Scientific notation is allowed and governed by the following rules:
  - The decimal point is shifted to the left so that only one digit remains in the INTEGER part.
  - The fractional part is followed by the letter E (upper or lower case) and ±an INTEGER. This part specifies the magnitude of the REAL number. For example, 123.5 is expressed as 1.235E2.
  - The fractional part and the decimal point can be omitted. For example, 100.0 can be expressed as 1.000E2, as 1.E2, or 1E2.

- All REAL variables with magnitudes between -1.175494E- 38 and +1.175494E-38 are treated as 0.0.
- Only REAL or INTEGER expressions can be assigned to REAL variables, returned from REAL function routines, or passed as arguments to REAL parameters.
- If an INTEGER expression is used in any of these instances, it is treated as a REAL value. If an INTEGER variable is used as an argument to a REAL parameter, it is always passed by value, not by reference.
- Valid REAL operators are (refer to [Table A-18](#)):
  - Arithmetic operators (+, +, \*, /)
  - Relational operators (>, >=, =, < >, <, <=)

**Table A-18. Valid and Invalid REAL operators**

VALID	INVALID	REASON
1.5	15	Decimal point is required (15 is an INTEGER not a REAL)
1.	.	Must include an INTEGER or a fractional part
+2500.450	+2,500.450	Commas not allowed
1.25E-4	1.25E -4	Spaces not allowed

**Example:** Refer to the following sections for detailed program examples:

[Section B.5, "Using Register Built-ins" \(REG\\_EX.KL\)](#)

[Section B.8, "Generating and Moving Along a Hexagon Path" \(GEN\\_HEX.KL\)](#)

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.11, "Manipulating Values of Dynamically Displayed Variables" \(CHG\\_DATA.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

## A.18.6 Relational Condition

**Purpose:** Used to test the relationship between two operands

**Syntax :** variable <[subscript]> rel\_op expression

where:

variable : a static INTEGER or REAL variable or a BOOLEAN port array element

subscript : an INTEGER expression (only used with port arrays)

rel\_op : a relational operator

expression : a static variable, constant, or EVAL clause

#### Details:

- Relational conditions are state conditions, meaning the relationship is tested during every scan.
- The following relational operators can be used:

= :equal

$\diamond$  :not equal

< :less than

=< :less than or equal

> :greater than

$\geq$  :greater than or equal

- Both operands must be of the same data type and can only be of type INTEGER, REAL, or BOOLEAN. INTEGER values can be used where REAL values are required, and will be treated as REAL values.
- *variable* can be any of the port array signals, a user-defined static variable, or a system variable that can be read by a KAREL program.
- *expression* can be a user-defined static variable, a system variable that can be read by a KAREL program, any constant, or an EVAL clause.
- Variables used in relational conditions must be initialized before the condition handler is enabled.

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

## A.18.7 RELAX HAND Statement

**Purpose:** Turns off open signal for a tool controlled by one signal or turns off both open and close signals for a tool controlled by a pair of signals.

**Syntax :** RELAX HAND hand\_num

where:

hand\_num : an INTEGER expression

**Details:**

- The actual effect of the statement depends on how the HAND signals are set up. Refer to Chapter 13, "Input/Output System."
- *hand\_num* must be a value in the range 1-2. Otherwise, the program is aborted with an error.
- The statement has no effect if the value of *hand\_num* is in range but the hand is not connected.
- If the value of *hand\_num* is in range but the HAND signal represented by that value has not been assigned, the program is aborted with an error.

**See Also:** Chapter 13, "Input/Output System," Appendix D, "Syntax Diagrams," for more syntax information

**Example:** In the following example, the robot hand, specified by **gripper**, is relaxed using the RELAX HAND statement. The robot then moves to the POSITION **pstart** before closing the hand.

#### **RELAX HAND Statement**

```
PROGRAM p_release
%NOPAUSE=TPENABLE
%ENVIRONMENT uif
BEGIN
    RELAX HAND gripper
    MOVE TO pstart
    CLOSE HAND gripper
END p_release
```

#### **A.18.8 RELEASE Statement**

**Purpose:** Releases all motion control of the robot arm and auxiliary or extended axes from the KAREL program so that they can be controlled by the teach pendant while a KAREL program is running

**Syntax :** RELEASE

**Details:**

- Motion stopped prior to execution of the RELEASE statement can only be resumed after the execution of the next ATTACH statement.
- If motion is initiated from the program while in a released state, the program is aborted with the following error, "MCTRL Denied because Released."
- If RELEASE is executed while motion is in progress or in a HOLD condition, the program is aborted with the following error, "Detach request failed."

- All motion control from all KAREL tasks will be released.

**See Also:** [Appendix E](#), “Syntax Diagrams,” for more syntax information

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.18.9 REMOVE\_DICT Built-In Procedure**

**Purpose:** Removes the specified dictionary from the specified language or from all existing languages

**Syntax :** REMOVE\_DICT(dict\_name, lang\_name, status)

Input/Output Parameters:

[in] dict\_name : STRING

[in] lang\_name : STRING

[out] status : INTEGER

%ENVIRONMENT Group :UIF

**Details:**

- *dict\_name* specifies the name of the dictionary to remove.
- *lang\_name* specifies which language the dictionary should be removed from. One of the following pre-defined constants should be used:

dp\_default

dp\_english

dp\_japanese

dp\_french

dp\_german

dp\_spanish

If *lang\_name* is "", it will be removed from all languages in which it exists.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred removing the dictionary file.

**See Also:** ADD\_DICT Built-In Procedure, [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### **A.18.10 RENAME\_FILE Built-In Procedure**

**Purpose:** Renames the specified file name

**Syntax :** RENAME\_FILE(*old\_file*, *new\_file*, *nowait\_sw*, *status*)

Input/Output Parameters:

[in] *old\_file* : STRING

[in] *new\_file* : STRING

[in] *nowait\_sw* : BOOLEAN

[out] *status* : INTEGER

%ENVIRONMENT Group :FDEV

**Details:**

- *old\_file* specifies the device, name, and type of the file to rename.
- *new\_file* specifies the name and type of the file to rename to.
- If *nowait\_sw* is TRUE, execution of the program continues while the command is executing. If it is FALSE, the program stops, including condition handlers, until the operation has completed. If you have time critical condition handlers in your program, put them in another program that executes as a separate task.

**Note** *nowait\_sw* is not available in this release and should be set to FALSE.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** COPY\_FILE, DELETE\_FILE Built-In Procedures

### **A.18.11 RENAME\_VAR Built-In Procedure**

**Purpose:** Renames a specified variable in a specified program to a new variable name

**Syntax :** RENAME\_VAR(*prog\_nam*, *old\_nam*, *new\_nam*, *status*)

Input/Output Parameters:

[in] prog\_nam : STRING  
 [in] old\_nam : STRING  
 [in] new\_nam : STRING  
 [out] status : INTEGER  
 %ENVIRONMENT Group :MEMO

**Details:**

- *prog\_nam* is the name of the program that contains the variable to be renamed.
- *old\_nam* is the current name of the variable.
- *new\_nam* is the new name of the variable.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CREATE\_VAR, SET\_VAR Built-In Procedures

**A.18.12 RENAME\_VARS Built-In Procedure**

**Purpose:** Renames all of the variables in a specified program to a new program name

**Syntax :** RENAME\_VARS(old\_nam, new\_nam, status)

Input/Output Parameters:

[in] old\_nam : STRING  
 [in] new\_nam : STRING  
 [out] status : INTEGER  
 %ENVIRONMENT Group :MEMO

**Details:**

- *old\_nam* is the current name of the program.
- *new\_nam* is the new name of the program.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CREATE\_VAR, RENAME\_VARS Built-in Procedures

### A.18.13 REPEAT ... UNTIL Statement

**Purpose:** Repeats statement(s) until a BOOLEAN expression evaluates to TRUE

**Syntax :** REPEAT

{ statement }

UNTIL boolean\_exp

where:

statement : a valid KAREL executable statement

boolean\_exp : a BOOLEAN expression

**Details:**

- *boolean\_exp* is evaluated after execution of the statements in the body of the REPEAT loop to determine if the statements should be executed again.
- *statement* continues to be executed and the *boolean\_exp* is evaluated until it equals TRUE.
- *statement* will always be executed at least once.



#### Caution

Make sure your REPEAT statement contains a boolean flag that is modified by some condition, and an UNTIL statement that terminates the loop. If it does not, your program could loop infinitely.

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for more syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

[Section B.7](#), "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

[Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL)

[Section B.11](#), "Manipulating Values of Dynamically Displayed Variables" (CHG\_DATA.KL)

[Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

[Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL)

### **A.18.14 RESET Built-In Procedure**

**Purpose:** Resets the controller

**Syntax :** RESET(successful)

Input/Output Parameters:

[out] successful : BOOLEAN

%ENVIRONMENT Group :MOTN

**Details:**

- *successful* will be TRUE even if conditions exist which prevent resetting the controller.
- To determine whether the reset operation was successful, delay 1 second and check OPOUT[3] (FAULT LED). If this is FALSE, the reset operation was successful.
- The statement following the RESET Built-In is not executed until the reset fails or has completed. The status display on the CRT or teach pendant will indicate PAUSED during the reset.
- The controller appears to be in a PAUSED state while a reset is in progress but, during this time, PAUSE condition handlers will not be triggered.

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.18.15 RESUME Action**

**Purpose:** Restarts the last stopped motion issued by the task

**Syntax :** RESUME <GROUP[n{,n}]>

**Details:**

- A motion set is a group of motions issued but not yet terminated when a STOP statement or action is issued.
- If there are no stopped motion sets, no motion will result from the RESUME.
- If more than one motion set has been stopped, RESUME restarts the most recently stopped, unresumed motion set. Subsequent RESUMEs will start the others in last-in-first-out sequence.
- The motions contained in a stopped motion set are resumed in the same order in which they were originally issued.
- If a motion is in progress when the RESUME action is issued, any resumed motion(s) occur after the current motion is completed.

- If the group clause is not present, all groups for which the task has control (when the condition is defined) will be resumed.
- If the motion that is stopped, resumed, canceled, or held is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are stopped, resumed, canceled, or held.
- Motion cannot be resumed for a different task.

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.18.16 RESUME Statement**

**Purpose:** Restarts the last stopped motion issued by the task

**Syntax :** RESUME <GROUP[n{,n}]>

- A motion set is a group of motions issued but not yet terminated when a STOP statement or action is issued.
- If there are no stopped motion sets, no motion will result from the RESUME.
- If more than one motion set has been stopped, RESUME restarts the most recently stopped, unresumed motion set. Subsequent RESUMEs will start the others in last-in-first-out sequence.
- Those motions in a stopped motion set are resumed in the same order in which they were originally issued.
- If a motion is in progress when the RESUME statement is issued, any resumed motion(s) occur after the current motion is completed.
- If the group clause is not present, all groups for which the task has control will be resumed.
- If the motion that is stopped, resumed, canceled, or held is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are stopped, resumed, canceled, or held.
- Motion cannot be resumed for a different task.

**See Also:** [Appendix E](#), “Syntax Diagrams” for more syntax information

**Example:** In the following example, motion is stopped if DIN[1] is ON. It is resumed after F1 is pressed.

#### **RESUME Statement**

```
MOVE ALONG some_path NOWAIT
IF DIN[1] THEN
    WRITE(' Motion stopped')
    STOP
    WRITE(CR, 'Motion and the program will resume')
```

```

    WRITE(CR, '      when F1 of teach pendant is pressed')
    WAIT FOR TPIN[129]
    RESUME
ENDIF

```

### A.18.17 RETURN Statement

**Purpose:** Returns control from a routine/program to the calling routine/program, optionally returning a result

**Syntax :** RETURN <(value)>

**Details:**

- *value* is required when returning from functions, but is not permitted when returning from procedures. The data type of *value* must be the same as the type used in the function declaration.
- If a main program executes a RETURN statement, execution is terminated and cannot be resumed. All motions in progress will be completed normally.
- If no RETURN is specified, the END statement serves as the return.
- If a function routine returns with the END statement instead of a RETURN statement, the program is aborted with the 12321 error, “END STMT of a func rtn.”

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for more syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.7](#), "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

[Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL)

### A.18.18 ROUND Built-In Function

**Purpose:** Returns the INTEGER value closest to the specified REAL argument

**Syntax :** ROUND(x)

Function Return Type :INTEGER

Input/Output Parameters:

[in] x :REAL

%ENVIRONMENT Group :SYStem

**Details:**

- The returned value is the INTEGER value closest to the REAL value x, as demonstrated by the following rules:
  - If  $x \geq 0$ , let n be a positive INTEGER such that  $n \leq x \leq n + 1$
  - If  $x \geq n + 0.5$ , then  $n + 1$  is returned; otherwise, n is returned.
  - If  $x \leq 0$ , let n be a negative INTEGER such that  $n \geq x \geq n - 1$
  - If  $x \leq n - 0.5$ , then  $n - 1$  is returned; otherwise, n is returned.
- $x$  must be in the range of -2147483648 to +2147483646. Otherwise, the program will be aborted with an error.

**See Also:** TRUNC Built-In Function

**Example:** Refer to [Section B.7](#), "Listing Files and Programs and Manipulating Strings" (LIST\_.EX.KL), for a detailed program example.

## **A.18.19 ROUTINE Statement**

**Purpose:** Specifies a routine name, with parameters and types, and a returned value data type for function routines

**Syntax :** ROUTINE name < param\_list > <: return\_type >

where:

name : a valid KAREL identifier

param\_list : described below

return\_type : any data type that can be returned by a function, that is, any type except FILE, PATH, and vision types

**Details:**

- *name* specifies the routine name.
- *param\_list* is of the form ( *name\_group* { ; *name\_group* } )
  - *name\_group* is of the form *param\_name* : *param\_type*
  - *param\_name* is a parameter which can be used within the routine body as a variable of data type *param\_type*.
  - If a *param\_type* or *return\_type* is an ARRAY, the size is excluded. If the *param\_type* is a STRING, the string length is excluded.

- When the routine body follows the ROUTINE statement, the names in *param\_list* are used to associate arguments passed in with references to parameters within the routine body.
- When a routine is from another program, the names in the parameter list are of no significance but must be present in order to specify the number and data types of parameters.
- If the ROUTINE statement contains a *return\_type*, the routine is a function routine and returns a value. Otherwise, it is a procedure routine.
- The ROUTINE statement must be followed by a routine body or a FROM clause.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.4, "Standard Routines" \(ROUT\\_EX.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.7, "Listing Files and Programs and Manipulating Strings" \(LIST\\_EX.KL\)](#)

[Section B.8, "Generating and Moving Along a Hexagon Path" \(GEN\\_HEX.KL\)](#)

[Section B.9, "Using the File and Device Built-ins" \(FILE\\_EX.KL\)](#)

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

## **A.18.20 RUN\_TASK Built-In Procedure**

**Purpose:** Runs the specified program as a child task

**Syntax :** RUN\_TASK (task\_name, line\_number, pause\_on\_sft, tp\_motion, lock\_mask, status)

Input/Output Parameters:

[in] task\_name : STRING

[in] line\_number : INTEGER

[in] pause\_on\_sft : BOOLEAN

[in] tp\_motion : BOOLEAN

[in] lock\_mask : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :MULTI

**Details:**

- *task\_name* is the name of the task to be run. This creates a child task. The task that executes this built-in is called the parent task.
- If the task already exists and is paused, it will be continued. A new task is not created.
- *line\_number* specifies the line from which execution starts. Use 0 to start from the beginning of the program. This is only valid for teach pendant programs.
- If *pause\_on\_sft* is TRUE, the task is paused when the teach pendant shift key is released.
- If *tp\_motion* is TRUE, the task can execute motion while the teach pendant is enabled. The TP must be enabled if *tp\_motion* is TRUE.
- The control of the motion groups specified in *lock\_mask* will be transferred from parent task to child task, if *tp\_motion* is TRUE and the teach pendant is enabled. The group numbers must be in the range of 1 to the total number of groups defined on the controller. Bit 1 specifies group 1, bit 2 specifies group 2, and so forth.

**Table A–19. Group\_mask setting**

GROUP	DECIMAL	BIT
Group 1	1	1
Group 2	2	2
Group 3	4	3

To specify multiple groups select the decimal values, shown in [Table A–19](#), which correspond to the desired groups. Then connect them together using the OR operator. For example to specify groups 1 and 3, enter "1 OR 4".



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CONT\_TASK, PAUSE\_TASK, ABORT\_TASK Built-In Procedures, [Chapter 15  
MULTI-TASKING](#)

**Example:** Refer to [Section B.10](#), "Using Dynamic Display Built-ins" (DYN\_DISP.KL), for a detailed program example.

## A.19 - S - KAREL LANGUAGE DESCRIPTION

### A.19.1 SAVE Built-In Procedure

**Purpose:** Saves the program or variables into the specified file

**Syntax :** SAVE (prog\_nam, file\_spec, status)

Input/Output Parameters :

[in] prog\_nam :STRING

[in] file\_spec :STRING

[out] status :INTEGER

%ENVIRONMENT Group :MEMO

#### Details:

- *prog\_nam* specifies the program name. If program name is '\*', all programs or variables of the specified type are saved. *prog\_name* must be set to "\*SYSTEM\*" in order to save all system variables.
- *file\_spec* specifies the device, name, and type of the file being saved to. The type also implies whether programs or variables are being saved.

The following types are valid:

.TP : Teach pendant program

.VR : KAREL variables

.SV : KAREL system variables

.IO : I/O configuration data

- If *file\_spec* already exists on the specified device, then an error is returned the save does not occur.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** CLEAR, LOAD Built-In Procedures

**Example:** Refer to [Section B.3](#) , "Saving Data to the Default Device" (SAVE\_VRS.KL), for a detailed program example.

## **A.19.2 SAVE\_DRAM Built-In Procedure**

**Purpose:**Saves the RAM variable content to FlashROM.

**Syntax:**SAVE\_DRAM (prog\_nam, status)

Input/Output Parameters:

[in] prog\_nam: STRING

[out] status: INTEGER

%ENVIRONMENT Group: MEMO

**Details:**

- prog\_nam specifies the program name. This operation will save the current values of any variables in DRAM to FlashROM for the specified program. At power up these saved values will automatically be loaded into DRAM.
- status explains the status of the attempted operation. If not equal to 0, then an error occurred.

## **A.19.3 SELECT ... ENDSELECT Statement**

**Purpose:** Permits execution of one out of a series of statement sequences, depending on the value of an INTEGER expression.

**Syntax:** SELECT case\_val OF

CASE(value{,value}):

{statement}

{ CASE(value{, value}):

{statement} }

<ELSE:

{ statement }>

ENDSELECT

where:

case\_val : an INTEGER expression

value : an INTEGER constant or literal

statement : a valid KAREL executable statement

#### Details:

- *case\_val* is compared with each of the values following the CASE in each clause. If it is equal to any of these, the statements between the CASE and the next clause are executed.
- Up to 1000 CASE clauses can be used in a SELECT statement.
- If the same INTEGER value is listed in more than one CASE, only the statement sequence following the first matching CASE will be executed.
- If the ELSE clause is used and the expression *case\_val* does not match any of the values in the CASE clauses, the statements between the keywords ELSE and ENDSELECT are executed.
- If no ELSE clause is used and the expression *case\_val* does not match any of the values in the CASE clauses, the program is aborted with the “No match in CASE” error.

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for more syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.3](#), "Saving Data to the Default Device" (SAVE\_VR.KL)

[Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

[Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL)

#### A.19.4 SELECT\_TPE Built-In Procedure

**Purpose:** Selects the program of the specified name

**Syntax :** SELECT\_TPE(prog\_name, status)

Input/Output Parameters :

[in] prog\_name :STRING

[out] status : :INTEGER

%ENVIRONMENT Group :TPE

**Details:**

- *prog\_name* specifies the name of the program to be selected as the teach pendant default. This is the program that is "in use" by the teach pendant. It is also the program that will be executed if the CYCLE START button is pressed or the teach pendant FWD key is pressed.
- *status* explains the status of the attempted operation. If it is not equal to 0, then an error has occurred.

**See Also:** OPEN\_TPE Built-in Procedure

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

### A.19.5 SEMA\_COUNT Built-In Function

**Purpose:** Returns the current value of the specified semaphore

**Syntax :** SEMA\_COUNT (semaphore\_no)

Function Return Type :INTEGER

Input/Output Parameters :

[in] semaphore\_no : INTEGER

%ENVIRONMENT Group :MULTI

**Details:**

- The value of the semaphore indicated by *semaphore\_no* is returned.
- This value is incremented by every POST\_SEMA call and SIGNAL SEMAPHORE Action specifying the same *semaphore\_no*. It is decremented by every PEND\_SEMA call.
- If SEMA\_COUNT is greater than zero, a PEND\_SEMA call will "fall through" immediately. If it is -*n* (minus *n*), then there are *n* tasks pending on this semaphore.

**See Also:** POST\_SEMA, PEND\_SEMA, CLEAR\_SEMA Built-In Procedures, [Chapter 15 MULTI-TASKING](#)

**Example:** See examples in [Chapter 15 MULTI-TASKING](#)

**A.19.6 SEMAPHORE Condition**

**Purpose:** Monitors the value of the specified semaphore

**Syntax :** SEMAPHORE[semaphore\_no]

**Details:**

- *semaphore\_no* specifies the semaphore number to use.
- *semaphore\_no* must be in the range of 1 to the number of semaphores defined on the controller.
- When the value of the indicated semaphore is greater than zero, the condition is satisfied (TRUE).

**A.19.7 SEND\_DATAPC Built-In Procedure**

**Purpose:** To send an event message and other data to the PC.

**Syntax :** SEND\_DATAPC(event\_no, dat\_buffer, status)

Input/Output Parameters :

[in] event\_no :INTEGER

[in] dat\_buffer :ARRAY OF BYTE

[out] status :INTEGER

%ENVIRONMENT Group :PC

**Details:**

- *event\_no* - a GEMM event number. Valid values are 0 to 255.
- *dat\_buffer* - an array of up to 244 bytes. The KAREL built-ins ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, and ADD\_STRINGPC can be used to format a KAREL byte buffer. The actual data buffer format depends on the needs of the PC. There is no error checking of the *dat\_buffer* format on the controller.
- *status* - the status of the attempted operation. If not 0, then an error occurred and the event request was not sent to the PC.

**See Also:** ADD\_BYNAMEPC, ADD\_INTPC, ADD\_REALPC, ADD\_STRINGPC

**Example:** The following example sends event 12 to the PC with a data buffer.

**SEND\_DATAPC Built-In Procedure**

PROGRAM TESTDATA

```
%ENVIRONMENT PC
CONST
    er_abort = 2
VAR
    dat_buffer: ARRAY[100] OF BYTE
    index: INTEGER
    status: INTEGER
BEGIN
    index = 1
    ADD_INTPC(dat_buffer, index, 55, status)
    ADD_REALPC(dat_buffer, index, 123.5, status)
    ADD_STRINGPC(dat_buffer, index, 'YES', status)

    -- send event 12 and data buffer to PC
    SEND_DATAPC(12, dat_buffer, status)
    IF status<>0 THEN
        POST_ERR(status, '', 0, er_abort)
    ENDIF

END testdata
```

### **A.19.8 SEND\_EVENTPC Built-In Procedure**

**Purpose:** To send an event message to the PC.

**Syntax :** SEND\_EVENTPC(event\_no, status)

Input/Output Parameters :

[in] event\_no :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PC

**Details:**

- *event\_no* - a GEMM event number. Valid values are 0 through 255.
- *status* - the status of the attempted operation. If not 0, then an error occurred and the event request was not sent to the PC.

**Example:** The following example sends event 12 to the PC.

#### **SEND\_EVENTPC Built-In Procedure**

```
PROGRAM TESTEVT
%ENVIRONMENT PC
```

```

CONST
    er_abort = 2
VAR
    status: INTEGER
BEGIN

    -- send event 12 to PC
    SEND_EVENTPC(12,status)      -- call built-in here
    IF status<>0 THEN
        POST_ERR(status,'',0,er_abort)
    ENDIF

END testevt

```

### **A.19.9 SET\_ATTR\_PRG Built-In Procedure**

**Purpose:** Sets attribute data of the specified teach pendant or KAREL program

**Syntax :** SET\_ATTR\_PRG(program\_name, attr\_number, int\_value, string\_value, status)

Input/Output Parameters :

[in] program\_name : STRING

[in] attr\_number : INTEGER

[in] int\_value : INTEGER

[in] string\_value : STRING

[out] status : INTEGER

%ENVIRONMENT Group :TPE

**Details:**

- *program\_name* specifies the program to which attribute data is set.
- *attr\_number* is the attribute whose value is to be set. The following attributes are valid:

AT\_PROG\_TYPE : (#) Program type

AT\_PROG\_NAME : Program name (String[12])

AT\_OWNER : Owner (String[8])

AT\_COMMENT : Comment (String[16])

AT\_PROG\_SIZE : (#) Size of program  
AT\_ALLC\_SIZE : (#) Size of allocated memory  
AT\_NUM\_LINE : (#) Number of lines  
AT\_CRE\_TIME : (#) Created (loaded) time  
AT\_MDFY\_TIME : (#) Modified time  
AT\_SRC\_NAME : Source file ( or original file ) name (String[128])  
AT\_SRC\_VRSN : Source file version  
AT\_DEF\_GROUP : Default motion groups (for task attribute)  
AT\_PROTECT : Protection code; 1 :protection OFF; 2 : protection ON  
AT\_STK\_SIZE : Stack size (for task attribute)  
AT\_TASK\_PRI : Task priority (for task attribute)  
AT\_DURATION : Time slice duration (for task attribute)  
AT\_BUSY\_OFF : Busy lamp off (for task attribute)  
AT\_IGNR\_ABRT : Ignore abort request (for task attribute)  
AT\_IGNR\_PAUS : Ignore pause request (for task attribute)  
AT\_CONTROL : Control code (for task attribute)  
(#) --- Cannot be set.

- If the attribute data is a number, it is set to *int\_value* and *string\_value* is ignored.
- If the attribute data is a string, it is set to *string\_value* and *int\_value* is ignored.
- *status* explains the status of the attempted operation. If it is not equal to 0, then an error has occurred. Some of the errors which could occur are:
  - 7073 The program specified in *program\_name* does not exist
  - 7093 The attribute of a program cannot be set while it is running
  - 17033 *attr\_number* has an illegal value or cannot be set

### A.19.10 SET\_CURSOR Built-In Procedure

**Purpose:** Set the cursor position in the window

**Syntax :** SET\_CURSOR(file\_var, row, col, status)

Input/Output Parameters :

[in] file\_var : FILE

[in] row : INTEGER

[in] col : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- Sets the current cursor of the specified file that is open to a window so subsequent writes will start in the specified position.
- *file\_var* must be open to a window.
- A *row* value of 1 indicates the top row of the window. A *col* value of 1 indicates the left-most column of the window.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** DEF\_WINDOW Built-In Procedure

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.13, "Using the DISCTRL\\_ALPHA Built-in" \(DCALP\\_EX.KL\)](#)

### A.19.11 SET\_EPOS\_REG Built-In Procedure

**Purpose:** Stores an XYZWPREXT value in the specified register

**Syntax :** SET\_EPOS\_REG(register\_no, posn, status <, group\_no>)

Input/Output Parameters :

[in] register\_no : INTEGER  
 [in] posn : XYZWPREXT  
 [out] status : INTEGER  
 [in] group\_no :INTEGER  
 %ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the position register in which to store the value.
- The *position* data is set in XYZWPREXT representation.
- *status* explains the status of the attempted operation. If it is not equal to 0, then an error occurred.
- If *group\_no* is omitted, the default group for the program is assumed. Data for other groups is not changed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.

**See Also:** SET\_POS\_REG, SET\_JPOS\_REG Built-In Procedures, GET\_POS\_REG, GET\_JPOS\_REG Built-In Functions

**Example:** The following example sets the extended position for the specified register.

**SET\_EPOS\_REG Built-In Procedure**

```
PROGRAM spe
%environment REGOPE
VAR
  cur_pos: XYZWPREXT
  posget: XYZWPREXT
  status: INTEGER
  v_mask, g_mask: INTEGER
  reg_no: INTEGER

BEGIN
  reg_no = 1
  cur_pos = CURPOS(v_mask,g_mask)
  SET_EPOS_REG(reg_no,cur_pos,status)
  posget = GET_POS_REG(reg_no,status)
END spe
```

### A.19.12 SET\_EPOS\_TPE Built-In Procedure

**Purpose:** Stores an XYZWPREXT value in the specified position in the specified teach pendant program

**Syntax:** SET\_EPOS\_TPE (open\_id, position\_no, posn, status <,group\_no>)

Input/Output Parameters :

[in] open\_id : INTEGER

[in] position\_no : INTEGER

[in] posn : XYZWPREXT

[out] status : INTEGER

[in] group\_no : INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *open\_id* specifies the opened teach pendant program. A program must be opened before calling this built-in.
- *position\_no* specifies the position in the program in which to store the value.
- A motion instruction must already exist that uses the *position\_no* or the position will not be used by the teach pendant program.
- The position data is set in XYZWPREXT representation with no conversion.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.
- If *group\_no* is omitted, the default group for the program is assumed. Data for other groups is not changed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.

### A.19.13 SET\_FILE\_ATR Built-In Procedure

**Purpose:** Sets the attributes of a file before it is opened

**Syntax :** SET\_FILE\_ATR(file\_id, atr\_type <,atr\_value>)

Input/Output Parameters :

[in] file\_id : FILE  
[in] atr\_type : INTEGER expression  
[in] atr\_value : INTEGER expression  
%ENVIRONMENT Group :PBCORE

**Details:**

- *file\_id* is the file variable that will be used in the OPEN FILE, WRITE, READ, and/or CLOSE FILE statements.
- *atr\_type* specifies the attribute type to set. The predefined constants as specified in Table 7-2 should be used.
- *atr\_value* is optional depending on the attribute type being set.

**See Also:** SET\_PORT\_ATR Built-In Function, [Section 7.2.1](#), “Setting File Attributes”.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

[Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL)

### **A.19.14 SET\_FILE\_POS Built-In Procedure**

**Purpose:** Sets the file position for the next READ or WRITE operation to take place in the specified file to the value of the new specified file position

**Syntax :** SET\_FILE\_POS(file\_id, new\_file\_pos, status)

Input/Output Parameters :

[in] file\_id : FILE  
[in] new\_file\_pos : INTEGER expression  
[out] status : INTEGER variable  
%ENVIRONMENT Group :FLBT

**Details:**

- The file associated with *file\_id* must be opened and uncompressed on either the FROM or RAM disks. Otherwise, the program is aborted with an error.

- *new\_file\_pos* must be in the range of -1 to the number of bytes in the file.  
 at\_eof : specifies that the file position is to be set at the end of the file. at\_sof : specifies that the file position is to be set at the start of the file.  
 — Any other value causes the file to be set the specified number of bytes from the beginning of the file.
- *status* is set to 0 if the *new\_file\_pos* is between -1 and the number of bytes in the file, indicating the file position was successfully set. If not equal to 0, then an error occurred.

**Note** SET\_FILE\_POS is not supported for files on the floppy disk.

**See Also:** [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#)

**Example:** The following example opens the **filepos.dt** data file, sets the file position from a directory, reads the positions from the file, and stores the positions in the PATH, **my\_path**.

### **SET\_FILE\_POS Built-In Procedure**

```
OPEN FILE file_id ('RW', 'filepos.dt')

FOR i = 1 TO PATH_LEN(my_path) DO
  SET_FILE_POS(file_id, pos_dir[i], status)
  IF status = 0 THEN
    READ file_id (temp_pos)
    my_path[i].node_pos = temp_pos
  ENDIF
ENDFOR
```

### **A.19.15 SET\_INT\_REG Built-In Procedure**

**Purpose:** Stores an integer value in the specified register

**Syntax :** SET\_INT\_REG(register\_no, int\_value, status)

Input/Output Parameters :

[in] register\_no : INTEGER

[in] int\_value : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the register into which *int\_value* will be stored.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** GET\_INT\_REG, GET\_REAL\_REG, SET\_REAL\_REG Built-in Procedures

**Example:** Refer to [Section B.5](#), "Using Register Built-ins" (REG\_EX.KL), for a detailed program example.

### **A.19.16 SET\_JPOS\_REG Built-In Procedure**

**Purpose:** Stores a JOINTPOS value in the specified register

**Syntax :** SET\_JPOS\_REG(register\_no, jpos, status<, group\_no>)

Input/Output Parameters :

[in] register\_no : INTEGER

[in] jpos : JOINTPOS

[out] status :INTEGER

[in] group\_no :INTEGER

%ENVIRONMENT Group :REGOPE

#### **Details:**

- *register\_no* specifies the position register in which to store the position, *jpos* .
- The position data is set in JOINTPOS representation with no conversion.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.
- If *group\_no* is omitted, the default group for the program is assumed. Data for other groups is not changed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.

**See Also:** GET\_JPOS\_REG, GET\_POS\_REG, SET\_POS\_REG, POS\_REG\_TYPE Built-in Procedures

**Example:** Refer to [Section B.5](#), "Using Register Built-ins" (REG\_EX.KL), for a detailed program example.

**A.19.17 SET\_JPOS\_TPE Built-In Procedure**

**Purpose:** Stores a JOINTPOS value in the specified position in the specified teach pendant program

**Syntax :** SET\_JPOS\_TPE(open\_id, position\_no, posn, status<, group\_no>)

Input/Output Parameters :

[in] open\_id : INTEGER

[in] position\_no : INTEGER

[in] posn : JOINTPOS

[out] status : INTEGER

[in] group\_no :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *open\_id* specifies the opened teach pendant program. Before calling this built-in, a program must be opened using the OPEN\_TPE Built-In, and have read/write access.
- *position\_no* specifies the position in the program in which to store the value.
- The position data is set in JOINTPOS representation with no conversion.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.
- If *group\_no* is omitted, the default group for the program is assumed. Data for other groups is not changed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.

**See Also:** GET\_JPOS\_TPE, GET\_POS\_TPE, SET\_POS\_TPE, GET\_POS\_TYP Built-in Procedures

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY.TP.KL), for a detailed program example.

**A.19.18 SET\_LANG Built-In Procedure**

**Purpose:** Changes the current language

**Syntax :** SET\_LANG(lang\_name, status)

Input/Output Parameters :

[in] lang\_name :STRING  
[out] status :INTEGER  
%ENVIRONMENT Group :PBCORE

**Details:**

- *lang\_name* specifies which language from which the dictionaries should be read/written. Use one of the following pre-defined constants:
  - dp\_default
  - dp\_english
  - dp\_japanese
  - dp\_french
  - dp\_german
  - dp\_spanish
- The read-only system variable \$LANGUAGE indicates which language is currently in use.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred setting the language.
- The error, 33003, "No dict found for language," will be returned if no dictionaries are loaded into the specified language. The KCL command "SHOW LANGS" can be used to view which languages are created in the system.

**See Also:** [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** Refer to [Section B.13](#), "Using the DISCTRL\_ALPHA Built-in" (DCALP\_EX.KL), for a detailed program example.

---

### A.19.19 SET\_PERCH Built-In Procedure

**Purpose:** Sets the perch position and tolerance for a group of axes

**Syntax :** SET\_PERCH(jpos, tolerance, indx)

Input/Output Parameters :

[in] jpos : JOINTPOS  
[in] tolerance : ARRAY[6] of REAL

[in] *indx* : INTEGER

%ENVIRONMENT Group :SYSTEM

**Details:**

- The values of *jpos* are converted to radians and stored in the system variable \$REFPOS1[ *indx* ].\$perch\_pos.
- The *tolerance* array is converted to degrees and stored in the system variable \$REFPOS1[ *indx* ].\$perchtol. If the tolerance array is uninitialized, an error is generated.
- *indx* specifies the element number to be set in the \$REFPOS1 array.
- The group of axes is implied from the specified position, *jpos*. If JOINTPOS is not in group 1, then the system variable \$REFPOSn is used where n corresponds to the group number of *jpos* and *indx* must be set to 1.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** The appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual* to setup Reference Positions

**Example:** In the following example, \$REFPOS1[2].\$perchpos and \$REFPOS1[2].\$perchtol are set according to **perch\_pos** and **tolerance[i]**.

#### SET\_PERCH Built-In Procedure

```

VAR
    perch_pos: JOINTPOS IN GROUP[1]
BEGIN
    FOR i = 1 to 6 DO
        tolerance[i] = 0.01
    ENDFOR
    SET_PERCH (perch_pos, tolerance, 2)
END

```

#### A.19.20 SET\_PORT\_ASG Built-In Procedure

**Purpose:** Allows a KAREL program to assign one or more logical ports to specified physical port(s)

**Syntax :** SET\_PORT\_ASG(log\_port\_type, log\_port\_no, rack\_no, slot\_no, phy\_port\_type, phy\_port\_no, n\_ports, status)

Input/Output Parameters :

[in] log\_port\_type : INTEGER

[in] log\_port\_no : INTEGER

[in] rack\_no : INTEGER

[in] slot\_no : INTEGER

[in] phy\_port\_type : INTEGER

[in] phy\_port\_no : INTEGER

[in] n\_ports : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *log\_port\_type* specifies the code for the type of port to be assigned. Codes are defined in KLIOTYPS.KL.
- *log\_port\_no* specifies the number of the port to be assigned.
- *rack\_no* is the rack containing the port module. For process I/O boards, memory-image, and dummy ports, this is zero; for Allen-Bradley and Genius ports, this is 16.
- *slot\_no* is the slot containing the port module. For process I/O boards, this is the sequence in the SLC-2 chain. For memory-image and dummy ports, this is zero; for Allen-Bradley and Genius ports, this is 1.
- *phy\_port\_type* is the type of port to be assigned to. Often this will be the same as *log\_port\_type*. Exceptions are if *log\_port\_type* is a group type ( *io\_gpin* or *io\_gpout* ) or a port is assigned to memory-image or dummy ports.
- *phy\_port\_no* is the number of the port to be assigned to. If *log\_port\_type* is a group, this is the port number for the least-significant bit of the group.
- *n\_ports* is the number of physical ports to be assigned to the logical port. If *log\_port\_type* is a group type, *n\_ports* indicates the number of bits in the group. When setting digital I/O, *n\_ports* is the number of points you are configuring. In most cases this will be 8, but may be 1 through 8.
- *status* is returned with zero if the parameters are valid. Otherwise, it is returned with an error code. The assignment is invalid if the specified port(s) do not exist or if the assignment of *log\_port\_type* to *phy\_port\_type* is not permitted.

For example, GINs cannot be assigned to DOUTs. Neither *log\_port\_type* nor *phy\_port\_type* can be a system port type (SOPIN, for example).

**Note** The assignment does not take effect until the next power-up.

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.19.21 SET\_PORT\_ATR Built-In Function

**Purpose:** Sets the attributes of a port

**Syntax :** SET\_PORT\_ATR(*port\_id*, *atr\_type*, *atr\_value*)

Function Return Type :INTEGER

Input/Output Parameters :

[in] *port\_id* : INTEGER

[in] *atr\_type* : INTEGER

[in] *atr\_value* : INTEGER

%ENVIRONMENT Group :FLBT

**Details:**

- *port\_id* is one of the predefined constants as follows:

port\_1

port\_2

port\_3

port\_4

- *atr\_type* specifies the attribute type to set. One of the following predefined constants should be used:

atr\_readahd :Read ahead buffer

atr\_baud :Baud rate

atr\_parity :Parity

atr\_sbts :Stop bits

atr\_dbts :Data length

atr\_xonoff :XON/XOFF

atr\_eol :End of line

atr\_modem :Modem line

- *atr\_value* specifies the value for the attribute type. See [Table A–20](#) on the following page which contains acceptable pre-defined attribute types with corresponding values.

**Table A–20. Attribute Values**

ATTR_TYPE	ATTR_VALUE
atr_readahd	any integer, represents multiples of 128 bytes (for example: atr_value=1 means the buffer length is 128 bytes.)
atr_baud	baud_9600 baud_4800 baud_2400 baud_1200
atr_parity	parity_none parity_even parity_odd
atr_sbts	sbits_1 sbits_15 sbits_2

**Table A–20.** Attribute Values (Cont'd)

<b>ATTR_TYPE</b>	<b>ATTR_VALUE</b>
atr_dbits	dbits_5 dbits_6 dbits_7 dbits_8
atr_xonoff	xf_not_used xf_used
atr_eol	an ASCII code value, Refer to <a href="#">Appendix D</a> , "Character Codes"
atr_modem	md_not_used md_use_dsr md_mouse_dsr md_use_dtr md_mouse_dtr md_use_rts md_mouse_rts

- A returned integer is the status of this action to port.

**See Also:** SET\_FILE\_ATR Built-In Procedure, [Section 7.2.1](#), “Setting File and Port Attributes,” for more information

**Example:** Refer to the example for the GET\_PORT\_ATR Built\_In Function.

## **A.19.22 SET\_PORT\_CMT Built-In Procedure**

**Purpose:** Allows a KAREL program to set the comment displayed on the teach pendant, for a specified logical port

**Syntax :** SET\_PORT\_CMT(port\_type, port\_no, comment\_str, status)

Input/Output Parameters :

[in] port\_type : INTEGER

[in] port\_no : INTEGER

[in] comment\_str : STRING

[out] status : INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port whose mode is being set. Codes are defined in KLIOTYPS.KL.
- *port\_no* specifies the port number whose mode is being set.
- *comment\_str* is a string whose value is the comment for the specified port. This must not be over 16 characters long.
- *status* is returned with zero if the parameters are valid and the specified mode can be set for the specified port.

**See Also:** SET\_PORT\_VALUE, SET\_PORT\_MOD, GET\_PORT\_CMT, GET\_PORT\_VALUE, GET\_PORT\_MOD Built-in Procedures

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.19.23 SET\_PORT\_MOD Built-In Procedure**

**Purpose:** Allows a KAREL program to set (or reset) special port modes for a specified logical port

**Syntax :** SET\_PORT\_MOD(port\_type, port\_no, mode\_mask, status)

Input/Output Parameters :

[in] port\_type : INTEGER

[in] port\_no : INTEGER

[in] mode\_mask : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port whose mode is being set. Codes are defined in KLIOTYPS.KL.
- *port\_no* specifies the port number whose mode is being set.
- *mode\_mask* is a mask specifying which modes are turned on. The following modes are defined:

1 :reverse mode - sense of the port is reversed; if the port is set to TRUE, the physical output is set to FALSE. If the port is set to FALSE, the physical output is set to TRUE. If a physical input is TRUE when the port is read, FALSE is returned. If a physical input is FALSE when the port is read, TRUE is returned.ports.

2 :complementary mode - the logical port is assigned to two physical ports whose values are complementary. In this case, *port\_no* must be an odd number. If port n is set to TRUE, port n is set to TRUE, and port n + 1 is set to FALSE. If port n is set to FALSE, port n is set to FALSE and port n + 1 is set to TRUE. This is effective only for output

**Note** The mode setting does not take effect until the next power-up.

- *status* is returned with zero if the parameters are valid and the specified mode can be set for the specified port.

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

#### **A.19.24 SET\_PORT\_SIM Built-In Procedure**

**Purpose:** Sets port simulated

**Syntax :** SET\_PORT\_SIM(*port\_type*, *port\_no*, *value*, *status*)

Input/Output Parameters :

[in] *port\_type* : INTEGER

[in] *port\_no* : INTEGER

[in] *value* : INTEGER

[out] *status* : INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port to simulate. Codes are defined in KLIOTYPS.KL.
- *port\_no* specifies the number of the port to simulate.
- *value* specifies the initial value to set.
- *status* is returned with zero if the port is simulated.

**See Also:** SET\_PORT\_ASG, GET\_PORT\_ASG, GET\_PORT\_SIM Built-in Procedures

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### A.19.25 SET\_PORT\_VAL Built-In Procedure

**Purpose:** Allows a KAREL program to set a specified output (or simulated input) for a specified logical port

**Syntax :** SET\_PORT\_VAL(*port\_type*, *port\_no*, *value*, *status*)

Input/Output Parameters :

[in] *port\_type* : INTEGER

[in] *port\_no* : INTEGER

[in] *value* : INTEGER

[out] *status* : INTEGER

%ENVIRONMENT Group :IOSETUP

**Details:**

- *port\_type* specifies the code for the type of port whose mode is being set. Codes are defined in KLIOTYPS.KL.
- *port\_no* specifies the port number whose mode is being set.
- *value* indicates the value to be assigned to a specified port. If the *port\_type* is BOOLEAN (i.e. DOUT), this should be 0 = OFF, or 1 = ON. This field can be used to set input ports if the port is simulated.
- *status* is returned with zero if the parameters are valid and the specified mode can be set for the specified port.

**See Also:** SET\_PORT\_VALUE, SET\_PORT\_MOD, GET\_PORT\_CMT, GET\_PORT\_VALUE, GET\_PORT\_MOD Built-in Procedures

**Example:** The following example sets the value for a specified port.

#### **SET\_PORT\_VAL Built-In Procedure**

```

PROGRAM setvalprog
%ENVIRONMENT IOSETUP
%INCLUDE FR:\kliotyps
ROUTINE set_value(port_type: INTEGER;
                  port_no:  INTEGER;
                  g_value:  BOOLEAN): INTEGER
VAR
  value:  INTEGER
  status: INTEGER

BEGIN
  IF g_value THEN
    value = 1
  ELSE
    value = 0;
  ENDIF

  SET_PORT_VAL (port_type, port_no, value, status)
  RETURN (status)
END set_value

BEGIN
END setvalprog

```

#### **A.19.26 SET\_POS\_REG Built-In Procedure**

**Purpose:** Stores an XYZWPR value in the specified position register

**Syntax :** SET\_POS\_REG(register\_no, posn, status<, group\_no>)

Input/Output Parameters :

[in] register\_no : INTEGER

[in] posn : XYZWPR

[out] status : INTEGER

[in] group\_no : INTEGER

%ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the position register in which to store the value.
- The position data is set in XYZWPR representation with no conversion.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.
- If *group\_no* is omitted, the default group for the program is assumed. Data for other groups is not changed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.

**Example:** Refer to [Section B.5,"Using Register Built-ins"](#) (REG\_EX.KL), for a detailed program example.

### **A.19.27 SET\_POS\_TPE Built-In Procedure**

**Purpose:** Stores an XYZWPR value in the specified position in the specified teach pendant program

**Syntax :** SET\_POS\_TPE(open\_id, position\_no, posn, status<, group\_no>)

Input/Output Parameters :

[in] open\_id : INTEGER

[in] position\_no : INTEGER

[in] posn : XYZWPR

[out] status : INTEGER

[in] group\_no : INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *open\_id* specifies the opened teach pendant program. Before calling this built-in, a program must be opened using the OPEN\_TPE Built-In, and have read/write access.
- *position\_no* specifies the position in the program in which to store the value.
- A motion instruction must already exist that uses the *position\_no* or the position will not be used by the teach pendant program.
- The position data is set in XYZWPR representation with no conversion.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

- If *group\_no* is omitted, the default group for the program is assumed. Data for other groups is not changed.
- If *group\_no* is specified, it must be in the range of 1 to the total number of groups defined on the controller.

**Example:** Refer to [Section B.14](#), "Applying Offsets to a Copied Teach Pendant Program" (CPY\_TP.KL), for a detailed program example.

### A.19.28 SET\_PREG\_CMT Built-In-Procedure

**Purpose:** To set the comment information of a KAREL position register based on a given register number and a given comment.

**Syntax:** SET\_PREG\_CMT (register\_no, comment\_string, status)

Input/Output Parameters:

[in] register\_no: INTEGER

[in] comment\_string: STRING

[out] status: INTEGER

%ENVIRONMENT group: REGOPE

### A.19.29 SET\_REAL\_REG Built-In Procedure

**Purpose:** Stores a REAL value in the specified register

**Syntax :** SET\_REAL\_REG(register\_no, real\_value, status)

Input/Output Parameters :

[in] register\_no : INTEGER

[in] real\_value : REAL

[out] status : INTEGER

%ENVIRONMENT Group :REGOPE

**Details:**

- *register\_no* specifies the register into which *real\_value* will be stored.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** SET\_INT\_REG, GET\_REAL\_REG, GET\_INT\_REG Built-in Procedures

### **A.19.30 SET\_REG\_CMT Built-In-Procedure**

**Purpose:** To set the comment information of a KAREL register based on a given register number and a given comment.

**Syntax:** SET\_REG\_CMT (register\_no, comment\_string, status)

Input/Output Parameters:

[in] register\_no: INTEGER

[in] comment\_string: STRING

[out] status: INTEGER

%ENVIRONMENT group REGOPE

**Details:**

- Register\_no specifies which register to retrieve the comments from. The comment\_string represents the data which is to be used to set the comment of the given register. If the comment\_string exceeds more than 16 characters, the built-in will truncate the string.

### **A.19.31 SET\_TIME Built-In Procedure**

**Purpose:** Set the current time within the KAREL system

**Syntax :** SET\_TIME(i)

Input/Output Parameters :

[in] i : INTEGER

%ENVIRONMENT Group :TIM

**Details:**

- *i* holds the INTEGER representation of time within the KAREL system. This value is represented in 32-bit INTEGER format as follows:

**Table A-21. 32-Bit INTEGER Format of Time**

31–25	24–21	20–16
year	month	day
15–11	10–5	4–0
hour	minute	second

- The contents of the individual fields are as follows:

— DATE:

Bits 15-9 — Year since 1980

Bits 8-5 — Month (1-12)

Bits 4-0 — Day of the month

— TIME:

Bits 31-25 — Number of hours (0-23)

Bits 24-21 — Number of minutes (0-59)

Bits 20-16 — Number of 2-second increments (0-29)

- This value can be determined using the GET\_TIME and CNV\_STR\_TIME Built-In procedures.
- If *i* is 0, the time on the system will not be changed.
- INTEGER values can be compared to determine if one time is more recent than another.

**See Also:** CNV\_STR\_TIME, GET\_TIME Built-In Procedures

**Example:** The following example converts the STRING variable *str\_time*, input by the user in “DD-MMM-YYY HH:MM:SS” format, to the INTEGER representation of time *int\_time* using the CNV\_STR\_TIME Built-In procedure. SET\_TIME is then used to set the time within the KAREL system to the time specified by *int\_time*.

#### **SET\_TIME Built-In Procedure**

```
WRITE('Enter the new time : ')
READ(str_time)
CNV_STR_TIME(str_time,int_time)
SET_TIME(int_time)
```

### **A.19.32 SET\_TPE\_CMT Built-In Procedure**

**Purpose:** Provides the ability for a KAREL program to set the comment associated with a specified position in a teach pendant program.

**Syntax :** SET\_TPE\_CMT(open\_id, pos\_no, comment, status)

Input/Output Parameters :

[in] open\_id :INTEGER

[in] pos\_no :INTEGER

[in] comment :STRING

[out] status :INTEGER

%ENVIRONMENT Group :TPE

**Details:**

- *open\_id* specifies the open\_id returned from a previous call to OPEN\_TPE. An open mode of TPE\_RWACC must be used in the OPEN\_TPE call.
- *pos\_id* specifies the number of the position in the teach pendant program to get a comment from. The specified position must have been recorded.
- *comment* is the comment to be associated with the specified position. A zero length string can be used to ensure that a position has no comment. If the string is over 16 characters, it is truncated and used and a warning error is returned.
- *status* indicates zero if the operation was successful, otherwise an error code will be displayed.

**See Also:** GET\_TPE\_CMT and OPEN\_TPE for more Built-in Procedures.

### **A.19.33 SET\_TRNS\_TPE Built-In Procedure**

**Purpose:** Stores a POSITION value within the specified position in the specified teach pendant program

**Syntax :** SET\_TRNS\_TPE(open\_id, position\_no, posn, status)

Input/Output Parameters :

[in] open\_id : INTEGER  
 [in] position\_no : INTEGER  
 [in] posn : POSITION  
 [out] status : INTEGER  
 %ENVIRONMENT Group :PBCORE

**Details:**

- *open\_id* specifies the opened teach pendant program. A program must be opened before calling this built-in.
- *position\_no* specifies the position in the program in which to store the value specified by *posn*. Data for other groups is not changed.
- The position data is set in POSITION representation with no conversion.
- *posn* is the group number of *position\_no*.
- *status* explains the status of the attempted operation. If not equal to 0, then an error has occurred.

**A.19.34 SET\_TSK\_ATTR Built-In Procedure**

**Purpose:** Set the value of the specified running task attribute

**Syntax :** SET\_TSK\_ATTR(task\_name, attribute, value, status)

Input/Output Parameters :

[in] task\_name : STRING  
 [in] attribute : INTEGER  
 [in] value : INTEGER  
 [out] status : INTEGER  
 %ENVIRONMENT Group :PBCORE

**Details:**

- *task\_name* is the name of the specified running task. A blank *task\_name* will indicate the calling task.

- *attribute* is the task attribute whose value is to be set. The following attributes are valid:

TSK\_PRIORITY :Priority, see %PRIORITY for value information

TSK\_TIMESLIC :Time slice duration, see %TIMESLICE for value information

TSK\_NOBUSY :Busy lamp off, see %NOBUSYLAMP

TSK\_NOABORT :Ignore abort request

Pg\_np\_error :no abort on error

Pg\_np\_cmd :no abort on command

TSK\_NOPAUSE :Ignore pause request

pg\_np\_error :no pause on error

pg\_np\_end :no pause on command when TP is enabled

pg\_np\_tpennb :no pause

TSK\_TRACE :Trace enable

TSK\_TRACELEN :Maximum number of lines to store when tracing

TSK TPMOTION :TP motion enable, see %TPMOTION for value information

TSK\_PAUSESFT :Pause on shift, reverse of %NOPAUSESHFT

- *value* depends on the task attribute being set.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** GET\_TSK\_INFO Built-in Procedure

**Example:** See examples in [Chapter 15 MULTI-TASKING](#)

### A.19.35 SET\_TSK\_NAME Built-In Procedure

**Purpose:** Set the name of the specified task

**Syntax :** SET\_TSK\_NAME(old\_name, new\_name, status)

Input/Output Parameters :

[in] old\_name : STRING  
 [in] new\_name : STRING  
 [out] status : INTEGER  
 %ENVIRONMENT Group :MULTI

**Details:**

- *task\_name* is the name of the task of interest. A blank *task\_name* will indicate the calling task.
- *new\_name* will become the new task name.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** GET\_ATTR\_PRG Built-in Procedure

**Example:** See examples in [Chapter 15 MULTI-TASKING](#)

**A.19.36 SET\_VAR Built-In Procedure**

**Purpose:** Allows a KAREL program to set the value of a specified variable

**Syntax :** SET\_VAR(entry, prog\_name, var\_name, value, status)

Input/Output Parameters :

[in,out] entry : INTEGER  
 [in] prog\_name : STRING  
 [in] var\_name : STRING  
 [in] value : Any valid KAREL data type except PATH, VIS\_PROCESS, and MODEL  
 [out] status : INTEGER  
 %ENVIRONMENT Group :SYSTEM

**Details:**

- *entry* returns the entry number in the variable data table of *var\_name* in the device directory where *var\_name* is located. **This variable should not be modified.**

- *prog\_name* specifies the name of the program that contains the specified variable. If *prog\_name* is "", then it defaults to the current task name being executed.
- Use *prog\_name* of '\*SYSTEM\*' to set a system variable.
- *var\_name* must refer to a static variable.
- *var\_name* can contain node numbers, field names, and/or subscripts.
- If both *var\_name* and *value* are ARRAYS, the number of elements copied will equal the size of the smaller of the two arrays.
- If both *var\_name* and *value* are STRINGs, the number of characters copied will equal the size of the smaller of the two strings.
- If both *var\_name* and *value* are STRUCTUREs of the same type, *value* will be an exact copy of *var\_name*.
- *var\_name* will be set to *value*.
- If *value* is uninitialized, the value of *var\_name* will be set to uninitialized and *status* will be set to 12311. *value* must be a static variable within the calling program.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Caution**

Using SET\_VAR to modify system variables could cause unexpected results.

**See Also:** CREATE\_VAR, RENAME\_VAR Built-In Procedures

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

### **A.19.37 SHORT Data Type**

**Purpose:** Defines a variable as a SHORT data type

**Syntax :** SHORT

**Details:**

- SHORT, is defined as 2 bytes with the range of (-32768 <= n >= 32766). A SHORT variable assigned to (32767) is considered uninitialized.
- SHORTs are allowed only within an array or within a structure.
- SHORTs can be assigned to BYTES and INTEGERs, and BYTES and INTEGERs can be assigned

to SHORTs. An assigned value outside the SHORT range is detected during execution and causes the program to be aborted.

### **A.19.38 SIGNAL EVENT Action**

**Purpose:** Signals an event that might satisfy a condition handler or release a waiting program

**Syntax :** SIGNAL EVENT[event\_no]

where:

event\_no : an INTEGER expression

**Details:**

- You can use the SIGNAL EVENT action to indicate a user-defined event has occurred.
- *event\_no* occurs when signaled and is not remembered. Thus, if a WHEN clause has the event as its only condition, the associated actions will occur.
- If other conditions are specified that are not met at the time the event is signaled, the actions are not taken, even if the other conditions are met at another time.
- *event\_no* must be in the range of -32768 to 32767. Otherwise, the program is aborted with an error.

**See Also:** EVENT Condition

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.19.39 SIGNAL EVENT Statement**

**Purpose:** Signals an event that might satisfy a condition handler or release a waiting program

**Syntax :** SIGNAL EVENT [event\_no]

where:

event\_no : an INTEGER

**Details:**

- You can use the SIGNAL EVENT statement to indicate a user-defined event has occurred.
- *event\_no* occurs when signaled and is not remembered. Thus, if a WHEN clause has the event as its only condition, the associated actions will occur.

- If other conditions are specified that are not met at the time the event is signaled, the actions are not taken, even if the other conditions are met at another time.
- *event\_no* must be in the range of -32768 to 32767. Otherwise, the program is aborted with an error.

**See Also:** [Appendix E, “Syntax Diagrams”](#) for more syntax information, EVENT Condition

**Example:** Refer to the DISABLE CONDITION Statement example program.

#### **A.19.40 SIGNAL SEMAPHORE Action**

**Purpose:** Adds one to the value of the indicated semaphore

**Syntax :** SIGNAL SEMAPHORE[semaphore\_no]

where:

semaphore\_no : an INTEGER expression

**Details:**

- The semaphore indicated by *semaphore\_no* is incremented by one.
- *semaphore\_no* must be in the range of 1 to the number of semaphores defined on the controller.

**See Also:** [Section 15.8, "Task Communication"](#) for more information and examples.

#### **A.19.41 SIN Built-In Function**

**Purpose:** Returns a REAL value that is the sine of the specified angle argument

**Syntax :** SIN(angle)

Function Return Type :REAL

Input/Output Parameters :

[in] angle : REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- *angle* specifies an angle in degrees.

- *angle* must be in the range of  $\pm 18000$  degrees. Otherwise, the program will be aborted with an error.

**Example:** Refer to [Section B.8](#), "Generating and Moving Along a Hexagon Path" (GEN\_HEX.KL), for a detailed program example.

### **A.19.42 SQRT Built-In Function**

**Purpose:** Returns a REAL value that is the positive square root of the specified REAL argument

**Syntax :** SQRT(x)

Function Return Type :REAL

Input/Output Parameters :

[in] x : REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- *x* must not be negative. Otherwise, the program will be aborted with an error.

**Example:** The following example calculates the square root of the expression (*a*\**a*+*b*\**b*) and indicates that this is the hypotenuse of a triangle.

#### **SQRT Built-In Function**

```
c = SQRT(a*a+b*b)
WRITE ('The hypotenuse of the triangle is ',c:::6:::2)
```

### **A.19.43 %STACKSIZE Translator Directive**

**Purpose:** Specifies stack size in long words.

**Syntax :** %STACKSIZE = n

**Details:**

- *n* is the stack size.
- The default value of *n* is 300 (1200 bytes).

**See Also:** [Section 5.1.6](#), “Stack Usage,” for information on computing stack size

### **A.19.44 STD\_PTH\_NODE Data Type**

**Purpose:** Defines a data type for use in PATHs.

**Syntax :** STD\_PTH\_NODE = STRUCTURE

node\_pos : POSITION in GROUP[1]

group\_data : GROUP\_ASSOC in GROUP[1]

common\_data : COMMON\_ASSOC

ENDSTRUCTURE

**Details:**

- If the NODEDATA clause is omitted from the PATH declaration, then STD\_PTH\_NODE will be the default.
- Each node in the PATH will be of this type.

### **A.19.45 STOP Action**

**Purpose:** Stops any motion in progress, leaving it in a resumable state

**Syntax :** STOP <GROUP[n{,n}]>

**Details:**

- Any motion in progress is decelerated to a stop. The unfinished motion as well as any pending motions are grouped together in a motion set and placed on a stack.
- More than one motion might be stacked by a single STOP action.
- If the KAREL program was waiting for the completion of the motion in progress, it will continue to wait.
- The stacked motion set can be removed from the stack and restarted with either a RESUME statement or action or by issuing RESUME from the operator interface (CRT/KB).
- If the group clause is not present, all groups for which the task has control (when the condition is defined) will be stopped.
- If the motion that is stopped, resumed, canceled, or held is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are stopped, resumed, canceled, or held.
- Motion cannot be stopped for a different task.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Chapter 8 MOTION](#), RESUME Statement

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.19.46 STOP Statement**

**Purpose:** Stops any motion in progress, leaving it in a resumable state

**Syntax :** STOP <GROUP[n{,n}]>

**Details:**

- Any motion in progress is decelerated to a stop. The unfinished motion as well as any pending motions are grouped together in a motion set and placed on a stack.
- More than one motion might be stacked by a single STOP statement.
- If the KAREL program was waiting for the completion of the motion in progress, it will continue to wait.
- The stacked motion set can be removed from the stack and restarted with either a RESUME statement or action, or by issuing RESUME from the CRT/KB.
- If the group clause is not present, all groups for which the task has control will be stopped.
- If the motion that is stopped, resumed, canceled, or held is part of a SIMULTANEOUS or COORDINATED motion with other groups, the motions for all groups are stopped, resumed, canceled, or held.
- Motion cannot be stopped for a different task.

**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Chapter 8 MOTION](#), RESUME Action, RESUME Statement, [Appendix E, “Syntax Diagrams,”](#) for more syntax information

**Example:** The following example stops motion if the digital input is ON.

**STOP Statement**

```
IF DIN[2] THEN  
    STOP  
ENDIF
```

### A.19.47 STRING Data Type

**Purpose:** Defines a variable or routine parameter as STRING data type

**Syntax :** STRING[length]

where:

length : an INTEGER constant or literal

**Details:**

- *length* , the physical length of the string, indicates the maximum number of characters for which space is allocated for a STRING variable.
- *length* must be in the range 1 through 128 and must be specified in a STRING variable declaration.
- A *length* value is not used when declaring STRING routine parameters; a STRING of any length can be passed to a STRING parameter.
- Attempting to assign a STRING to a STRING variable that is longer than the physical length of the variable results in the STRING value being truncated on the right to the physical length of the STRING variable.
- Only STRING expressions can be assigned to STRING variables or passed as arguments to STRING parameters.
- STRING values cannot be returned by functions.

- Valid STRING operators are:
  - Relational operators ( $>$ ,  $\geq$ ,  $=$ ,  $\diamond$ ,  $<$ , and  $\leq$ )
  - Concatenation operator (+)
- STRING literals consist of a series of ASCII characters enclosed in single quotes (apostrophes). Examples are given in the following table.

**Table A-22. Example STRING Literals**

VALID	INVALID	REASON
'123456'	123456	Without quotes 123456 is an INTEGER literal

**Example:** Refer to the following sections for detailed program examples:

[Section B.2, "Copying Path Variables" \(CPY\\_PTH.KL\)](#)

[Section B.3, "Saving Data to the Default Device" \(SAVE\\_VR.KL\)](#)

[Section B.7, "Listing Files and Programs and Manipulating Strings" \(LIST\\_EX.KL\)](#)

[Section B.9, "Using the File and Device Built-ins" \(FILE\\_EX.KL\)](#)

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.12, "Displaying a List From a Dictionary File" \(DCLST\\_EX.KL\)](#)

[Section B.13, "Using the DISCTRL\\_ALPHA Built-in" \(DCALP\\_EX.KL\)](#)

[Section B.14, "Applying Offsets to a Copied Teach Pendant Program" \(CPY\\_TP.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

#### A.19.48 STR\_LEN Built-In Function

**Purpose:** Returns the current length of the specified STRING argument

**Syntax :** STR\_LEN(str)

Function Return Type :INTEGER

Input/Output Parameters :

[in] str : STRING

%ENVIRONMENT Group :SYSTEM

**Details:**

- The returned value is the length of the STRING currently stored in the *str* argument, not the maximum length of the STRING specified in its declaration.

**Example:** Refer to [Section B.12](#), "Displaying a List from a Dictionary File" (DCLST\_EX.KL) for a detailed program example.

## **A.19.49 STRUCTURE Data Type**

**Purpose:** Defines a data type as a user-defined structure

**Syntax :** new\_type\_name = STRUCTURE

field\_name\_1: type\_name\_1

field\_name\_2: type\_name\_2

...

ENDSTRUCTURE

**Details:**

- A user-defined structure is a data type consisting of a list of component fields, each of which can be a standard data type or another, previously defined, user data type.
- When a program containing variables of user-defined types is loaded, the definitions of these types is checked against a previously created definition. If this does not exist, it is created.
- The following data types are not permitted as part of a data structure:
  - STRUCTURE definitions (types that are declared structures are permitted)
  - PATH types
  - FILE types
  - Vision types
  - Variable length arrays

- The data structure itself, or any type that includes it, either directly or indirectly
- A variable may not be defined as a structure, but as a data type previously defined as a structure

**See Also:** [Section 2.4.2](#), “User-Defined Data Structures”

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

## **A.19.50 SUB\_STR Built-In Function**

**Purpose:** Returns a copy of part of a specified STRING argument

**Syntax :** SUB\_STR(src, strt, len)

Function Return Type :STRING

Input/Output Parameters :

[in] src : STRING

[in] strt : INTEGER

[in] len : INTEGER

%ENVIRONMENT Group :SYSTEM

### **Details:**

- A substring of *src* is returned by the function.
- The length of substring is the number of characters, specified by *len* , that starts at the indexed position specified by *strt* .
- *strt* must be positive. Otherwise, the program is aborted with an error. If *strt* is greater than the length of *src* , then an empty string is returned.
- *len* must be positive. Otherwise, the program is aborted with an error. If *len* is greater than the declared length of the return STRING, then the returned STRING is truncated to fit.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

[Section B.7](#), "Listing Files and Programs and Manipulating Strings" (LIST\_EX.KL)

[Section B.9](#), "Using the File and Device Built-ins" (FILE\_EX.KL)

## A.20 - T - KAREL LANGUAGE DESCRIPTION

### A.20.1 TAN Built-In Function

**Purpose:** Returns a REAL value that is the tangent of the specified REAL argument

**Syntax :** TAN(angle)

Function Return Type :REAL

Input/Output Parameters:

[in] angle : REAL

%ENVIRONMENT Group :SYSTEM

**Details:**

- The value of *angle* must be in the range of  $\pm 18000$  degrees. Otherwise, the program will be aborted with an error.

**Example:** The following example uses the TAN Built-In function to specify the tangent of the variable *angle*. The tangent should be equal to the SIN(*angle*) divided by COS(*angle*).

#### TAN Built-In Function

```
WRITE ('enter an angle:')
READ (angle,CR)

ratio = SIN(angle)/COS(angle)
IF ratio = TAN(angle) THEN
    WRITE ('ratio is correct',CR)
ENDIF
```

### A.20.2 TIME Condition

**Purpose:** Monitors the progress of a move to a POSITION or along a PATH

**Syntax :** TIME t ||BEFORE | AFTER|| NODE[n]

where:

t : INTEGER expression

n : INTEGER expression

**Details:**

- The TIME conditions can be used only in local condition handlers.
- $t$  indicates the time interval in milliseconds BEFORE or AFTER NODE[  $n$  ].
- The maximum value for  $t$  is 500.
- NODE[  $n$  ] indicates the node BEFORE which or AFTER which the condition is satisfied.
- If  $n$  is a wildcard (\*), any node will satisfy the BEFORE or AFTER condition.
- Node 0 indicates the start of the move.
- If the move is along a PATH or to a path node,  $n$  specifies a path node.
- If the move is to a POSITION, node 1 can be used to indicate the destination.
- If  $n$  is greater than the length of the path (or greater than 1 if the move is to a POSITION), the condition is never satisfied.
- If  $n$  is less than zero or greater than 1000, the program is aborted with an error.

**See Also:** [Chapter 6 CONDITION HANDLERS](#), [Appendix E, “Syntax Diagrams,”](#) for more syntax information

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.20.3 %TIMESLICE Translator Directive**

**Purpose:** Supports round-robin type time slicing for tasks with the same priority

**Syntax :** %TIMESLICE = n

**Details:**

- $n$  specifies task execution time in msec for one slice. The default value is 256 msec.
- The timeslice value must be greater than 0.
- This value is the maximum duration for executing the task continuously if there are other tasks with the same priority that are ready to run.

- This function is effective only when more than one KAREL task with the same priority is executing at the same time.
- The timeslice duration can be set during task execution by the SET\_TSK\_ATTR Built-In routine.

#### **A.20.4 %TPMOTION Translator Directive**

**Purpose:** Specifies that task motion is enabled when the teach pendant is on

**Syntax :** %TPMOTION

**Details:**

- This attribute can be set during task execution by the SET\_TSK\_ATTR Built-In routine.

#### **A.20.5 TRANSLATE Built-In Procedure**

**Purpose:** Translates a KAREL source file (.KL file type) into p-code (.PC file type), which can be loaded into memory and executed.

**Syntax :** TRANSLATE(file\_spec, listing\_sw, status)

Input/Output Parameters:

[in] file\_spec : STRING

[in] listing\_sw : BOOLEAN

[out] status : INTEGER

%ENVIRONMENT Group :trans

**Details:**

- *file\_spec* specifies the device, name and type of the file to translate. If no device is specified, the default device will be used. The type, if specified, is ignored and .KL is used instead.
- The p-code file will be created on the default device. The default device should be set to the ram disk.
- *listing\_sw* specifies whether a .LS file should be created. The .LS file contains a listing of the source lines and any errors which may have occurred. The .LS file will be created on the default device.
- The KAREL program will wait while the TRANSLATE Built-In executes. If the KAREL

program is paused, translation will continue until completed. If the KAREL program is aborted, translation will also be aborted and the .PC file will not be created.

- If the KAREL program must continue to execute during translation, use the KCL\_NO\_WAIT Built-In instead.
- *status* explains the status of the attempted operation. If the number 0 is returned, the translation was successful. If not, an error occurred. Some of the status codes are shown below:

0 Translation was successful

268 Translator option is not installed

35084 File cannot be opened or created.KL file cannot be found or default device is not the RAM disk

-1 Translation was not successful (Please see .LS file for details)

**Example:** The following example program will create, translate, load, and run another program called hello.

### TRANSLATE Built-In Procedure

```

OPEN FILE util_file ('RW', 'hello.kl')
  WRITE util_file ('PROGRAM hello', CR)
  WRITE util_file ('%NOLOCKGROUP', CR)
  WRITE util_file ('BEGIN', CR)
  WRITE util_file (' WRITE (''hello world'', CR)', CR)
  WRITE util_file ('END hello', CR)
CLOSE FILE util_file

TRANSLATE('hello', TRUE, status)
IF status = 0 THEN
  LOAD('hello.pc', 0, status)
ENDIF
IF status = 0 THEN
  CALL_PROG('hello', prog_index)
ENDIF

```

### A.20.6 TRUNC Built-In Function

**Purpose:** Converts the specified REAL argument to an INTEGER value by removing the fractional part of the REAL argument

**Syntax :** TRUNC(x)

Function Return Type :INTEGER

Input/Output Parameters:

[in] x : REAL

%ENVIRONMENT Group :SYStem

**Details:**

- The returned value is the value of  $x$  after any fractional part has been removed. For example, if  $x = 2.3$ , the .3 is removed and a value of 2 is returned.
- $x$  must be in the range of -2147483648 to +2147483583. Otherwise, the program is aborted with an error.
- ROUND and TRUNC can both be used to convert a REAL expression to an INTEGER expression.

**See Also:** ROUND Built-In Function

**Example:** The following example uses the TRUNC Built-In to determine the actual INTEGER value of **miles** divided by **hours** to get **mph**.

**TRUNC Built-In Function**

```
WRITE ('enter miles driven, hours used: ')
READ (miles,hours,CR)
mph = TRUNC(miles/hours)
WRITE ('miles per hour=',mph::5)
```

## A.21 - U - KAREL LANGUAGE DESCRIPTION

### A.21.1 UNHOLD Action

**Purpose:** Releases a HOLD of motion

**Syntax :** UNHOLD <GROUP [n{,n}]>

**Details:**

- Any motion that was in progress when the last HOLD was executed is resumed.
- If motions are not held, the action has no effect.
- Held motions are canceled if a RELEASE statement is executed.
- If the group clause is not present, all groups or which the task has control (when the condition is defined) will be resumed.
- Motion cannot be stopped for a different task.

**Example:** The following example moves the robot along the PATH **pathvar** and holds the robot

motion 200 milliseconds before node[3]. The global condition handler is triggered when TPIN[1] is pressed. This condition handler then issues a UNHOLD statement to resume robot motion.

### **UNHOLD Action**

```
CONDITION[1]:
    WHEN TPIN[1]+ DO
        UNHOLD
    ENDCONDITION

    ENABLE CONDITION[1]

MOVE ALONG pathvar,
    WHEN TIME 200 BEFORE NODE[3] DO
        HOLD
    ENDMOVE
```

## **A.21.2 UNHOLD Statement**

**Purpose:** Releases a HOLD of motion

**Syntax :** UNHOLD <GROUP [n{,n}]>

**Details:**

- Any motion that was in progress when the last HOLD was executed is resumed.
- If motions are not held, the statement has no effect.
- Held motions are canceled if a RELEASE statement is executed.
- If the group clause is not present, all groups or which the task has control (when the condition is defined) will be resumed.
- Motion cannot be stopped for a different task.

**See Also:** [Appendix E](#) , “Syntax Diagrams,” for more syntax information

**Example:** The following example initiates a move to **p1** and HOLDS the motion. If **DIN[1]** is ON, UNHOLD allows the program to resume motion.

### **UNHOLD Statement**

```
MOVE TO p1 NOWAIT
HOLD
IF DIN[1] THEN
    UNHOLD
ENDIF
```

### **A.21.3 UNINIT Built-In Function**

**Purpose:** Returns a BOOLEAN value indicating whether or not the specified argument is uninitialized

**Syntax :** UNINIT(variable)

Function Return Type :BOOLEAN

Input/Output Parameters :

[in] variable :any KAREL variable

%ENVIRONMENT Group :SYSTEM

**Details:**

- A value of TRUE is returned if *variable* is uninitialized. Otherwise, FALSE is returned.
- *variable* can be of any data type except an unsubscripted ARRAY, PATH, or structure.

**Example:** Refer to [Section B.12](#) , "Displaying a List from a Dictionary File" (DCLST\_EX.KL) for a detailed program example.

### **A.21.4 UNLOCK\_GROUP Built-In Procedure**

**Purpose:** Unlocks motion control for the specified group of axes

**Syntax :** UNLOCK\_GROUP(group\_mask, status)

Input/Output Parameters:

[in] group\_mask :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :MULTI

**Details:**

- *group\_mask* specifies the group of axes to unlock for the running task. The group numbers must be in the range of 1 to the total number of groups defined on the controller.

**Table A-23. Group\_mask Settings**

GROUP	DECIMAL	BIT
Group 1	1	1
Group 2	2	2
Group 3	4	3

To specify multiple groups select the decimal values, shown in [Table A-23](#), which correspond to the desired groups. Then connect them together using the OR operator. For example to specify groups 1, 3, enter "1 OR 4".

- Unlocking a group indicates that the task is done with the motion group.
- When a task completes execution (or is aborted), all motion groups that are locked by the program will be unlocked automatically.
- If motion is executing or pending when the UNLOCK\_GROUP Built-In is called, then status is set to 17039, "Executing motion exists."
- If motion is stopped when the UNLOCK\_GROUP Built-In is called, then status is set to 17040, "Stopped motion exists."
- If a motion statement is encountered in a program that has the %NOLOCKGROUP Directive, the task will attempt to get motion control for all the required groups if it does not already have it. The task will pause if it cannot get motion control.



### Caution

Many of the fields in the \$GROUP system variable are initialized to a set of default values when the UNLOCK\_GROUP built-in is executed, see [KAREL Motion Initialization](#). This could cause unexpected motion.

### KAREL Motion Initialization

```
$GROUP[n].$MOTYPE      = JOINT
$GROUP[n].$TERMTYPE    = FINE
$GROUP[n].$SEGTERMTYPE = FINE
$GROUP[n].$DECELTOL   = 0
$GROUP[n].$USE_CONFIG  = TRUE
$GROUP[n].$ORIENT_TYPE = RSWORLD
$GROUP[n].$SPEED        = 300.0
$GROUP[n].$ROTSPEED     = 500.0 ($MRR_GRP[n].$ROTSPEEDLIM x 57.29577951)
$GROUP[n].$CONTAXISVEL = 0.0
```

```
$GROUP[n].$SEG_TIME = 0
```

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**See Also:** LOCK\_GROUP Built-In Procedure, [Chapter 15 MULTI-TASKING](#), for more information and examples.

**Example:** The following example unlocks groups 1, 2, and 3, and then locks group 3.

### **UNLOCK\_GROUP Built-In Procedure**

```
PROGRAM lock_grp_ex
%ENVIRONMENT MOTN
%ENVIRONMENT MULTI
VAR
    status: INTEGER
BEGIN
    REPEAT
        -- Unlock groups 1, 2, and 3
        UNLOCK_GROUP(1 OR 2 OR 4, status)
        IF status = 17040 THEN
            CNCL_STP_MTN      -- or RESUME
        ENDIF
        DELAY 500
    UNTIL status = 0
    -- Lock only group 3
    LOCK_GROUP(4, status)
END lock_grp_ex
```

## **A.21.5 UNPAUSE Action**

**Purpose:** Resumes program execution long enough for a routine action to be executed

**Syntax :** UNPAUSE

**Details:**

- If a routine is called as an action, but program execution is paused, execution is resumed only for the duration of the routine and then is paused again.
- If more than one routine is called, all of the routines will be executed before execution is paused again.
- The resume and pause caused by UNPAUSE do not satisfy any RESUME and PAUSE conditions.

**See Also:** RESUME, PAUSE Actions

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

### **A.21.6 UNPOS Built-In Procedure**

**Purpose:** Sets the specified REAL variables to the location (x,y,z) and orientation (w,p,r) components of the specified XYZWPR variable and sets the specified CONFIG variable to the configuration component of the XYZWPR

**Syntax :** UNPOS(posn, x, y, z, w, p, r, c)

Input/Output Parameters:

[in] posn :XYZWPR

[out] x, y, z :REAL

[out] w, p, r :REAL

[out] c :CONFIG

%ENVIRONMENT Group :SYSTEM

**Details:**

- $x, y, z, w, p$ , and  $r$  arguments are set to the  $x, y$ , and  $z$  location coordinates and yaw, pitch, and roll orientation angles of  $posn$ .
- $c$  returns the configuration of  $posn$ .

**See Also:** [Chapter 8 MOTION](#)

**Example:** The following example uses the UNPOS Built-In to add 100 to the  $x$  location argument.

#### **UNPOS Built-In Procedure**

```
UNPOS (CURPOS,x,y,z,w,p,r,config)
      next_pos = POS (x+100,y,z,w,p,r,config)
      MOVE TO next_pos
```

### **A.21.7 UNTIL Clause**

**Purpose:** Used in a MOVE statement to specify a local condition handler

**Syntax :** UNTIL cond\_list < THEN action\_list >

where:

cond\_list : one or more conditions

action\_list : one or more actions

**Details:**

- Multiple conditions in *cond\_list* must be separated by the AND operator or the OR operator. Mixing of AND and OR is not allowed.
- For the AND operator, all of the conditions in a single UNTIL clause must be satisfied simultaneously for the condition handler to be triggered.
- If the condition handler is triggered, the motion is canceled.
- The optional *action\_list* represents a list of additional actions to be taken when the condition handler is triggered.
- Multiple actions must be separated by a comma or a new line.
- Calls to function routines are not allowed in an UNTIL clause.
- Local condition handlers can include multiple WHEN and UNTIL clauses.
- The condition handler is enabled when the motion physically begins.
- The condition handler is purged when the motion completes.
- The motion is treated as complete if the condition handler is triggered.

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , Appendix E, “Syntax Diagrams,” for more syntax information

## **A.21.8 USING ... ENDUSING Statement**

**Purpose:** Defines a range of executable statements in which fields of a variable of a STRUCTURE type can be accessed without repeating the name of the variable.

**Syntax :** USING struct\_var{,struct\_var} DO  
{statement} ENDUSING

where:

struct\_var : a variable of STRUCTURE type

statement : an executable KAREL statement

**Details:**

- In the executable statement, if the same name is both a field name and a variable name, the field name is used.
- If the same field name appears in more than one variable, the right-most variable in the USING statement is used.
- When the translator sees any field, it searches the structure type variables listed in the USING statement from right to left.

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

## A.22 - V - KAREL LANGUAGE DESCRIPTION

### A.22.1 VAR\_INFO Built-In Procedure

**Purpose:** Allows a KAREL program to determine data type and numerical information regarding internal or external program variables

**Syntax:** VAR\_INFO(prog\_name, var\_name, uninit, type\_nam, type\_value, dims, slen, status)

Input/Output Parameters:

```
[in] prog_name :STRING
[in] var_name :STRING
[out] uninit_b :BOOLEAN
[out] type_nam :STRING
[out] dims:ARRAY[3] OF INTEGER
[out] type_value :INTEGER
[out] status :INTEGER
[out] slen :INTEGER
%ENVIRONMENT Group :BYNAM
```

**Details:**

- *prog\_name* specifies the name of the program that contains the specified variable. If *prog\_name* is blank, then it defaults to the current program being executed.
- *var\_name* must refer to a static program variable.

- *var\_name* can contain node numbers, field names, and/or subscripts.
- *uninit\_b* will return a value of TRUE if the variable specified by *var\_name* is uninitialized and FALSE if the variable specified by *var\_name* is initialized.
- *type\_nam* returns a STRING specifying the type name of *var\_name*
- *type\_value* returns an INTEGER corresponding to the data type of *var\_name*. The following table lists valid data types and their representative INTEGER values.

**Table A-24. Valid Data Types**

Data Type	Value
POSITION	1
XYZWPR	2
XYZWPREXT	6
INTEGER	16
REAL	17
BOOLEAN	18
VECTOR	19
COMMON_ASSOC	20
VIS_PROCESS	21
MODEL	22
SHORT	23
BYTE	24
JOINTPOS1	25
CONFIG	28

Table A-24. Valid Data Types (Cont'd)

Data Type	Value
FILE	29
GROUP_ASSOC	30
PATH	31
CAM_SETUP	32
JOINTPOS2	41
JOINTPOS3	57
JOINTPOS4	73
JOINTPOS5	89
JOINTPOS6	105
JOINTPOS7	121
JOINTPOS8	137
JOINTPOS9	153
JOINTPOS	153
STRING	209
user-defined type	210

- *dims* returns the dimensions of the array, if any. The size of the *dims* array should be 3.
  - *dims[1]* = 0 if not an array
  - *dims[2]* = 0 if not a two-dimensional array
  - *dims[3]* = 0 if not a three-dimensional array
- *slen* returns the declared length of the variable specified by *var\_name* if it is a STRING variable.

- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred.

**Example:** The following example retrieves information regarding the variable **counter**, located in **util\_prog**, from within the program **task**.

### **VAR\_INFO Built-In Procedure**

```

PROGRAM util_prog
  VAR
    counter, i : INTEGER
  BEGIN
    counter = 0
    FOR i = 1 TO 10 DO
      counter = counter + 1
    ENDFOR
  END util_prog

PROGRAM task
  VAR
    uninit_b          : BOOLEAN
    type_name         : STRING[12]
    type_code         : INTEGER
    slen, status      : INTEGER
    alen              : ARRAY[3] OF INTEGER

  BEGIN
    VAR_INFO('util_prog', 'counter', uninit_b, type_name, type_code,
             alen, slen, status)
    WRITE('counter : ', CR)
    WRITE('UNINIT : ', uninit_b, '      TYPE : ', type_name, cr)
  END task

```

### **A.22.2 VAR\_LIST Built-In Procedure**

**Purpose:** Locates variables in the specified KAREL program with the specified name and data type

**Syntax :** VAR\_LIST(prog\_name, var\_name, var\_type, n\_skip, format, ary\_nam, n\_vars, status)

Input/Output Parameters:

[in] prog\_name : STRING

[in] var\_name : STRING

[in] var\_type : INTEGER

[in] n\_skip : INTEGER

[in] format : INTEGER

[out] ary\_nam : ARRAY of STRING

[out] n\_vars : INTEGER

[out] status : INTEGER

%ENVIRONMENT Group :BYNAM

**Details:**

- *prog\_name* specifies the name of the program that contains the specified variables. *prog\_name* can be specified using the wildcard (\*) character, which specifies all loaded programs.
- *var\_name* is the name of the variable to be found. *var\_name* can be specified using the wildcard (\*) character, which specifies that all variables for *prog\_name* be found.
- *var\_type* represents the data type of the variables to be found. The following is a list of valid data types:

**Table A-25. Valid Data Types**

Data Type	Value
All variable types	0
POSITION	1
XYZWPR	2
INTEGER	16
REAL	17
BOOLEAN	18
VECTOR	19
COMMON_ASSOC	20
VIS_PROCESS	21
MODEL	22
SHORT	23
BYTE	24
JOINTPOS1	25
CONFIG	28
FILE	29

**Table A–25. Valid Data Types (Cont'd)**

Data Type	Value
GROUP_ASSOC	30
PATH	31
CAM_SETUP	32
JOINTPOS2	41
JOINTPOS3	57
JOINTPOS4	73
JOINTPOS5	89
JOINTPOS6	105
JOINTPOS7	121
JOINTPOS8	137
JOINTPOS9	153
JOINTPOS	153
STRING	209
user-defined type	210

- *n\_skip* is used when more variables exist than the declared length of *ary\_nam*. Set *n\_skip* to 0 the first time you use VAR\_LIST. If *ary\_nam* is completely filled with variable names, copy the array to another ARRAY of STRINGS and execute the VAR\_LIST again with *n\_skip* equal to *n\_vars*. The call to VAR\_LIST will skip the variables found in the first pass and locate only the remaining variables.
- *format* specifies the format of the program name and variable name. The following values are valid for *format* :
 

```

1=prog_name only, no blanks
2 =var_name only, no blanks
3 =[prog_name]var_name, no blanks
4 ='prog_name var_name   ',
Total length = 27 characters, prog_name
starts with character 1 and var_name starts with character 16.
      
```
- *ary\_nam* is an ARRAY of STRINGS to store the variable names. If the declared length of the STRING in *ary\_nam* is not long enough to store the formatted data, then status is returned with an error.
- *n\_vars* is the number of variables stored in *ary\_name*.
- *status* will return zero if successful.

**See Also:** FILE\_LIST, PROG\_LIST Built-In Procedures

**Example:** Refer to [Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL), for a detailed program example.

### A.22.3 VECTOR Data Type

**Purpose:** Defines a variable, function return type, or routine parameter as VECTOR data type

**Syntax :** VECTOR

**Details:**

- A VECTOR consists of three REAL values representing a location or direction in three dimensional Cartesian coordinates.
- Only VECTOR expressions can be assigned to VECTOR variables, returned from VECTOR function routines, or passed as arguments to VECTOR parameters.
- Valid VECTOR operators are:
  - Addition (+) and subtraction (-) mathematical operators
  - Equal (=) and the not equal ( $\neq$ ) relational operators
  - Cross product (#) and the inner product (@) operators.
  - Multiplication (\*) and division (÷) operators
  - Relative position (: ) operator
- Component fields of VECTOR variables can be accessed or set as if they were defined as follows:

#### VECTOR Data Type

```
VECTOR = STRUCTURE
  X:  REAL
  Y:  REAL
  Z:  REAL
ENDSTRUCTURE
```

Note: All fields are read-write

**Example:** The following example shows VECTOR as variable declarations, as parameters in a routine, and as a function routine return type.

#### VECTOR Data Type

```
VAR
  direction, offset : VECTOR

ROUTINE calc_offset(offset_vec:VECTOR):VECTOR FROM util_prog
```

#### A.22.4 VIA Clause

**Purpose:** Specifies an intermediate POSITION in a move statement using circular interpolation

**Syntax :** VIA posn

where:

posn : a POSITION variable

**Details:**

- VIA clauses are required and permitted only in moves using circular interpolation (\$MOTYPE=CIRCULAR).
- VIA clauses are permitted only in MOVE TO statements (not in MOVE ALONG, MOVE NEAR, and so on).
- The circle is computed using the current POSITION, the POSITION given in the VIA clause, and the destination POSITION specified in the MOVE statement.

**Example:** Refer to [Section B.6, "Path Variables and Condition Handlers Program"](#) (PTH\_MOVE.KL) for a detailed program example.

#### A.22.5 VOL\_SPACE Built-In Procedure

**Purpose:** Returns the total bytes, free bytes, and volume name for the specified device

**Syntax :** VOL\_SPACE(device, total, free, volume)

Input/Output Parameters:

[in] device :STRING

[out] total :INTEGER

[out] free :INTEGER

[out] volume :STRING

%ENVIRONMENT Group :FLBT

**Details:**

- *devices* can be:

**RD:** The RAM disk returns all three parameters, but the volume name is " " since it is not supported. The RAM disk must be mounted in order to query it.

**FR:** The FROM disk returns all three parameters, but the volume name is " " since it is not supported. The FROM disk must be mounted in order to query it.

**FR:** Size of the Flash ROM. This only sets the *total* parameter.

**DRAM:** Size of the DRAM. This only sets the *total* parameter.

**CMOS:** Size of the CMOS ROM. This only sets the *total* parameter.

**TPP:** The area of system memory where teach pendant programs are stored.

**PERM:** The area of permanent CMOS RAM memory where system variables and selected KAREL variables are stored.

**TEMP:** The area of temporary DRAM memory used for loaded KAREL programs, KAREL variables, program execution information, and system operations.

**SYSTEM:** The area of temporary DRAM memory where the system software and options are stored. This memory is saved to FROM and restored on power up.

**Note** All device names must end with a *colon* (:).

- *total* is the original size of the memory, in bytes.
- *free* is the amount of available memory, in bytes.
- *volume* is the name of the storage device used.

**See Also:** [Section 1.4.1](#), "Memory." Status Memory in the "Status Displays and Indicators," chapter of the appropriate application-specific *FANUC Robotics SYSTEM R-J3iB Controller Setup and Operations Manual*.

**Example:** The following example gets information about the different devices.

### VOL\_SPACE Built-In Procedure

```

PROGRAM space
%NOLOCKGROUP
%ENVIRONMENT FLBT

VAR
    total:   INTEGER
    free:    INTEGER
    volume: STRING [30]

BEGIN
    VOL_SPACE('rd:', total, free, volume)

```

```
VOL_SPACE('fr:', total, free, volume)
VOL_SPACE('frp:', total, free, volume)
VOL_SPACE('fr:', total, free, volume)
VOL_SPACE('dram:', total, free, volume)
VOL_SPACE('cmos:', total, free, volume)
VOL_SPACE('tpp:', total, free, volume)
VOL_SPACE('perm:', total, free, volume)
VOL_SPACE('temp:', total, free, volume)
END space
```

## **A.23 - W - KAREL LANGUAGE DESCRIPTION**

### **A.23.1 WAIT FOR Statement**

**Purpose:** Delays continuation of program execution until some condition(s) are met

**Syntax :** WAIT FOR cond\_list

where:

cond\_list: one or more conditions

**Details:**

- All of the conditions in a single WAIT FOR statement must be satisfied simultaneously for execution to continue.

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , Appendix E, “Syntax Diagrams,” for more syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

### **A.23.2 WHEN Clause**

**Purpose:** Used to specify a conditions/actions pair in a local or global condition handler

**Syntax :** WHEN cond\_list DO action\_list

where:

`cond_list` : one or more conditions

`action_list` : one or more conditions

**Details:**

- All of the conditions in the `cond_list` of a single WHEN clause must be satisfied simultaneously for the condition handler to be triggered.
- The `action_list` represents a list of actions to be taken when the corresponding conditions of a WHEN clause are satisfied simultaneously.
- Calls to function routines are not allowed in a CONDITION or MOVE statement and, therefore, cannot be used in a WHEN clause.
- CONDITION and MOVE statements can include multiple WHEN clauses.

**See Also:** [Chapter 6 CONDITION HANDLERS](#), [Appendix E, “Syntax Diagrams,”](#) for more syntax information

**Example:** Refer to the following sections for detailed program examples:

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.10, "Using Dynamic Display Built-ins" \(DYN\\_DISP.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

### **A.23.3 WHILE...ENDWHILE Statement**

**Purpose:** Used when an action is to be executed as long as a BOOLEAN expression remains TRUE

**Syntax :** WHILE boolean\_exp DO{ statement }ENDWHILE

where:

`boolean_exp` : a BOOLEAN expression

`statement` : a valid KAREL executable statement

**Details:**

- `boolean_exp` is evaluated before each iteration.
- As long as `boolean_exp` is TRUE, the statements in the loop are executed.
- If `boolean_exp` is FALSE, control is transferred to the statement following ENDWHILE, and the statement or statements in the body of the loop are not executed.

**See Also:** [Appendix E](#), “Syntax Diagrams,” for more syntax information

**Example:** Refer to [Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL) for a detailed program example.

#### A.23.4 WITH Clause

**Purpose:** Used in a MOVE statement to specify temporary values for system variables. Also used in condition handlers to specify condition handler qualifiers

**Syntax :** WITH param\_spec {, param\_spec}

where:

param\_spec is of the form : move\_sys\_var = value or move\_sys\_var[n] = value

move\_sys\_var : one of the system variables available for use in the WITH clause

n : specifies the group number

value : an expression of the type corresponding to the type of the system variable

**Details:**

- The actual system variables specified are not changed. The temporary value is used only by the motion environment while executing the move in which the WITH clause is used.
- The temporary value remains in effect until the next time the system variable is used by the motion environment. At that time, the assigned system variable value is used and the temporary value ceases to exist.
- INTEGER values can be used where REAL values are expected.
- Predefined constants are used to specify values for some system variables that can be used in the WITH clause. For example, \$MOTYPE is specified as LINEAR, CIRCULAR, or JOINT.
- \$PRIORITY and \$SCAN\_TIME are condition handler qualifiers that can be used in a WITH clause only when the WITH clause is part of a condition handler statement.



**Warning**

**Do not run a KAREL program that performs motion if more than one motion group is defined on your controller. If your controller is set up for more than one motion group, all motion must be initiated from a teach pendant program. Otherwise, the robot could move unexpectedly and injure personnel or damage equipment.**

**See Also:** [Chapter 6 CONDITION HANDLERS](#) , [Chapter 12 SYSTEM VARIABLES](#) , for a list of the system variables that can be used in the WITH clause

**Example:** Refer to the following sections for detailed program examples:

[Section B.6, "Path Variables and Condition Handlers Program" \(PTH\\_MOVE.KL\)](#)

[Section B.8, "Generating and Moving Along a Hexagon Path" \(GEN\\_HEX.KL\)](#)

[Section B.1, "Setting Up Digital Output Ports for Monitoring" \(DOUT\\_EX.KL\)](#)

## **A.23.5 WRITE Statement**

**Purpose:** Writes data to a serial device or file

**Syntax :** WRITE <file\_var> (data\_item { ,data\_item })

where:

file\_var : a FILE variable

data\_item : an expression and its optional format specifiers or the reserved word CR

**Details:**

- If *file\_var* is not specified in a WRITE statement the default TPDISPLAY is used. %CRTDEVICE directive will change the default to OUTPUT.
- If *file\_var* is specified, it must be one of the output devices or a variable that has been equated to one of them.
- If *file\_var* attribute was set with the UF option, data is transmitted to the specified file or device in binary form. Otherwise, data is transmitted as ASCII text.
- *data\_item* can be any valid KAREL expression.
- If *data\_item* is of type ARRAY, a subscript must be provided.
- If *data\_item* is of type PATH, you can specify that the entire path be read, a specific node be read [n], or a range of nodes be read [n .. m].
- Optional format specifiers can be used to control the amount of data that is written for each *data\_item* .
- The reserved word CR, which can be used as a data item, specifies that the next data item to be written to the file\_var will start on the next line.
- Use the IO\_STATUS Built-In to determine if the write operation was successful.

**See Also:** PATH Data Type, for more information on writing PATH variables, [Chapter 7 FILE INPUT/OUTPUT OPERATIONS](#), for more information on format specifiers and file\_vars. [Appendix E](#), “Syntax Diagrams,” for more syntax information

**Example:** Refer to [Appendix B](#), "KAREL Example Programs" for more detailed program examples.

### **A.23.6 WRITE\_DICT Built-In Procedure**

**Purpose:** Writes information from a dictionary

**Syntax :** WRITE\_DICT(file\_var, dict\_name, element\_no, status)

Input/Output Parameters:

[in] file\_var :FILE

[in] dict\_name :STRING

[in] element\_no :INTEGER

[out] status :INTEGER

%ENVIRONMENT Group :PBCORE

**Details:**

- *file\_var* must be opened to the window where the dictionary text is to appear.
- *dict\_name* specifies the name of the dictionary from which to write.
- *element\_no* specifies the element number to write. This number is designated with a “\$” in the dictionary file.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred writing the element from the dictionary file.

**See Also:** READ\_DICT, REMOVE\_DICT Built-In Procedures, [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** Refer to [Section B.12](#), "Displaying a List From a Dictionary File" (DCLST\_EX.KL), for a detailed program example.

### **A.23.7 WRITE\_DICT\_V Built-In Procedure**

**Purpose:** Writes information from a dictionary with formatted variables

**Syntax :** WRITE\_DICT\_V(file\_var, dict\_name, element\_no, value\_array, status)

Input/Output Parameters:

[in] file\_var :FILE

[in] dict\_name :STRING

[in] element\_no :INTEGER

[in] value\_array :ARRAY OF STRING

[out] status :INTEGER

%ENVIRONMENT Group :UIF

#### Details:

- *file\_var* must be opened to the window where the dictionary text is to appear.
- *dict\_name* specifies the name of the dictionary from which to write.
- *element\_no* specifies the element number to write. This number is designated with a \$ in the dictionary file.
- *value\_array* is an array of variable names that corresponds to each formatted data item in the dictionary text. Each variable name may be specified as '[*prog\_name*]*var\_name*'.
  - [*prog\_name*] specifies the name of the program that contains the specified variable. If not specified, then the current program being executed is used.
  - *var\_name* must refer to a static, global program variable.
  - *var\_name* may contain node numbers, field names, and/or subscripts.
- *status* explains the status of the attempted operation. If not equal to 0, then an error occurred writing the element from the dictionary file.

**See Also:** READ\_DICT\_V Built-In Procedure, [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** In the following example, TPTASKEG.TX contains dictionary text information which will display a system variable. This information is the first element in the dictionary and element numbers start at 0. **util\_prog** uses WRITE\_DICT\_V to display the text on the teach pendant.

#### WRITE\_DICT\_V Built-In Procedure

---

TPTASKEG.TX

---



---

\$ "Maximum number of tasks = %d"

---



---

UTILITY PROGRAM:

```
-----
PROGRAM util_prog
%ENVIRONMENT uif
VAR
    status: INTEGER
    value_array: ARRAY[1] OF STRING[30]
BEGIN
    value_array[1] = '[*system*].$scr.$maxnumtask'

    ADD_DICT('TPTASKEG', 'TASK', dp_default, dp_open, status)
    WRITE_DICT_V(TPDISPLAY, 'TASK', 0, value_array, status)
END util_prog
```

## **A.24 - X - KAREL LANGUAGE DESCRIPTION**

### **A.24.1 XYZWPR Data Type**

**Purpose:** Defines a variable, function return type, or routine parameter as XYZWPR data type

**Syntax :** XYZWPR <IN GROUP [n]>

**Details:**

- An XYZWPR consists of three REAL components specifying a Cartesian location (x,y,z), three REAL components specifying an orientation (w,p,r), and a component specifying a CONFIG Data Type, 32 bytes total.
- The configuration string indicates the joint placements and multiple turns that describe the configuration of the robot when it is at a particular position.
- A position is always referenced with respect to a specific coordinate frame.
- Components of XYZWPR variables can be accessed or set as if they were defined as follows:

#### **XYZWPR Data Type**

```
XYZWPR = STRUCTURE
    X: REAL
    Y: REAL
    Z: REAL
    W: REAL
    P: REAL
    R: REAL
    CONFIG_DATA: CONFIG
ENDSTRUCTURE
```

**Note:** All fields are read-write access.

**Example:** Refer to the following sections for detailed program examples:

[Section B.2](#), "Copying Path Variables" (CPY\_PTH.KL)

[Section B.5](#), "Using Register Built-ins" (REG\_EX.KL)

[Section B.6](#), "Path Variables and Condition Handlers Program" (PTH\_MOVE.KL)

[Section B.8](#), "Generating and Moving Along a Hexagon Path" (GEN\_HEX.KL)

[Section B.1](#), "Setting Up Digital Output Ports for Monitoring" (DOUT\_EX.KL)

## A.24.2 XYZWPREXT Data Type

**Purpose:** Defines a variable, function return type, or routine parameter as an XYZWPREXT

**Syntax :** XYZWPREXT <IN GROUP [n]>

**Details:**

- An XYZWPREXT consists of three REAL components specifying a Cartesian location (x,y,z), three REAL components specifying an orientation (w,p,r), and a component specifying a configuration string. It also includes three extended axes, 44 bytes total.
- The configuration string indicates the joint placements and multiple turns that describe the configuration of the robot when it is at a particular position.
- A position is always referenced with respect to a specific coordinate frame.
- Components of XYZWPREXT variables can be accessed or set as if they were defined as follows:

### XYZWPREXT Data Type

```

XYZWPRext = STRUCTURE
  X: REAL
  Y: REAL
  Z: REAL
  W: REAL
  P: REAL
  R: REAL
  CONFIG_DATA: CONFIG
  EXT1: REAL
  EXT2: REAL
  EXT3: REAL
ENDSTRUCTURE

--Note: All fields are read-write access.

```

## **A.25 - Y - KAREL LANGUAGE DESCRIPTION**

There are no KAREL descriptions beginning with "Y".

## **A.26 - Z - KAREL LANGUAGE DESCRIPTION**

There are no KAREL descriptions beginning with "Z".

# Appendix B

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## KAREL EXAMPLE PROGRAMS

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This appendix contains some KAREL program examples. These programs are meant to show you how to use the KAREL built-ins and commands described in [Appendix A](#), "KAREL Language Alphabetical Description."

Refer to this section for examples of how to use the KAREL built-ins and commands in a program. Refer to [Appendix A](#), for more detailed information on each of the KAREL built-ins and commands.

**Table B–1** lists the programs in this section, their main function, the built-ins used in each program, and the section to refer to for the program listing.

### **Conventions**

Each program in this appendix is divided into five sections.

Section 0 - Lists each element of the KAREL language that is used in the example program.

Section 1 - Contains the program and environment declarations.

Section 2 - Contains the constant, variable, and type declarations.

Section 3 - Contains the routine declarations.

Section 4 - Contains the main body of the program.

**Table B-1.** KAREL Example Programs

Program Name	Program Function	Built-ins Used	Section to Refer
CPY_PTH.KL	Copies path variables.	APPEND_NODE BY_NAME CALL_PROG CNV_INT_STR COPY_PATH CREATE_VAR CURPOS DELETE_NODE LOAD PATH_LEN PROG_LIST READ_KB SET_CURSOR SET_FILE_ATR SET_VAR SUB_STR VAR_LIST	<a href="#">Section B.2</a>
SAVE_VRS.KL	Saves data to the default device.	DELETE_FILE SAVE	<a href="#">Section B.3</a>

**Table B-1.** KAREL Example Programs (Cont'd)

Program Name	Program Function	Built-ins Used	Section to Refer
ROUT_EX.KL	Contains standard routines that are used throughout the program examples.	CHR FORCE_SPMENU	<a href="#">Section B.4</a>
REG_EX.KL	Uses Register built-ins.	CALL_PROGLIN CHR CURPOS GET_JPOS_REG GET_POS_REG GET_REG POS_REG_TYP SET_INT_REG SET_JPOS_REG SET_POS_REG FORCE_SPMENU	<a href="#">Section B.5</a>
PTH_MOVE.KL	Teaches and moves along a path. Also uses condition handlers.	CHR CNV_REL_JPOS PATH_LEN SET_CURSOR	<a href="#">Section B.6</a>

**Table B-1.** KAREL Example Programs (Cont'd)

Program Name	Program Function	Built-ins Used	Section to Refer
LIST_EX.KL	Lists files and programs, and manipulate strings.	ABS ARRAY_LEN CNV_INT_STR FILE_LIST LOAD LOAD_STATUS PROG_LIST ROUND SUB_STR	<a href="#">Section B.7</a>
GEN_HEX.KL	Generates a hexagon, and moves along the path.	CNV_REL_JPOS COS CURPOS SIN	<a href="#">Section B.8</a>
FILE_EX.KL	Uses the File and Device built-ins.	CNV_TIME_STR COPY_FILE DISMOUNT_DEV FORMAT_DEV GET_TIME MOUNT_DEV SUB_STR	<a href="#">Section B.9</a>

**Table B-1.** KAREL Example Programs (Cont'd)

Program Name	Program Function	Built-ins Used	Section to Refer
DYN_DISP.KL	Uses Dynamic Display built-ins.	ABORT_TASK CNC_DYN_DISB CNC_DYN_DISE CNC_DYN_DISP CNC_DYN_DISS CNC_DYN_DISI CNC_DYN_DISR INI_DYN_DISB INI_DYN_DISE INI_DYN_DISP INI_DYN_DISS INI_DYN_DISI INI_DYN_DISR LOAD LOAD_STATUS RUN_TASK	<a href="#">Section B.10</a>
CHG_DATA.KL	Processes and changes values of dynamically displayed variables.		<a href="#">Section B.11</a>

**Table B-1.** KAREL Example Programs (Cont'd)

Program Name	Program Function	Built-ins Used	Section to Refer
DCLST_EX.KL	Displays a list from a dictionary file.	ADD_DICT ACT_SCREEN ATT_WINDOW_S CHECK_DICT CLR_IO_STAT CNV_STR_INT DEF_SCREEN DISCTRL_LIST FORCE_SPENU IO_STATUS ORD READ_DICT REMOVE_DICT SET_FILE_ATR SET_WINDOW STR_LEN UNINIT WRITE_DICT	<a href="#">Section B.12.1</a>
DCLISTEG.UTX	Dictionary file.	N/A	<a href="#">Section B.12</a>

**Table B-1.** KAREL Example Programs (Cont'd)

Program Name	Program Function	Built-ins Used	Section to Refer
DCALP_EX.KL	Uses the DISCTRL_ALPHA Built-in.	ADD_DICT  CHR  DISCTRL_ALPH  FORCE_SPEMU  POST_ERR  SET_CURSOR  SET_LANG	<a href="#">Section B.13</a>
DCALPHEG.UTX	Dictionary file.	N/A	<a href="#">Section B.13.1</a>

**Table B-1.** KAREL Example Programs (Cont'd)

Program Name	Program Function	Built-ins Used	Section to Refer
CPY_TP.KL	Applies offsets to copied teach pendant programs.	AVL_POS_NUM CHR CLOSE_TPE CNV_JPOS_REL CNV_REL_JPOS COPY_TPE GET_JPOS_TYP GET_POS_TPE GET_POS_TYP OPEN TPE PROG_LIST SELECT_TPE SET_JPOS_TPE SET_POS_TPE	<a href="#">Section B.14</a>

**Table B-1.** KAREL Example Programs (Cont'd)

Program Name	Program Function	Built-ins Used	Section to Refer
DOUT_EX.KL	Sets up digital output ports for process monitoring. The DOUTs are used to monitor the status of the external equipment and to show the current status of the process. The equipment status DOUTs are simulated, but in practice they are looked up to the actual external equipment as a feedback response. The robot is moved along a path until the external equipment needs servicing, which is triggered by the DOUT values.	CHRPATH_LEN CURPOS DELAY FORCE_SPMENU RESET SET_PORT_ASG SET_PORT_CMT SET_PORT_MOD SET_PORT_SIM	<a href="#">Section B.1</a>

## **B.1 SETTING UP DIGITAL OUTPUT PORTS FOR PROCESS MONITORING**

This program sets up digital output ports for process monitoring. The DOUT are to monitor the external equipment status and show the current status of the process. The equipment status DOUT's are simulated, but in practice are hooked up to the actual external equipments as a feedback response. The robot is moved along a path until external equipment needs to be serviced, which is triggered by the DOUT values.

### **Setting Up Digital Output Ports for Process Monitoring - Overview**

---

----- DOUT\_EX.KL

```
-----
----- Section 0: Detail about DOUT_EX.kl
-----
----- Elements of KAREL Language Covered:
----- Action:
-----      CONTINUE                      Sec 4-A
-----      PORT_ID                       Sec 4-D,E
-----      ENABLE CONDITION               Sec 3-B; 4-D
-----      NOMESSAGE                     Sec 4-A
-----      PULSE                          Sec 4-E
-----      RESUME                         Sec 4-D
-----      ROUTINE CALL                  Sec 4-A,D
-----      SIGNAL EVENT                 Sec 4-D
-----      STOP                           Sec 4-D
-----      UNPAUSE                        Sec 4-A

----- Clauses:
-----      FROM                           Sec 3-A
-----      WHEN                          Sec 4-A,D,E
-----      WITH                          Sec 3-E

----- Conditions:
-----      AT NODE                       Sec 4-E
-----      PORT_ID                      Sec 4-D
-----      ERROR[xxx]                   Sec 4-A
-----      EVENT                         Sec 4-D
-----      RELATIONAL condition        Sec 4-A
-----      TIME xxx BEFORE             Sec 4-E

----- Data types:
-----      BOOLEAN                      Sec 2
-----      INTEGER                      Sec 2
-----      PATH                         Sec 2
-----      POSITION                     Sec 2
-----      STRING                       Sec 2
-----      XYZWPR                      Sec 2
```

**Setting Up Digital Output Ports for Monitoring Teach Pendant Program - Overview Continued**

```
----- Directives:
-----      ALPHABETIZE                  Sec 1
-----      COMMENT                     Sec 1
-----      CMOSVARS                    Sec 1
-----      INCLUDE                     Sec 1

----- Built-in Functions & Procedures:
-----      CHR                          Sec 3-E; 4-E
```

```

---- CURPOS Sec 3-E
---- DELAY Sec 3-B,E
---- FORCE_SPMENU Sec 3-E; 4-E
---- PATH_LEN Sec 4-C; 4-E
---- RESET Sec 3-B
---- SET_PORT_ASG Sec 3-D
---- SET_PORT_CMT Sec 3-D
---- SET_PORT_MOD Sec 3-C
---- SET_PORT_SIM Sec 4-E

---- Statements:
---- ABORT Sec 3-D; 4-C,E
---- ATTACH Sec 4-C
---- CONNECT TIMER Sec 4-A
---- CONDITION...ENDCONDITON Sec 4-A,D,E
---- ENABLE CONDITION Sec 3-E; 4-A,D
---- FOR...ENDFOR Sec 3-D
---- IF...THEN...ENDIF Sec 3-B,C,D; 4-C,D,E
---- MOVE ALONG Sec 4-E
---- MOVE NEAR Sec 3-E
---- RELEASE Sec 4-C
---- ROUTINE Sec 3-A,B,C,D,E
---- WAIT FOR Sec 3-E
---- WHILE...ENDWHILE Sec 4-C
---- WRITE Sec 3-B,D,E; 4-C,E

---- Reserve Words:
---- BEGIN Sec 3-B,C,D,E; 4
---- CONST Sec 2
---- CR Sec 3-B,D,E; 4-C,E
---- END Sec 3-B,C,D,E, 4-E
---- NOT Sec 3-B; 4-D
---- PROGRAM Sec 1
---- VAR Sec 2

---- Predefined FILE names:
---- TPPFUNC Sec 4-E

```

### Setting Up Digital Output Ports for Process Monitoring - Declaration Section

```

---- Section 1: Program and Environment Declaration
----  

PROGRAM DOUT_EX -- Define the program name
%ALPHABETIZE -- Create the variables in alphabetical order
%NOPAUSE = TPENABLE -- Do not pause the program if TP is ENABLED.
-- during execution.
%COMMENT = 'PORT/CH DOUT_EX'

```

```
%CMOSVARS                                -- Make sure variables are stored in CMOS
%INCLUDE KLIOTYPS

-----
----- Section 2: Constant and Variable Declarations
-----

CONST
-- Condition Handler Numbers
  CONT_CH      = 2                      -- Continue execution condition
  EQIP_FAIL    = 3                      -- Equipment Failure Condition
  RESTART      = 6                      -- Restart condition Handler
  SERV_DONE    = 4                      -- Servicing Done condition
  UNINIT_CH   = 10                     -- Monitor for uninit error
  WARMED_UP    = 5                      -- Event to notify eqip is ready

-- Process DOUT numbers ( 1 thru 6 are complementary DOUT )
--                               ( 3 and 4 are simulated DOUT )
  EQIP_READY   = 1                      -- Equipment Ready
  EQIP_NOT_RD= 2                      -- Equipment Not Ready
  EQIP_ERROR   = 3                      -- Equipment Failed during process
  EQIP_FIXED   = 4                      -- Equipment Fixed after failure
  EQIP_ON      = 5                      -- Turn Eqip-1 ON DOUT
  EQIP_OFF     = 6                      -- Turn Eqip-1 OFF DOUT
  NODE_PULSE   = 7                      -- Node Pulsing DOUT
  FINISH       = 8                      -- Path Finishing signal DOUT

-- Process Constants
  SUCCESS      = 0                      -- Successful Operation Status
  UNASIGNED    = 13007                  -- Unassigned Port Deletion Error

VAR
  cont_timer,
  last_node,
  status          : INTEGER            -- Status from builtin calls
  prg_abrt       : BOOLEAN           -- Set when the program is aborted
  pth1           : PATH               -- Process Path
  stop_pos        : POSITION           -- Process Stop Position
  perch_pos       : XYZWPR            -- Perch Position
  indx           : INTEGER            -- Used a FOR loop counter
  ports_ready    : BOOLEAN           -- Check if ports assigned
  cmt_str        : STRING[10]         -- Comment String
```

**Setting Up Digital Output Ports for Process Monitoring - Declare Routines**

```
-----
----- Section 3: Routine Declaration
-----

-----
----- Section 3-A: TP_CLS Declaration
----- This routine is from ROUT_EX.kl and will
----- clear the TP USER menu screen and force
```

```

----          it to be visible.
-----

ROUTINE tp_cls FROM rout_ex           -- ROUT_EX must also be loaded.

-----
----      Section 3-B:  port_init Declaration
----          This routine assigns a value to, ports_ready, which
----          allows the ports to be initialized.  It resets the
----          controller so that program execution may be continued
----          automatically thought the CONT_CH condition handler.
-----
```

```

ROUTINE init_port
VAR
    reset_ok: BOOLEAN
BEGIN
    ports_ready = FALSE             -- Set false so ports will be initialized
    DELAY 500;
    RESET(reset_ok)                -- Reset the controller
    IF (NOT reset_ok) THEN
        WRITE('Reset Failed', CR)
    ENDIF
    cont_timer = 0                  -- Set a timer to continue the processprocess
    ENABLE CONDITION[CONT_CH]       -- Enabled the CONT_CH which continues
                                    -- program execution
END init_port

```

### Setting Up Digital Output Ports for Process Monitoring - Declaration Section

```

----      Section 3-C:  SET_MODE Declaration
----          Sets up the mode of IO's.  Depending on the passed
----          parameter the IO ports will be set to REVERSE
----          and/or COMPLEMENTARY mode.  When the ports are set
----          to REVERSE mode, the TRUE condition is represented by
----          a FALSE signal.  When COMPLEMENTARY mode is selected
----          for a port (odd number port), the port n and n+1 are
----          complementary signal of each other.
-----
```

```

ROUTINE set_mode(port_type:      INTEGER;
                 port_no:        INTEGER;
                 reverse:        BOOLEAN;
                 complmnt:      BOOLEAN)

VAR
    mode:           INTEGER

```

```

BEGIN -- set_mode
  IF reverse THEN
    mode = 1                                -- Set the reverse mode
  ELSE
    mode = 0
  ENDIF

  IF complmnt THEN
    mode = mode OR 2                         -- Set complementary mode
  ENDIF

  SET_PORT_MOD(port_type, port_no, mode, status)

END set_mode

```

### Setting Up Digital Output Ports for Process Monitoring - Declaration Section

```

----- Section 3-D: SETUP_PORTS Declaration
----- This section assumes that you do not have an AB or GENIUS I/O
----- or any other external I/O board. Therefore, any previous port
----- assignments are no longer needed for this application, and
----- can be deleted.
-----

ROUTINE setup_ports
VAR
  port_n : INTEGER
BEGIN
-- Delete DIGITAL OUTPUT PORTS 1 thru 48
  FOR port_n = 0 to 5 DO
    -- Indexing of 0 to 5 may not be obvious, But look into the DIGITAL
    -- OUT Configuration screen in TP, you will see the 8 DIGITAL OUTPUT
    -- ports are grouped together in configuration.
    SET_PORT_ASG(IO_DOUT, port_n*8+1, 0, 0, 0, 0, 0, status)
    IF (status <> SUCCESS) AND (status <> UNASIGNED) THEN
      -- Verify that deletion by SET_PORT_ASG was successful
      WRITE ('SET_PORT_ASG built-in for DOUT (deletion) failed',CR)
      WRITE ('Status = ',status,CR)
    ENDIF
  ENDFOR
  -- Assign the DIGITAL PORTS 1 THRU 48 as memory images.
  FOR port_n = 0 TO 5 DO
    SET_PORT_ASG(IO_DOUT, port_n*8+1, 0, 0, io_mem_boo, port_n*8+1, 8, status)
    IF (status <> 0 ) THEN      -- Verify that SET_PORT_ASG was successful
      WRITE ('SET_PORT_ASG built-in for DOUT (assignment) failed',CR)
      WRITE ('Status = ',status,CR)
    ENDIF
  ENDFOR

```

```

-- Suppose equipment-1 is turned ON by the DOUT[1] = TRUE signal and
-- turned OFF by the DOUT[2] = TRUE signal. To avoid both signals being
-- TRUE or FALSE at the same time, set DOUT[1] to be a complement.
-- Once the DOUT[1] is set in complementary mode, the DOUT[1] and
-- DOUT[2] will always show the opposite signal of each other.
-- Thus avoiding the confusion of turning the equipment OFF and ON
-- at the same time.
-- Set port-1, port-3 and port-5 to COMPLEMENTARY mode.
FOR port_n = 1 to 6 DO
    SET_MODE(io_dout, port_n, TRUE, TRUE)
    IF (status <> SUCCESS) THEN
        WRITE ('SET_PORT_MODE Failed on port ',1,CR)
        WRITE ('With Status = ',status,CR)
    ENDIF
ENDFOR

```

### Setting Up Digital Output Ports for Process Monitoring - Main

```

-- Set appropriate comments for the ports.
SET_PORT_CMT(IO_DOUT, EQIP_READY, 'Equip-READY ',status)
IF (status <> 0 ) THEN           -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)
ENDIF
SET_PORT_CMT(IO_DOUT, EQIP_NOT_RD, 'E - NOT READY',status)
IF (status <> 0 ) THEN           -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)
ENDIF
SET_PORT_CMT(IO_DOUT, EQIP_ERROR, 'Equip- ERROR',status)
IF (status <> 0 ) THEN           -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)
ENDIF
SET_PORT_CMT(IO_DOUT, EQIP_FIXED, 'Equip- FIXED',status)
IF (status <> 0 ) THEN           -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)
ENDIF
SET_PORT_CMT(IO_DOUT, EQIP_ON, 'Equip- ON',status)
IF (status <> 0 ) THEN           -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)
ENDIF
SET_PORT_CMT(IO_DOUT, EQIP_OFF, 'Equip- OFF',status)
IF (status <> 0 ) THEN           -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)

```

```

ENDIF
SET_PORT_CMT(IO_DOUT, NODE_PULSE, 'Pulse @ node',status)
IF (status <> 0 ) THEN -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)
ENDIF
SET_PORT_CMT(IO_DOUT, FINISH, 'Finish PATH',status)
IF (status <> 0 ) THEN -- Verify SET_PORT_CMT was successful
    WRITE ('SET_PORT_CMT built-in failed',CR)
    WRITE ('Status = ',status,CR)
ENDIF

```

**Setting Up Digital Output Ports for Process Monitoring - Main**

```

TP_CLS -- clear the teach pendant USER sCREEN

WRITE ('PORT SETUP IS COMPLETE',CR)
WRITE ('AT THIS POINT YOU NEED TO COLD START',CR)
WRITE ('Configuration changes of PORTs will not',CR)
WRITE ('take effect until after a COLD START.',CR,CR)
WRITE ('Once the controller is ready after',CR)
WRITE ('COLD START, re-load this program',CR)
WRITE ('rerun.',CR)

ports_ready = TRUE -- Set the ports_ready variable so re-execution of
-- this routine, setup_ports, is not performed.
-- Aborting program to allow for the cold start.
ABORT

END setup_ports

-----
----- Section 3-E: SERVICE_RTN interrupt routine Declaration
----- This routine waits until the equipment has been
----- serviced and then moves the robot back to where
----- it was before servicing. It then sets the DOUT
----- to notify that the equipment is ready.
-----

ROUTINE service_rtn
BEGIN
    TP_CLS

    -- store the current position, where the process is stopped due to failure
    -- so after resuming the process can be started from this point.
    stop_pos = CURPOS(0,0)

    -- move the robot to the perch position so the equipment

```

```
-- can be worked on safely.
WITH $SPEED = 1000 MOVE TO perch_pos
WRITE (chr(139),' PLEASE READ ',chr(143),CR)      --Display in reverse video
WRITE ('Equipment - 1 failed during',CR)
WRITE ('processing. Motions have been stopped.',CR)
WRITE ('Please Fix the equipment then',CR)
WRITE ('SET DOUT[,EQIP_FIXED,] = TRUE ',CR)
--Display the following message in reverse video
WRITE (chr(139), 'IMPORTANT: Once the DOUT is set, current',CR)
WRITE ('STOPPED motion will be RESUMED',chr(143),CR)
WAIT FOR DOUT[EQIP_FIXED] -- wait until equipment has been fixed
```

**Setting Up Digital Output Ports for Process Monitoring - Main**

```
-- Move close to the point where the process was stopped
-- Depending on orientation and path , the "by offset" value should be
-- selected properly.
WITH $SPEED = 1000 MOVE NEAR stop_pos by +100

-- Move slowly to the point where the process was stopped
WITH $SPEED = 500 MOVE NEAR stop_pos by 0

-- Enable the SERVICE-DONE condition handler to resume the process.
ENABLE CONDITION[SERV_DONE]

-- Wait a sufficient time to allow equipment to warm up and get ready for
-- processing after the fix is completed.
WRITE ('Continuing the process.....',CR)
DELAY 2000

--Signal that the equipment is now ready.
DOUT[EQIP_READY] = TRUE

-- Force the teach pendant back to the IO sCREEN
FORCE_SPMENU(tp_panel, SPI_TPDIGIO, 1)

END service_rtn

-----
----- Section 4: Main Program
-----
BEGIN -- DOUT_EX
-----
----- Section 4-A: Global Condition Handler Declaration
-----

CONDITION[UNINIT_CH]:
WHEN ERROR[12311] DO                                -- Trap UNINITIALIZATION error
```

```

NOMESSAGE                                -- Supress the error message
UNPAUSE                                    -- UNPAUSE
init_port                                  -- Allow ports to be initialized.
ENDCONDITION

ENABLE CONDITION[UNINIT_CH]

CONNECT TIMER to cont_timer

CONDITION [CONT_CH]:
WHEN cont_timer > 1000 DO
    CONTINUE
ENDCONDITION

```

### Setting Up Digital Output Ports for Process Monitoring - Main

---

```

----- Section 4-C: Verify PATH variable, pth1, has been taught.
-----
TP_CLS                                     -- Routine Call; Clears the TP USER menu and
                                            -- forces the TP USER menu to be visible.
-- Check the number of nodes in the path
IF PATH_LEN(pth1) = 0 THEN                  -- Path is empty (no nodes)
    WRITE ('You need to teach the path.',CR) -- Display instructions
    WRITE ('before executing this program.',CR)
    WRITE ('Teach the PATH variable pth1', CR, 'and restart the program',CR)
    WRITE ('PROGRAM ABORTED',CR)
    ABORT                                     -- ABORT the task. do not continue
                                            -- There are no nodes to move to
ENDIF
-- Set Perch Position
-- This position is used in the service_rtn routine

IF UNINIT(perch_pos) THEN
    WRITE ('PERCH POSITION is not recorded.',cr)
    WRITE ('RELEASING Motion Control to TP.',cr)
    WRITE ('Please Move robot to desired Perch Pos',cr)

    -- Wait until the DEADMAN switch is HELD and
    -- TP is TURNED ON to move robot from TP.
    WHILE ((TPIN[248] = ON) AND (TPIN[247] = ON)) DO
        WRITE TPPROMPT(CHR(128),CHR(137),'Hold Down the DEAD-MAN switch')
        DELAY 500
    ENDWHILE

    -- Release motion control from the KAREL program to the
    -- TP control. Robot can be moved to desired Perch

```

```

-- position without disturbing the flow of this KAREL task.
RELEASE

WHILE (TPIN[249] = OFF ) DO
    WRITE TPPROMPT(CHR(128),CHR(137),'Turn the TP ON')
    DELAY 1000
ENDWHILE

WRITE ('ROBOT is ready to move from TP',cr)
WRITE ('After moving ROBOT to PERCH position ',cr)
WRITE ('Turn OFF the TP then RELEASE DEADMAN ',cr)

WHILE (TPIN[249] = ON ) DO
    WRITE TPPROMPT(CHR(128),CHR(137),'Turn OFF TP, after MOVE is done')
    DELAY 10000
ENDWHILE

```

### Setting Up Digital Output Ports for Process Monitoring - Main

```

-- KAREL program execution will not continue passed ATTACH
-- statement until the TP is turned OFF.
-- Wait until the TP is TURNED OFF after move from TP is completed.
WHILE (TPIN[249] = ON ) DO
    DELAY 2000
ENDWHILE
-- At this point the robot is positioned to the desired
-- Perch position. Get the motion
-- control back from TP and record the perch position.
ATTACH
perch_pos = CURPOS(0,0,1)
ENDIF
-----
----Section 4-D: Set up Ports and Declare Process dependant condition
handler
-----
-- Port assignments need to be assigned only once and take effect
-- after the controller is COLD STARTED.
-- The ports_ready variable is used to determine if the ports have
-- already been assigned by this program.
-- Therefore only the first execution of this program will assign the ports
IF NOT(ports_ready) THEN
    setup_ports
ENDIF
-- Define a condition handler to trap equipment failure.
-- If equipment fails during the process, then the DOUT[EQIP_ERROR] is
-- set to TRUE. Which will stop the motion and require the equipment to be
-- fixed before motion can be resumed.
CONDITION[EQIP_FAIL]:

```

```

WHEN DOUT[EQIP_ERROR] DO
  STOP
  DOUT[EQIP_FIXED] = FALSE
  DOUT[EQIP_READY] = FALSE
  ENABLE CONDITION[RESTART]
  service rtn
ENDCONDITION
ENABLE CONDITION[EQIP_FAIL]
-- Define a condition handler to monitor the servicing process.
-- Once Servicing/Fixing of equipment is complete, wait for the equipment
-- to be in READY mode. When the equipment is READY, signal an event
-- which will restart the process where it left off. The SERV_DONE
-- condition handler is ENABLED from the SERVICE_RTN interrupt routine.
CONDITION[SERV_DONE]:
WHEN DOUT[EQIP_READY] DO
  SIGNAL EVENT[WARMED_UP]
  DOUT[EQIP_ERROR] = FALSE
ENDCONDITION

```

### Setting Up Digital Output Ports for Process Monitoring - Main

```

-- Define a condition handler to monitor when the warm up is complete, then
-- resume the stopped motion and continue the process. Also re-enable
-- the EQIP_FAIL condition handler to continue monitoring for equipment
-- failure.

```

```

CONDITION[RESTART]:
WHEN EVENT[WARMED_UP] DO
  RESUME
  ENABLE CONDITION[EQIP_FAIL]
ENDCONDITION

```

```
-----  
---- Section 4-E: Do process manipulation  
-----
```

```
-- Using the PATH_LEN built-in find out the last node of the path
last_node = PATH_LEN(pth1)
```

```
-- Setting EQIP_ERROR/EQIP_FIXED number ports to be simulated.
-- This setup does not require cold start, can change the port to be
-- simulated on the fly.
```

```

SET_PORT_SIM(io_dout, NODE_PULSE, 1, status)
IF (status <> SUCCESS) THEN
  WRITE ('SET_PORT_SIM Failed on port ', indx, CR)
  WRITE ('With Status = ', status, CR)
ENDIF

```

```

SET_PORT_SIM(io_dout, FINISH, 1, status)
IF (status <> SUCCESS) THEN
    WRITE ('SET_PORT_SIM Failed on port ',indx,CR)
    WRITE ('With Status = ',status,CR)
ENDIF

```

### Setting Up Digital Output Ports for Process Monitoring - Main

```

WRITE (' NOW YOU WILL SEE THE DOUT[',NODE_PULSE,'] PULSE',CR)
WRITE (' as the robot moves through every node.',CR,CR)
WRITE (' To simulate EQUIPMENT failure, change ',CR)
WRITE (' DOUT[',EQIP_ERROR,'] = TRUE. ',CR)
WRITE (' Press ''ENTER'' to Continue',CR)
READ(CR)

-- Change the TP display to the DI/O sCREEN
FORCE_SPMENU(tp_panel, SPI_TPDIGIO, 1)

-- Moving along path when equipment is ready.
-- Need to turn on equipment-1 for 1/2 second when robot position
-- is at 1st node. Pulse the DOUT[NODE_PULSE] for every node
-- Turn on the DOUT[FINISH] about 200 ms before the last node.

IF DOUT[EQIP_READY] THEN
    MOVE ALONG pth1,
    WHEN AT NODE[*] DO
        PULSE DOUT[NODE_PULSE] for 1000
    WHEN AT NODE[1] DO
        PULSE DOUT[EQIP_ON] for 500
    WHEN TIME 200 BEFORE NODE[last_node] DO
        DOUT[FINISH] = TRUE
    ENDMOVE
ELSE
    FORCE_SPMENU(TP_PANEL,SPI_TPUSER,1)
    WRITE (' Equipment is not READY',CR)
    WRITE (' Set equipment to READY MODE',CR)
    WRITE (' before executing this program.',CR)
    WRITE (' SET DOUT[',EQIP_READY,'] = TRUE ',CR)
    ABORT
ENDIF

WRITE TPFUNC      (CHR(128),CHR(137)) -- Home Cursor and Clear to End-of-line
                                         -- This will remove the ABORT displayed
                                         -- above F1.

END DOUT_EX

```

## **B.2 COPYING PATH VARIABLES**

This example shows the different ways of copying and appending PATH variables. The PATH Data Type can be copied from one to another only with hard coded path variable names. However, user defined paths can be copied from one to another. The path variable names can be determined during execution of the program.

### **Copy Path Variables Program - Overview**

---

```

---- Detail about CPY_PTH.KL
-----
---- Elements of KAREL Language Covered: In Section:
---- Action:
---- Clauses:
----      FROM          Sec 3-A
----      IN DRAM       Sec 2
----      WHEN          Sec 4-A
---- Conditions:
----      Data types:
----          ARRAY OF STRING      Sec 2
----          BOOLEAN           Sec 2; 3-C
----          COMMON_ASSOC       Sec 2
----          FILE              Sec 2
----          GROUP_ASSOC        Sec 2
----          INTEGER            Sec 2; 3-B,C
----          PATH              Sec 2
----          STRING             Sec 2; 3-B
----          STRUCTURE...ENDSTRUCTURE Sec 2
----          USER DEFINED PATH   Sec 2
----          XYZWPR            Sec 2
---- Directives:
----      ALPHABETIZE        Sec 1
----      COMMENT            Sec 1
----      CMOSVARS           Sec 1
----      CRTDEVICE          Sec 1
----      INCLUDE            Sec 2

```

### **Copy Path Variables Program - Overview and Declaration Section**

```

---- Built-in Functions & Procedures:
----      APPEND_NODE        Sec 4-D
----      BYNAME             Sec 4-E
----      CALL_PROG           Sec 4-B
----      COPY_PATH           Sec 3-C; 4-D

```

```

----      CNV_INT_STR          Sec 4-E
----      CREATE_VAR           Sec 4-E
----      CURPOS               Sec 4-B
----      DELETE_NODE          Sec 4-C
----      LOAD                 Sec 4-B
----      PATH_LEN              Sec 4-C,E
----      PROG_LIST             Sec 4-B
----      READ_KB               Sec 3-B
----      SET_CURSOR            Sec 4-E
----      SET_FILE_ATR          Sec 4-A
----      SET_VAR               Sec 4-B
----      SUB_STR               Sec 4-E
----      VAR_LIST              Sec 4-E

----      Statements:
----      ABORT                Sec 4-C,E
----      CLOSE FILE            Sec 4-E
----      FOR .... ENDFOR       Sec 3-C; 4-C,D,E
----      IF...THEN...ENDIF      Sec 3-B,C; 4-B,C,D,E
----      MOVE ALONG            Sec 4-D
----      OPEN FILE             Sec 4-A
----      REPEAT...UNTIL        Sec 3-B; 4-E
----      ROUTINE              Sec 3
----      WRITE                Sec 3-B,C; 4-A,B,C,E
----      USING...ENDUSING      Sec 4-D

----      Reserve Word:
----      BEGIN                Sec 3-B,C; 4
----      END                  Sec 3-B,C; 4-E
----      PROGRAM              Sec 1
----      TYPE                 Sec 2
----      VAR                  Sec 2

----      Predefined File Names:
----      CRTFUNC              Sec 3-B
----      CRTPROMPT            Sec 3-B,C
-----Section 1: Program and Environment Declaration
-----PROGRAM CPY_PTH
%ALPHABETIZE
%COMMENT = 'COPY PATH'          -- Display information by default to
CRT/KB
%CRTDEVICE                      -- Use CMOS RAM to store all static
variables,
%CMOSVARS                        -- except those specified with IN DRAM

```

**Copy Path Variables Program - Declaration Section**

```
-----Section 2: Constant, Variable and Type Declarations
```

```

-----  

CONST  

    SUCCESS      = 0 -- The value returned from all built-ins when successful  

TYPE  

    node_struct   = STRUCTURE          -- Create a user defined node structure  

        posn_dat    :XYZWPR  

        grup_dat    :GROUP_ASSOC  

        comn_dat    :COMMON_ASSOC  

    ENDSTRUCTURE  

    user_path     = PATH nodedata = node_struct --Create a user defined path  

VAR  

    pth1,  

    pth2,  

    pth3  

    pth4      :PATH           -- These are system defined PATHs  

    upth1,  

    upth2,  

    upth3,  

    upth4      :user_path       -- These are user defined PATHs  

    p1_len,  

    p2_len,  

    status,  

    total_node :INTEGER  

    F1_press,  

    F2_press   :BOOLEAN  

    src_num,  

    des_num    :INTEGER  

    dummy_str,  

    src_var,  

    des_var    :STRING[ 20 ]  

    cur_name    :STRING[ 12 ]  

    entry       :INTEGER  

    var_type    :INTEGER  

    mem_loc     :INTEGER

```

**Copy Path Variables Program - Storing Variables in Memory**

```

-- Store the following variables in DRAM, which is temporary memory
    idx      IN DRAM  :INTEGER
    prog_name IN DRAM :STRING[10]
    prog_type IN DRAM :INTEGER
    n_match  IN DRAM  :INTEGER

```

```

n_skip      IN DRAM   :INTEGER
format      IN DRAM   :INTEGER
ary_nam     IN DRAM   :ARRAY[ 5 ] OF STRING[ 20 ]
prog_indx   IN DRAM   :INTEGER
do_copy     IN DRAM   :BOOLEAN
crt_kb      IN DRAM   :FILE

%INCLUDE KLEVKMSK      -- system supplied file: definition of KC_FUNC_KEY
%INCLUDE KLEVKEYS      -- system supplied file: definition of KY_F1 & KY_F2

```

**Copy Path Variables Program - Monitor User Response**

```

-----  

---- Section 3: Routine Declaration  

-----  

-----  

---- Section 3-A: CRT_CLS Declaration  

-----  

ROUTINE CRT_CLS FROM rout_ex -- include this routine from the file rout_ex.kl  

-----  

---- Section 3-B: YES_NO Declaration  

----          LABEL the F1 key as YES and F2 key as NO, ask for user  

----          confirmation. These two keys are monitored by global  

----          condition handler, so User response can be trapped.  

-----  

ROUTINE YES_NO  

VAR  

key_press : INTEGER  

str : STRING[1]  

n_chars: INTEGER  

l_status: INTEGER  

BEGIN ---- YES_NO  

WRITE CRTFUNC    (CHR(128),CHR(137)) --- Clear Window, Home Cursor  

-- Display YES above F1 & NO above F2 & clear rest of Function window  

WRITE CRTFUNC    ('    YES      NO ',chr(129))  

F1_press = FALSE  

F2_press = FALSE  

REPEAT -- until user presses either the F1 or F2 key  

-- Read just the function keys of the CRT/KB.  

-- The read will be satisfied only when a function key is pressed.  

READ_KB (crt_kb, str , 0, 0, kc_func_key, -1,  

        '', n_chars, key_press, l_status)  

-- key_press must be converted from a "raw" CRT character to the teach

```

```

-- pendant equivalent character.g
key_press = $CRT_KEY_TBL[key_press+1]
IF (key_press = ky_f1) THEN -- The user pressed F1
    F1_press = true
ENDIF
IF (key_press = ky_f2) THEN -- The user pressed F2
    F2_press = true
ENDIF
UNTIL ((f1_press = TRUE) OR (F2_press = TRUE))
WRITE CRTFUNC    (CHR(128),CHR(137)) --- Clear Window, Home Cursor
WRITE CRTPROMPT  (CHR(128),CHR(137)) --- Clear Window, Home Cursor
END YES_NO

```

### Copy Path Variables Program - Copying Path Variables

```

-----
----- Section 3-C: PTH_CPY Declaration
-----      Copy one user defined path variable to another user defined path
-----      variable. The first parameter is the source path. The second
-----      parameter is the destination path. The path parameters can only
-----      be passed using BYNAME and the path's must be user defined
-----
ROUTINE PTH_CPY(src_path: USER_PATH; des_path: USER_PATH)
VAR
    node_idx   :INTEGER
    do_it      :BOOLEAN
    l_stat     :INTEGER
BEGIN --- pth_cpy

    CRT_CLS      -- Clear the CRT/KB USER Menu screen
    do_it = true
    -- WRITE ('Peform copy',CR)
    yes_no
    do_it = F1_press -- F1_press will be true only if the user selected
YES
    IF (do_it) THEN
        -- Copy the entire path of src_path to des_path
        COPY_PATH (src_path, 0,0, des_path, l_stat)
        IF (l_stat <> 0) THEN
            WRITE ('Error in COPY_PATH', l_stat, CR)
        ELSE
            WRITE ('Path Copy function Completed ',cr)
        ENDIF
    ELSE
        WRITE ('Path Copy function canceled by choice',cr,cr)
    ENDIF
END PTH_CPY

```

**Copy Path Variables Program - Opens CRT/KB & Sends Data to Default Device**

```
-----
----- Section 4: Main Program
-----
BEGIN --- CPY_PATH
-----
----- Section 4-A: Open CRT KB for reading YES/NO inputs from user
-----
CRT_CLS -- will force the CRT USER menu to be visible & clear the screen
SET_FILE_ATR(crt_kb, ATR_FIELD) -- Needed so the read is satisfied with one
-- character.
OPEN FILE crt_kb ('RO', 'KB:crkb') -- Open a file to the CRT/KB
-- Used within the YES_NO routine.

-----
----- Section 4-B: Check if SAVE_VRS.PC is loaded. If loaded then execute
-----
---- First check if the "SAVE_VRS" program is loaded or not.

prog_name = 'SAVE_VRS' -- Only interested in SAVE_VRS program
prog_type = 6           -- Interested only in PC type files
n_skip = 0              -- First time do not skip any files
format = 1              -- Return just the filename

do_copy = TRUE
WRITE ('Checking Program List',cr)
PROG_LIST(prog_name, prog_type, n_skip, format, ary_nam, n_match, status)
IF (status <> SUCCESS ) THEN
    IF (status = 7073 ) THEN ---- Program does not exist error
        --- Program SAVE_VRS is not loaded on the controller.
        WRITE ( 'LOADING ',prog_name, CR)
        LOAD (prog_name+'.PC', 0, status)
        IF (status <> SUCCESS) THEN
            WRITE ('Error loading ', prog_name,cr)
            WRITE CRTPROMPT('Copy path''s WITHOUT saving program variables?',CR)
            YES_NO
            do_copy = F1_press -- F1_press is true only if user selected
YES
                -- Copy without saving variables.
ENDIF
ELSE
    -- The program listing failed.
    WRITE ('PROG_LIST built-in failed',cr,' with Status = ',status,cr)
    WRITE CRTPROMPT('Copy path''s WITHOUT saving program variables?',CR)
    YES_NO
    do_copy = F1_press -- F1_press is true only if user selected
YES
```

```

ENDIF          -- Copy without saving variables.
ENDIF

```

### Copy Path Variables Program - Checks Path Initialization

```

IF (status = SUCCESS) THEN
    -- This is one way to set variables within another program without
    -- using the FROM clause in the variable section.
    -- It is very useful if you want to have run-time independent code,
    -- where the program or variable name you are setting is not
    -- known until run-time.
    cur_name = CURR_PROG
    SET_VAR (entry, prog_name, 'del_vr', TRUE, status)
    SET_VAR (entry, prog_name, 'prog_name', cur_name, status)
    SET_VAR (entry, prog_name, 'sav_type', 1, status)
    SET_VAR (entry, prog_name, 'dev', 'FLPY:', status)
    WRITE ('Saving program variables before copy', CR)
    CALL_PROG(prog_name,prog_indx) -- call SAVE_VRS
ENDIF
-----
---- Section 4-C: Check for initialization of PATHs pth1 and pth2.
-----
IF (NOT do_copy) THEN
    WRITE ('Program exiting, unable to save variables.',cr)
    WRITE ('before copying path''s',cr)
    -- NOTICE:
    -- Two single quotes will display as one single quote
    -- so this write statement will appear as :
    -- "before copying path's"
    ABORT
ENDIF
WRITE ('Checking Variable initialization',cr)
-- Check if the pth variables are initialized.
p1_len = PATH_LEN(pth1) ; p2_len = PATH_LEN(pth2)
IF ( (p1_len = 0) OR (p2_len = 0) )THEN
    WRITE ('PTH1 or PTH2 is empty path',cr)
    WRITE ('Please make sure both paths are taught then restart',cr)
    ABORT -- Cannot copy uninitialized variables.
ENDIF
-- Check if the pth3 variable is initialized.
IF (PATH_LEN(pth3) <> 0) THEN
    WRITE ('Deleting nodes from pth3',cr) -- Delete the old path of pth3
    FOR indx = PATH_LEN(pth3) DOWNTO 1 DO
        -- its easy to delete nodes from the end instead of deleting node from
        -- the front end. Since after every deletion the nodes are renumbered.
        DELETE_NODE(pth3, indx, status) -- Delete last node of pth3
    IF status <> SUCCESS THEN
        WRITE ('While Deleting ',indx, ' node',cr)

```

```

        WRITE ('DELETE_NODE unsuccessful: Status = ',status,cr)
    ENDIF
ENDFOR
ENDIF

```

### Copy Path Variables Program - Path Initialization

```

----- Section 4-D: Add pth1 and pth2 together to create pth3.
----- Move along pth1 and pth2.
----- Move backwards through pth3.
-----
total_node = p1_len + p2_len      -- Total number of nodes needed for pth3

-- Copy the node data from pth1 to pth3
WRITE ('copying pth1 to pth3',cr)
COPY_PATH (pth1, 0,0, pth3, status)
IF (status <> 0) THEN
    WRITE ('ERROR in COPY_PATH', status, CR)
ENDIF

-- Create the required number of nodes for pth3.
-- We know that pth3 now has PATH_LEN(pth3) nodes.
WRITE ('Appending nodes to pth3',cr)
FOR indx = p1_len+1 TO total_node DO -- Append the correct number of nodes.
    APPEND_NODE(pth3, status)
    IF (status <> 0) THEN
        WRITE ('While Appending ',indx, ' node',cr)
        WRITE ('APPEND_NODE unsuccessful: Status = ',status,cr)
    ENDIF
ENDFOR
-- Append the node data of pth2 to pth3.
WRITE ('Appending pth2 to pth3',cr)
FOR indx = p1_len+1 TO total_node DO
    USING pth2[indx - p1_len] DO
        pth3[indx].node_pos      = node_pos
        pth3[indx].group_data   = group_data
        pth3[indx].common_data = common_data
    ENDUSING
ENDFOR

-- Move Along the path pth1 and pth2
WRITE ('Moving Along Path pth1',cr)
MOVE ALONG pth1
WRITE ('Moving Along Path pth2',cr)
MOVE ALONG pth2

--Copy pth3 in reverse order to pth4

```

```

COPY_PATH (pth3, PATH_LEN(pth3), 1, pth4, status)
IF (status <> 0) THEN
    WRITE ('ERROR in COPY_PATH', status, CR)
ENDIF--- Move along pth4 which is a reverse order of pth3.
WRITE ('Moving Along Path pth4',cr)
MOVE ALONG pth4

```

### Copy Path Variables Program - Copy User Defined Paths

```

-----  

---- Section 4-E: Copy User Defined Paths.  

---- Copy one user defined path to another user defined path,  

---- where the user specifies which paths to be copied.  

-----  

CRT_CLS  

SET_CURSOR(OUTPUT,2,10, status)      -- Position cursor nicely on CRT  

IF (status <> 0 ) THEN  

    WRITE ('SET_CURSOR built-in failed with status = ',status,cr)  

ENDIF  

-- write message in reverse video and then set back to normal video  

WRITE (chr(139),' COPY PATH FUNCTION',chr(143),CR,cr)  

WRITE ('Currently you have the following ',cr)  

WRITE ('User Defined Paths',cr,cr)  

n_skip = 0  

var_type = 31                      -- Get listing of only PATH type variables  

REPEAT  

VAR_LIST ('CPY_PTH', '*',var_type, n_skip, 2, ary_nam, n_match, status)  

FOR indx = 1 TO n_match DO  

    IF (SUB_STR (ary_nam[indx], 1, 4) = 'UPTH') THEN -- Verify it's one of  

                                                -- the user defined path's  

        WRITE (ary_nam[indx], CR)  

    ENDIF  

ENDFOR  

n_skip = n_skip + n_match  

UNTIL (n_match < ARRAY_LEN(ary_nam))  

Write ('Enter the source path number: ')
READ(src_num);
Write ('Enter the destination path number: ')
READ(des_num);

CNV_INT_STR(src_num,2,0,dummy_str)      -- Convert source number to string
src_var = 'UPTH'+ SUB_STR(dummy_str,2,1) -- SUB_STR will remove the leading
                                         -- blank from dummy_str before

```

```

var_type = 0
VAR_LIST ('CPY_PTH', src_var, var_type, 0, 2, ary_nam, n_match, status)
IF (status <> SUCCESS) THEN
    WRITE ('Var_list for src_var: status ', status, cr)
ENDIF

```

**Copy Path Variables Program - Copy User Defined Paths Continued**

```

-- If the variable does not exist create it.
IF (n_match = 0) THEN
    CREATE_VAR ('', src_var, '', 'USER_PATH', 1, 0, 0, 0, status, mem_loc)
    IF (status <> SUCCESS) THEN
        WRITE ('Error creating ', src_var, '::', status, cr)
    ENDIF
ENDIF
--Create the destination variable name
CNV_INT_STR(des_num,2,0,dummy_str)      -- Convert des_num to a string
des_var = 'UPTH'+ SUB_STR(dummy_str,2,1)-- The SUB_STR will remove the leading
                                         -- blank from dummy_str before
                                         -- concatenating to create the
                                         -- source variable name
-- Verify that the des_var variable exists.
VAR_LIST ('CPY_PTH', des_var, var_type, 0, 2, ary_nam, n_match, status)
IF (status <> SUCCESS) THEN
    WRITE ('Var_list for des_vr: status', status, cr)
ENDIF
-- If the variable does not exist create it.
IF (n_match = 0) THEN
    CREATE_VAR ('', des_var, '', 'USER_PATH', 1, 0, 0, 0, status, mem_loc)
    IF (status <> SUCCESS) THEN
        WRITE ('Error creating ', des_var, '::', status, cr)
    ENDIF
ENDIF
-- Copy the specified source path to the specified destination path
pth_cpy(BYNAME('', src_var, indx), BYNAME('', des_var, indx) )

-- Close file before quitting
CLOSE FILE crt_kb

WRITE ('CPY_PTH example completed',cr)
END CPY_PTH

```

## **B.3 SAVING DATA TO THE DEFAULT DEVICE**

This program will save variables or teach pendant programs to the default device. If the user specified to overwrite the file then the file will be deleted before performing the save.

**Note** This program is called by the CPY\_PTH.KL program. Refer to [Section B.2](#), for information on CPY\_PTH.KL.

### **Saving Data Program - Overview**

----	SAVE_VRS.KL	
<hr/>		
----	Section 0: Detail about SAVE_VRS.KL	
<hr/>		
----	Elements of KAREL Language Covered:	In Section:
----	Actions:	
----	Clauses:	
----	Conditions:	
----	Data types:	
----	BOOLEAN	Sec 2
----	INTEGER	Sec 2
----	STRING	Sec 2
----	Directives:	
----	COMMENT	Sec 1
----	ENVIRONMENT	Sec 1
----	NOLOCKGROUP	Sec 1
----	Built-in Functions & Procedures:	
----	DELETE_FILE	Sec 4-B
----	SAVE	Sec 4-B
----	Statements:	
----	IF, THEN, ENDIF	Sec 4-B
----	SELECT, CASE, ENDSELECT	Sec 4-A
----	WRITE	Sec 4-B
----	Reserve Words:	
----	BEGIN	Sec 4
----	CONST	Sec 2
----	CR	Sec 4-B
----	END	Sec 4-B

```
----          PROGRAM          Sec 1
----          VAR             Sec 2
```

**Saving Data Program - Declarations Section**

```
-----  
----      Section 1:  Program and Environment Declaration  
-----
```

```
PROGRAM SAVE_VRS
%NOLOCKGROUP
%COMMENT = 'Save .vr, .tp, .sv'
%ENVIRONMENT MEMO
%ENVIRONMENT FDEV
```

```
-----  
----      Section 2:  Constant, Variable and Type Declarations  
-----
```

## CONST

```
DO_VR  = 1      -- Save variable file(s)
DO_TP  = 2      -- Save TP program(s)
DO_SYS = 3      -- Save system variables
```

```
SUCCESS = 0      -- The value expected from all built-in calls.
```

## VAR

```
sav_type : INTEGER      -- Specifies the type of save to perform
prog_name : STRING[12]   -- The program name to save
status    : INTEGER       -- The status returned from the built-in calls
file_spec : STRING[30]   -- The created file specification for SAVE
dev       : STRING[5]     -- The device to save to specify whether to
del_vr    : BOOLEAN       -- delete file_spec before performing the SAVE.
```

```
-----  
----      Section 3:  Routine Declaration  
-----
```

**Saving Data Program - Create File Spec**

```
-----  
----      Section 4:  Main Program  
-----
```

```
BEGIN -- SAVE_VRS
```

```
-----  
----      Section 4-A: Create the file_spec, which contains the device, file  
-----      name and type to be saved.  
-----
```

```
SELECT (sav_type) OF
```

```

CASE (DO_VR):
-- If prog_name is '*' then all PC variables will be saved with the
-- correct program name, irregardless of the file name part of
-- file_spec.
file_spec = dev+prog_name+'.VR'      -- Create the variable file name
CASE (DO_TP):
-- If prog_name is '*' then all TP programs will be saved with the
-- correct TP program name, irregardless of the prog_name part of
-- file_spec.
file_spec = dev+prog_name+'.TP'      -- Create the TP program name
CASE (DO_SYS):
prog_name = '*SYSTEM*'
file_spec = dev+'ALLSYS.SV'          -- All system variables will be
-- saved into this one file.
ENDSELECT

```

### Saving Data Program - Delete/Overwrite

```

-----  

---- Section 4-B: Decide whether to delete the file before saving  

---- and then perform the SAVE.  

-----  

-- If the user specified to delete the file before saving, then  

-- delete the file and verify that the delete was successful.  

-- It is possible that the delete will return a status of:  

-- 10003 : "file does not exist", for the FLPY: device  

-- OR  

-- 85014 : "file not found", for all RD: and FR: devices  

-- We will disregard these errors since we do not care if the  

-- file did not previously exist.  

IF (del_vr = TRUE) THEN  

  DELETE_FILE (file_spec, FALSE, status) -- Delete the file.  

  IF (status <> SUCCESS) AND (status <> 10003) AND  

    (status <> 85014) THEN  

    WRITE ('Error ', status, ' in attempt to delete ',cr, file_spec,cr)  

  ENDIF  

ENDIF  

-- If prog_name is specified as an '*' for either .tp or .vr files then  

-- the SAVE builtin will save the appropriate files/programs with the  

-- correct names.  

SAVE (prog_name, file_spec, status) -- Save the variable/program  

IF (status <> SUCCESS) THEN      -- Verify SAVE was successful  

  WRITE ('error saving ', file_spec, 'variables', status, cr)
ENDIF  

END  SAVE_VRS

```

## B.4 STANDARD ROUTINES

This program is made up of several routines which are used through out the examples. The following is a list of the routines within this file:

- CRT\_CLS Clears the CRT/KB USER Menu screen
- TP\_CLS Clears the teach pendant USER Menu screen

### Standard Routines - Overview

---

```
----- ROUT_EX.KL
-----
----- Section 0: Detail about ROUT_EX.kl
-----
----- Elements of KAREL Language Covered: In Section:
----- Actions:
----- Clauses:
----- Conditions:
----- Data types:
----- Built-in Functions & Procedures:
-----           CHR                      Sec 3-A,B
-----           FORCE_SPMENU            Sec 3-A,B
----- Statements:
-----           ROUTINE                Sec 3-A,B
-----           WRITE                  Sec 3-A,B
-----
----- Reserve Words:
-----           BEGIN                 Sec 3-A,B; 4
-----           CR                    Sec 3-B
-----           END                  Sec 3-A,B; 4
-----           PROGRAM              Sec 1
-----
----- Predefined File Names:
-----           CRTERROR             Sec 3-A
-----           CRTFUNC              Sec 3-A
-----           CRTPROMPT            Sec 3-A
-----           CRTSTATUS             Sec 3-A
-----           OUTPUT                Sec 3-A
-----           TPERROR              Sec 3-B
```

----	TPFUNC	Sec 3-B
----	TPSTATUS	Sec 3-B
----	TPPROMPT	Sec 3-B

**Standard Routines - Declaration Section**

-----  
---- Section 1: Program and Environment Declaration  
-----

```
PROGRAM ROUT_EX
%NOLOCKGROUP ---- Don't lock any motion groups
%COMMENT = 'MISC_ROUTINES'
```

-----  
---- Section 2: Constant and Variable Declarations  
-----

-----  
---- Section 3: Routine Declarations  
-----

-----  
---- Section 3-A: CRT\_CLS Declaration
   
---- Clear the predefined windows:
   
---- CRTPROMPT, CRTSTATUS, CRTFUNC, CRTERror, OUTPUT
   
---- Force Display of the CRT/KB USER SCREEN.  
-----

ROUTINE CRT\_CLS

```
BEGIN ---- CRT_CLS
--See Chapter 7.9.2 for more information on the PREDEFINED window names
  WRITE CRTERror  (CHR(128),CHR(137)) -- Clear Window, Home Cursor
  WRITE CRTSTATUS (CHR(128),CHR(137)) -- Clear Window, Home Cursor
  WRITE CRTPROMPT (CHR(128),CHR(137)) -- Clear Window, Home Cursor
  WRITE CRTFUNC   (CHR(128),CHR(137)) -- Clear Window, Home Cursor
  WRITE OUTPUT    (CHR(128),CHR(137)) -- Clear Window, Home Cursor
  FORCE_SPMENU(CRT_PANEL,SPI_TPUSER,1) -- Force the CRT USER Menu
                                         -- to be visible last. This will
                                         -- avoid the screen from flashing
                                         -- since the screen will be clean
                                         -- when you see it.
```

END CRT\_CLS

**Standard Routines - Clears Screen and Displays Menu**

---

```

----  Section 3-B:   TP_CLS Declaration
      Clear the predefined windows:
----          TPERROR, TPSTATUS, TPPROMPT, TPFUNC TPDISPLAY
----          Force Display of the TP USER Menu SCREEN.
-----

ROUTINE TP_CLS
BEGIN
    WRITE (CHR(128),CHR(137)) -- By default this will clear TPDISPLAY
    WRITE TPERROR (CR,'                                ',CR)
    WRITE TPSTATUS(CR,'                                ',CR)
    WRITE TPPROMPT(CR,'                                ',CR)
    WRITE TPFUNC  (CR,'                                ',CR)
    FORCE_SPMENU(TP_PANEL,SPI_TPUSER,1) -- Force the USER menu screen
    -- to be visible last.
    -- This will avoid the screen from
    -- flashing since the screen will
    -- be clean when you see it.

END TP_CLS

-----

----  Section 4:  Main Program
-----

BEGIN -- ROUT_EX
END ROUT_EX

```

## B.5 USING REGISTER BUILT-INS

This program demonstrates the use of the REGISTER builtins. REG\_EX.KL retrieves the current position and stores it in PR[1]. Then it executes the program PROG\_VAL.TP. PROG\_VAL will modify the value within the Position Register PR[1].

After PROG\_VAL is completed, REG\_EX.KL retrieves the PR[1] position. The position is then manipulated and restored in PR[2], and an INTEGER number is stored in R[1]. A different teach pendant program, PROG\_1.TP, is executed which loops through some positions and stores a value to R[2]. The number of loops depends on the value of the R[1] (which was initially set by the KAREL program.)

After PROG\_1.TP has completed, the KAREL program gets the value from R[2] and verifies it was the expected value.

The PROG\_VAL.TP teach pendant program should look similar to the following.

PROG_VAL	JOINT 10%
<pre> 1: !POSITION REG VALUE ; 2:J P[1:ABOVE JOINT] 100% FINE ; 3: PR[1,2]=600 ; 4:L PR[1] 100.0 Inch/mm FINE ; 5:J P[1:ABOVE JOINT]100% FINE ; </pre>	

The PROG\_VAL.TP teach pendant program does the following:

- Moves to position 1 in joint mode.
- Changes the 'y' location of the position in Position Register 1, PR[1] (which was set by the KAREL program).
- Moves to the new PR[1] position.
- Finally moves back to position 1.

The PROG\_1.TP teach pendant program should look similar to the following.

PROG_1	JOINT 10%
<pre> 1: LBL[1:START] ; 2: IF R[1]=0, JMP LBL[2] ; 3:J P[1] 100% FINE ; 4:J P[2] 100% FINE ; 5: R[1]=R[1]-1 ; 6: JMP LBL[1] ; 7: LBL[2:DONE] ; 8: R[2]=1 ; </pre>	

The PROG\_1.TP teach pendant program does the following:

- Checks the value of the R[1].
- If the value of R[1] is not 0, then moves to J P[1] and J P[2] and decrements the value of R[1]. PROG\_1.TP continues in this loop until the Register R[1] is zero.
- After the looping is complete, PROG\_1.TP stores value 1 in R[2], which will be checked by the KAREL program.

## Using Register Built-ins Program - Overview

---

-----	REG_EX.K1	
-----	-----	-----
-----	Elements of KAREL Language Covered:	In Section:
-----	Actions:	
-----	Clauses:	
-----	Conditions:	
-----	Data types:	
-----	BOOLEAN	Sec 2
-----	JOINTPOS	Sec 2
-----	REAL	Sec 2
-----	XYZWPR	Sec 2
-----	Directives:	
-----	ALPHABETIZE	Sec 1
-----	COMMENT	Sec 1
-----	NOLOCKGROUP	Sec 1
-----	Built-in Functions & Procedures:	
-----	CALL_PROGLIN	Sec 4-A, 4-C
-----	CHR	Sec 4
-----	CURPOS	Sec 4-A
-----	FORCE_SPMENU	Sec 4
-----	GET_POS_REG	Sec 4-B
-----	GET_JPOS_REG	Sec 4-B
-----	GET_REG	Sec 4-C
-----	POS_REG_TYP	Sec 4-B
-----	SET_JPOS_REG	Sec 4-B
-----	SET_INT_REG	Sec 4-B
-----	SET_POS_REG	Sec 4-A
-----	Statements:	
-----	WRITE	Sec 4, 4-A,B,C
-----	IF..THEN..ELSE..ENDIF	Sec 4-A,B,C
-----	SELECT...CASE...ENDSELECT	Sec 4-B
-----	Reserve Words:	
-----	BEGIN	Sec 4
-----	CONST	Sec 2
-----	CR	Sec 4-A,B,C
-----	END	Sec 4-C
-----	PROGRAM	Sec 4
-----	VAR	Sec 2

### Using Register Built-ins Program - Declaration Section

```
-----  
---- Section 1: Program and Environment Declaration  
-----  
  
PROGRAM reg_ex  
%nolockgroup  
%comment = 'Reg-Ops'  
%alphabetize  
-----  
---- Section 2: Variable Declaration  
-----  
  
CONST  
    cc_success      = 0          -- Success status  
    cc_xyzwpr       = 2          -- Position Register has an XYZWPR  
    cc_jntpos       = 9          -- Position Register has a JOINTPOS  
  
VAR  
    xyz             :XYZWPR  
    jpos            :JOINTPOS  
    r_val           :REAL  
    prg_indx,  
    i_val,  
    pos_type,  
    num_axes,  
    status          :INTEGER  
    r_flg           :BOOLEAN  
-----  
---- Section 3: Routine Declaration  
-----  
-----  
---- Section 4: Main program  
-----  
  
BEGIN -- REG_EX  
  
    write(chr(137),chr(128));           -- Clear the TP USER menu screen  
    FORCE_SPMENU(TP_PANEL,SPI_TPUSER,1) -- Force the TP USER menu to be  
                                         -- visible
```

### Using Register Built-ins - Storing and Manipulating Positions

```
-----  
---- Section 4-A: Store current position in PR[1] and execute PROG_VAL.TP  
-----  
  
    WRITE('Getting Current Position',cr)  
    xyz = CURPOS(0,0)                  -- Get the current position
```

```

        WRITE('Storing Current position to PR[1]',cr)
        SET_POS_REG(1,xyz, status)           -- Store the position in PR[1]
        IF (status = cc_success) THEN      -- verify SET_POS_REG is successful
            WRITE('Executing "PROG_VAL.TP"',cr)
            CALL_PROGLIN('PROG_VAL',2,prg_indx, FALSE)
                                --Execute 'PROG_VAL.TP' starting
                                -- at line 2. Do not pause on
                                -- entry of PROG_VAL.
-----
----- Section 4-B: Get new position from PR[1]. Manipulate and store in PR[2]
-----

        WRITE('Getting Position back from PR[1]',cr)
        -- Decide what type of position is stored in Position Register 1, PR[1]
        POS_REG_TYPE(1, 1, pos_type, num_axes, status)
        IF (status = cc_success) THEN
        -- Get the position back from PR[1], using the correct builtin.
        -- This position was modified in PROG_VAL.TP
            SELECT pos_type OF
                CASE (cc_xyztwpr):
                    xyz= GET_POS_REG(1, status)
                CASE (cc_jntpos):
                    jpos = GET_JPOS_REG(1, status)
                    xyz = jpos
                ELSE:
                    write ('The position register set to invalid type', pos_type,CR)
                    status = -1                         -- set status so do not continue.
            ENDSELECT
            IF (status = cc_success) THEN          -- Verify GET_POS_REG/GET_JPOS_REG is
                xyz.x = xyz.x+10                  -- successful
                xyz.z = xyz.z-10                  -- Manipulate the position.
                jpos = xyz                         -- Convert to a JOINTPOS
        WRITE('Setting New Position to PR[2]',cr)
        SET_JPOS_REG(2,jpos,status)           -- Set the JOINTPOS into PR[2]
        IF (status = cc_success) THEN        -- Verify SET_JPOS_REG is successful
            WRITE('Setting Integer Value to R[1]',cr)
            SET_INT_REG(1, 10, status)         -- Set the value 10 into R[1]

```

### Using Register Built-ins - Executing Program and Checking Register

```

-----
----- Section 4-C: Execute PROG_1.TP and check the R[2]
-----
IF (status=cc_success) THEN --Verify SET_INT_REG is successful
    WRITE('Executing "PROG_1.TP"',cr)

```

```

CALL_PROGLIN('PROG_1',1, prg_idx, FALSE)
--Execute PROG_1.TP starting on first line.
--Do not pause on entry of PROG_1.
    WRITE('Getting Value from R[2]',cr)
    GET_REG(2,r_flg, i_val, r_val, status) --Get R[2] value
    IF (status = cc_success) THEN      --Verify GET_REG success
        IF (r_flg) THEN             --REAL value in register
            WRITE('Got REAL value from R[2]',cr)
            IF (r_val <> 1.0) THEN           --Verify value set
                WRITE ('PROG_1 failed to set R[2]',cr)-- by PROG_1_TP
                WRITE ('PROG_1 failed to set R[2]',cr)
            ENDIF
        ELSE                         --Register contained an INTEGER
            WRITE('Got INTEGER value from R[2]',cr)
            IF (i_val <> 1) THEN           --Verify value set by
                WRITE ('PROG_1 failed to set R[2]',cr) --PROG_1.TP
            ENDIF
        ENDIF
    ELSE                           --GET_REG was NOT successful
        WRITE('GET_REG Failed',cr,' Status = ',status,cr)
    ENDIF
    ELSE                           --SET_INT_REG was NOT successful
        WRITE('SET_INT_REG Failed, Status = ',status,cr)
    ENDIF
    ELSE                           --SET_JPOS_REG was NOT successful
        WRITE('SET_JPOS_REG Failed, Status = ',status,cr)
    ENDIF
    ELSE                           -- GET_POS_REG was NOT Successful
        WRITE('GET_POS_REG Failed, Status = ',status,cr)
    ENDIF
    ELSE
        WRITE ('POS_REG_TYPE Failed, Status =', status, cr)
    ENDIF
    ELSE                           -- SET_POS_REG was NOT successful
        WRITE('SET_POS_REG Failed, Status = ',status,cr)
    ENDIF
    IF (status = cc_success) THEN; WRITE ('Program Completed
Successfully',cr)
    ELSE ;                      WRITE ('Program Aborted due to error',cr)
    ENDIF
END reg_ex

```

## **B.6 PATH VARIABLES AND CONDITION HANDLERS PROGRAM**

This program checks to determine if PATH variables are taught or not. If the paths are taught, the robot moves to a joint position and then loops along a path 5 times.

This example also sets up two global condition handlers.

- The first condition handler detects if the user has pushed a teach pendant key, and if so aborts the program.
- The second condition handler sets a variable when the program is aborted.

**Path Variables and Condition Handlers Program - Overview**

-----	PTH_MOVE.kl	
<hr/>		
-----	Section 0: Detail about PTH_MOVE.kl	
<hr/>		
-----	Elements of KAREL Language Covered:	In Section:
-----	Actions:	
-----	ABORT	Sec 4-A
-----	Clauses:	
-----	WHEN	Sec 4-A
-----	WITH	Sec 4-D
-----	FROM	Sec 3-A
-----	VIA	Sec 4-D
-----	Conditions:	
-----	ABORT	Sec 4-A
-----	Data types:	
-----	ARRAY OF REAL	Sec 2
-----	BOOLEAN	Sec 2
-----	INTEGER	Sec 2
-----	JOINTPOS6	Sec 2
-----	PATH	Sec 2
-----	XYZWPR	Sec 2
-----	Directives:	
-----	ALPHABETIZE	Sec 1
-----	COMMENT	Sec 1
-----	ENVIRONMENT	Sec 1
-----	Built-in Functions & Procedures:	
-----	PATH_LEN	Sec 4-C
-----	CHR	Sec 3-B; 4-B,D
-----	CNV_REL_JPOS	Sec 4-D
-----	SET_CURSOR	Sec 4-B

**Path Variables and Condition Handlers Program - Overview Continued**

-----	Statements:	
-----	Abort	Sec 4-C
-----	CONDITION...ENDCONDITION	Sec 4-A
-----	FOR...ENDFOR	Sec 4-D
-----	ROUTINE	Sec 3-A, B
-----	WAIT FOR	Sec 3-B
-----	WRITE	Sec 3-B; 4-B,C,D
-----	Reserve Words:	
-----	BEGIN	Sec 3-A,B, 4
-----	CONST	Sec 2
-----	END	Sec 3-A,B: 4-D
-----	VAR	Sec 2
-----	PROGRAM	Sec 1
-----	Predefined File Names:	
-----	TPFUNC	Sec 3-B; 4-D
-----	TPDISPLAY	Sec 4-B

**Path Variables and Condition Handlers Program - Declaration Section**


---

-----	Section 1: Program and Environment Declaration	
-----	PROGRAM PTH_MOVE	-- Define the program name
-----	%ALPHABETIZE	-- Create the variables in alphabetical order
-----	%COMMENT = 'PATH MOVES'	
-----	%ENVIRONMENT PATHOP	-- Necessary for PATH_LEN
-----	%ENVIRONMENT SYSDEF	-- Necessary for using the \$MOTYPE in the
-----	MOVES	
-----	%ENVIRONMENT UIF	-- Necessary for SET_CURSOR
-----	-----	
-----	Section 2: Constant and Variable Declarations	
-----	CONST	
-----	CH_ABORT = 1	-- Number associated with the -- abort Condition handler
-----	CH_F1 = 2	-- Number associated with the -- F1 key Condition handler
-----	VAR	
-----	status : INTEGER	-- Status from built-in calls
-----	loop_pth : INTEGER	-- Used in a FOR loop counter
-----	prg_abrt : BOOLEAN	-- Set when program is aborted

pth1	:PATH	
strt_jnt	:JOINTPOS6	-- starting position of a move
via_pos	:XYZWPR	-- via point for a circular move
des_pos	:XYZWPR	-- destination point
real_ary	:ARRAY[6] OF REAL	-- This is used for creating -- a joint position with 6 axes
index	:INTEGER	-- FOR loop counter

**Path Variables and Condition Handlers Program - Declare Routines**

```
-----  
----- Section 3: Routine Declaration  
-----  
----- Section 3-A: RANDOM Declaration  
----- ROUTINE TP_CLS FROM ROUT_EX           -- ROUT_EX must also be loaded.  
-----  
-----  
----- Section 3-B: YES_NO Declaration  
-----          Display maximum elements of ary_nam.  
---          Display choices on the function line of the TP.  
---          Asks for user response.  
---          F1 key is monitored by the Global condition handler  
---          [CH_F1] and the F2 is monitored here.  
---          If F1 is pressed the program will abort.  
---          But, if the F2 is pressed the program will continue.  
-----  
ROUTINE YES_NO  
BEGIN  
    WRITE TPPFUNC (CHR(137))                  -- Home Cursor in Function window  
    WRITE TPPFUNC (' ABORT CONT')             -- Display Function key options  
    WAIT FOR TPIN[131]                        -- Wait for user to respond to  
                                              -- continue. If the user presses  
                                              -- F1 (abort) condition handler  
                                              -- CH_ABORT will abort program.  
    WRITE TPPFUNC (CHR(137))                  -- Home Cursor in Function window  
    WRITE TPPFUNC (' ABORT',chr(129))         -- Redisplay just Abort option and  
                                              -- clear rest of Function window  
END YES_NO
```

**Path Variables and Condition Handlers Program - Declare Condition Handlers**

```
-----  
----- Section 4: Main Program  
-----  
BEGIN  -- PTH_MOVE  
-----  
----- Section 4-A: Global Condition Handler Declaration  
-----  
CONDITION[CH_ABORT]:
```

```

WHEN ABORT DO          -- When the program is aborting set prg_abrt flag.
                      -- This will be triggered if this program aborts itself
                      -- or if an external mechanism aborts this program.
prg_abrt = TRUE        -- You may then have another task which detects
                      -- prg_abrt being set, and does shutdown operations
                      -- (ie: set DOUT/GOUT's, send signals to a PLC)
ENDCONDITION

CONDITION[CH_F1]:
WHEN TPIN[129] DO      -- Monitor TP 'F1' Key. If 'F1' key is pressed,
ABORT                  -- abort the program.
ENDCONDITION

prg_abrt = false        -- Initialize variable which is set
only if                  -- the program is aborted and CH_ABORT is
                           -- enabled.
ENABLE CONDITION[CH_ABORT]    -- Start scanning abort condition as defined.
ENABLE CONDITION[CH_F1]      -- Start scanning F1 key condition as defined.

-----
---- Section 4-B: Display banner message and wait for users response
-----

TP_CLS                  -- Routine Call; Clears the TP USER
                        -- menu, and forces the TP USER menu
                        -- to be visible.

SET_CURSOR(TPDISPLAY,2,13, status)   -- Set cursor position in TP
USER menu
IF (status <> 0 ) THEN           -- Verify that SET_CURSOR was successful
  WRITE ('SET_CURSOR built-in failed with status = ',status,cr)
  YES_NO                         -- Ask whether to quit, due to error.
ENDIF
--- Write heading in REVERSE video, then turn reverse video off
WRITE (chr(139),' PLEASE READ ',chr(143),CR)
WRITE (cr,' *** F1 Key is labelled as ABORT key *** ')
WRITE (cr,' Any time the F1 key is pressed the program')
WRITE (cr,' will abort. However, the F2 key is active ')
WRITE (cr,' only when the function key is labeled.',cr,cr)
YES_NO -- Wait for user response

```

**Path Variables and Condition Handlers Program - Teach and Move Along Path**

```

-----
---- Section 4-C: Verify PATH variable, pth1, has been taught
-----
```

```

-- Check the number of nodes in the path
IF PATH_LEN(pth1) = 0 THEN                                -- Path is empty (has no nodes)
    WRITE ('You need to teach the path.',cr)   -- Display instructions to user
    WRITE ('before executing this program.',cr)
    WRITE ('Teach the PATH variable pth1', CR, ' and restart the program',cr)
    ABORT                                         -- Simply ABORT the task
                                                -- do not continue since there
                                                -- are no nodes to move to

ENDIF

-----
----- Section 4-D: Creating a joint position and moving along path's
-----

FOR indx = 1 to 6 DO                                     -- Set all joint angles to zero
    real_ary[indx] = 0.0
ENDFOR

real_ary[5] = 90.0                                       -- Make sure that the position
                                                        -- is not at a singularity point.

CNV_REL_JPOS(real_ary, strt_jnt, status)    -- Convert real_ary values into
                                                -- a joint position, strt_jnt
IF (status <> 0 ) THEN                               -- Converting joint position
                                                        -- was NOT successful
    WRITE ('CNV_REL_JPOS built-in failed with status = ',status,cr)
    YES_NO                                         -- Ask user if want to continue.
ELSE
    -- The start position, strt_jnt, has been created and is located at
    -- axes 1-4 = 0.0, axes 5 = 90.0, axes 6 = 0.0.

    via_pos = strt_jnt                            -- Copy the strt_jnt to via_pos
    via_pos.x = via_pos.x +200                    -- Add offset to the x location
    via_pos.y = via_pos.y +200                    -- Add offset to the y location

    -- The via position, via_pos, has been created to be the same position
    -- as strt_jnt except it has been offset in the x and y locations by
    -- 200 mm.

    des_pos = strt_jnt                            -- Copy the strt_jnt to des_pos
    des_pos.x = des_pos.x + 400                  -- Add offset to the x location
    -- The destination position, des_pos, has been created to be the same
    -- position as strt_jnt except it has been offset in the x location by
    -- 200 mm.

```

**Path Variables and Condition Handlers Program - Move Along Path**

```
MOVE TO strt_jnt                                         -- Move to the start position
```

```

        WRITE (cr,'Moving to Destination Position',cr)
        WITH $MOTYPE = CIRCULAR MOVE TO des_pos VIA via_pos
                            -- Move robot to destination
                            -- position using circular motion
                            -- via the via_pos
ENDIF

--- Execute the same path for 5 times.

FOR loop_pth = 1 TO 5 DO
    WRITE ('Moving Along pth1 ',loop_pth::2, ' times',cr)
        -- Display the loop iteration
        -- NOTICE: that "loop_pth::2" will cause 2 blanks to be
        -- displayed after "pth1 '" and before loop_pth.

    MOVE ALONG pth1
ENDFOR

WRITE TPFUNC      (CHR(128),CHR(137)) -- Home Cursor and Clear to
                                         -- End-of-line. This will remove
                                         -- the ABORT displayed above F1.

WRITE ('pth_move Successfully Completed',cr)

END PTH_MOVE

```

## B.7 LISTING FILES AND PROGRAMS AND MANIPULATING STRINGS

This program displays the list of files on the FLPY: device, and lists the programs loaded on the controller. It also shows basic STRING manipulating capabilities, using semi-colons(;) as a statement separator, and nesting IF statements.

### **Listing Files and Programs and Manipulating Strings - Overview**

---

```

----- LIST_EX.KL
-----
----- Section 0: Detail about LIST_EX.kl
-----
----- Elements of KAREL Language Covered: In Section:
----- Actions:
----- Clauses:
-----          FROM                      Sec 3-B

```

```
----  
---- Conditions:  
  
---- Data types:  
---- ARRAY OF STRING Sec 2  
---- BOOLEAN Sec 2, 3  
---- INTEGER Sec 2, 3  
---- STRING Sec 2  
  
---- Directives:  
---- %COMMENT Sec 1  
---- %NOLOCKGROUP Sec 1  
  
---- Built-in Functions & Procedures:  
---- ABS Sec 4-A  
---- ARRAY_LEN Sec 4-C&D  
---- CNV_INT_STR Sec 4-A  
---- FILE_LIST Sec 4-C  
---- LOAD Sec 4-B  
---- LOAD_STATUS Sec 4-B  
---- PROG_LIST Sec 4-D  
---- ROUND Sec 4-A  
---- SUB_STR Sec 4-A
```

**Listing Files and Programs and Manipulating Strings - Overview Continued**

```
---- Statements:  
---- FOR .... ENDFOR Sec 3-B  
---- IF...THEN...ENDIF Sec 4-A,B,C,D  
---- ROUTINE Sec 3-A,B,C  
---- REPEAT...UNTIL Sec 4-C,D  
---- RETURN Sec 3-A  
---- WRITE Sec 3-B; 4-A,B  
  
---- Reserve Words:  
---- BEGIN Sec 3-A,B; 4  
---- CONST Sec 2  
---- CR Sec 3-B; 4-A,B  
---- END Sec 3-A,B, 4-B  
---- PROGRAM Sec 1  
---- VAR Sec 2  
  
---- Operators:  
---- MOD Sec 3-A  
---- / Sec 3-A  
---- * Sec 3-A  
  
---- Devices Used:
```

```
----          FLPY:                      Sec 4-C
----      Basic Concepts:
----          Semi-colon(;) as statement separator
----          Nested IF..THEN..ELSE..IF..THEN..ELSE..ENDIF..ENDIF structure
----          Concatenation of STRINGS using '+'
----
```

### **Listing Files and Programs and Manipulating Strings - Declarations Section**

---

```
----      Section 1: Program and Environment Declaration
```

---

```
PROGRAM LIST_EX
%NOLOCKGROUP    ---- Don't lock any motion groups
%COMMENT = 'FILE_LIST'
```

---

```
----      Section 2: Constant and Variable Declarations
```

---

#### CONST

```
INCREMENT      = 13849
MODULUS        = 65536
MULTIPLIER     = 25173
```

#### VAR

```
pr_cases       :STRING[6]   -- psuedo random number converted to string
prg_nm         :STRING[50]   -- Concatenated program name
loaded         :BOOLEAN      -- Used to see if program is loaded
initi          :BOOLEAN      -- Used to see if variables initialized

indx1          :INTEGER      -- FOR loop index
cases,          -- Random number returned
max_number,    -- Maximum random number
seed           :INTEGER      -- Seed for generating a random number

file_spec      :STRING[20]   -- File specification for FILE_LIST
n_files        :INTEGER      -- Number of files returned from FILE_LIST
n_skip         :INTEGER      -- Number to skip for FILE_LIST & PROG_LIST
format         :INTEGER      -- Format of returned names
                   -- For FILE_LIST & PROG_LIST
ary_nam        :ARRAY[9] OF STRING[20] -- Returned names
                   -- from FILE_LIST & PROG_LIST

prog_name      :STRING[10]   -- Program names to list from PROG_LIST
prog_type      :INTEGER      -- Program types to list form PROG_LIST
n_progs        :INTEGER      -- Number of programs returned from PROG_LIST
```

```
status      :INTEGER -- Status of built-in procedure call
```

### **Listing Files and Programs and Manipulating Strings - Declare Routines**

```
-----  
---- Section 3: Routine Declaration  
-----  
  
-----  
---- Section 3-A: RANDOM Declaration  
---           Creates a pseudo-random number and returns the number.  
-----  
ROUTINE random(seed : INTEGER) : REAL  
BEGIN  
    seed = (seed * MULTIPLIER + INCREMENT) MOD MODULUS  
    RETURN(seed/65535.0)  
END random  
  
-----  
---- Section 3-B: DISPL_LIST Declaration  
---           Display maxnum elements of ary_nam.  
-----  
ROUTINE displ_list(maxnum :INTEGER)  
BEGIN  
    FOR indx1 = 1 TO maxnum DO ; WRITE (ary_nam[indx1],cr); ENDFOR  
    -- Notice the use of the semi-colon, which allows multiple statements  
    -- on a line.  
END displ_list  
  
-----  
---- Section 3-C: TP_CLS Declaration  
---           This routine is from ROUT_EX.KL and will  
---           clear the TP USER menu screen and force it to be visible.  
-----  
  
ROUTINE tp_cls FROM rout_ex
```

### **Listing Files and Programs and Manipulating Strings - Main Program**

```
-----  
---- Section 4: Main Program  
-----  
BEGIN -- LIST_EX  
tp_cls           -- Use routine from the rout_ex.kl file  
  
-----  
---- Section 4-A: Generate a pseudo random number, convert INTEGER to STRING  
-----  
max_number = 255 ;                         -- So the random number is 0..255
```

```

seed = 259 ;

WRITE ('Manipulating String',cr)
cases = ROUND(ABS((random(seed)*max_number)))-- Call random then take the
-- absolute value of the number
-- returned and round off the
-- number.
-- Convert cases to its
-- ascii representation

CNV_INT_STR(cases, 1, 0, pr_cases)

pr_cases = SUB_STR(pr_cases, 2,3) -- get at most 3 characters,
-- starting at the second
-- character, since first
-- character is a blank.

```

**Listing Files and Programs and Manipulating Strings - Create and Load Program**

```

----- Section 4-B: Build a program name from the number and try to load it
-----
--- Build a random program name to show the manipulation of
--- STRINGS and INTEGERS.

prg_nm = 'MYPROG' + pr_cases + '.PC'      -- Concatenate the STRINGS together
                                              -- which create a program name

--- Verify that the program is not already loaded
WRITE ('Checking load status of ',prg_nm,cr)
LOAD_STATUS(prg_nm, loaded, init)
IF (NOT loaded) THEN                      -- The program is not loaded
    WRITE ('Loading ',prg_nm,cr)
    LOAD(prg_nm, 0 , status)               -- Load in the program
    IF (status = 0 ) THEN                 -- Verify load is successful
        WRITE ('Loading ','MYPROG' + pr_cases + '.VR',cr)
        LOAD('MYPROG' + pr_cases + '.VR', 0, status) -- Load the .vr file
        IF (status <> 0 ) THEN           -- Loading variables failed
            WRITE ('Loading of ', 'MYPROG' + pr_cases + '.VR', ' failed',cr)
            WRITE ('Status = ',status);
        ENDIF
    ELSE                                -- Load of program failed
        IF (status = 10003) THEN          -- File does not exist
            WRITE (prg_nm, ' file does not exist',cr)
        ELSE
            WRITE ('Loading of ',prg_nm, ' failed',cr,'Status = ',status);
        ENDIF
    ENDIF

ELSE                                     -- The program is already loaded

```

```

IF (NOT initi) THEN                                -- Variables not initialized
    WRITE ('Loading ','MYPROG' + pr_cases + '.VR',cr)
    LOAD('MYPROG' + pr_cases + '.VR', 0, status) -- Load in variables
    IF (status <> 0 ) THEN                      -- Load of variables failed
        WRITE ('Loading of ', 'MYPROG' + pr_cases + '.VR', ' failed',cr)
        WRITE ('Status = ',status);
    ENDIF
ENDIF
ENDIF

```

**Listing Files and Programs and Manipulating Strings - List Programs**

```

-----  

---- Section 4-C: Check the file listing of the drive FLPY: and display them  

-----  

--- Display a directory listing of files on the Flpy:  

file_spec = 'FLPY:.*.'          -- All files in FLPY: drive  

n_skip = 0                      -- First time do not skip any files  

format = 3                      -- Return list in filename.filetype format  

WRITE ('Doing File list',cr)  

REPEAT                           -- UNTIL all files have been listed  

    FILE_LIST(file_spec, n_skip, format, ary_nam, n_files, status)  

    IF (status <>0 ) THEN      -- Error occurred  

        WRITE ('FILE_LIST builtin failed with Status = ',status,cr)  

    ELSE  

        displ_list(n_files)   -- Write the names to the TP USER menu  

        n_skip = n_skip + n_files -- Skip the files we already got.  

    ENDIF  

UNTIL (ARRAY_LEN(ary_nam) <> n_files) -- When n_files does not equal  

                                         -- declared size of ary_name then  

                                         -- all files have been listed.  

-----  

---- Section 4-D: Show the programs loaded in controller  

-----  

--- Display the list of programs loaded on the controller  

prog_name = '*'                  -- All program names should be listed  

prog_type = 6                    -- Only PC type files should be listed  

n_skip = 0                      -- First time do not skip any file  

format = 2                      -- Return list in filename.filetype format  

WRITE ('Doing Program list',cr)  

REPEAT                           -- UNTIL all programs have been listed  

    PROG_LIST(prog_name, prog_type, n_skip, format, ary_nam, n_progs, status)  

    -- The program names are stored in ary_nam

```

```

-- n_progs is the number of program names stored in ary_nam
IF (status <>0 ) THEN
    WRITE ('PROG_LIST builtin failed with Status = ',status,cr)
ELSE
    displ_list(n_progs)           -- Display the current list
    n_skip = n_skip + n_progs   -- Skip the programs already listed
ENDIF
UNTIL (ARRAY_LEN(ary_nam) <> n_progs) -- When n_files does not equal the
                                         -- declared size of ary_name then all
                                         -- programs have been listed.
END LIST_EX

```

## B.8 GENERATING AND MOVING ALONG A HEXAGON PATH

This program generates a hexagon path and moves along each side of the hexagon.

### Generate and Move Along Hexagon Path - Overview

```

-----  

----- GEN_HEX.KL  

-----  

----- Section 0: Detail about GEN_HEX.KL  

-----  

----- Elements of KAREL Language Covered: In Section:---- Action:---- Clauses:  

-----      WITH                               Sec 3-B; 4-B  

----- Conditions:---- Data types:  

-----      ARRAY OF REAL                      Sec 3-B  

-----      ARRAY OF XYZWPR                     Sec 2  

-----      INTEGER                            Sec 2; 3-A,B  

-----      JOINTPOS6                         Sec 2  

-----      REAL                               Sec 3-A  

----- Directives:  

-----      %COMMENT                          Sec 1---- Built-in Functions &  

                                         Procedures:  

-----      CHECK_EPOS                        Sec 4-B  

-----      CNV_REL_JPOS                      Sec 3-B  

-----      COS                                Sec 3-A  

-----      CURPOS                            Sec 4-A  

-----      SIN                                Sec 3-A---- Statements:  

-----      CONNECT TIMER                     Sec 4-A  

-----      FOR ... ENDFOR                   Sec 3-A,B; 4-B  

-----      MOVE TO                           Sec 3-B; 4-B  

-----      ROUTINE                           Sec 3-A,B  

-----      WRITE                             Sec 4-A,B---- Reserve Word:  

-----      BEGIN                            Sec 3-A,B; 4  

-----      CONST                            Sec 2  

-----      CR                               Sec 4-A

```

```
----          END          Sec 3-A,B; 4-B
----          PROGRAM       Sec 1
----          VAR          Sec 2
```

**Generate and Move Along Hexagon Path - Declaration Section**

```
-----  
----      Section 1: Program and Environment Declaration  
-----  
  
PROGRAM gen_hex  
%COMMENT = 'HEXAGON'  
  
-----  
----      Section 2: Constant and Variable Declaration  
-----  
  
CONST  
    L_HEX_SIDE = 300           -- Length of one side of the hexagon  
    NUM_AXES      = 6           -- Number of robot axes  
    p_cntr        : JOINTPOS6  -- Center of the hexagon  
    p_xyzwpr      : ARRAY[NUM_AXES] OF XYZWPR  
                           -- Six vertices of the hexagon  clock,  
    t_start,  
    t_end,  
    t_total       : INTEGER   status,  
    p_indx         : INTEGER
```

**Generate and Move Along Hexagon Path - Declare Routines**

```
-----  
----      Section 3: Routine Declaration  
-----  
  
-----  
----      Section 3-A: R_CALC_HEX Declaration  
----          Calculates the hexagon points based on distance  
----          between point 1 and 4 of the hexagon.  
-----  
  
ROUTINE r_calc_hex  
VAR  
    pl_to_pcntr : REAL -- Distance from the center of the hex to point 1  
    vertice      : INTEGER  -- the index used specify each vertice of hexagon  
BEGIN  
    pl_to_pcntr = (L_HEX_SIDE / 2) + (L_HEX_SIDE * COS(60))  
    p_xyzwpr[1] = p_cntr    -- p_cntr was calculated in r_hex_center  
    p_xyzwpr[1].y = p_xyzwpr[1].y - pl_to_pcntr --set the first vertice of hex  
    FOR vertice = 2 TO NUM_AXES DO  -- start at 2 since 1 is already set  
        p_xyzwpr[vertice] = p_xyzwpr[1]  -- Intialize all vertices  
    ENDFOR  
    -- Calculating individual components for each vertice of the hexagon  
    p_xyzwpr[2].x = p_xyzwpr[1].x + (L_HEX_SIDE * SIN(60))
```

```

p_xyzwpr[2].y = p_xyzwpr[1].y + (L_HEX_SIDE * COS(60))
p_xyzwpr[3].x = p_xyzwpr[1].x + (L_HEX_SIDE * SIN(60))
p_xyzwpr[3].y = p_xyzwpr[1].y + (L_HEX_SIDE + (L_HEX_SIDE * COS(60)))

p_xyzwpr[4].y = p_xyzwpr[1].y + (L_HEX_SIDE + (2 * (L_HEX_SIDE * COS(60))))
p_xyzwpr[5].x = p_xyzwpr[1].x - (L_HEX_SIDE * SIN(60))
p_xyzwpr[5].y = p_xyzwpr[3].y
p_xyzwpr[6].x = p_xyzwpr[1].x - (L_HEX_SIDE * SIN(60))
p_xyzwpr[6].y = p_xyzwpr[2].y
END r_calc_hex

```

**Generate and Move Along Hexagon Path - Declare Routines**

```

-----  

---- Section 3-B: R_CALC_HEX Declaration  

---- Positions the face plate perpendicular  

---- to the xy world coordinate plane.  

-----  

ROUTINE r_hex_center  

VAR  

    status, indx    : INTEGER  

    p_cntr_array    : ARRAY[NUM_AXES] OF REAL  

BEGIN  

-- Initialize the center position array to zero  

    FOR indx = 1 TO NUM_AXES DO  

        p_cntr_array[indx] = 0  

    ENDFOR  

-- Set JOINT 3 and 5 to -45 and 45 degrees  

    p_cntr_array[3] = -45  

    p_cntr_array[5] = 45-- Convert the REAL array to a joint position,  

    p_cntr  

    CNV_REL_JPOS(p_cntr_array,p_cntr,status)  

    $motype = JOINT  

    WITH $GROUP[1].$SPEED = 1000  

        MOVE TO p_cntr  

END r_hex_center

```

**Generate and Move Along Hexagon Path - Main Program**

```

-----  

---- Section 4: Main Program  

-----  

BEGIN --- GEN_HEX  

-----  

---- Section 4-A: Connect timer, set uframe, call routines  

-----  

clock = 0           -- Initialize clock value to zero

```

```

CONNECT TIMER TO clock                                -- Connect the timer
WRITE ('Moving to the center of the HEXAGON',CR) -- update user of process
r_hex_center                         -- position the face plate of robot.
$UFRAME = CURPOS(0,0)                  -- Set uframe to CURPOS of the robot.
WRITE ('Calculating the sides of HEXAGON',CR) -- update user
r_calc_hex                           -- Calculate the hexagon points

-----
---- Section 4-B: Move on sides of hexagon
-----

WRITE ('Moving along the sides of the Hexagon',CR) -- Update user
$MOTYPE    = JOINT           -- Set the system variable $GROUP[1].$MOTYPE
$SPEED     = 2000            -- Set the system variable $GROUP[1].$SPEED
$TERMTYPE  = FINE            -- Set the system variable $GROUP[1].$TERMTYPE
t_start = clock                   -- Record the time before motion begins

FOR p_indx = 1 TO 6 DO
  -- Verify that the position is reachable
  CHECK_EPOS ((p_xyzwpr[p_indx]), $UFRAME, $UTOOL, status)
  IF (status <> 0) THEN
    WRITE ('unable to move to p_xyzwpr[, p_indx,',CR);
  ELSE
    MOVE TO p_xyzwpr[1]          -- Move to first vertice of hexagon
  ENDIF
ENDFOR
MOVE TO p_xyzwpr[1]          -- Move back to first vertice of hexagon
WITH $GROUP[1].$MOTYPE = LINEAR MOVE TO p_cntr -- Move TCP in a straight
                                         -- line to the center position
t_end = clock                 -- Record ending time
WRITE('Total motion time = ',t_end-t_start,CR) --Display the total time for
                                              -- motion.
                                              -- NOTE that the total was
                                              -- computed in the
                                              -- statement.

WRITE
END GEN_HEX

```

## B.9 USING THE FILE AND DEVICE BUILT-INS

This program demonstrates how to use the File and Device built-ins. This program FORMATS and MOUNTS the RAM disk. Then copies files from the FLPY: device to RD:. If the RAM disk gets full the RAM disk size is increased and reformatted. This program continues until either all the files are copied successfully, or the built-in operations fail.

**File and Device Built-ins Program - Overview**


---

```

----- FILE_EX.KL
----- Section 0: Detail about FILE_EX.kl
----- Elements of KAREL Language Covered: In Section:
----- Action:
----- Clauses:
-----      FROM          Sec 3
----- Conditions:
----- Data types:
-----      BOOLEAN        Sec 2
-----      INTEGER        Sec 2
-----      STRING         Sec 2
----- Directives:
-----      COMMENT        Sec 1
-----      NOLOCKGROUP    Sec 1
----- Built-in Functions & Procedures:
-----      CNV_TIME_STR   Sec 4-A
-----      COPY_FILE      Sec 4-B
-----      DISMOUNT_DEV   Sec 4-B
-----      FORMAT_DEV     Sec 4-B
-----      GET_TIME       Sec 4-A
-----      MOUNT_DEV      Sec 4-B
-----      PURGE_DEV      Sec 4-B
-----      SUB_STR        Sec 4-A
----- Statements:
-----      IF...THEN...ELSE...ENDIF   Sec 4-B
-----      REPEAT...UNTIL        Sec 4-A
-----      ROUTINE             Sec 3
-----      SELECT...ENDSELECT    Sec 4-B
-----      WRITE               Sec 4-A,B

```

**File and Device Built-ins Program - Overview Continued**

```

----- Reserve Words:
-----      BEGIN          Sec 4
-----      CONST          Sec 2
-----      CR             Sec 4-A,B
-----      END            Sec 4-B
-----      PROGRAM        Sec 4
-----      VAR            Sec 2

```

```
---- Devices Used:
----          FLPY                      Sec 4-B
----          MF3                       Sec 4-B
----          RD                        Sec 4-B
----          FR                        Sec 4-B
```

**File and Device Built-ins Program - Declaration Section, Declare Routines**

```
---- Section 1: Program and Environment Declaration
```

```
PROGRAM FILE_EX
```

```
%nolockgroup
```

```
%comment = 'COPY FILES'
```

```
---- Section 2: Variable Declaration
```

```
CONST
```

SUCCESS	= 0	-- Success status from builtins
FINISHED	= TRUE	-- Finished Copy
TRY AGAIN	= FALSE	-- Try to copy again
RD_FULL	= 85020	-- RAM disk full
NOT_MOUNT	= 85005	-- Device not mounted
FR_FULL	= 85001	-- FROM disk is full
MNT_RD	= 85004	-- RAM disk must be mounted

```
--Refer to FANUC Robotics SYSTEM R-J3iB Controller KAREL  
Setup and Operations Manual for an Error Code listing
```

```
VAR
```

time_int	: INTEGER
time_str	: STRING[30]
status	: INTEGER
cpy_stat	: BOOLEAN
to_dev	: STRING[5]

```
---- Section 3: Routine Declaration
```

```
ROUTINE tp_cls FROM ROUT_EX
```

```
---- Section 4: Main program
```

```
BEGIN -- FILE_EX
```

```
    tp_cls      -- from rout_ex.kl
```

```
---- Section 4-A: Get Time and FORMAT ramdisk with date as volume name
```

```
    GET_TIME(time_int)                         -- Get the system time
```

```

CNV_TIME_STR(time_int, time_str)           -- Convert the INTEGER time
                                            -- to readable format
WRITE ('Today is ', SUB_STR(time_str, 2,8),CR) -- Display the date part
WRITE ('Time is ', SUB_STR(time_str, 11,5),CR) -- Display the time part

```

### File and Device Built-ins Program - Mount and Copy to RAM Disk

```

-----  

----- Section 4-B: Mount RAMDISK and start copying from FLPY to  

MF3:  

-----  

to_dev = 'MF3:'  

REPEAT                                -- Until all files have been copied  

    cpy_stat = FINISHED  

    WRITE('COPYing.....',cr)  

    -- Copy the files from FLPY: to to_dev and overwrite the file if it  

    -- already exists.  

    COPY_FILE('FLPY:*.kl', to_dev, TRUE, FALSE, status)  

    SELECT (status) OF  

        CASE (RD_FULL):          -- RAM disk is full  

            -- Dismount and re-size the RAM-DISK  

            WRITE ('DISMOUNTing RD: ....',cr)  

            DISMOUNT_DEV('RD:', status)  

                -- Verify DISMOUNT was successful or that  

                -- the device was not already mounted  

        IF (status = SUCCESS) OR (status = NOT_MOUNT) THEN  

            -- Increase the size of RD:  

            WRITE('Increasing RD: size...',cr)  

            $FILE_MAXSEC = ROUND($FILE_MAXSEC * 1.2)  

                -- Increase the RAM disk size  

                -- Format the RAM-DISK  

            WRITE('FORMATTING RD:.....',cr)  

            FORMAT_DEV('RD:', '', FALSE, status) -- Format the RAM disk  

        IF (status <> SUCCESS) THEN  

            WRITE ('FORMAT of RD: failed, status:', status,CR)  

            WRITE ('Copy incomplete',cr)  

        ELSE  

            cpy_stat = TRY AGAIN  

        ENDIF  

        WRITE('MOUNTing RD:.....',cr)  

        MOUNT_DEV ('RD:', status)  

        IF (status <> SUCCESS) THEN  

            WRITE ('MOUNTing of RD: failed, status:', status,CR)  

            WRITE ('Copy incomplete',cr)  

        ELSE  

            cpy_stat = TRY AGAIN  

        ENDIF  

    ELSE

```

```

        WRITE ('DISMOUNT of RD: failed, status:', status,cr)
        WRITE ('Copy incomplete',cr)
    ENDIF

```

### File and Device Built-ins Program - Mount and Copy to RAM Disk Continued

```

CASE (FR_FULL):      -- FROM disk is full
    WRITE ('FROM disk is full',CR, 'PURGING FROM.....', CR)
    PURGE_DEV ('FR:', status)   -- Purge the FROM
    IF (status <> SUCCESS) THEN
        WRITE ('PURGE of FROM failed, status:', status, CR)
        WRITE ('Copy incomplete', CR)
    ELSE
        cpy_stat = TRY AGAIN
    ENDIF
CASE (NOT_MOUNT, MNT_RD):  -- Device is not mounted
    WRITE ('MOUNTing ',to_dev,'.....',CR)
    MOUNT_DEV(to_dev, status)
    IF (status <> SUCCESS) THEN
        WRITE ('MOUNTing of ',to_dev,' failed, status:', status, CR)
        WRITE ('Copy incomplete', CR)
    ELSE
        cpy_stat = TRY AGAIN
    ENDIF
CASE (SUCCESS):
    WRITE ('Copy completed successfully!',CR)
ELSE:
    WRITE ('Copy failed, status:', status,CR)
ENDSELECT
UNTIL (cpy_stat = FINISHED)

END file_ex

```

## B.10 USING DYNAMIC DISPLAY BUILT-INS

This program demonstrates how to use the dynamic display built-ins. This program initiates the dynamic display of various data types. It then executes another task, CHG\_DATA, which changes the values of these variables.

Before exiting this program the dynamic displays are cancelled and the other task is aborted. If DYN\_DISP is aborted, it will set a variable which CHG\_DATA detects. This ensures that CHG\_DATA cannot continue executing once DYN\_DISP is aborted.

### Using Dynamic Display Built-ins - Overview

---

```

----  DYN_DISP.KL
-----
----  Section 0:  Detail about DYN_DISP.KL

```

---

---- Elements of KAREL Language Covered:	In Section:
---- Actions:	
---- Clauses:	
---- FROM	Sec 3-C
---- IN CMOS	Sec 2
---- WHEN	Sec 4
---- Conditions:	
---- ABORT	Sec 4
---- Data types:	
---- BOOLEAN	Sec 2
---- INTEGER	Sec 2
---- REAL	Sec 2
---- STRING	Sec 2
---- Directives:	
---- ALPHABETIZE	Sec 1
---- COMMENT	Sec 1
---- NOLOCKGROUP	Sec 1

### Using Dynamic Display Built-ins - Overview Continued

---- Built-in Functions & Procedures:	
---- ABORT_TASK	Sec 4-C
---- CNC_DYN_DISI	Sec 4-C
---- CNC_DYN_DISR	Sec 4-C
---- CNC_DYN_DISB	Sec 4-C
---- CNC_DYN_DISE	Sec 4-C
---- CNC_DYN_DISP	Sec 4-C
---- CNC_DYN_DISS	Sec 4-C
----INI_DYN_DISI	Sec 3-A, 4-A
----INI_DYN_DISR	Sec 3-B, 4-A
----INI_DYN_DISB	Sec 3-C, 4-A
----INI_DYN_DISE	Sec 3-D, 4-A
----INI_DYN_DISP	Sec 3-E, 4-A
----INI_DYN_DISS	Sec 3-F, 4-A
----LOAD_STATUS	Sec 4-B
----LOAD	Sec 4-B
----RUN_TASK	Sec 4-B
---- Statements:	
---- CONDITION...ENDCONDITION	Sec 4
---- IF...THEN...ENDIF	Sec 4-A,B,C
---- READ	Sec 4-C

```

-----          ROUTINE          Sec 3-A,B,C
-----          WRITE           Sec 4-A,B,C
-----
-----      Reserve Words:
-----          BEGIN           Sec 3-A,B; 4
-----          CR              Sec 4-A
-----          CONST            Sec 2
-----          END              Sec 3-A,B; 4-C
-----          PROGRAM          Sec 4
-----          VAR              Sec 2
-----
-----      Predefined File Variables:
-----          TPPROMPT         Sec 4-B,C
-----
-----      Predefined Windows:
-----          T_FU             Sec 3-A,B

```

### Using Dynamic Display Built-ins - Declaration Section

```

-----      Section 1: Program and Environment Declaration
-----
PROGRAM DYN_DISP
%nolockgroup
%comment = 'Dynamic Disp'
%alphabetize
%INCLUDE KLIOTYPS
-----
-----      Section 2: Variable Declaration
-----
CONST

    cc_success      = 0      -- Success status
    cc_clear_win   = 128     -- Clear window
    cc_clear_eol   = 129     -- Clear to end of line
    cc_clear_eow   = 130     -- Clear to end of window

    CH_ABORT       = 1      -- Condition Handler to detect when program aborts

VAR

    Int_wind        : STRING[10]
    Rel_wind        : STRING[10]
    Field_Width     : INTEGER
    Attr_Mask       : INTEGER
    Char_Size       : INTEGER
    Row             : INTEGER
    Col             : INTEGER

```

```

Interval          : INTEGER
Buffer_Size       : INTEGER
Format            : STRING[7]
bool_names        : ARRAY[2] OF STRING[10]
enum_names        : ARRAY[4] OF STRING[10]
pval_names        : ARRAY[2] OF STRING[10]
bool1 IN CMOS    : BOOLEAN
enum1 IN CMOS    : INTEGER
port_type         : INTEGER
port_no           : INTEGER
Str1  IN CMOS    : STRING[10]
Int1  IN CMOS    : INTEGER      -- Using IN CMOS will create the variables
Reall IN CMOS    : REAL         -- in CMOS RAM, which is permanent memory.
status            : INTEGER
loaded,
initialized     : BOOLEAN
dynd_abrt        : BOOLEAN    -- Set to true when program aborts.

```

## Using Dynamic Display Built-ins - Declare Routines

---

```

----- Section 3: Routine Declaration
-----

-----
----- Section 3-A: SET_INT Declaration
----- Set all the input parameters for theINI_DYN_DISI call.
-----

ROUTINE Set_Int
Begin

-- Valid predefined windows are described in
-- Chapter 7.9.1, "USER MENU on the Teach Pendant
-- Error Line    --> 'ERR'    1 line
-- Status Line   --> 'T_ST'   3 lines
-- Display Window --> 'T_FU'   10 lines
-- Prompt Line   --> 'T_PR'   1 line
-- Function Key  --> 'T_FK'   1 line

Int_Wind         = 'T_FU'           -- Use the predefined display window
Field_Width      = 0                -- Use the minimum width necessary
Attr_Mask        = 1 OR 4          -- BOLD and UNDERLINED
Char_Size         = 0                -- Normal
Row              = 1                -- Specify the location within 'T_FU'
Col              = 16               -- to dynamically displayed
Interval          = 250              -- 250ms between updates
Buffer_Size       = 10               -- Minimum value required.
Format            = '%-8d'          -- 8 character minimum field width

```

```

--- With this specification the INTEGER will be displayed as follows:
---           -----
---           |xxxxxxxxx|
---           -----
--- Where the integer value will be left justified.
--- The x's will be the integer value unless the integer value is
--- less than 8 characters, then the right side will be blanks up to
--- a total 8 characters. If the integer value is greater than the 8
--- characters the width is dynamically increased to display the whole
--- integer value. The INTEGER value will also be bold and underlined.

End Set_Int

```

### Using Dynamic Display Built-ins - Declare Routines Continued

```

----- Section 3-B: SET_REAL Declaration
----- Set all the input parameters for theINI_DYN_DISR call.

ROUTINE Set_Real
Begin

    Rel_Wind      = 'T_FU'          -- Use the predefined display window
    Field_Width   = 10             -- Maximum width of display.
    Attr_Mask     = 2 OR 8         -- blinking and reverse video
    Char_Size     = 0              -- Normal
    Row           = 2              -- Specify the location within 'TFU'
    Col           = 16             -- to dynamically display
    Interval      = 200            -- 200ms between update
    Buffer_Size   = 10             -- Minimum value required.
    Format        = '%2.2f'

--- With the format and field_width specification the REAL will be
--- displayed as follows:
---           -----
---           |xxxx.xx  |
---           -----
--- Where the real value will be left justified.
--- There will always be two digits after the decimal point.
--- A maximum width of 10 will be used.
--- If the real value is less than 10 characters the right side will be
--- padded with blanks up to 10 character width.
--- If the real value exceeds 10 characters, the display width will not
--- expand but will display a ">" as the last character, indicating the
--- entire value is not displayed.
--- The value will also be blinking and in reverse video.

```

```
End Set_Real
```

### Using Dynamic Display Built-ins - Declare Routines Continued

```
-----  
---- Section 3-C: SET_BOOL Declaration  
---- Set all the input parameters for the INI_DYN_DISB call  
-----  
ROUTINE Set_Bool  
Begin  
  
-- Valid predefined windows are described in  
-- Chapter 7.9.1, "USER MENU on the Teach Pendant  
-- Error Line    --> 'ERR'    1  line  
-- Status Line   --> 'T_ST'   3  lines  
-- Display Window --> 'T_FU'   10 lines  
-- Prompt Line   --> 'T_PR'   1  line  
-- Function Key  --> 'T_FK'   1  line  
  
Int_Wind          = 'T_FU'           -- Use the predefined display window  
Field_Width       = 10              -- Display 10 chars  
Attr_Mask         = 2               -- Blinking  
Char_Size         = 0               -- Normal  
Row               = 3               -- Specify the location within 'T_FU'  
Col               = 16              -- to dynamically displayed  
Interval          = 250             -- 250ms between updates  
Buffer_Size       = 10              -- Minimum value required  
bool_names[1]     = 'YES'            -- string display in bool_var is FALSE  
bool_names[2]     = 'NO'             -- string display in bool_var is TRUE  
--- With this specification the BOOLEAN will be displayed as follows:  
---  
---      -----  
---      |xxxxxxxxx|  
---      -----  
--- Where the boolean value will be left justified.  
--- The x's will be one of the strings 'YES' or 'NO', depending on  
--- the value of booll. The string will be blinking.
```

```
End Set_Bool
```

### Using Dynamic Display Built-ins - Declare Routines Continued

```
-----  
---- Section 3-D: SET_ENUM Declaration  
---- Set all the input parameters for the INI_DYN_DISE call.  
-----  
ROUTINE Set_Enum  
Begin
```

```

-- Valid predefined windows are described in
-- Chapter 7.9.1, "USER MENU on the Teach Pendant
-- Error Line    --> 'ERR'    1 line
-- Status Line   --> 'T_ST'   3 lines
-- Display Window --> 'T_FU'   10 lines
-- Prompt Line   --> 'T_PR'   1 line
-- Function Key  --> 'T_FK'   1 line

Int_Wind      = 'T_FU'           -- Use thE predefined display window
Attr_Mask     = 8                -- REVERSED
Field_Width   = 10               -- Display to characters
Char_Size     = 0                -- Normal
Row          = 4                -- Specify the location within 'T_FU'
Col          = 16               -- to dynamically displayed
Interval      = 250              -- 250ms between updates
Buffer_Size   = 10               -- Minimum value required
enum_names[1]  = 'Enum-0'         -- value displayed if enum_var = 0
enum_names[2]  = 'Enum-1'         -- value displayed if enum_var = 1
enum_names[3]  = 'Enum-2'         -- value displayed if enum_var = 2
enum_names[4]  = 'Enum-3'         -- value displayed if enum_var = 3
--- With this specification enum_var will be displayed as follows:
---      -----
---      |xxxxxxxxx|
---      -----
---      Where one of the strings enum_names will be displayed,
---      depending on the integer value enum1. If enum1 is outside
---      the range 0-3, a string of 10 '?'s will be displayed.
---      The string will be displayed in reversed video.

End Set_Enum

```

### Using Dynamic Display Built-ins - Declare Routines Continued

```

-----  

---- Section 3-E: SET_PORT Declaration  

----           Set all the input parameters for the INI_DYN_DISP call.  

-----  

ROUTINE Set_Port  

Begin  
  

-- Valid predefined windows are described in
-- Chapter 7.9.1, "USER MENU on the Teach Pendant
-- Error Line    --> 'ERR'    1 line
-- Status Line   --> 'T_ST'   3 lines
-- Display Window --> 'T_FU'   10 lines
-- Prompt Line   --> 'T_PR'   1 line
-- Function Key  --> 'T_FK'   1 line

```

```

Int_Wind      = 'T_FU'           -- Use the predefined display window
Field_Width   = 10              -- Display to characters
Attr_Mask     = 1                -- BOLD
Char_Size     = 0                -- Normal
Row          = 5                -- Specify the location within 'T_FU'
Col          = 16               -- to dynamically displayed
Interval     = 250              -- 250ms between updates
Buffer_Size   = 10              -- Minimum value required.
pval_names[1] = 'RELEASED'     -- text displayed if key is not pressed
pval_names[2] = 'PRESSED'      -- text displayed if key is pressed
port_type     = io_tpin        -- port type = TP key
port_no       = 175             -- user-key 3

--- With this specification PRESSED or RELEASED will be displayed as follows:
---           -----
---           |xxxxxxxxx|
---           -----
---           Where the string will be left justified.
---           The x's will be either 'RELEASED' or 'PRESSED'.
---           The string will also be normal video.
---           (Bold is not supported on the teach pendant.)
```

End Set\_Port

### Using Dynamic Display Built-ins - Declare Routines Continued

```

-----  

---- Section 3-F: SET_STR Declaration  

----           Set all the input parameters for the INI_DYN_DISS call.  

-----  

ROUTINE Set_Str  

Begin  

-- Valid predefined windows are described in  

-- Chapter 7.9.1, "USER MENU on the Teach Pendant  

--   Error Line    --> 'ERR'    1  line  

--   Status Line   --> 'T_ST'   3  lines  

--   Display Window --> 'T_FU'   10 lines  

--   Prompt Line   --> 'T_PR'   1  line  

--   Function Key  --> 'T_FK'   1  line  

Int_Wind      = 'T_FU'           -- Use the predefined display window
Field_Width   = 10              -- Use the minimum width necessary
Attr_Mask     = 1 OR 4          -- BOLD and UNDERLINED
Char_Size     = 0                -- Normal
Row          = 6                -- Specify the location within 'T_FU'
```

```

Col           = 16          --      to dynamically displayed
Interval      = 250         -- 250ms between updates
Buffer_Size   = 10          -- Minimum value required.
Format        = '%10s'       -- 10 character minimum field width

--- With this specification the STRING will be displayed as follows:
--- -----
--- |xxxxxxxxx|
--- -----
--- Where the string value will be left justified.
--- The x's will be the string value.
--- The STRING will also be underlined.

End Set_Str

-----
----- Section 3-G: TP_CLS Declaration
----- Clear the TP USER menus screen and force it to be visible.
-----
ROUTINE tp_cls FROM rout_ex

```

### Using Dynamic Display Built-ins - Initiate Dynamic Displays

```

----- Section 4: Main program
-----
BEGIN --- DYN_DISP
dynd_abrt = FALSE

CONDITION[CH_ABORT]:
WHEN ABORT DO      -- When the program is aborting set dynd_abrt flag.
                    -- This will be triggered if this program aborts itself
                    -- or if an external mechanism aborts this program.
    dynd_abrt = TRUE -- CHG_DATA will detect this and complete execution.
ENDCONDITION

ENABLE CONDITION [CH_ABORT]
-----
----- Section 4-A: Setup variables, initiate dynamic display
-----
TP_CLS                      -- Clear the TP USER screen
                             -- Force display of the TP USER screen
STATUS = cc_success           -- Initialize the status variable
-- Initialize the dynamically displayed variables
Int1     = 1
Reall    = 1.0

```

```

Bool1      = FALSE
Enum1     = 0
Str1      = ''
-- Display messages to the TP USER screen
WRITE ('Current INT1 =',CR)
WRITE ('Current REAL1=',CR)
WRITE ('Current BOOL1=',CR)
WRITE ('Current ENUM1=',CR)
WRITE ('Current PORT =',CR)
WRITE ('Current STR1 =',CR)
Set_Int          -- Set parameter values for INTEGER DYNAMIC DISPLAY
INI_DYN_DISI(Int1,Int_Wind,Field_Width,Attr_Mask,Char_Size,
              Row,Col, Interval, Buffer_Size, Format ,Status)
IF Status <> cc_success THEN -- Check the status
    WRITE('INI_DYN_DISI failed, Status=',status,CR)
ENDIF
Set_Bool         -- Set parameter values for BOOLEAN DYNAMIC
DISPLAY
INI_DYN_DISB(Bool1,Int_Wind,Field_Width,Attr_Mask,Char_Size,
              Row,Col, Interval, bool_names,Status)
IF Status <> cc_success THEN -- Check the status
    WRITE('INI_DYN_DISB failed, Status=',status,CR)
ENDIF

```

### Using Dynamic Display Built-ins - Initiate Dynamic Displays

```

Set_Enum          -- Set parameter values for Enumerated Integer
                  -- DYNAMIC DISPLAY
INI_DYN_DISE(Enum1,Int_Wind,Field_Width,Attr_Mask,Char_Size,
              Row,Col, Interval, enum_names,Status)
IF Status <> cc_success THEN -- Check the status
    WRITE('INI_DYN_DISE failed, Status=',status,CR)
ENDIF

Set_Port          -- Set parameter values for Port DYNAMIC DISPLAY
INI_DYN_DISP(port_type, port_no ,Int_Wind,Field_Width,Attr_Mask,Char_Size,
              Row,Col, Interval, pval_names, Status)
IF Status <> cc_success THEN -- Check the status
    WRITE('INI_DYN_DISP failed, Status=',status,CR)
ENDIF

Set_Real          -- Set parameter values for REAL DYNAMIC DISPLAY
INI_DYN_DISR(Real1,Rel_Wind,Field_Width,Attr_Mask,Char_Size,
              Row,Col, Interval, Buffer_Size, Format ,Status)
IF Status <> cc_success THEN -- Check the status
    WRITE('INI_DYN_DISR failed, Status=',status,CR)
ENDIF

```

```

Set_Str          -- Set parameter values for STRING DYNAMIC
DISPLAY
INI_DYN_DISS(Str1,Int_Wind,Field_Width,Attr_Mask,Char_Size,
               Row,Col, Interval, Buffer_Size, Format ,Status)
IF Status <> cc_success THEN -- Check the status
    WRITE('INI_DYN_DISS failed, Status=',status,CR)
ENDIF

```

### Using Dynamic Display Built-ins - Execute Subordinate Task

```

----- Section 4-B: Check on subordinate program and execute it.
-----

-- Check the status of the other program which will change the value
-- of the variables.

LOAD_STATUS('chg_data', loaded, initialized)
IF (loaded = FALSE ) THEN
    WRITE TPPROMPT(CHR(cc_clear_win))           -- Clear the prompt line
    WRITE TPPROMPT('CHG_DATA is not loaded. Loading now... ')
    LOAD('chg_data.pc',0,status)
    IF (status = cc_success) THEN             -- Check the status
        RUN_TASK('CHG_DATA',1,false,false,1,status)
        IF (Status <> cc_success) THEN         -- Check the status
            WRITE ('Changing the value of the variables',CR)
            WRITE ('by another program failed',CR)
            WRITE ('BUT you can try changing the values',CR)
            WRITE ('from KCL',CR)
        ENDIF
    ELSE
        WRITE ('LOAD Failed, status = ',status,CR)
    ENDIF
ELSE
    RUN_TASK('CHG_DATA',1,false,false,1,status)
    IF (Status <> cc_success) THEN           -- Check the status
        WRITE ('Changing the value of the variables',CR)
        WRITE ('by another program failed',CR)
        WRITE ('BUT you can try changing the values',CR)
        WRITE ('from KCL',CR)
    ENDIF
ENDIF

```

### Using Dynamic Display Built-ins - User Response Cancels Dynamic Displays

```

----- Section 4-C: Wait for user response, and cancel dynamic displays
-----
```

```

        WRITE TPPROMPT(CHR(cc_clear_win))          -- Clear the prompt line
        WRITE TPPROMPT('Enter a number to cancel DYNAMIC display: ')
        READ (CR)                                -- Read only one character
                                                -- See Chapter 7.7.1,
                                                -- "Formatting INTEGER Data Items"

        ABORT_TASK('CHG_DATA',TRUE, TRUE,status)   -- Abort CHG_DATA
        IF (status <> cc_success) THEN           -- Check the status
            WRITE(' ABORT_TASK failed, Status=',status,CR)
        ENDIF

        CNC_DYN_DISI(Int1, Int_Wind,Status)         -- Cancel display of Int1
        IF Status <> 0 THEN                      -- Check the status
            WRITE(' CND_DYN_DISI failed, Status=',status,CR)
        ENDIF

        CNC_DYN_DISR(Real1,Rel_Wind,Status)         -- Cancel display of Real1
        IF Status <> 0 THEN                      -- Check the status
            WRITE(' CND_DYN_DISR failed, Status=',status,CR)
        ENDIF

        CNC_DYN_DISB(Bool1, Int_Wind,Status)         -- Cancel display of Bool1
        IF Status <> 0 THEN                      -- Check the status
            WRITE(' CND_DYN_DISB failed, Status=',status,CR)
        ENDIF

        CNC_DYN_DISE(Enum1, Int_Wind,Status)         -- Cancel display of Enum1
        IF Status <> 0 THEN                      -- Check the status
            WRITE(' CND_DYN_DISE failed, Status=',status,CR)
        ENDIF

        CNC_DYN_DISP(port_type, Port_no, Int_Wind,Status) -- Cancel display of Port
        IF Status <> 0 THEN                      -- Check the status
            WRITE(' CND_DYN_DISP failed, Status=',status,CR)
        ENDIF

        CNC_DYN_DISS(Str1, Int_Wind,Status)          -- Cancel display of String
        IF Status <> 0 THEN                      -- Check the status
            WRITE(' CND_DYN_DISS failed, Status=',status,CR)
        ENDIF

    END DYN_DISP

```

## B.11 MANIPULATING VALUES OF DYNAMICALLY DISPLAYED VARIABLES

The CHG\_DATA.KL program is called by DYN\_DISP, where the actual variables are displayed dynamically. This program does some processing and changes the value of those variables.

### Manipulate Dynamically Displayed Variables - Overview

```
-----  
---- CHG_DATA.KL  
-----  
-----  
---- Section 0: Detail about CHG_DATA.KL  
-----  
  
---- Elements of KAREL Language Covered:           In Section:  
---- Actions:  
  
---- Clauses:  
----          FROM                               Sec 2  
---- Conditions:  
  
---- Data types:  
----          INTEGER                            Sec 2  
----          REAL                               Sec 2  
----  
---- Directives:  
  
---- Built-in Functions & Procedures:  
  
---- Statements:  
----          DELAY                             Sec 4  
----          FOR....ENDFOR                      Sec 4  
----          REPEAT...UNTIL                     Sec 4  
----  
---- Reserve Words:  
----          BEGIN                            Sec 4  
----          END                              Sec 4  
----          PROGRAM                           Sec 1  
----          VAR                             Sec 2  
----  
-----  
---- Section 1: Program and Environment Declaration  
-----  
PROGRAM CHG_DATA  
%nolockgroup  
%comment = 'Dynamic Disp2'
```

**Manipulate Dynamically Displayed Variables - Declaration Section**

```
-----
----      Section 2:  Variable Declaration
-----
VAR

-- IF the following variables did NOT have IN CMOS, the following errors
-- would be posted when loading this program:
-- VARS-012 Create var -INT1 failed VARS-038 Cannot change CMOS/DRAM type
-- VARS-012 Create var -REAL1 failed VARS-038 Cannot change CMOS/DRAM type
-- This indicates that there is a discrepancy between DYN_DISP and CHG_DATA.
-- One program has specified to create the variables in DRAM the
-- other specified CMOS.

Int1 IN CMOS FROM dyn_disp :INTEGER      -- dynamically displayed variable
Real1 IN CMOS FROM dyn_disp :REAL        -- dynamically displayed variable
Bool1 IN CMOS FROM dyn_disp :BOOLEAN     -- dynamically displayed variable
Enum1 IN CMOS FROM dyn_disp :INTEGER      -- dynamically displayed variable
Str1 IN CMOS FROM dyn_disp :STRING[10]   -- dynamically displayed variable

indx                         :INTEGER
dynd_abrt FROM dyn_disp      :BOOLEAN    -- Set in dyn_disp when dyn_disp
                                         -- is aborting
-----
```

---- Section 3: Routine Declaration

-----**Manipulate Dynamically Displayed Variables - Main Program**

```
-----
----      Section 4: Main program
-----
BEGIN  -- CHG_DATA

-- This demonstrates that the variables are changed from this task, CHG_DATA.
-- The dynamic display initiated in task DYN_DISP, will continue
-- to correctly display the updated values of these variables.

-- Do real application processing.
-- Simulated here in a FOR loop.

REPEAT
FOR indx = -9999 to 9999 DO
    int1 = (indx DIV 2) * 7
    real1 = (indx DIV 3)* 3.13
    bool1 = ((indx AND 4) = 0)
```

```

enum1 = (ABS(indx) DIV 5) MOD 5
Str1 = SUB_STR('123456789A', 1, (ABS(indx) DIV 6) MOD 7 + 1)
delay 200 -- Delay for 1/5 of a second as if processing is going on.
ENDFOR
UNTIL (DYND_ABRT) -- This task is aborted from DYN_DISP. However, if
-- DYN_DISP aborts abnormally (ie from a KCL> ABORT), it
-- will set DYND_ABRT, which will allow CHG_DATA to
-- complete execution.

END CHG_DATA

```

## B.12 DISPLAYING A LIST FROM A DICTIONARY FILE

This program controls the display of a list which is read in from the dictionary file DCLISTEG.UTX. For more information on DCLISTEG.UTX refer to [Section B.12.1](#). DCLST\_EX.KL controls the placement of the cursor along with the action taken for each command.

**Note** The use of DISCTRL\_FORM is the preferred method of displaying information. DISCTRL\_FORM will automatically take care of all the key inputs and is much easier to use. For more information, refer to [Chapter 10 DICTIONARIES AND FORMS](#).

### Display List from Dictionary File - Overview

---

```

---- DCLST_EX.KL
-----
---- Section 0: Detail about DCLST_EX.KL
-----
---- Elements of KAREL Language Covered: In Section:
---- Actions:
-----
---- Clauses:
----      FROM                               Sec 3-E
-----
---- Conditions:
-----
---- Data types:
----      ARRAY OF STRING                  Sec 2
----      BOOLEAN                         Sec 2
----      DISP_DAT_T                      Sec 2
----      FILE                            Sec 2
----      INTEGER                         Sec 2
----      STRING                          Sec 2
-----
---- Directives:
----      ALPHABETIZE                     Sec 1
----      COMMENT                         Sec 1

```

----	INCLUDE	Sec 1
----	NOLOCKGROUP	Sec 1
 ---- Built-in Functions & Procedures:		
----	ADD_DICT	Sec 3-B
----	ACT_SCREEN	Sec 4-I
----	ATT_WINDOW_S	Sec 4-C
----	CHECK_DICT	Sec 3-B
----	CLR_IO_STAT	Sec 3-A,C
----	CNV_STR_INT	Sec 4-E
----	DEF_SCREEN	Sec 4-B
----	DET_WINDOW	Sec 4-I
----	DISCTRL_LIST	Sec 4-G,H
----	FORCE_SPMENU	Sec 4-A,B,C
----	IO_STATUS	Sec 3-A,
----	ORD	Sec 4-H
----	READ_DICT	Sec 4-E,F

#### **Display List from Dictionary File - Overview Continued**

----	REMOVE_DICT	Sec 4-I
----	SET_FILE_ATR	Sec 4-G
----	STR_LEN	Sec 4-F
----	UNINIT	Sec 3-C
----	WRITE_DICT	Sec 4-D,H,I
 ---- Statements:		
----	ABORT	Sec 3-B
----	CLOSE FILE	Sec 4-I
----	FOR...ENDFOR	Sec 4-F
----	IF...THEN...ENDIF	Sec 3-A,B,C,D; 4-F,H,I
----	OPEN FILE	Sec 3-A; 4-H
----	READ	Sec 4-A,B,H
----	REPEAT...UNTIL	Sec 4-H
----	ROUTINE	Sec 3-A,B,C,D,E
----	SELECT...ENDSELECT	Sec 4-H
----	WRITE	Sec 3-A,B,C,D;4-A,I
 ---- Reserve Words:		
----	BEGIN	Sec 3-A,B,C,D;4
----	CR	Sec 4-A,B,C
----	END	Sec 3-A,B,C,D; 4-I
----	PROGRAM	Sec 1
----	VAR	Sec 2
 ---- Predefined File Names:		
----	TPDISPLAY	Sec 4-D,G,H,I
----	TPFUNC	Sec 4-D,H

----	TPPROMPT	Sec 4-D,H,I
----	TPSTATUS	Sec 4-D,I
 ---- Devices Used:		
----	RD2U	Sec 3-B
 ---- Predefined Windows:		
----	ERR	Sec 4-C
----	T_ST	Sec 4-C
----	T_FU	Sec 4-C
----	T_PR	Sec 4-C
----	T_FR	Sec 4-C

### Display List from Dictionary File - Declaration Section

```
-----  
---- Section 1: Program and Environment Declaration  
-----  
  
PROGRAM DCLST_EX  
  
%COMMENT='DISCTRL_LIST '  
%ALPHABETIZE  
%NOLOCKGROUP  
%INCLUDE DCLIST -- the include file from the dictionary DCLISTEG.UTX  
  
-----  
---- Section 2: Variable Declarations  
-----  
  
VAR  
    exit_Cmnd      : INTEGER  
    act_pending     : INTEGER          -- decide if any action is pending  
    display_data   : DISP_DAT_T       -- information needed for DICTRL_LIST  
    done           : BOOLEAN          -- decides when to complete execution  
    Kb_file        : FILE             -- file opened to the TPKB  
    i               : INTEGER          -- just a counter  
    key             : INTEGER          -- which key was pressed  
    last_line       : INTEGER          -- number of last line of information  
    list_data      : ARRAY[20] OF STRING[40] -- exact string information  
    num_options    : INTEGER          -- number of items in list  
    old_screen     : STRING[4]         -- previously attached screen  
    status          : INTEGER          -- status returned from built-in call  
    str             : STRING[1]         -- string read in from teach pendant  
    Err_file       : FILE             -- err log file  
    Opened         : BOOLEAN          -- err log file open or not
```

**Display List from Dictionary File - Declare Routines**

```
-----
-----      Section 3:  Routine Declaration
-----

-----
-----      Section 3-A: Op_Err_File Declaration
-----          Open the error log file.

-----
Routine Op_Err_File
Begin
    Opened = false
    Write TPPROMPT(CR,'Creating Auto Error File .....')
    OPEN FILE Err_File ('RW','RD2U:\D_LIST.ERR') -- open for output
    IF (IO_STATUS(Err_File) <> 0 ) THEN
        CLR_IO_STAT(Err_File)
        Write TPPROMPT('*** USE USER WINDOW FOR ERROR OUTPUT ***',CR)
    ELSE
        Opened = TRUE
    ENDIF
End Op_Err_File

-----
-----      Section 3-B: Chk_Add_Dct Declaration
-----          Check whether a dictionary is loaded.
-----          If not loaded then load in the dictionary.

-----
Routine Chk_Add_Dct

Begin -- Chk_Add_Dct

    -- Make sure 'DLST' dictionary is added.

    CHECK_DICT('DLST',TPTSSP_TITLE,STATUS)
    IF STATUS <> 0 THEN
        Write TPPROMPT(CR,'Loading Required Dictionary.....')
        ADD_DICT('RD2U:\DCLISTEG','DLST',DP_DEFAULT,DP_DRAM,STATUS)
        IF status <> 0 THEN
            WRITE TPPROMPT('ADD_DICT failed, STATUS=',STATUS,CR)
            ABORT -- Without the dictionary this program can not continue.
        ENDIF
    ELSE
        WRITE TPPROMPT ('Dictionary already loaded in system.      ')
    ENDIF

End Chk_Add_Dct
```

**Display List from Dictionary File - Declare Error Routines**

```
-----
----      Section 3-C:  Log_Errors Declaration
----              Log detected errors to a file to be reviewed later.
-----
ROUTINE Log_Errors(Out: FILE; Err_Str:STRING;Err_No:INTEGER)
BEGIN
    IF NOT Opened THEN -- If error log file not opened then write errors to
                        -- screen
        WRITE (Err_Str,Err_No,CR)
    ELSE
        IF NOT UNINIT(Out)  THEN
            CLR_IO_STAT(Out)
            WRITE Out(Err_Str,Err_No,CR,CR)
        ELSE
            WRITE (Err_Str,Err_No, CR)
        ENDIF
    ENDIF
END Log_Errors

-----
----      Section 3-D:  Chk_Stat Declaration
----              Check the global variable, status.
----              If not zero then log input parameter, err_str,
----              to error file.
-----
ROUTINE Chk_Stat ( err_str: STRING)
BEGIN -- Chk_Stat
    IF( status <> 0) then
        Log_Errors(Err_File, err_str,Status)
    ENDIF
END Chk_Stat

-----
----      Section 3-E:  TP_CLS Declaration
-----
ROUTINE TP_CLS FROM ROUT_EX
```

**Display List from Dictionary File - Setup and Define Screen**

```
-----
----      Section 4:  Main Program
-----
BEGIN -- DCLST_EX
```

```

----      Section 4-A:  Perform Setup operations
-----

TP_CLS    -- Call routine to clear and force the TP USER menu to be visible

Write ('  ***** Starting DISCTRL_LIST Example *****', CR, CR)

Chk_Add_Dct     -- Call routine to check and add dictionary
Op_Err_File     -- Call routine open error log file

-----
----      Section 4-B:  Define and Active a screen
-----

DEF_SCREEN('LIST', 'TP', status)   -- Create/Define a screen called LIST
Chk_Stat ('DEF_SCREEN LIST')      -- Verify DEF_SCREEN was successful

ACT_SCREEN('LIST', old_screen, status) -- activate the LIST screen that
                                         -- that was just defined.
Chk_Stat ('ACT_SCREEN LIST')        -- Verify ACT_SCREEN was successful

-----
----      Section 4-C:  Attach windows to the screen
-----

-- Attach the required windows to the LIST screen.
-- SEE:
-- Chapter 7.9.1 "USER Menu on the Teach Pendant,
-- for more details on predefined window names.

ATT_WINDOW_S('ERR', 'LIST', 1, 1, status) -- attach the error window
  Chk_Stat('Attaching ERR')
ATT_WINDOW_S('T_ST', 'LIST', 2, 1, status) -- attach the status window
  Chk_Stat('T_ST not attached')
ATT_WINDOW_S('T_FU', 'LIST', 5, 1, status) -- attach the full window
  Chk_Stat('T_FU not attached')
ATT_WINDOW_S('T_PR', 'LIST', 15, 1, status)-- attach the prompt window
  Chk_Stat('T_PR not attached')
ATT_WINDOW_S('T_FK', 'LIST', 16, 1, status)-- attach the function window
  Chk_Stat('T_FK not attached')

```

#### **Display List from Dictionary File - Write Elements to the Screen**

```

-----      Section 4-D:  Write dictionary elements to windows
-----

-- Write dictionary element,TPTSSP_TITLE, from DLST dictionary.
-- Which will clear the status window, and display intro message in
-- reverse video.

```

```

        WRITE_DICT(TPSTATUS, 'DLST', TPTSSP_TITLE, status)
        Chk_Stat( 'TPTSSP_TITLE not written')

        -- Write dictionary element,TPTSSP_FK1, from DLST dictionary.
        -- Which will display "[TYPE]" to the function line window.
        WRITE_DICT(TPFUNC, 'DLST', TPTSSP_FK1, status)
        Chk_Stat( 'TPTSSP_FK1 not written')

        -- Write dictionary element, TPTSSP_CLRSC, from DLST dictionary.
        -- Which will clear the teach pendant display window.
        WRITE_DICT(TPDISPLAY, 'DLST', TPTSSP_CLRSC, status)
        Chk_Stat( 'TPTSSP_CLRSC not written')

        -- Write dictionary element, TPTSSP_INSTR, from DLST dictionary.
        -- Which will display instructions to the prompt line window.
        WRITE_DICT(TPPROMPT, 'DLST', TPTSSP_INSTR, status)
        Chk_Stat( 'TPTSSP_INSTR not written')

-----
-----      Section 4-E:      Determine the number of menu options
-----

        -- Read the dictionary element, TPTSSP_NUM, from DLST dictionary,
        -- Into the first element of list_data.
        -- list_data[1] will be an ASCII representation of the number of
        -- menu options. last_line will be returned with the number of
        -- lines/elements used in list_data.
        READ_DICT('DLST', TPTSSP_NUM, list_data, 1, last_line, status)
        Chk_Stat( 'TPTSSP_NUM not read')

        -- convert the string into the INTEGER, num_options
        CNV_STR_INT(list_data[1], num_options)

```

### Display List from Dictionary File - Initialize Display Data

```

-----      Section 4-F:      Initialize the data structure, display_data
-----              Which is used to display the list of menu options.
-----

        -- Initialize the display data structure
        -- In this example we only deal with window 1.
        display_data.win_start[1] = 1    -- Starting row for window 1.
        display_data.win_end[1]   = 10   -- Ending row for window 1.
        display_data.curr_win = 0       -- The current window to display, where
                                         -- zero (0) specifies first window.
        display_data.cursor_row = 1     -- Current row the cursor is on.
        display_data.lins_per_pg = 10   -- The number of lines scrolled when the

```

```

-- user pushes SHIFT Up or Down. Usually
-- it is the same as the window size.
display_data.curs_st_col[1] = 0 -- starting column for field 1
display_data.curs_en_col[1] = 0 -- ending column for field 1, will be
-- updated a little later

display_data.curr_field = 0      -- Current field, where
-- zero (0) specifies the first field

display_data.last_field = 0      -- Last field in the list (only using one
-- field in this example).

display_data.curr_it_num = 1      -- Current item number the cursor is on.
display_data.sob_it_num = 1       -- Starting item number.
display_data.eob_it_num = num_options -- Ending item number, which is
-- the number of options read in.
display_data.last_it_num = num_options -- Last item number, also the
-- number of options read in

-- Make sure the window end is not beyond total number of elements in list.
IF display_data.win_end[1] > display_data.last_it_num THEN
    display_data.win_end[1] = display_data.last_it_num --reset to last item
ENDIF

-- Read dictionary element, TPTSSP_MENU, from dictionary DLST.
-- list_data will be populated with the menu list information
-- list_data[1] will contain the first line of information from
-- the TPTSSP_MENU and list_data[last_line] will contain the last
-- line of information read from the dictionary.
READ_DICT('DLST', TPTSSP_MENU, list_data, 1, last_line, status)
    Chk_Stat('Reading menu list failed')

-- Determine longest list element & reset cursor end column for first field.
FOR i = 1 TO last_line DO
    IF (STR_LEN(list_data[i]) > display_data.curs_en_col[1]) THEN
        display_data.curs_en_col[1] = STR_LEN(list_data[i])
    ENDIF
ENDFOR

```

### Display List from Dictionary File - Control Cursor Movement

---

```

----- Section 4-G:   Display the list.
-----

-- Initial Display the menu list.
DISCTRL_LIST(TPDISPLAY, display_data, list_data, DC_DISP, status)
    Chk_Stat('Error displaying list')

-- Open a file to the TPDISPLAY window with PASSALL and FIELD attributes
-- and NOECHO
SET_FILE_ATR(kb_file, ATR_PASSALL) -- Get row teach pendant input

```

```

SET_FILE_ATR(kb_file, ATR_FIELD)      -- so that a single key will
                                         -- satisfy the reads.
SET_FILE_ATR(kb_file, ATR_NOECHO)     -- don't echo the keys back to
                                         -- the screen
OPEN FILE Kb_file ('RW', 'KB:TPKB')   -- open a file to the Teach pendant
                                         -- keyboard (keys)
status = IO_STATUS(Kb_file)
Chk_Stat('Error opening TPKB')

act_pending = 0
done = FALSE
-----
----- Section 4-H: Control cursor movement within the list
-----
REPEAT      -- Wait for a key input
  READ Kb_file (str::1)
  key = ORD(str,1)
  key = key AND 255                  -- Convert the key to correct value.
  SELECT key OF                     -- Decide how to handle key inputs
    CASE (KY_UP_ARW) :             -- up arrow key pressed
      IF act_pending <> 0 THEN    -- If a menu item was selected...
        -- Clear confirmation prompt
        WRITE_DICT(TPPROMPT, 'DLST', TPTSSP_CLRSC, status)
        -- Clear confirmation function keys
        WRITE_DICT(TPFUNC, 'DLST', TPTSSP_CLRSC, status)
    ENDIF
    DISCTRL_LIST(TPDISPLAY, display_data, list_data, DC_UP, status)
    Chk_Stat ('Error displaying list')
  CASE (KY_DN_ARW) : -- down arrow key pressed
    IF act_pending <> 0 THEN -- If a menu item was selected...
      -- Clear confirmation prompt
      WRITE_DICT(TPPROMPT, 'DLST', TPTSSP_CLRSC, status)
      -- Clear confirmation function keys
      WRITE_DICT(TPFUNC, 'DLST', TPTSSP_CLRSC, status)
    ENDIF
    DISCTRL_LIST(TPDISPLAY, display_data, list_data,
DC_DN, status)
    Chk_Stat ('Error displaying list')

```

**Display List from Dictionary File - Control Cursor Movement Continued**

```

CASE (KY_ENTER) :
  -- Perform later
CASE (KY_F4) : -- "YES" function key pressed
  IF act_pending <> 0 THEN -- If a menu item was selected...
    -- Clear confirmation prompt
    WRITE_DICT(TPPROMPT, 'DLST', TPTSSP_CLRSC, status)
    -- Clear confirmation function keys

```

```

        WRITE_DICT(TPFUNC, 'DLST', TPTSSP_CLRSC, status)
        IF act_pending = num_options THEN
            -- Exit the routine
            done = TRUE
        ENDIF
        -- Clear action pending
        act_pending = 0
    ENDIF

CASE (KY_F5) : -- "NO" function key pressed
    -- Clear confirmation prompt
    WRITE_DICT(TPPROMPT, 'DLST', TPTSSP_INSTR, status)
        -- Clear confirmation function keys
    WRITE_DICT(TPFUNC, 'DLST', TPTSSP_CLRSC, status)

        -- Clear action pending
        act_pending = 0
ELSE :      -- User entered an actual item number. Calculate which
            -- row the cursor should be on and redisplay the list.
    IF ((key > 48) AND (key <= (48 + num_options))) THEN
        -- Translate number to a row
        key = key - 48
        display_data.cursor_row = key
        DISCTRL_LIST(TPDISPLAY,display_data,list_data,DC_DISP,status)
            Chk_Stat ('Error displaying list')
        key = KY_ENTER
    ENDIF
ENDSELECT
IF key = KY_ENTER THEN -- User has specified an action
    -- Write confirmation prompt for selected item
    WRITE_DICT (TPPROMPT, 'DLST',
                (TPTSSP_CNF1 - 1 + display_data.cursor_row), status)
    -- Display confirmation function keys
    WRITE_DICT(TPFUNC, 'DLST', TPTSSP_FK2, status)
    -- Set action pending to selected item
    act_pending = display_data.cursor_row -- this is the item selected
ENDIF
UNTIL done -- repeat until the user selects the exit option

```

### Display List from Dictionary File - Cleanup and Exit Program

```

-----
----- Section 4-I: Cleanup before exiting program
-----
-- Clear the TP USER menu windows
WRITE_DICT(TPDISPLAY, 'DLST', TPTSSP_CLRSC, status)
WRITE_DICT(TPSTATUS, 'DLST', TPTSSP_CLRSC, status)

```

```

-- Close the file connected to the TP keyboard.
CLOSE FILE Kb_file

-- Close the error log file if it is open.
IF opened THEN
    close file Err_File
ENDIF

Write TPPROMPT (cr,'Example Finished ')

REMOVE_DICT ( 'LIST', dp_default, status) -- remove the dictionary
    write ('remove dict', status,cr)
    Chk_Stat ('Removing dictionary')

ACT_SCREEN(old_screen, old_screen, status) -- activate the previous screen
    Chk_stat ('Activating old screen')

DET_WINDOW('ERR', 'LIST', status) -- Detach all the windows that were
    Chk_stat ('Detaching ERR window')
DET_WINDOW('T_ST', 'LIST', status) -- previously attached.
    Chk_stat ('Detaching T_ST window')
DET_WINDOW('T_FU', 'LIST', status)
    Chk_stat ('Detaching T_FU window')
DET_WINDOW('T_PR', 'LIST', status)
    Chk_stat ('Detaching T_PR window')
DET_WINDOW('T_FK', 'LIST', status)
    Chk_stat ('Detaching T_FK window')
END DCLST_EX

```

### B.12.1 Dictionary Files

This ASCII dictionary file is used to create a teach pendant screen which is used with DCLST\_EX.KL. For more information on DCLST\_EX.KL refer to [Section B.7](#).

#### Dictionary File

```

.kl dclist
*
$-,TPTSSP_TITLE &home &reverse "Karel DISCTRL_LIST Example
"
&standard
$-,TPTSSP_CLRSC &home &clear_2_eow
$-,TPTSSP_FK1 &home" [TYPE]
$-,TPTSSP_FK2 &home" YES      NO      "
$-,TPTSSP_INSTR &home "Press 'ENTER' or number key to select." &clear_2_eol

```

```

* Add menu options here, "Exit" must be last option
* TPTSSP_NUM specifies the number of menu options
$-,TPTSSP_NUM "14"
$-,TPTSSP_MENU
" 1  Test Cycle 1" &new_line
" 2  Test Cycle 2" &new_line
" 3  Test Cycle 3" &new_line
" 4  Test Cycle 4" &new_line
" 5  Test Cycle 5" &new_line
" 6  Test Cycle 6" &new_line
" 7  Test Cycle 7" &new_line
" 8  Test Cycle 8" &new_line
" 9  Test Cycle 9" &new_line
" 10 Test Cycle 10" &new_line
" 11 Test Cycle 11" &new_line
" 12 Test Cycle 12" &new_line
" 13 Test Cycle 13" &new_line
" 14 EXIT"
* Confirmations must be in order
$-,TPTSSP_CNF1 &home"Perform test cycle 1? [NO]" &clear_2_eol
$-,TPTSSP_CNF2 &home"Perform test cycle 2? [NO]" &clear_2_eol
$-,TPTSSP_CNF3 &home"Perform test cycle 3? [NO]" &clear_2_eol
$-,TPTSSP_CNF4 &home"Perform test cycle 4? [NO]" &clear_2_eol
$-,TPTSSP_CNF5 &home"Perform test cycle 5? [NO]" &clear_2_eol
$-,TPTSSP_CNF6 &home"Perform test cycle 6? [NO]" &clear_2_eol
$-,TPTSSP_CNF7 &home"Perform test cycle 7? [NO]" &clear_2_eol
$-,TPTSSP_CNF8 &home"Perform test cycle 8? [NO]" &clear_2_eol
$-,TPTSSP_CNF9 &home"Perform test cycle 9? [NO]" &clear_2_eol
$-,TPTSSP_CNF10 &home"Perform test cycle 10? [NO]" &clear_2_eol
$-,TPTSSP_CNF11 &home"Perform test cycle 11? [NO]" &clear_2_eol
$-,TPTSSP_CNF12 &home"Perform test cycle 12? [NO]" &clear_2_eol
$-,TPTSSP_CNF13 &home"Perform test cycle 13? [NO]" &clear_2_eol
$-,TPTSSP_CNF14 &home"Exit? [NO]" &clear_2_eol

```

## **B.13 USING THE DISCTRL\_ALPHA BUILT-IN**

This program shows three different ways to use the DISCTRL\_ALPHA built-in. The DISCTRL\_ALPHA built-in displays and controls alphanumeric string entry in a specified window. Refer to [Appendix A](#), "KAREL Language Alphabetic Description" for more information.

Method 1 allows a program name to be entered using the default value for the dictionary name. See Section 4-A in [Using the DISCTRL\\_ALPHA Built-in - Enter Data from Teach Pendant](#).

Method 2 allows a comment to be entered using the default value for the dictionary name. See Section 4-B in [Using the DISCTRL\\_ALPHA Built-in - Enter Data from Teach Pendant](#).

Method 3 uses a user specified dictionary name and element to enter a program name. See Section 4-C in [Using the DISCTRL\\_ALPHA Built-in - Enter Data from CRT/KB](#).

This program also posts all errors to the controller.

### Using the DISCTRL\_ALPHA Built-in - Overview

-----	DCALP_EX.KL	
		-----
----- Elements of KAREL Language Covered:		In Section:
----- Actions:		
----- Clauses:		
----- Conditions:		
----- Data types:		
-----       INTEGER		Sec 2
-----       STRING		Sec 2
----- Directives:		
-----       COMMENT		Sec 1
-----       INCLUDE		Sec 1
-----       NOLOCKGROUP		Sec 1
----- Built-in Functions & Procedures:		
-----       ADD_DICT		Sec 4-C
-----       CHR		Sec 4-A,B,C
-----       DISCTRL_ALPH		Sec 4-A,B,C
-----       FORCE_SPMENU		Sec 4-A,B,C
-----       POST_ERR		Sec 4-A,B,C
-----       SET_CURSOR		Sec 4-A,B,C
-----       SET_LANG		Sec 4-C
----- Statements:		
-----       READ		Sec 4-A,B
-----       WRITE		Sec 4-A,B,C
-----       IF...THEN...ENDIF		Sec 4-A,B,C
----- Reserve Words:		
-----       BEGIN		Sec 4
-----       CONST		Sec 2
-----       CR		Sec 4-A,B,C
-----       END		Sec 4-C
-----       PROGRAM		Sec 1
-----       VAR		Sec 2
----- Predefined File Names:		
-----       OUTPUT		Sec 4-C
-----       TPDISPLAY		Sec 4-A,B

---- Predefined Windows:  
 ---- T\_FU Sec 4-A,B  
 ---- C\_FU Sec 4-C

### Using the DISCTRL\_ALPHA Built-in - Declaration Section

-----  
 ---- Section 1: Program and Environment Declaration  
 -----

```
PROGRAM DCALP_EX
%COMMENT      = 'Display Alpha'
%NOLOCKGROUP
%INCLUDE KLEVKEYS    -- Necessary for the KY_ENTER
%INCLUDE DCALPH     -- Necessary for the ALPH_PROG Element, see section 4-C
```

-----  
 ---- Section 2: Constant and Variable Declarations  
 -----

```
CONST
  cc_home      = 137
  cc_clear_win = 128
  cc_warn      = 0      -- Value passed to POST_ERR to display warning only.
  cc_pause      = 1      -- value passed to POST_ERR to pause program.
```

```
VAR
  status       : INTEGER
  device_stat : INTEGER
  term_char   : INTEGER
  window_name : STRING[4]
  prog_name   : STRING[12]
  comment     : STRING[40]
```

-----  
 ---- Section 3: Routine Declaration  
 -----

### Using the DISCTRL\_ALPHA Built-in - Enter Data from Teach Pendant

-----  
 ---- Section 4: Main Program  
 -----

```
BEGIN  -- DCALP_EX
```

-----  
 ---- Section 4-A: Enter a program name from the teach pendant USER menu  
 -----

```
WRITE (CHR(cc_home), CHR(cc_clear_win))    -- Clear TP USER menu
FORCE_SPMENU(tp_panel, SPI_TPUSER, 1)        -- Force TP USER menu to be
```

```

-- visible
SET_CURSOR(TPDISPLAY, 12, 1, status)      -- reposition cursor

WRITE ('prog_name: ')
prog_name = ''                            -- initialize program name
DISCTRL_ALPH('t_fu', 12, 12, prog_name, 'PROG', 0, term_char, status)
IF status <> 0 THEN
    POST_ERR(status, '', 0, cc_warn)
ENDIF
IF term_char = ky_enter THEN              -- User pressed the ENTER key
    WRITE (CR, 'prog_name was changed:', prog_name, CR)
ELSE
    WRITE (CR, 'prog_name was not changed')
ENDIF

WRITE (CR, 'Press enter to continue')
READ (CR)

-----
---- Section 4-B: Enter a comment from the teach pendant
-----

WRITE (CHR(cc_home) + CHR(cc_clear_win))-- Clear TP USER menu
SET_CURSOR(TPDISPLAY, 12, 1, status)      -- reposition cursor
comment = ' '                            -- Initialize the comment
WRITE ('comment: ')                      -- Display message
DISCTRL_ALPH('t_fu', 12, 10, comment, 'COMM', 0, term_char, status)
IF status <> 0 THEN                      -- Verify DISCTRL_ALPH was successful
    POST_ERR(status, '', 0, cc_warn)      -- Post the status as a warning
ENDIF
IF term_char = ky_enter THEN
    WRITE (CR, 'comment was changed:', comment, CR) -- Display new comment
ELSE
    WRITE (CR, 'comment was not changed', CR)
ENDIF

WRITE (CR, 'Press enter to continue')
READ (CR)

```

### Using the DISCTRL\_ALPHA Built-in - Enter Data from CRT/KB

```

-----
---- Section 4-C: This section will perform program name entry from the
----             CRT/KB.  The dictionary name and element values are
----             explicitly stated here, instead of using the available
----             default values.
-----
-- Set the dictionary language to English

```

```

-- This is useful if you want to use this same code for multiple
-- languages. Then any time you load in a dictionary you check
-- to see what the current language, $language, is and load the
-- correct dictionary.
-- For instance you could have a DCALPHJP.TX file which
-- would be the Japanese dictionary. If the current language, $language,
-- was set to Japanese you would load this dictionary.
SET_LANG ( dp_english, status)
IF (status <> 0) THEN
    POST_ERR (status, '', 0,cc_warn)      -- Post the status as a warning
ENDIF
-- Load the dcalpheg.tx file, using ALPH as the dictionary name,
-- to the English language, using DRAM as the memory storage device.
ADD_DICT ('DCALPHEG', 'ALPH', dp_english, dp_dram, status)
IF (status <> 0 ) THEN
    POST_ERR (status, '', 0, cc_pause)      -- Post the status and pause the
                                              -- program, since the dictionary
                                              -- must be loaded to continue.
ENDIF
device_stat = crt_panel                  -- Give control to the CRT/KB
WRITE OUTPUT (CHR(cc_home) + CHR(cc_clear_win))--Clear CRT/KB USER menu
FORCE_SPMENU (device_stat, SPI_TPUSER, 1) -- Force the CRT/KB USER menu
                                              -- to be visible
SET_CURSOR(OUTPUT, 12, 1, status)          -- Reposition the cursor
WRITE OUTPUT ('prog_name: ')
prog_name = ' '                          -- Initialize program name
DISCTRL_ALPH('c_fu',12,12,prog_name,'ALPH',alph_prog,term_char,status)
--DISCTRL_ALPHA uses the ALPH dictionary and ALPH_PROG dictionary element
IF status <> 0 THEN                      -- Verify DISCTRL_ALPH was
                                              -- successful.
    POST_ERR(status, '', 0, cc_warn)      -- Post returned status to the
                                              -- error ('err') window.
ENDIF
IF term_char = ky_enter THEN
    WRITE (CR, 'prog_name was changed:', prog_name, CR)
ELSE
    WRITE (CR, 'prog_name was NOT changed.', CR)
ENDIF
device_stat = tp_panel                   -- Make sure to reset
END DCALP_EX

```

### B.13.1 Dictionary Files

This ASCII dictionary file is used to write text to the specified screen. DCALPH\_EG.UTX is also used with DCAL\_EX.KL. For more information on DCAL\_EX.KL, refer to [Section B.13](#).

**DCALPHEG.UTX Dictionary File**

```
.KL DCALPH

$, alpha_prog
" PRG      MAIN      SUB      TEST      >"&new_line
" PROC     JOB       MACRO      >"&new_line
" TEST1    TEST2     TEST3     TEST4      >"
```

**Note** The greater than symbol (>) in [DCALPHEG.UTX Dictionary File](#) is a reminder to use the NEXT key to scroll through the multiple lines. Also notice that the &new\_line appears only on the first two lines. This ensures that the lines will scroll correctly.

## **B.14 APPLYING OFFSETS TO A COPIED TEACH PENDANT PROGRAM**

This program copies a teach pendant program and then applies an offset to the positions within the newly created program. This is useful when you create the teach pendant program offline and then realized that all the teach pendant positions are off by some determined amount. However, you should be aware that the utility PROGRAM ADJUST is far more adequate for this job.

### **Applying Offsets to Copied Teach Pendant Program - Overview**

-----	CPY_TP.KL	
-----	Elements of KAREL Language Covered:	In Section:
-----	Actions:	
-----	Clauses:	
-----	FROM	Sec 3-F
-----	Conditions:	
-----	Data Types:	
-----	ARRAY OF REAL	Sec 2
-----	ARRAY OF STRING	Sec 2
-----	BOOLEAN	Sec 2
-----	INTEGER	Sec 2; 3-B,C,D,E
-----	JOINTPOS	Sec 2
-----	REAL	Sec 2
-----	STRING	Sec 2
-----	XYZWPR	Sec 2
-----	Directives:	
-----	ENVIRONMENT	Sec 1
-----	Built-in Functions & Procedures:	
-----	AVL_POS_NUM	Sec 3-E
-----	CHR	Sec 3-B, 4

----	CLOSE_TPE	Sec 3-E
----	CNV_REL_JPOS	Sec 3-E
----	CNV_JPOS_REL	Sec 3-E
----	COPY_TPE	Sec 3-E
----	GET_JPOS_TPE	Sec 3-E
----	GET_POS_TYP	Sec 3-E
----	GET_POS_TPE	Sec 3-E
----	OPEN_TPE	Sec 3-E
----	PROG_LIST	Sec 3-B
----	SELECT_TPE	Sec 3-E
----	SET_JPOS_TPE	Sec 3-E
----	SET_POS_TPE	Sec 3-E

**Applying Offsets to Copied Teach Pendant Program - Overview Continued**

----	Statements:	
----	FOR...ENDFOR	Sec 3-B,D,E
----	IF ...THEN...ELSE...ENDIF	Sec 3-A,B,C,E
----	READ	Sec 3-B,C,D
----	REPEAT...UNTIL	Sec 3-B,C,D
----	RETURN	Sec 3-E
----	ROUTINE	Sec 3-A,B,C,D,E,F
----	SELECT...ENDSELECT	Sec 3-E
----	WRITE	Sec 3-B,C,D,E,4
----	Reserve Words:	
----	BEGIN	Sec 3-A,B,C,D,E;
4		
----	CONST	Sec 2
----	CR	Sec 3-B,C,D,E
----	END	Sec 3-A,B,C,D,E;
4		
----	PROGRAM	Sec 1
----	VAR	Sec 2

**Applying Offsets to Copied Teach Pendant Program - Declaration Section**


---

-----

---- Section 1: Program and Environment Declaration

---

-----

```
PROGRAM CPY_TP
%ENVIRONMENT TPE          -- necessary for all xxx_TPE built-ins
%ENVIRONMENT BYNAM         -- necessary for PROG_LIST built-in
```

---

---- Section 2: Constant and Variable Declaration

---

```
CONST
ER_WARN = 0                -- warning constant for use in POST_ERR
SUCCESS = 0                 -- success constant
```

```

JNT_POS = 9                                -- constant for GET_POS_TYP
XYZ_POS = 2                                -- constant for GET_POS_TYP
MAX_AXS = 9                                 -- Maximum number of axes JOINTPOS has

VAR
    from_prog: STRING[13]                  -- TP program name to be copied FROM
    to_prog : STRING[13]                   -- TP program name to be copied TO
    over_sw : BOOLEAN                      -- Decides whether to overwrite an existing
                                              -- program when performing COPY_TPE
    status : INTEGER                       -- Holds error status from the builtin calls
    off_xyz : XYZWPR                      -- Offset amount for the XYZWPR positions
    jp_off : ARRAY [9] of REAL             -- Offset amount for the JOINT positions
    new_xyz : XYZWPR                      -- XYZWPR which has offset applied
    org_xyz : XYZWPR                      -- Original XYZWPR from to_prog
    new_jpos : JOINTPOS                   -- JOINTPOS which has the offset applied
    org_jpos : JOINTPOS                   -- Original JOINTPOS from to_prog
    open_id : INTEGER                      -- Identifier for the opened to_prog
    jp_org : ARRAY [9] of REAL            -- REAL representation of org_jpos
    jp_new : ARRAY [9] of REAL            -- REAL representation of jp_new

```

### Applying Offsets to Copied Teach Pendant Program - Declare Routines

```

-----  

---- Section 3: Routine Declaration  

-----  

-----  

---- Section 3-A: CHK_STAT Declaration  

---- Tests whether the status was successful or not.  

---- If the status was not successful the status is posted  

-----  

ROUTINE chk_stat (rec_stat: integer)  

begin  

    IF (rec_stat <> SUCCESS) THEN      -- if rec_stat is not SUCCESS  

        -- then post the error  

        POST_ERR (rec_stat, '', 0, ER_WARN)   -- Post the error to the system.  

    ENDIF  

END chk_stat  

-----  

---- Section 3-B: GetFromPrg Declaration  

---- Generate a list of loaded TPE programs.  

---- Lets the user select one of these programs  

---- to be the program to be copied, ie FROM_prog  

-----  

ROUTINE GetFromPrg  

VAR
    tp_type : INTEGER                  -- Types of program to list
    n_skip : INTEGER                   -- Index into the list of programs
    format : INTEGER                   -- What type of format to store programs in

```

```

n_progs      : INTEGER          -- Number of programs returned in prg_name
prg_name    : ARRAY [8] of STRING[20] --Program names returned from PROG_LIST
status       : INTEGER          -- Status of PROG_LIST call
f_index      : INTEGER          -- Fast index for generating the program listing.
arr_size     : INTEGER          -- Array size of prg_name
prg_select   : INTEGER          -- Users selection for which program to copy
indx         : INTEGER          -- FOR loop counter which displays prg_name

```

### Applying Offsets to Copied Teach Pendant Program - Generate Program List for User

```

BEGIN
    f_index = 0      -- Initialize the f_index
    n_skip  = 0      -- Initialize the n_skip
    tp_type = 2      -- find any TPE program
    format  = 1      -- return just the program name in prg_name
    n_progs = 0      -- Initialize the n_progs
    arr_size = 8      -- Set equal to the declared array size of prg_name
    prg_select = 0 -- Initialize the program selector

    REPEAT
        WRITE (chr(128),chr(137)) -- Clear the TP USER screen
        -- Get a listing of all TP program which begin with "TEST"
        PROG_LIST('TEST*',tp_type,n_skip,format,prg_name,n_progs,status,f_index)
        chk_stat (status) --Check status from PROG_LIST
        FOR indx = 1 to n_progs DO
            WRITE (indx,':',prg_name[indx], CR) -- Write the list of programs out
        ENDFOR

        IF (n_skip > 0) OR ( n_prog >0) THEN
            WRITE ('select program to be copied:',CR)
            WRITE ('PRESS -1 to get next page of programs:')
            REPEAT
                READ (prg_select) -- get program selection
            UNTIL ((prg_select >= -1) AND (prg_select <= n_progs)
                    AND (prg_select <> 0))
        ELSE
            WRITE ('no TP programs to COPY', CR)
            WRITE ('Aborting program, since need',CR)
            WRITE ('at least one TP program to copy.',CR)
            ABORT
        ENDIF

        -- Check if listing is complete and user has not made a selection.
        IF ((prg_select = -1) AND (n_progs < arr_size)) THEN
            f_index = 0          --reset f_index to re-generate list.
            n_progs = arr_size   --set so the REPEAT/UNTIL will continue
        ENDIF

```

```
-- Check if user has made a selection
IF (prg_select <> -1) then
    from_prog = prg_name[prg_select]-- Set from_prog to name selected
    n_progs = 0                      -- Set n_prog to stop looping.
    ENDIF
    UNTIL (n_progs < arr_size)

END GetFromPrg
```

**Applying Offsets to Copied Teach Pendant Program - Overwrite or Delete Program**

```
-----
----      Section 3-C: GetOvrSw Declaration
----              Ask user whether to overwrite the copied
----              program, TO_prog, if it exists.
-----
ROUTINE GetOvrSw
VAR
    yesno : INTEGER
BEGIN

    WRITE (CR, 'If Program already exists do you want',CR)
    WRITE ('to overwrite the file Yes:1, No:0 ? ')
    REPEAT
        READ (yesno)
    UNTIL ((yesno = 0) OR( yesno = 1))
    IF yesno = 1 then    --Set over_sw so program is overwritten if it exists
        over_sw = TRUE
    ELSE                  --Set over_sw so program is NOT overwritten if it exists
        over_sw = FALSE
    ENDIF
END GetOvrSw
```

**Applying Offsets to Copied Teach Pendant Program - Input Offset Positions**

```
-----
----      Section 3-D: GetOffset Declaration
----              Have the user input the offset for both
----              XYZWPR and JOINTPOS positions.
-----
ROUTINE GetOffset
VAR
    yesno : INTEGER
    index : INTEGER
BEGIN

    --Get the XYZWPR offset, off_xyz
REPEAT
    WRITE ( 'Enter offset for XYZWPR positions',CR)
```

```

        WRITE (' X = ')
        READ (off_xyz.x)
        WRITE (' Y = ')
        READ (off_xyz.y)
        WRITE (' Z = ')
        READ (off_xyz.z)
        WRITE (' W = ')
        READ (off_xyz.w)
        WRITE (' P = ')
        READ (off_xyz.p)
        WRITE (' R = ')
        READ (off_xyz.r)
--Display the offset values the user input
        WRITE (' Offset XYZWPR position is',CR, off_xyz,CR)
        WRITE ('Is this offset correct? Yes:1, No:0 ? ')
        READ (yesno)
UNTIL (yesno = 1)      -- enter offset amounts until the user
-- is satisfied.
--Get the JOINTPOS offset, jp_off
REPEAT
        WRITE ('Enter offset for JOINT positions',CR)
        FOR indx = 1 TO 6 DO      -- loop for number of robot axes
            WRITE (' J',indx,' = ')
            READ (jp_off[indx])
        ENDFOR    WRITE ('JOINT position offset is', CR)
        FOR indx = 1 TO 6 DO
            write ( jp_off[indx],CR)      -- Display the values the user input
        ENDFOR
        WRITE ('Is this offset correct? Yes:1, No:0 ? ')
        READ (yesno)
UNTIL (yesno = 1)      -- Enter offset amounts until the user
END GetOffset      -- is satisfied

```

### Applying Offsets to Copied Teach Pendant Program - Apply Offsets to Positions

---

-----  
 ----- Section 3-E: ModifyPrg Declaration  
 ----- Apply the offsets to each position within the TP program  
-----

```

ROUTINE ModifyPrg
VAR
    pos_typ : INTEGER      --The type of position returned from GET_POS_TYP
    num_axs : INTEGER      -- The number of axes if position is a JOINTPOS type
    indx_pos: INTEGER      -- FOR loop counter, that increments through TP position
    group_no: INTEGER      -- The group number of the current position setting.
    num_pos : INTEGER      -- The next available position number within TP program
    indx_axs: INTEGER      -- FOR loop counter, increments through REAL array

```

```

BEGIN
    SELECT_TPE ('', status) -- Make sure the to_prog is currently not selected
    to_prog = 'MDFY_TP'      -- Set the to_prog to desired name.

    ----- Copy the from_prog to to_prog -----
    COPY_TPE (from_prog, to_prog, over_sw, status)
    chk_stat(status)          -- check status of COPY_TPE

    --- If the user specified not to overwrite the TPE program and
    --- the status returned is 7015, "program already exist",
    --- then quit the program. This will mean not altering the already
    --- existing to_prog.
    IF ((over_sw = FALSE) AND (status = 7015)) THEN
        WRITE ('ABORTING::: PROGAM ALREADY EXISTS!',CR)
        RETURN
    ENDIF

    --- Open the to_prog with the Read/Write access
    OPEN_TPE (to_prog, TPE_RWACC, TPE_RDREJ, open_id, status)
    chk_stat(status)          -- check status of OPEN_TPE

    group_no = 1

    --- apply offset to each position within to_prog
    --- The current number of position that the TPE program has is num_pos -1
    FOR indx_pos = 1 to num_pos-1 DO
        --Get the DATA TYPE of each position within the to_prog
        --If it is a JOINTPOS also get the number of axes.
        GET_POS_TYP (open_id, indx_pos, group_no, pos_typ, num_axs, status)
        chk_stat (status)
        WRITE('get_pos_typ status', status,cr)

```

### Applying Offsets to Copied Teach Pendant Program - Apply Offsets to Positions Cont.

```

--Decide if the position, indx_pos, is a JOINTPOS or a XYZWPR
    SELECT pos_typ OF
        CASE (JNT_POS):           -- The position is a JOINTPOS
            FOR indx_axs = 1 TO MAX_AXS DO      -- initialize with default values
                jp_org[indx_axs] = 0.0          -- This avoids problems with the
                jp_new[indx_axs] = 0.0          -- CNV_REL_JPOS
            ENDFOR

            -- get the JOINTPOS P[indx_pos] from to_prog -----
            org_jpos = GET_JPOS_TPE (open_id, indx_pos, status)
            chk_stat( status)

            -- Convert the JOINTPOS to a REAL array, in order to perform offset
            CNV_JPOS_REL (org_jpos, jp_org, status)

```

```

chk_stat (status)

-- Apply the offset to the REAL array
FOR indx_axs = 1 to num_axs DO
    jp_new[indx_axs] = jp_org[indx_axs] + jp_off[indx_axs]
ENDFOR

-- Converted back to a JOINTPOS.
-- The input array, jp_new, must not have any uninitialized values
-- or the error 12311 - "Data uninitialized" will be posted.
-- This is why we previously set all the values to zero.
CNV_REL_JPOS (jp_new, new_jpos, status)
chk_stat(status)

-- Set the new offset position, new_jpos, into the indx_pos
SET_JPOS_TPE (open_id, indx_pos, new_jpos, status)
chk_stat(status)
write ('indx_pos', indx_pos, 'new_jpos', cr, new_jpos, cr)

CASE (XYZ_POS): -- The position is a XYZWPR
    -- Get the XYZWPR position P[indx_pos] from to_prog
    org_xyz = GET_POS_TPE (open_id , indx_pos, status)
    chk_stat( status)           -- Check status from GET_POS_TPE

```

### Applying Offsets to Copied Teach Pendant Program - Clears TP User Menu

```

-- Apply offset to the XYZWPR
    new_xyz.x = org_xyz.x + off_xyz.x
    new_xyz.y = org_xyz.y + off_xyz.y
    new_xyz.z = org_xyz.z + off_xyz.z
    new_xyz.w = org_xyz.w + off_xyz.w
    new_xyz.p = org_xyz.p + off_xyz.p
    new_xyz.r = org_xyz.r + off_xyz.r

    --Set the new offset position, new_xyz, into the indx_pos
    SET_POS_TPE (open_id, indx_pos, new_xyz, status)
    chk_stat (status)           -- Check status from SET_POS_TPE
ENDSELECT
ENDFOR
---Close TP program before quitting program
CLOSE_TPE (open_id, status)
chk_stat (status)           --Check status from CLOSE_TPE
END ModifyPrg
-----
---- Section 3-F:  TP_CLS Declaration
----             Clears the TP USER Menu screen and forces it to
----             become visible.  The actual code resides in
ROUT_EX.KL

```

```
ROUTINE TP_CLS FROM rout_ex

-----
---- Section 4: Main Program
-----

BEGIN -- CPY_TP
    tp_cls                                -- Clear the TP USER Menu screen
    GetFromPrg                            -- Get the TPE program to copy FROM
    GetOvrSw                               -- Get the TPE program name to copy TO
    GetOffset                             -- Get the offset for modifying
    ModifyPrg                            -- the teach pendant program
                                         -- Modify the copied program by the offset

END CPY_TP
```

## **Appendix C**

---

### **KCL COMMAND ALPHABETICAL DESCRIPTION**

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---

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This section describes each KCL command in alphabetical order. Each description includes the purpose of the command, its syntax, and details of how to use it. Examples of each command are also provided.

The following notation is used to describe KCL command syntax:

- < > indicates optional arguments to a command
- | indicates a choice which must be made
- { } indicates an item can be repeated
- file\_spec: <device\_name:><\host\_name><path\_name><file\_name>file\_type  
|<device\_name:><\host\_name>'host\_specific\_name'
- path\_name: <file\_device:><dir\dir\...>
- file\_name: maximum of 8 characters, no file type

*device\_name*: is a two to five-character optional field, followed by a colon. The first character is a letter, the remaining characters must be alphanumeric. If this field is left blank, the default device from the system variable \$DEVICE will be used.

*host\_name*: file\_name type - is a one to eight character optional field. The host\_name selects the network node that receives this command. It must be preceded by two backslashes and separated from the remaining fields by a backslash.

*path\_name* : file\_name<path\_name> - is a recursively defined optional field consisting of a maximum of 64 characters. It is used to select the file subdirectory. The root or source directory is handled as a special case. It is designated by a file\_name of zero length. For example, access to the subdirectory SYS linked off of the root would have path name '\SYS'. A fully qualified file\_spec using this path\_name would look like this, 'C1:\HOST\SYS\FILE.KL'.

*file\_name*: from one to eight characters

*file\_type*: from zero to three characters

KCL commands can be abbreviated allowing you to type in fewer letters as long as the abbreviated version remains unique among all keywords. For example, "ABORT" can be "AB" but "CONTINUE" must be "CONT" to distinguish it from "CONDITION."

KCL commands that have <prog\_name> as part of the command syntax will use the default program if none is specified. KCL commands that have <file\_name> as part of the command syntax will use the default program as the file name if none is specified.

## C.1 ABORT command

**Syntax:** ABORT <(prog\_name ) | ALL) > <FORCE>

where:

**prog\_name** : the name of any KAREL or TP program which is a task

**ALL** : aborts all running or paused tasks

**FORCE** : aborts the task even if the NOABORT attribute is set. FORCE only works with ABORT prog\_name; FORCE does not work with ABORT ALL

**Purpose:** Aborts the specified running or paused task. If **prog\_name** is not specified, the default program is used.

Execution of the current program statement is completed before the task aborts except for the current motion, DELAY, WAIT, or READ statements, which are canceled.

**Examples:** KCL> ABORT test\_prog FORCE

KCL> ABORT ALL

## **C.2 APPEND FILE command**

**Syntax:** APPEND FILE **input\_file\_spec** TO **output\_file\_spec**

where:

**input\_file\_spec** : a valid file specification

**output\_file\_spec** : a valid file specification

**Purpose:** Appends the contents of the specified input file to the end of the specified output file. The **input\_file\_spec** and the **output\_file\_spec** must include both the file name and the file type.

**Examples:** KCL> APPEND FILE flpy:test.kl TO productn.kl

KCL> APPEND FILE test.kl TO productn.kl

## **C.3 APPEND NODE command**

**Syntax:** APPEND NODE <[ **prog\_name** ]> **var\_name**

where:

**prog\_name** : the name of any KAREL or TP program

**var\_name** : the name of any variable of type PATH

**Purpose:** Appends one node to the end of the specified PATH variable previously loaded in RAM. The appended node value is uninitialized and the index number is one more than the last node index. Execute the KCL> SAVE VARS command to make the change permanent.

**Examples:** KCL> APPEND NODE [test\_prog]weld\_pth

KCL> APPEND NODE weld\_pth

## **C.4 CHDIR command**

**Syntax:** CHDIR <**device\_name**>\<**path\_name**>\ or CD <**device\_name**>\<**path\_name**>

where:

**device\_name** : a specified device

**path\_name** : a subdirectory previously created on the memory card device using the mkdir command. When the chdir command is used to change to a subdirectory, the entire path will be displayed on the teach pendant screen as mc:\new\_dir\new\_file.

The double dot (..) can be used to represent the directory one level above the current directory.

**Purpose:** Changes the default device. If a **device\_name** is not specified, displays the default device.

**Examples:** KCL> CHDIR rd:\

KCL> CD

KCL> CD mc:\a

KCL> CD ..

## **C.5 CLEAR ALL command**

**Syntax:** CLEAR ALL <YES>

where:

**YES** : confirmation is not prompted

**Purpose:** Clears all KAREL and teach pendant programs and variable data from memory. All cleared programs and variables (if they were saved with the KCL> SAVE VARS command) can be reloaded into memory using the KCL> LOAD command.

**Examples:** KCL> CLEAR ALL

Are you sure? YES

KCL> CLEAR ALL Y

## C.6 CLEAR BREAK CONDITION command

**Syntax:** CLEAR BREAK CONDITION <prog\_name> ( brk\_pnt\_no | ALL)

where:

**prog\_name** : the name of any KAREL program in memory

**brk\_pnt\_no** : a particular condition break point

ALL : clears all condition break points

**Purpose:** Clears specified condition break point(s) from the specified or default program.

A condition break point only affects the program in which it is set.

**Examples:** KCL> CLEAR BREAK CONDITION test\_prog 3

KCL> CLEAR BREAK COND ALL

## C.7 CLEAR BREAK PROGRAM command

**Syntax:** CLEAR BREAK PROGRAM <prog\_name> ( brk\_pnt\_no | ALL)

where:

**prog\_name** : the name of any KAREL program in memory

**brk\_pnt\_no** : a particular program break point

ALL : clears all break points

**Purpose:** Clears specified break point(s) from the specified or default program.

A break point only affects the program in which it is set.

**Examples:** KCL> CLEAR BREAK PROGRAM test\_prog 3

KCL> CLEAR BREAK PROG ALL

## C.8 CLEAR DICT command

**Syntax:** CLEAR DICT dict\_name <( lang\_name | ALL)>

where:

**dict\_name** : the name of any dictionary to be cleared

**lang\_name** : the name of the language. The available choices are ENGLISH, JAPANESE, FRENCH, GERMAN, SPANISH or DEFAULT.

ALL : clears the dictionary from all languages

**Purpose:** Clears a dictionary from the specified language or from all languages. If no language is specified, it is cleared from the DEFAULT language only.

**Examples:** KCL> CLEAR DICT tpsy ENGLISH

KCL> CLEAR DICT tpsy

## **C.9 CLEAR PROGRAM command**

**Syntax:** CLEAR PROGRAM <**prog\_name**> <YES>

where:

**prog\_name** : the name of any KAREL or teach pendant program in memory

YES : confirmation is not prompted

**Purpose:** Clears the program data from memory for the specified or default program.

**Examples:** KCL> CLEAR PROGRAM test\_prog

Are you sure? YES

KCL> CLEAR PROG test\_prog Y

## **C.10 CLEAR VARS command**

**Syntax:** CLEAR VARS <**prog\_name**> <YES>

where:

**prog\_name** : the name of any KAREL or teach pendant program with variables

YES : confirmation is not prompted

**Purpose:** Clears the variable and type data associated with the specified or default program from memory.

Variables and types that are referenced by a loaded program are not cleared.

**Examples:** KCL> CLEAR VARS test\_prog

Are you sure? YES

KCL> CLEAR VARS test\_prog Y

## **C.11 COMPRESS DICT command**

**Syntax:** COMPRESS DICT **file\_name**

where:

**file\_name** : the file name of the user dictionary you want to compress.

**Purpose:** Compresses a dictionary file from the default storage device, using the specified dictionary name. The file type of the user dictionary must be “.UTX”. The compressed dictionary file will have the same file name as the user dictionary, and be of type “.TX”.

**See Also:** [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** KCL> COMPRESS DICT tphcmneg

## **C.12 COMPRESS FORM command**

**Syntax:** COMPRESS FORM <**file\_name**>

where:

**file\_name** : the file name of the form you want to compress.

**Purpose:** Compresses a form file from the default storage device using the specified form name. The file type of the form must be “.FTX”. A compressed dictionary file and variable file will be created. The compressed dictionary file will have the same file name as the form file and be of type ".TX". The variable file will have a four character file name, that is extracted from the form file name, and be of type “.VR”. If no form file name is specified, the name “FORM” is used.

**See Also:** [Chapter 10 DICTIONARIES AND FORMS](#)

**Examples:** KCL> COMPRESS FORM

KCL> COMPRESS FORM mnpalteg

## **C.13 CONTINUE command**

**Syntax:** CONTINUE <(prog\_name ) | ALL>

where:

**prog\_name** : the name of any KAREL or teach pendant program which is a task

**ALL** : continues all paused tasks

**Purpose:** Continues program execution of the specified task that has been paused by a hold, pause, or test run operation. If the program is aborted, the program execution is started at the first executable line.

When a task is paused, the CYCLE START button on the operator panel has the same effect as the KCL> CONTINUE command.

CONTINUE is a motion command; therefore, the device from which it is issued must have motion control.

**See Also:** Refer to the \$RMT\_MASTER description in the *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for more information about assigning motion control to a remote device.

**Examples:** KCL> CONTINUE test\_prog

KCL> CONT ALL

## C.14 COPY FILE command

**Syntax:** COPY <FILE> **from\_file\_spec** TO **to\_file\_spec** <OVERWRITE>

where:

**from\_file\_spec** : a valid file specification

**to\_file\_spec** : a valid file specification

**OVERWRITE** : specifies copy over (overwrite) an existing file

**Purpose:** Copies the contents of one file to another with overwrite option. Allows file transfers between different devices and between the controller and a host system.

The wildcard character (\*) can be used to replace **from\_file\_spec**'s entire file name, the first part of the file name, the last part of the file name, or both the first and last parts of the file name. The file type can also use the wildcard in the same manner. The wildcard character in the **to\_file\_spec** can only replace the entire file name or the entire file type.

**Examples:** KCL> COPY flpy:\test.kl TO rdu:newtest.kl

KCL> COPY mc:\test\_dir\test.kl TO mc:\test\_dir\newtest.kl

KCL> COPY FILE flpy:\\*.kl TO rd:\*.kl

KCL> COPY \*.\* TO fr:

KCL> COPY FILE \*.kl TO rd:\\*.bak OVERWRITE

KCL> COPY FILE flpy:\\*main\*.kl TO rd:/\* OV

KCL> COPY mdb:\*.tp TO mc:

## **C.15 CREATE VARIABLE command**

**Syntax:** CREATE VARIABLE <[ prog\_name ]> var\_name <IN (CMOS | DRAM)> : data\_type

where:

**prog\_name** : the name of any KAREL or TP program

**var\_name:data\_type** : a valid variable name and data type

**Purpose:** Allows you to declare a variable that will be associated with the specified or default program. You must specify a valid identifier for the **var\_name** and a valid **data\_type**.

Only one variable can be declared with the CREATE VAR command. You must enter the KCL> SAVE VARS command to save the declared variable with the program variable data. Use the KCL> SET VARIABLE command to assign a value to a variable.

The following data types are valid (user types are also supported): ARRAY OF BYTE, JOINTPOS, ARRAY OF SHORT, JOINTPOS1 to JOINTPOS9, BOOLEAN, POSITION, COMMON\_ASSOC, REAL, CONFIG, VECTOR, FILE, XYZWPR, GROUP\_ASSOC, XYZWPREXT, INTEGER

You can create multi-dimensional arrays of the above type. A maximum of 3 dimensions may be specified. Paths may only be created from a user defined type.

By default, the variable will be created in temporary memory (in DRAM), and must be recreated every power up. The value will always be reset to uninitialized.

If IN CMOS is specified the variable will be created in permanent memory. The variable's value will be recovered every time the controller is turned on.

**See Also:** SET VARIABLE command

**Examples:** KCL> CREATE VAR [test\_prog]count IN CMOS: INTEGER

KCL> CREATE VAR vec:ARRAY[3,2,4] OF VECTOR

## **C.16 DELETE FILE command**

**Syntax:** DELETE FILE file\_spec <YES>

where:

**file\_spec** : a valid file specification

YES : confirmation is not prompted

**Purpose:** Deletes the specified file from the specified storage device. The wildcard character (\*) can be used to replace the entire file name, the first part of the file name, the last part of the file name, or both the first and last parts of the file name. The file type can also use the wildcard in the same manner.

**Examples:** KCL> DELETE FILE testprog.pc

Are you sure? YES

KCL> DELETE FILE rd:\testprog.pc YES

KCL> DELETE FILE rd:\\*.\* Y

## C.17 **DELETE NODE command**

**Syntax:** DELETE NODE <[ **prog\_name** ]> **var\_name** [ **node\_index** ]

where:

**prog\_name** : the name of any KAREL or TP program

**var\_name** : the name of any variable of type PATH

[ **node\_index** ] : a node in the path

**Purpose:** Deletes the specified node from the specified PATH variable. The PATH variable must be loaded in memory. Enter the KCL> SAVE VARS command to make the change permanent.

**Examples:** KCL> DELETE NODE [test\_prog]weld\_pth[4]

KCL> DELETE NODE weld\_pth[3]

## C.18 **DELETE VARIABLE command**

**Syntax:** DELETE VARIABLE <[ **prog\_name** ]> **var\_name**

where:

**prog\_name** : the name of any KAREL or TP program with variables

**var\_name** : the name of any program variable

**Purpose:** Deletes the specified variable from memory. A variable that is linked with loaded p-code cannot be deleted. Enter the KCL> SAVE VARS command to make the change permanent.

**Examples:** KCL> DELETE VARIABLE [test\_prog]weld\_pth

KCL> DELETE VAR weld\_pth

## **C.19 DIRECTORY command**

**Syntax:** DIRECTORY <file\_spec>

where:

**file\_spec** : a valid file specification

**Purpose:** Displays a list of the files that are on a storage device. If **file\_spec** is not specified, directory information is displayed for all of the files stored on a specified device. The directory information displayed includes the following:

The volume name of the device (if specified when the device was initialized)

The name of the subdirectory, if available

The names and types of files currently stored on the device and the sizes of the files in bytes

The number of files, the number of bytes left, and the number of bytes total, if available

The wildcard character (\*) can be used to replace the entire file name, the first part of the file name, the last part of the file name, or both the first and last parts of the file name. The file type can also use the wildcard in the same manner.

**Examples:** KCL> DIRECTORY rd:

KCL> DIR \*.kl

KCL> DIR \*SPOT\*.kl

KCL> CD MC: \test\_dir

Use the CD command to change to the KCL> DIR subdirectory before you use the DIR command or KCL> DIR \test\_dir\\*.\* display the subdirectory contents without using the CD command.

## **C.20 DISABLE BREAK PROGRAM command**

**Syntax:** DISABLE BREAK PROGRAM <prog\_name> brk\_pnt\_no

where:

**prog\_name** : the name of any KAREL or TP program in memory

**brk\_pnt\_no** : a particular program break point

**Purpose:** Disables the specified break point in the specified or default program.

**Examples:** KCL> DISABLE BREAK PROGRAM test\_prog 3

KCL> DISABLE BREAK PROG 3

## **C.21 DISABLE CONDITION command**

**Syntax:** DISABLE CONDITION <**prog\_name**> **condition\_no**

where:

**prog\_name** : the name of any KAREL program in memory

**condition\_no** : a particular condition

**Purpose:** Disables the specified condition in the specified or default program.

**Examples:** KCL> DISABLE CONDITION test\_prog 3

KCL> DISABLE COND 3

## **C.22 DISMOUNT command**

**Syntax:** DISMOUNT **device\_name**:

where:

**device\_name** : device to be dismounted

**Purpose:** Dismounts a mounted storage device and indicates to the controller that a storage device is no longer available for reading or writing data.

**Example:** KCL> DISMOUNT rd:

## **C.23 EDIT command**

**Syntax:** EDIT <**file\_spec**>

where:

**file\_spec** : a valid file specification

**Purpose:** Provides an ASCII text editor which can be used for editing dictionary files, command files and KAREL source files.

If **file\_spec** is not specified, the default program name is used as the file name and the default file type is .KL (KAREL source code).

If a previous editing session exists, then **file\_spec** is ignored and the editing session is resumed.

**See Also :** [Chapter 11 FULL SCREEN EDITOR](#) , for more information on KCL> EDIT and the editor commands.

**Examples:** KCL> EDIT startup.cf

KCL> ED

## **C.24 ENABLE BREAK PROGRAM**

**Syntax:** ENABLE BREAK PROGRAM <**prog\_name**> **brk\_pnt\_no**

where:

**prog\_name** : the name of any KAREL or TP program in memory

**brk\_pnt\_no** : a particular program break point

**Purpose:** Enables the specified break point in the specified or default program.

**Examples:** KCL> ENABLE BREAK PROGRAM test\_prog 3

KCL> ENABLE BREAK PROG 3

## **C.25 ENABLE CONDITION command**

**Syntax:** ENABLE CONDITION <**prog\_name**> **condition\_no**

where:

**prog\_name** : the name of any KAREL program in memory

**condition\_no** : a particular condition

**Purpose:** Enables the specified condition in the specified or default program.

**Examples:** KCL> ENABLE CONDITION test\_prog 3

KCL> ENABLE COND 3

## **C.26 FORMAT command**

**Syntax:** FORMAT **device\_name:** <**volume\_name**> <YES>

where:

**device\_name** : the specified device to be initialized

**volume\_name** : label for the device

YES : confirmation is not prompted

**Purpose:** Formats a specified device. A device must be formatted before storing files on it.

**Examples:** KCL> FORMAT rd:

Are you sure? YES

KCL> FORMAT rd: Y

## **C.27 HELP command**

**Syntax:** HELP <**command\_name**>

where:

**command\_name** : a KCL command

**Purpose:** Displays on-line help for KCL commands. If you specify a **command\_name** argument, the required syntax and a brief description of the specified command is displayed.

**Examples:** KCL> HELP LOAD PROG

KCL> HELP

## **C.28 HOLD command**

**Syntax:** HOLD <(prog\_name | ALL)>

where:

**prog\_name** : the name of any KAREL or TP program

ALL : holds all executing programs

**Purpose:** Pauses the specified or default program that is being executed and holds motion at the current position (after a normal deceleration).

Use the KCL> CONTINUE command or the CYCLE START button on the operator panel to resume program execution.

**Examples:** KCL> HOLD test\_prog

KCL> HO ALL

## **C.29 INSERT NODE command**

**Syntax:** INSERT NODE <[ prog\_name ]> var\_name [ node\_index ]

where:

**prog\_name** : the name of any KAREL or TP program

**var\_name** : the name of any variable of type PATH

**node\_index:** : a node in the path

**Purpose:** Inserts a node in front of the specified node in the PATH variable. The PATH variable must be loaded in memory.

The inserted node index number is the **node\_index** you specify and the inserted node value is uninitialized. The index numbers for subsequent nodes are incremented by one. You must enter the KCL> SAVE VARS command to make the change permanent.

**Examples:** KCL> INSERT NODE [test\_prog]weld\_pth[2]

KCL> INSERT NODE weld\_pth[3]

## **C.30 LOAD ALL command**

**Syntax:** LOAD ALL <file\_name> <CONVERT>

where:

**file\_name** : a valid file name

**CONVERT** : converts variables to system definition

**Purpose:** Loads a p-code and variable file from the default storage device and default directory into memory using the specified or default file name. The file types for the p-code and variable files are assumed to be “.PC” and “.VR” respectively.

If **file\_name** is not specified, the default program is used. If the default has not been set, then the message, "Default program name not set," will be displayed.

**Examples:** KCL> LOAD ALL test\_prog

KCL> LOAD ALL

## C.31 LOAD DICT command

**Syntax:** LOAD DICT **file\_name** **dict\_name** <**lang\_name**>

where:

**file\_name** : the name of the file to be loaded

**dict\_name** : the name of any dictionary to be loaded. The name will be truncated to 4 characters.

**lang\_name** : a particular language. The available choices are ENGLISH, JAPANESE, FRENCH, GERMAN, SPANISH or DEFAULT.

**Purpose:** Loads a dictionary file from the default storage device and default directory into memory using the specified file name. The file type is assumed to be ".TX."

**See Also:** [Chapter 10 DICTIONARIES AND FORMS](#)

**Examples:** KCL> LOAD DICT tpaleg tpal FRENCH

KCL> LOAD DICT tpaleg tpal

## C.32 LOAD FORM command

**Syntax:** LOAD FORM <**form\_name**>

where:

**form\_name** : the name of the form to be loaded

**Purpose:** Loads the specified form, from the default storage device, into memory. A form consists of a compressed dictionary file and a variable file. If no name is specified, 'FORM.TX' and 'FORM.VR' are loaded.

If the specified **form\_name** is greater than four characters, the first two characters are not used for the dictionary name or the variable file name.

**See Also:** For more information on creating and using forms, refer to [Chapter 10 DICTIONARIES AND FORMS](#)

**Example:** KCL> LOAD FORM

Loading FORM.TX with dictionary name FORM

Loading FORM.VR

KCL> LOAD FORM tpxameg

Loading TPEXAMEG.TX with dictionary name EXAM

Loading EXAM.VR

### **C.33 LOAD MASTER command**

**Syntax:** LOAD MASTER <**file\_name**> <CONVERT>

where:

**file\_name** : a valid file name

CONVERT : converts variables to system definition

**Purpose:** Loads a mastering data file from the default storage device and default directory into memory using the specified or default file name. The file type is assumed to be “.SV.”

If **file\_name** is not specified, the default file name, “SYSMAST.SV,” is used.

**Example:** KCL> LOAD MASTER

### **C.34 LOAD PROGRAM command**

**Syntax:** LOAD PROGRAM <**file\_name**>

where:

**file\_name** : a valid file name

**Purpose:** Loads a p-code file from the default storage device and default directory into memory using the specified or default file name. The file type is assumed to be “.PC.”

If **file\_spec** is not specified, the default program is used. If the default has not been set, then the message, “Default program name not set,” will be displayed.

**Examples:** KCL> LOAD PROGRAM test\_prog

KCL> LOAD PROG

## C.35 LOAD SERVO command

**Syntax:** LOAD SERVO <**file\_name**> <CONVERT>

where:

**file\_name** : a valid file name

CONVERT : converts variables to system definition

**Purpose:** Loads a servo parameter file from the default storage device and default directory into memory using the specified or default file name. The file type is assumed to be ".SV."

If **file\_name** is not specified, the default file name, "SYSSERVO.SV," is used.

**Example:** KCL> LOAD SERVO

## C.36 LOAD SYSTEM command

**Syntax:** LOAD SYSTEM <**file\_name**> <CONVERT>

where:

**file\_name** : a valid file name

CONVERT : converts variables to system definition

**Purpose:** Loads the specified system variable file into memory, assigning values to all of the saved system variables. The default storage device and default directory are used with the specified or default file name. The file type is assumed to be ".SV."

If **file\_name** is not specified, the default file name, "SYSVARS.SV," is used.

**Examples:** KCL> LOAD SYSTEM awdef

KCL> LOAD SYSTEM CONVERT

The following rules are applicable for system variables:

- If an array system variable that is not referenced by a program already exists when a .SV file is loaded, the size in the .SV file is used and the contents are loaded. No errors are posted.
- If an array system variable that is referenced by a program already exists when a .SV file with a LARGER size is loaded, the size in the .SV file is ignored, and NONE of the array values are loaded. The following errors are posted; "var\_name memory not updated", "Array len creation mismatch".

- If an array system variable that is referenced by a program already exists when a .SV file with a SMALLER size is loaded, the size in the .SV file is ignored but ALL the array values are loaded. No errors are posted.
- If a .SV file with a different type definition is loaded, the .SV file will stop loading and detect the error. The following errors are posted; "Create type - var\_name failed", "Duplicate creation mismatch".
- If a .SV file with a different type definition is loaded, but the CONVERT option is specified, it tries to load as much as it can. For example, the controller has a SCR\_T type which has the field \$NEW but not the field \$OLD. When an old .SV file is loaded that has \$OLD but not \$NEW, the load procedure creates the SCR\_T type based on what is in the .SV file and posts a "Create type - var\_name failed", "Duplicate creation mismatch" error. It then creates the type SCR\_! which has the field \$OLD but not the field \$NEW. It then does a field by field copy of all of the old valid fields into the new type. Therefore, since there is not \$NEW information in the old type that field is not updated and the \$OLD information is discarded. Any fields whose types don't match are discarded from the loaded type. So if a field was changed from integer to real, the integer field in the loaded data would be discarded. Any fields that are arrays will follow the same rules as array system variables.

## C.37 LOAD TP command

**Syntax:** LOAD TP <file\_name> <OVERWRITE>

where:

**file\_name** : a valid file name

**OVERWRITE** : If specified, may overwrite a previously loaded TP program with the same name

**Purpose:** Loads a TP program from the default storage device and default directory into memory using the specified or default file name. The file type is assumed to be ".TP."

If **file\_name** is not specified, the default program is used. If the default has not been set, then the message, "Default program name not set," will be displayed.

**Examples:** KCL> LOAD TP testprog

KCL> LOAD TP

## C.38 LOAD VARS command

**Syntax:** LOAD VARS <file\_name> <CONVERT>

where:

**file\_name** : a valid file name

**CONVERT** : converts variables to system definition

**Purpose:** Loads the specified or default variable data file from the default storage device and directory into memory. The file type is assumed to be ".VR."

If **file\_name** is not specified, the default program is used. If the default has not been set then the message, "Default program name not set," will be displayed.

**Examples:** KCL> LOAD VARS test\_prog

KCL> LOAD VARS

The following rules are applicable for array variables:

- If an array variable that is not referenced by a program already exists when a .VR file is loaded, the size in the .VR file is used and the contents are loaded. No errors are posted.
- If an array variable already exists when a program is loaded, the size in the .PC file is ignored and the program is loaded anyway. The following errors are posted: "*var\_name* PC array length ignored", and "Array len creation mismatch".
- If an array variable that is referenced by a program already exists when a .VR file with a LARGER size is loaded, the size in the .VR file is ignored and NONE of the array values are loaded. The following errors are posted; "*var\_name* memory not updated," "Array len creation mismatch."
- If an array variable that is referenced by a program already exists when a .VR file with a SMALLER size is loaded, the size in the .VR file is ignored but ALL the array values are loaded. The following errors are posted; "*var\_name* array length updated," "Array len creation mismatch."

The following rules are applicable for user-defined types in KAREL programs:

- Once a type is created it can never be changed, regardless of whether a program references it or not. If all the variables referencing the type are deleted, the type will also be deleted. A new version can then be loaded.
- If a type already exists when a program with a different type definition is loaded, the .PC file will not be loaded. The following errors are posted; "Create type - *var\_name* failed," "Duplicate creation mismatch."
- If a type already exists when a .VR file with a different type definition is loaded, the .VR file will stop loading when it detects the error. The following errors are posted; "Create type -*var\_name* failed," "Duplicate creation mismatch".

## C.39 LOGOUT command

**Syntax:** LOGOUT

**Purpose:** Logs the current user from the KCL device out of the system. The password level reverts to the OPERATOR level. If passwords are not enabled, an error message will be displayed by KCL such as, "No user currently logged in".

**Example:** KCL>LOGOUT

(The alarm message: "Logout (SAM) SETUP from KCL")

KCL Username>

## **C.40 MKDIR command**

**Syntax:** MKDIR <device\_name>\path\_name

where:

**device\_name** : a valid storage device

**path\_name** : a subdirectory previously created on the memory card device using the mkdir command.

**Purpose:** MKDIR creates a subdirectory on the memory card (MC:) device. FANUC Robotics recommends you nest subdirectories only to 8 levels.

**Example:** KCL> MKDIR mc:\test\_dir

KCL> MKDIR mc:\prog\_dir\tpnx\_dir

## **C.41 MOUNT command**

**Syntax:** MOUNT device\_name

where:

**device\_name** : a valid storage device

**Purpose:** MOUNT indicates to the controller that a storage device is available for reading or writing data.

A device must be formatted with the KCL> FORMAT command before it can be mounted successfully.

**Example:** KCL> MOUNT rd:

## **C.42 MOVE FILE command**

**Syntax:** MOVE <FILE> file\_spec

where:

**file\_spec** : a valid file specification.

**Purpose:** Moves the specified file from one memory file device to another. The file should exist on the FROM or RAM disks. If file\_spec is a file on the FROM disk, the file is moved to the RAM disk, and vice versa.

The wildcard character (\*) can be used to replace the entire file name, the first part of the file name, the last part of the file name, or both the first and last parts of the file name. The file type can also use the wildcard in the same manner. If file\_spec specifies multiple files, then they are all moved to the other disk.

**Examples:** KCL> MOVE FILE fr:\*.kl

KCL> MOVE rd:\*.\*

## C.43 PAUSE command

**Syntax:** PAUSE <(prog\_name | ALL)> <FORCE>

where:

**prog\_name** : the name of any KAREL or TP program which is a task

ALL : pauses all running tasks

FORCE : pauses the task even if the NOPAUSE attribute is set

**Purpose:** Pauses the specified running task. If **prog\_name** is not specified, the default program is used.

Execution of the current motion segment and the current program statement is completed before the task is paused.

Condition handlers remain active. If the condition handler action is NOPAUSE and the condition is satisfied, task execution resumes.

If the statement is a WAIT FOR and the wait condition is satisfied while the task is paused, the statement following the WAIT FOR is executed immediately when the task is resumed.

If the statement is a DELAY, timing will continue while the task is paused. If the delay time is finished while the task is paused, the statement following the DELAY is immediately executed when the task is resumed. If the statement is a READ, it will accept input even though the task is paused.

The KCL> CONTINUE command resumes execution of a paused task. When a task is paused, the CYCLE START button on the operator panel has the same effect as the KCL> CONTINUE command.

**Examples:** KCL> PAUSE test\_prog FORCE

KCL> PAUSE ALL

## C.44 PURGE command

**Syntax:** PURGE **device\_name**

where:

**device\_name** : the name of the memory file device to be purged

**Purpose:** Purges the specified memory file device by freeing any used blocks that are no longer needed. The device should be set to "FR:" for FROM disk, "RD:" for RAM disk, or "MF:" for both disks.

The purge operation is only necessary when the device does not have enough memory to perform an operation. The purge operation will erase file blocks that were previously used, but are no longer needed. These are called garbage blocks. The FROM disk can contain many garbage blocks if files are deleted or overwritten. The RAM disk will not normally contain garbage blocks, but they may occur when power is removed during a file copy.

The device must be mounted and no files can be open on the device or an error will be displayed.

**Examples:** KCL> PURGE fr:

KCL> PURGE mf:

## C.45 PRINT command

**Syntax:** PRINT **file\_spec**

where:

**file\_spec** : a valid file specification

**Purpose:** Allows you to print the contents of an ASCII file using a serial printer. A serial printer can connect to the RS-232-C port on the operator panel. Use the SET comm\_port BAUD command to set the printer baud rate.

**Example:** KCL> PRINT testprog.kl

## C.46 RECORD command

**Syntax:** RECORD <**prog\_name** > **var\_name**

where:

**prog\_name** : the name of any KAREL or TP program

**var\_name** : the name of any POSITION, XYZWPR, or JOINTPOS variable

**Purpose:** Records the position of the TCP and/or auxiliary or extended axes. The robot must be calibrated before the RECORD command is issued. The variable can be a system variable or a program variable that exists in memory. The position is recorded relative to the user frame of reference.

You must enter the KCL> SAVE command to permanently assign the recorded position. The Record function key, F3, under the teach pendant TEACH menu also allows you to record positions.

**Example:** KCL> RECORD [paint\_prog]start\_pos

```
KCL> RECORD $GROUP[1].$uframe
```

## C.47 RENAME FILE command

**Syntax:** RENAME FILE **old\_file\_spec** TO **new\_file\_spec**

where:

**old\_file\_spec** : a valid file specification

**new\_file\_spec** : a valid file specification

**Purpose:** Changes the **old\_file\_spec** to the **new\_file\_spec**. The file will no longer exist under the **old\_file\_spec**. The **old\_file\_spec** and the **new\_file\_spec** must include both the file name and the file type. The same file type must be used in both file\_specs but they cannot be the same file.

Use the KCL> COPY FILE command to change the device name of a file.

**Examples:** KCL> RENAME FILE test.kl TO productn.kl

```
KCL> RENAME FILE mycmd.cf TO yourcmd.cf
```

## C.48 RENAME VARIABLE command

**Syntax:** RENAME VARIABLE <[ **prog\_name** ]> **old\_var\_name** **new\_var\_name**

where:

**prog\_name** : the name of any KAREL or TP program

**old\_var\_name** : the name of any program variable

**new\_var\_name** : a valid program variable name

**Purpose:** Changes the **old\_var\_name** to the **new\_var\_name** in the program specified with the **old\_var\_name**. The variable will no longer exist under the **old\_var\_name**. The variable must exist in memory under the **old\_var\_name** in the specified program.

The **new\_var\_name** cannot already exist in memory. The variable still belongs to the same program. You cannot specify a **prog\_name** with the **new\_var\_name**.

You must enter the KCL> SAVE VARS command to make the change permanent.

**Examples:** KCL> RENAME VARIABLE [test\_prog]count part\_count

KCL> RENAME VAR count part\_count

## **C.49 RENAME VARS command**

**Syntax:** RENAME VARS **old\_prog\_name** **new\_prog\_name**

where:

**old\_prog\_name** : the name of any KAREL or TP program

**new\_prog\_name** : the name of any KAREL or TP program

**Purpose:** Changes the name of the variable data associated with the **old\_prog\_name** to the **new\_prog\_name**. The variable data will no longer exist under the **old\_prog\_name**.

Before you use the RENAME VARS command, the variable data must exist in memory under the **old\_prog\_name**. Variable data cannot already exist in memory under the **new\_prog\_name**.

The command does not rename the program. To rename a KAREL program, use the KCL> RENAME FILE to rename the .KL file, edit the program name in the .KL file, translate the program, and load the new C file. To rename a TP program, use the SELECT menu.

You must enter the KCL> SAVE VARS command to make the change permanent.

**Example:** KCL> RENAME VARS test\_1 test\_2

Use this sequence of KCL commands to copy the variable data of one program ( **prog\_1** ) into a variable file that is then used by another program ( **prog\_2** ):

LOAD VARS **prog\_1**

RENAME VARS **prog\_1** **prog\_2**

SAVE VARS **prog\_2**

LOAD ALL **prog\_2**

The effect of this sequence of commands cannot be accomplished with the KCL> COPY FILE command.

The name of the program to which the variable data belongs is stored in the variable file. The KCL> COPY FILE command does not change that stored program name, so the data cannot be used with another program.

## **C.50 RESET command**

**Syntax:** RESET

**Purpose:** Enables servo power after an error condition has shut off servo power, provided the cause of the error has been cleared. The command also clears the message line on the CRT/KB display. The error message remains displayed if the error condition still exists.

The RESET command has no effect on a program that is being executed. It has the same effect as the FAULT RESET button on the operator panel and the RESET function key on the teach pendant RESET screen.

**Example:** KCL> RESET

## **C.51 RMDIR command**

**Syntax:** RMDIR <device\_name>\path\_name

where:

**device\_name** : a valid storage device

**path\_name** : a subdirectory previously created on the memory card device using the mkdir command.

**Purpose:** RMDIR deletes a subdirectory on the memory card (MC:) device. The directory must be empty before it can be deleted.

**Example:** KCL> RMDIR mc:\test\_dir

KCL> RMDIR mc:\test\_dir\prog\_dir

## **C.52 RUN command**

**Syntax:** RUN <prog\_name>

where:

**prog\_name** : the name of any KAREL or TP program

**Purpose:** Executes the specified program. The program must be loaded in memory. If no program is specified the default program is run. If uninitialized variables are encountered, program execution is paused.

Execution begins at the first executable line. RUN is a motion command; therefore, the device from which it is issued must have motion control. If a RUN command is issued in a command file, it is executed as a NOWAIT command. Therefore, the statement following the RUN command will be executed immediately after the RUN command is issued without waiting for the program, specified by the RUN command, to end.

**See Also:** Refer to the \$RMT\_MASTER description in the *FANUC Robotics SYSTEM R-J3iB Controller Software Reference Manual* for more information about assigning motion control to a remote device.

**Example:** KCL> RUN test\_prog

## **C.53 RUNCF command**

**Syntax:** RUNCF **input\_file\_spec** < **output\_file\_spec** >

where:

**input\_file\_spec** : a valid file specification

**output\_file\_spec** : a valid file specification

**Purpose:** Executes the KCL command procedure that is stored in the specified input file and displays the output to the specified output file. The input file type is assumed to be .CF. The output file type is assumed to be .LS if no file type is supplied.

If **output\_file\_spec** is not specified, the output will be displayed to the KCL output window.

The RUNCF command can be nested within command files up to four levels. Use **%INCLUDE input\_file\_spec** to include another .CF file into the command procedure. RUNCF command itself is not allowed inside a command procedure.

If the command file contains motion commands, the device from which the RUNCF command is issued must have motion control.

**See Also:** Refer to [Section 13.4](#), “Command Procedures,” for more information

**Examples:** KCL> RUNCF startup output

KCL> RUNCF startup

## C.54 SAVE MASTER command

**Syntax:** SAVE MASTER <**file\_name**>

where:

**file\_name** : a valid file name

**Purpose:** Saves the mastering data file from the default storage device and default directory into memory using the specified or default file name. The file type will be “.SV.”

If **file\_name** is not specified, the default file name, “SYSMAST.SV,” is used.

**Example:** KCL> SAVE MASTER

## C.55 SAVE SERVO command

**Syntax:** SAVE SERVO <**file\_name**>

where:

**file\_name** :a valid file name

**Purpose:** Saves the servo parameters into the default storage device using the specified or default file name. The file type will be “.SV.”

If **file\_name** is not specified, the default file name, “SYSSEERO.SV,” is used.

**Example:** KCL> SAVE SERVO

## C.56 SAVE SYSTEM command

**Syntax:** SAVE SYSTEM <**file\_name**>

where:

**file\_name** :a valid file name

**Purpose:** Saves the system variable values into the default storage device and default directory using the specified system variable file (.SV). If you do not specify a **file\_spec** the default name, “SYSVARS.SV,” is used. For example:

SAVE SYSTEM **file\_1**

In this case, the system variable data is saved in a variable file called **file\_1.SV**.

SAVE SYSTEM

In this case, the system variable data is saved in a system variable file “SYSVARS.SV.”

**Examples:** KCL> SAVE SYSTEM file\_1

KCL> SAVE SYSTEM

## **C.57 SAVE TP command**

**Syntax:** SAVE TP <**file\_name**> <= **prog\_name**>

where:

**file\_name** : a valid file name

**prog\_name** : the name of any TP program

**Purpose:** Saves the specified TP program to the specified file (.TP). If you do not specify a **file\_name** or a **prog\_name**, the default program name is used. If only a **file\_name** is specified, that name will also be used for **prog\_name**. For example:

SAVE TP **file\_1**

In this case, the TP program **file\_1** is saved in a file called **file\_1.TP**.

SAVE TP = **prog\_1**

In this case, the TP program **prog\_1** is saved in a file whose name is the default program name.

If you specify a program name, it must be preceded by an equal sign (=).

**Examples:** KCL> SAVE TP file\_1 = prog\_1

KCL> SAVE TP file\_1

KCL> SAVE TP = prog\_1

KCL> SAVE TP

## **C.58 SAVE VARS command**

**Syntax:** SAVE VARS <**file\_name**> <= **prog\_name**>

where:

**file\_name** : a valid file name

**prog\_name** : the name of any KAREL or TP program

**Purpose:** Saves variable data from the specified program, including the currently assigned values, to the specified variable file (.VR). If you do not specify a **file\_name** or a **prog\_name**, the default program name is used. If only a **file\_name** is specified, that name will also be used for **prog\_name**. For example:

**SAVE VARS file\_1**

In this case, the variable data for the program **file\_1** is saved in a variable file called **file\_1.VR**.

**SAVE VARS = prog\_1**

In this case, the variable data for **prog\_1** is saved in a variable file whose name is the default program name.

If you specify a program name, it must be preceded by an equal sign (=).

Any variable data that is not saved is lost when an initial start of the controller is performed.

**Examples:** KCL> SAVE VARS file\_1 = prog\_1

KCL> SAVE VARS file\_1

KCL> SAVE VARS = prog\_1

KCL> SAVE VARS

## **C.59 SET BREAK CONDITION command**

**Syntax:** SET BREAK CONDITION <**prog\_name**> **condition\_no**

where:

**prog\_name** : the name of any running or paused KAREL program

**condition\_no** : a particular condition

**Purpose:** Allows you to set a break point on the specified condition in the specified program or default program. The specified condition must already exist so the program must be running or paused. When the break point is triggered, a message will be posted to the error log and the break point will be cleared.

**Examples:** KCL> SET BREAK CONDITION test\_prog 1

KCL> SET BREAK COND 2

## C.60 SET BREAK PROGRAM command

**Syntax:** SET BREAK PROGRAM <**prog\_name**> **brk\_pnt\_no** **line\_no** <(PAUSE | DISPLAY | TRACE ON | TRACE OFF)>

where:

**prog\_name** : the name of any KAREL or TP program in memory

**brk\_pnt\_no** : a particular program break point

**line\_no** : a line number

PAUSE : task is paused when break point is executed

DISPLAY : message is displayed on the teach pendant USER menu when break point is executed

TRACE ON : trace is enabled when break point is executed

TRACE OFF : trace is disabled when break point is executed

**Purpose:** Allows you to set a break point at a specified line in the specified or default program. The specified line must be an executable line of source code. Break points will be executed before the specified line in the program. By default the task will pause when the break point is executed. DISPLAY, TRACE ON, and TRACE OFF will not pause task execution.

Break points are local only to the program in which the break points were set. For example, break point #1 can exist among one or more loaded programs with each at a unique line number. If you specify an existing break point number, the existing break point is cleared and a new one is set in the specified program at the specified line.

Break points in a program are cleared if the program is cleared from memory. You also use the KCL> CLEAR BREAK PROGRAM command to clear break points from memory.

Use the KCL> CONTINUE command or the operator panel CYCLE START button to resume execution of a paused program.

**Examples:** KCL> SET BREAK PROGRAM test\_prog 1 22 DISPLAY

KCL> SET BREAK PROG 3 30

## C.61 SET CLOCK command

**Syntax:** SET CLOCK 'dd-mmm-yy hh:mm'

where:

The date is specified using two numeric characters for the day, a three letter abbreviation for the month, and two numeric characters for the year; for example, 01-JAN- 00.

The time is specified using two numeric characters for the hour and two numeric characters for the minutes; for example, 12:45.

**Purpose:** Sets the date and time of the internal controller clock.

The date and time are included in directory and translator listings.

**See Also:** SHOW CLOCK command

**Example:** KCL> SET CLOCK '02-JAN-xx 21:45'

## **C.62 SET DEFAULT command**

**Syntax:** SET DEFAULT **prog\_name**

where:

**prog\_name** : the name of any KAREL or TP program

**Purpose:** Sets the default program name to be used as an argument default for program and file names. The default program name can also be set at the teach pendant.

**See Also:** [Section 13.1.1](#), “Default Program”

**Examples:** KCL> SET DEFAULT test\_prog

KCL> SET DEF test\_prog

## **C.63 SET GROUP command**

**Syntax:** SET GROUP **group\_no**

where:

**group\_no** : a valid group number

**Purpose:** Sets the default group number to use in other commands.

**Example:** KCL> SET GROUP 1

## **C.64 SET LANGUAGE command**

**Syntax:** SET LANGUAGE **lang\_name**

where:

**lang\_name** : a particular language. The available choices are ENGLISH, JAPANESE, FRENCH, GERMAN, SPANISH or DEFAULT.

**Purpose:** Sets the \$LANGUAGE system variable which determines the language to use.

**Example:** KCL> SET LANG ENGLISH

## **C.65 SET LOCAL VARIABLE command**

**Syntax:** SET LOCAL VARIABLE **var\_name** <IN **rout\_name** > <FROM **prog\_name** >  
<**task\_name** > = **value** <{, **value** }>

where:

**var\_name** : a local variable or parameter name

**rout\_name** : the name of any KAREL routine

**prog\_name** : the name of any KAREL program

**task\_name** : the name of any KAREL task

**value** : new value for variable

**Purpose:** Assigns the specified value to the specified local variable or routine parameter. You can assign constant values or variable values, but the value must be of the data type that has been declared for the variable.

Please use the HELP SET VAR command for more information on assigning data types.

If the IN clause is omitted, the routine at the top of the stack is assumed. If the FROM clause is omitted, the default program is assumed. If the task\_name is omitted, the stack of the KCL default task is searched.

**Note** The file RD: **prog\_name.rs** is required to obtain local variable information.

**Example:** See SHOW LOCAL VARIABLE command.

**See Also:** SHOW LOCAL VARIABLE and TRANSLATE command.

## **C.66 SET PORT command**

**Syntax:** SET PORT **port\_name** [**index**] = **value**

where:

**port\_name[index]** : a valid I/O port **value** : a new value for the port

**Purpose:** Assigns the specified value to a specified input or output port. SET PORT can be used with either physical or simulated output ports, but only with simulated input ports.

The valid ports are:

DIN, DOUT, RDO, OPOUT, TPOUT, WDI, WDO (BOOLEAN)-AIN, AOUT, GIN, GOUT (INTEGER)

**See Also:** SIMULATE, UNSIMULATE command, [Chapter 14 INPUT/OUTPUT SYSTEM](#), *FANUC Robotics SYSTEM R-J3iB Controller Handling Tool Setup and Operations Manual*.

**Example:** KCL> SET PORT DOUT [1] = ON

KCL> SET PORT GOUT [2] = 255

KCL> SET PORT AIN [1] = 1000

## C.67 SET TASK command

**Syntax:** SET TASK <[**prog\_name**]> **attr\_name** = **value**

where:

**prog\_name** : the name of any KAREL or TP program which is a task

**attr\_name** : PRIORITY or TRACELEN

**value** : new integer value for attribute

**Purpose:** Sets the specified task attribute. PRIORITY sets the task priority. The lower the number, the higher the priority. 1 to 89 is lower than motion, but higher than the user interface. 90 to 99 is lower than the user interface. The default is 50. TRACELEN sets the trace buffer length. The default is 10 lines.

## C.68 SET TRACE command

**Syntax:** SET TRACE (OFF | ON) <[ **prog\_name** ]>

where:

**prog\_name** : the name of any KAREL or TP program loaded in memory

**Purpose:** Turns the trace function ON or OFF (default is OFF). The program statement currently being executed and its line number are stored in a buffer when TRACE is ON. TRACE should only

be set to ON during debugging operations because it slows program execution. To see the trace data, SHOW TRACE command must be used.

**See Also:** SHOW TRACE command

## C.69 SET VARIABLE command

**Syntax:** SET VARIABLE <[ prog\_name ]> var\_name = value <{, value }>

where:

**prog\_name** : the name of any KAREL or TP program

**var\_name** : a valid program variable

**value** : new value for variable or a program or system variable

**Purpose:** Assigns the specified value to the specified variable. You can assign constant values or variable values, but the value must be of the data type that has been declared for the variable.

You can assign values to system variables with KCL write access, to program variables, or to standard and user-defined variables and fields. You can assign only one ARRAY element. Use brackets ([]) after the variable name to specify an element.

Certain data types like positions and vectors might have more than one value specified.

**KCL> SET VAR position\_var = 0,0,0,0,0,0**

The SET VARIABLE command displays the previous value of the specified variable followed by the value which you have just assigned, providing you with an opportunity to check the assignment. The DATA key on the teach pendant also allows you to assign values to variables.

When you use SET VARIABLE to define a position you can use one of the following formats:

**KCL> SET VARIABLE var\_name.X = value**

**KCL> SET VARIABLE var\_name.Y = value**

**KCL> SET VARIABLE var\_name.Z = value**

**KCL> SET VARIABLE var\_name.W = value**

**KCL> SET VARIABLE var\_name = value**

where X,Y,Z,W,P, and R specify the location and orientation, c\_str is a string value representing configuration in terms of joint placement and turn numbers. Refer to Section 8.1, “Positional Data.” For example, to set X=200.0, W=60.0 and the turn numbers for axes 4 and 6 to 1 and 0 you would type the following lines:

**KCL> SET VARIABLE var\_name.X = 200**

**KCL> SET VARIABLE var\_name.W = 60**

**KCL> SET VARIABLE var\_name.C = '1,0'**

You must enter the KCL>SAVE VARS command to make the changes permanent.

**See Also:** [Section 2.3](#), “Data Types”

**Examples:** KCL> SET VARIABLE [prog1] scale = \$MCR.\$GENOVERRIDE

KCL> SET VAR weld\_pgm.angle = 45.0

KCL> SET VAR v[2,1,3].r = -0.897

KCL> SET VAR part\_array[2] = part\_array[1]

KCL> SET VAR weld\_pos.x = 50.0

KCL> SET VAR pth\_b[3].nodepos = pth\_a[3].nodepos

## **C.70 SET VERIFY command**

**Syntax:** SET VERIFY (ON | OFF)

**Purpose:** This turns the display of KCL commands ON or OFF during execution of a KCL command procedure (default is ON, meaning each command is displayed as it is executed). Only the RUNCF command is displayed when VERIFY is OFF.

## **C.71 SHOW BREAK command**

**Syntax:** SHOW BREAK <prog\_name>

where:

**prog\_name** : the name of any KAREL or TP program in memory

**Purpose:** Displays a list of program break points for the specified or default program. The following information is displayed for each break point:

- Break point number
- Line number of the break point in the program

**Examples:** KCL> SHOW BREAK test\_prog

KCL> SH BREAK

## C.72 SHOW BUILTINS command

**Syntax:** SHOW BUILTINS

**Purpose:** Displays all the softpart built-ins that are loaded on the controller.

**Example:** KCL> SHOW BUILTINS

## C.73 SHOW CONDITION command

**Syntax:** SHOW CONDITION <**prog\_name**><**condition\_no**>

where:

**prog\_name** : the name of any running or paused KAREL program

**condition\_no** : a particular condition

**Purpose:** Displays the specified condition handler or a list of condition handlers for the specified or default program. Also displays enabled/disabled status and whether a break point is set. Condition handlers only exist when a program is running or paused.

**Examples:** KCL> SHOW CONDITION test\_prog 5

KCL> SH COND

## C.74 SHOW CLOCK command

**Syntax:** SHOW CLOCK

**Purpose:** Displays the current date and time of the controller clock.

**See Also:** SET CLOCK command

**Example:** KCL> SHOW CLOCK

## C.75 SHOW CURPOS command

**Syntax:** SHOW CURPOS

**Purpose:** Displays the position of the TCP relative to the current user frame of reference with an x, y, and z location in millimeters; w, p, and r orientation in degrees; and the current configuration string. Be sure the robot is calibrated.

**Example:** KCL> SHOW CURPOS

## **C.76 SHOW DEFAULT command**

**Syntax:** SHOW DEFAULT

**Purpose:** Shows the current default program name.

**Example:** KCL> SHOW DEFAULT

## **C.77 SHOW DEVICE command**

**Syntax:** SHOW DEVICE **device\_name**:

where:

**device\_name** : device to be shown

**Purpose:** Shows the status of the device.

**Example:** KCL> SHOW DEVICE rd:

## **C.78 SHOW DICTS command**

**Syntax:** SHOW DICTS

**Purpose:** Shows the dictionaries loaded in the system for the language specified in the system variable \$LANGUAGE.

**Example:** KCL> SHOW DICTS

## **C.79 SHOW GROUP command**

**Syntax:** SHOW GROUP

**Purpose:** Shows the default group number.

**Example:** KCL> SHOW GROUP

## **C.80 SHOW HISTORY command**

**Syntax:** SHOW HISTORY

**Purpose:** Shows the nesting information of the routine calls. To display the source lines of KAREL programs, the .KL programs must exist on the RAM disk.

**Example:** KCL> SHOW HIST

## **C.81 SHOW LANG command**

**Syntax:** SHOW LANG

**Purpose:** Shows the language specified in the system variable \$LANGUAGE.

**Example:** KCL> SHOW LANG

## **C.82 SHOW LANGS command**

**Syntax:** SHOW LANGS

**Purpose:** Shows all language currently available in the system.

**Example:** KCL> SHOW LANGS

## **C.83 SHOW LOCAL VARIABLE command**

**Syntax:** SHOW LOCAL VARIABLE **var\_name** <(HEXADECIMAL | BINARY)> <IN **rout\_name**> <FROM **prog\_name**> <**task\_name**>

where:

**var\_name** : a local variable or parameter name

**rout\_name** : the name of any KAREL routine

**prog\_name** : the name of any KAREL program

**task\_name** : the name of any KAREL task

**Purpose:** Displays the name, type, and value of the specified local variable or routine parameter. Use brackets ([ ]) after the variable name to specify a specific ARRAY element. If you do not specify a specific element the entire variable is displayed.

If the IN clause is omitted, the routine at the top of the stack is assumed. If the FROM clause is omitted, the default program is assumed. If the **task\_name** is omitted, the stack of the KCL default task is searched.

**Note** The file RD: **prog\_name.rs** is required to obtain local variable information.

**Example:** Generate a .rs file from the KAREL translator.

KCL> TRANS testprog RS

Copy the .rs file to the RD device.

This is done automatically when you load the program from the KCL.

KCL> SET DEF testprog

KCL> LOAD PROG

Copied testprog.rs to RD:testprog.rs

To show local variables, the program must be running, paused, or aborted in the routine specified.

KCL> RUN

KCL> SHOW LOCAL VARS

KCL> SHOW LOCAL VARS IN testprog VALUES

KCL> SHOW LOCAL VAR var\_1 IN rout\_1 FROM testprog testtask

KCL> SHOW LOCAL VAR param\_1

To set local variables, the program must be paused.

KCL> pause

KCL> set local var int\_var = 12345

KCL> set local var strparam = "This is a string parameter"

**See Also:** TRANSLATE command.

## **C.84 SHOW LOCAL VARS command**

**Syntax:** SHOW LOCAL VARS <VALUES> <IN **rout\_name**> <FROM **prog\_name**> <**task\_name**>

where:

**VALUES:** :specifies values should be displayed

**rout\_name** :the name of any KAREL routine

**prog\_name** :the name of any KAREL program

**task\_name** :the name of any KAREL task

**Purpose:** Displays a list including the name, type, and if specified, the current value of each local variable and each routine parameter.

If the IN clause is omitted, the routine at the top of the stack is assumed. If the FROM clause is omitted, the default program is assumed. If the **task\_name** is omitted, the stack of the KCL default task is searched

**Note** The file RD: **prog\_name.rs** is required to obtain local variable information.

**Example:** See SHOW LOCAL VARIABLE command.

**See Also:** TRANSLATE command and SHOW LOCAL VARIABLE.

## **C.85 SHOW MEMORY command**

**Syntax:** SHOW MEMORY

**Purpose:** Displays current memory status. The command displays the following status information for memory and lists each memory pool separately:

Total number of bytes in the pool

Available number of bytes in the pool

**Example:** KCL> SHOW MEMORY

## **C.86 SHOW PROGRAM command**

**Syntax:** SHOW PROGRAM <**prog\_name**>

where:

**prog\_name** : the name of any KAREL or TP program in memory

**Purpose:** Displays the status information of the specified or default program being executed.

**Example:** KCL> SHOW PROGRAM test\_prog

KCL> SH PROG

## **C.87 SHOW PROGRAMS command**

**Syntax:** SHOW PROGRAMS

**Purpose:** Shows a list of programs and variable data that are currently loaded in memory.

**Examples:** KCL> SHOW PROGRAMS

KCL> SH PROGS

## **C.88 SHOW SYSTEM command**

**Syntax:** SHOW SYSTEM <**data\_type**> <VALUES>

where:

**data\_type** : any valid KAREL data type

**Purpose:** Displays a list including the name, type, and if specified, the current value of each system variable. If you specify a **data\_type**, only the system variables of that type are listed.

**See Also:** SHOW VARIABLE command

**Examples:** KCL> SHOW SYSTEM REAL VALUES

KCL> SH SYS

## **C.89 SHOW TASK command**

**Syntax:** SHOW TASK <**prog\_name**>

where:

**prog\_name** : the name of any KAREL or TP program which is a task

**Purpose:** Displays the task control data for the specified task. If **prog\_name** is not specified, the default program is used.

**Examples:** KCL> SHOW TASK test\_prog

KCL> SH TASK

## **C.90 SHOW TASKS command**

**Syntax:** SHOW TASKS

**Purpose:** Displays the status of all known tasks running KAREL programs or TP programs.

You may see extra tasks running that are not yours. If the teach pendant is displaying a menu that was written using KAREL, such as Program Adjustment or Setup Passwords, you will see the status for this task also.

**Examples:** KCL> SHOW TASKS

## **C.91 SHOW TRACE command**

**Syntax:** SHOW TRACE <**prog\_name**>

where:

**prog\_name** : the name of any KAREL or TP program which is a task

**Purpose:** Shows all the program statements and line numbers that have been executed since TRACE has been turned on.

The number of lines that are shown depends on the trace buffer length, which can be set with the SET\_TASK command or the SET\_TSK\_ATTR built-in routine. To display the source lines of KAREL programs, the .KL files must exist on the RAM disk.

**See Also:** SET TRACE command

**Example:** KCL> SHOW TRACE

## **C.92 SHOW TYPES command**

**Syntax:** SHOW TYPES <**prog\_name**> <**FIELDS**>

where:

**prog\_name** : the name of any KAREL or TP program

**FIELDS** : specifies fields should be displayed

**Purpose:** Displays a list including the name, type, and if specified, the fields of each user-defined type in the specified or default program. The actual array dimensions and string sizes are not shown.

**See Also:** SHOW VARS command, SHOW VARIABLE command

**Examples:** KCL> SHOW TYPES test\_prog FIELDS

KCL> SH TYPES

## C.93 SHOW VARIABLE command

**Syntax:** SHOW VARIABLE <[ **prog\_name** ]> **var\_name** <(HEXADECIMAL | BINARY)>

where:

**prog\_name** : the name of any KAREL or TP program

**var\_name** : a valid program variable

**Purpose:** Displays the name, type, and value of the specified variable.

You can display the values of system variables that allow KCL read access or the values of program variables. Use brackets ([ ]) after the variable name to specify a specific ARRAY element. If you do not specify a specific element the entire variable is displayed.

**See Also:** SHOW VARS command, SHOW SYSTEM command

**Examples:** KCL> SHOW VARIABLE \$UTOOL

KCL> SH VAR [test\_prog]group\_mask HEX

KCL> SH VAR [test\_prog]group\_mask BINARY

KCL> SH VAR weld\_pth[3]

## C.94 SHOW VARS command

**Syntax:** SHOW VARS <**prog\_name**> <VALUES>

where:

**prog\_name** : the name of any KAREL or TP program

**VALUES** : specifies values should be displayed

**Purpose:** Displays a list including the name, type and, if specified, the current value of each variable in the specified or default program.

**See Also:** SHOW VARIABLE command, SHOW SYSTEM command, SHOW TYPES command

**Example:** KCL> SHOW VARS test\_prog VALUES

KCL> SH VARS

## C.95 SHOW data\_type command

**Syntax:** SHOW **data\_type** < **prog\_name** > <VALUES>

where:

**data\_type** : any valid KAREL data type

**prog\_name** : the name of any KAREL or TP program

**VALUES** : specifies values should be displayed

**Purpose:** Displays a list of variables in the specified or default program ( **prog\_name** ) of the specified data type ( **data\_type** ). The list includes the name, type, and if specified, the current value of each variable.

**See Also:** SHOW VARS command, SHOW VARIABLE command

**Examples:** KCL> SHOW REAL test\_prog VALUES

KCL> SH INTEGER

## C.96 SIMULATE command

**Syntax:** SIMULATE **port\_name[index]** <= **value** >

where:

**port\_name[index]** : a valid I/O port

**value** : a new value for the port

**Purpose:** Simulating I/O allows you to test a program that uses I/O. Simulating I/O does not actually send output signals or receive input signals.



### Warning

Depending on how signals are used, simulating signals might alter program execution. Do not simulate signals that are set up for safety checks. If you do, you could injure personnel or damage equipment.

When simulating a port value, you can specify its initial simulated value or allow the initial value to be the same as the physical port value. If no value is specified, the current physical port value is used.

The valid ports are:

DIN, DOUT, WDI, WDO (BOOLEAN)AIN, AOUT, GIN, GOUT (INTEGER)

**See Also:** UNSIMULATE command

**Examples:** KCL> SIMULATE DIN[17]

KCL> SIM DIN[1] = ON

KCL> SIM AIN[1] = 100

## C.97 SKIP command

**Syntax:** SKIP <prog\_name>

where:

**prog\_name** : the name of any KAREL or TP program which is a task

**Purpose:** Skips execution of the current statement in the specified task. If **prog\_name** is not specified, the default program is used. It has no effect when a task is running or when the system is in a READY state.

Entire motion statements are skipped with this command. You cannot skip single motion segments. The KCL> CONTINUE command resumes execution of the paused task with the statement following the last skipped statement. END statements cannot be skipped.

If you skip the last RETURN statement in a function routine, there is no way to return the value of the function to the calling program. Therefore, when executing the END statement of the routine, the task will abort.

If you skip into a FOR loop, you have skipped the statement that initializes the loop counter. When the ENDFOR statement is executed the program will try to remove the loop counter from the stack. If the FOR loop was nested in another FOR loop, the loop counter for the previous FOR loop will be removed from the stack, causing potentially invalid results. If the FOR loop was not nested, a stack underflow error will occur, causing the task to abort.

READ, MOVE, DELAY, WAIT FOR, and PULSE statements can be paused after they have begun execution. In these cases, when the task is resumed, execution of the paused statement must be finished before subsequent statements are executed. Subsequent skipped statements will not be executed. In particular, READ and WAIT FOR statements often require user intervention, such as entering data, before statement execution is completed.

Step mode operation and step mode type have no effect on the KCL> SKIP command.

**Examples:** KCL> SKIP test\_prog

KCL> SKIP

## **C.98 STEP OFF command**

**Syntax:** STEP OFF

**Purpose:** Disables single stepping for the program in which it was enabled.

**Example:** KCL> STEP OFF

## **C.99 STEP ON command**

**Syntax:** STEP ON <prog\_name>

where:

**prog\_name** : the name of any KAREL or TP program which is a task

**Purpose:** Enables single stepping for the specified or default program.

**Examples:** KCL> STEP ON test\_prog

KCL> STEP ON

## **C.100 TRANSLATE command**

**Syntax:** TRANSLATE <file\_spec> <DISPLAY> <LIST> <RS>

where:

**file\_spec** : a valid file specification

DISPLAY : display source during translation

LIST : create listing file

RS : create routine stack (.rs) file for local var access

**Purpose:** Translates KAREL source code (.KL type files) into p-code (.PC type files), which can be loaded into memory and executed.

Translation of a program can be canceled using the CANCEL COMMAND key, CTRL-C, or CTRL-Y on the CRT/KB.

**Examples:** KCL> TRANSLATE testprog DISPLAY LIST

KCL> TRAN

## C.101 TYPE command

**Syntax:** TYPE file\_spec

where:

**file\_spec** : a valid file specification

**Purpose:** This command allows you to display the contents of the specified ASCII file on the CRT/KB. You can specify any type of ASCII file.

**Examples:** KCL> TYPE rd:testprog.kl

KCL> TYPE testprog.kl

## C.102 UNSIMULATE command

**Syntax:** UNSIMULATE (port\_name[index] | ALL )

where:

**port\_name[index]** : a valid I/O port

**ALL** : all simulated I/O ports

**Purpose:** Discontinues simulation of the specified input or output port. When a port is unsimulated, the physical value replaces the simulated value.



### Warning

Depending on how signals are used, unsimulating signals might alter program execution or activate peripheral equipment. Do not unsimulate a signal unless you are sure of the result. If you do, you could injure personnel or damage equipment.

If you specify ALL instead of a particular port, simulation on all the simulated ports is discontinued.

The valid ports are:

DIN, DOUT, WDI, WDOAIN, AOUT, GIN, GOUT

**See Also:** SIMULATE command

**Examples:** KCL> UNSIMULATE DIN[17]

KCL> UNSIM ALL

## C.103 WAIT command

**Syntax:** WAIT <prog\_name> (DONE | PAUSE)

where:

**prog\_name** : the name of any KAREL or TP program which is a task

DONE : specifies that the command procedure wait until execution of the current task is completed or aborted

PAUSE : specifies that the command procedure wait until execution of the current task is paused, completed, or aborted.

**Purpose:** Defers execution of the commands that follow the KCL> WAIT command in a command procedure until a task pauses or completes execution.

The command procedure waits until the condition specified with the DONE or PAUSE argument is met.

**See Also:** [Section 13.4](#), “Command Procedures”

**Example:** The following is an example of an executable command procedure:

```
> SET DEF testprog
> LOAD ALL
> RUN -- execute program
> WAIT PAUSE
> SHOW CURPOS -- display position of TCP when program pauses
> CONTINUE
> WAIT DONE
> CLEAR ALL YES -- clear after execution
```

# **Appendix D**

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## **CHARACTER CODES**

### **Contents**

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## D.1 CHARACTER CODES

This appendix lists the ASCII numeric decimal codes and their corresponding ASCII, Multinational, graphic, and European characters as implemented on the KAREL system. The ASCII character set is the default character set for the KAREL system. Use the CHR Built-In Function, in Appendix A, to access the Multinational and Graphics character sets.

**Table D-1. ASCII Character Codes**

Decimal Code	Character Value						
000	(NUL)	032	SP	064	@	096	'
001	(SOH)	033	!	065	A	097	a
002	(STX)	034	"	066	B	098	b
003	(ETX)	035	#	067	C	099	c
004	(EOT)	036	\$	068	D	100	d
005	(ENQ)	037	%	069	E	101	e
006	(ACK)	038	&	070	F	102	f
007	(BEL)	039	,	071	G	103	g
008	(BS)	040	(	072	H	104	h
009	(HT)	041	)	073	I	105	i
010	(LF)	042	*	074	J	106	j
011	(VT)	043	+	075	K	107	k
012	(FF)	044	,	076	L	108	l
013	(CR)	045	-	077	M	109	m
014	(SO)	046	.	078	N	110	n

Table D-1. ASCII Character Codes (Cont'd)

Decimal Code	Character Value						
015	(SI)	047	/	079	O	111	o
016	(DLE)	048	0	080	P	112	p
017	(DC1)	049	1	081	Q	113	q
018	(DC2)	050	2	082	R	114	r
019	(DC3)	051	3	083	S	115	s
020	(DC4)	052	4	084	T	116	t
021	(NAK)	053	5	085	U	117	u
022	(SYN)	054	6	086	V	118	v
023	(ETB)	055	7	087	W	119	w
024	(CAN)	056	8	088	X	120	x
025	(EM)	057	9	089	Y	121	y
026	(SUB)	058	:	090	Z	122	z
027	(ESC)	059	;	091	[	123	{
028	(FS)	060	<	092	\	124	
029	(GS)	061	=	093	]	125	}
030	(RS)	062	>	094	^	126	~
031	(US)	063	?	095	—	127	(DEL)

**Table D-2.** Special ASCII Character Codes

Decimal Code	Character Value	Decimal Code	Character Value
128	Clear window	139	Reverse video attribute
129	Clear to end of line	140	Bold video attribute
130	Clear to end of window	141	Underline video attribute
131	Set cursor position	142	Wide video size
132	Carriage return	143	Normal video attribute
133	Line feed	146	Turn Graphics mode on
134	Reverse line feed	147	Turn ASCII mode on
135	Carriage return & line feed	148	High/wide video size
136	Back Space	153	Normal video size
137	Home cursor in window	154	Turn Multinational mode on
138	Blink video attribute		

**Table D-3.** Multinational Character Codes

Decimal Codes	Character Value						
000		032		064	À	096	à
001		033	i	065	Á	097	á
002		034	©	066	Â	098	â
003		035	£	067	Ã	099	ã
004	(IND)	036		068	Ä	100	ä
005	(NEL)	037	¥	069	Å	101	å
006	(SSA)	038		070	Æ	102	æ
007	(ESA)	039	§	071	Ҫ	103	ҫ

Table D-3. Multinational Character Codes (Cont'd)

Decimal Codes	Character Value						
008	(HTS)	040	¤	072	È	104	è
009	(HTJ)	041	©	073	É	105	é
010	(VTS)	042	¤	074	Ê	106	ê
011	(PLD)	043	«	075	Ë	107	ë
012	(PLU)	044		076	Ì	108	ì
013	(RI)	045		077	Í	109	í
014	(SS2)	046		078	Î	110	î
015	(SS3)	047		079	Ï	111	ï
016	(DCS)	048		080		112	
			○				
017	(PU1)	049	±	081	Ñ	113	ñ
018	(PU2)	050	²	082	Ò	114	ò
019	(STS)	051	³	083	Ó	115	ó
020	(CCH)	052		084	Ô	116	ô
021	(MW)	053	µ	085	Õ	117	õ
022	(SPA)	054	¶	086	Ö	118	ö
023	(EPA)	055	•	087	Œ	119	œ
024		056		088	Ø	120	ø
025		057	‘	089	Ù	121	ù
026		058		090	Ú	122	ú
027	(CSI)	059	»	091	Û	123	û
028	(ST)	060	¼	092	Ü	124	ü
029	(OSC)	061	½	093	Ý	125	ÿ
030	(PM)	062		094		126	
031	(APC)	063	¿	095	ß	127	

Table D-4. Graphics Character Codes

Decimal Codes	Character Value						
000	(NUL)	032	SP	064	@	096	◆
001	(SOH)	033	!	065	A	097	■
002	(STX)	034	"	066	B	098	H T
003	(ETX)	035	#	067	C	099	F F
004	(EOT)	036	\$	068	D	100	C R
005	(ENQ)	037	%	069	E	101	L F
006	(ACK)	038	&	070	F	102	○
007	(BEL)	039	,	071	G	103	±
008	(BS)	040	(	072	H	104	N L
009	(HT)	041	)	073	I	105	V T
010	(LF)	042	*	074	J	106	Ј
011	(VT)	043	+	075	K	107	҃
012	(FF)	044	,	076	L	108	҂
013	(CR)	045	-	077	M	109	҄
014	(SO)	046	.	078	N	110	+
015	(SI)	047	/	079	O	111	-
016	(DLE)	048	0	080	P	112	-
017	(DC1)	049	1	081	Q	113	-
018	(DC2)	050	2	082	R	114	-
019	(DC3)	051	3	083	S	115	-

Table D-4. Graphics Character Codes (Cont'd)

Decimal Codes	Character Value						
020	(DC4)	052	4	084	T	116	†
021	(NAK)	053	5	085	U	117	‡
022	(SYN)	054	6	086	V	118	⊥
023	(ETB)	055	7	087	W	119	⊤
024	(CAN)	056	8	088	X	120	
025	(EM)	057	9	089	Y	121	≤
026	(SUB)	058	:	090	Z	122	≥
027	(ESC)	059	;	091	[	123	∏
028	(FS)	060	<	092		124	≠
029	(GS)	061	=	093	]	125	£
030	(RS)	062	>	094	^	126	•
031	(US)	063	?	095	(blank)	127	(DEL)

**Table D-5. Teach Pendant Input Codes**

<b>Code</b>	<b>Value</b>	<b>Code</b>	<b>Value</b>
0	48	174	USER KEY 2
1	49	175	USER KEY 3
2	50	176	USER KEY 4
3	51	177	USER KEY 5
4	52	178	USER KEY 6
5	53	185	FWD
6	54	186	BWD
7	55	187	COORD
8	56	188	+X
9	57	189	+Y
128	PREV	190	+Z
129	F1	191	+X rotation
131	F2	192	+Y rotation
132	F3	193	+Z rotation
133	F4	194	-X
134	F5	195	-Y
135	NEXT	196	-Z
143	SELECT	197	-X rotation

**Table D-5.** Teach Pendant Input Codes (Cont'd)

<b>Code</b>	<b>Value</b>	<b>Code</b>	<b>Value</b>
144	MENUS	198	-Y rotation
145	EDIT	199	-Z rotation
146	DATA	210	USER KEY
147	FCTN	212	Up arrow
148	ITEM	213	Down arrow
149	+%	214	Right arrow
150	-%	215	Left arrow
151	HOLD	147	DEADMAN switch, left
152	STEP	248	DEADMAN switch, right
153	RESET	249	ON/OFF switch
173	USER KEY 1	250	EMERGENCY STOP

**Table D-6.** European Character Codes

<b>Code</b>	<b>Value</b>	<b>Code</b>	<b>Value</b>	<b>Code</b>	<b>Value</b>
192	A‘	213	O~	234	e^
193	A‘	214	O:	235	e:
194	A^	215	OE	236	i‘
195	A~	216	O/	237	i‘
196	A:	217	U‘	238	j^

Table D-6. European Character Codes (Cont'd)

Code	Value	Code	Value	Code	Value
197	Ao	218	U'	239	i:
198	AE	219	U^	240	
199	CC	220	U:	241	n~
200	E'	221	Y:	242	o'
201	E'	222		243	o'
202	E^	223	Bb	244	o^
203	E:	224	a'	245	o~
204	I'	225	a'	246	o:
205	I'	226	a^	247	oe
206	I^	227	a~	248	
207	I:	228	a:	249	u'
208		229	ao	250	u'
209	N~	230	ae	251	u^
210	O'	231		252	u:
211	O'	232	e'	253	y:
212	O^	233	e'	254	

A^ = A with ^ on top

A' = A with ' on top

Ao = A with o on top

A~ = A with ~ on top

A: = A with .. on top

AE = A and E run together

OE = A and E run together

Bb = Beta

**Table D-7. Graphics Characters**

Decimal Value	ASCII Character	Graphic Character
97	a	solid box
102	f	diamond
103	g	plus/minus
106	j	lower-right box corner
107	k	upper-right box corner
108	l	upper-left box corner
109	m	lower-left box corner
110	n	intersection lines
111	o	pixel row 1 horizontal line
112	p	pixel row 2 horizontal line
113	q	pixel row 3 horizontal line
114	r	pixel row 4 horizontal line
115	s	pixel row 5 horizontal line
116	t	T from right

**Table D-7. Graphics Characters (Cont'd)**

Decimal Value	ASCII Character	Graphic Character
117	u	T from left
119	v	T from above
119	w	T from below
120	x	Vertical Line
121	y	Less than or equal
122	z	Greater than or equal
123	{	Pi
124		Not equal
125	}	British pound symbol

# **Appendix E**

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## **SYNTAX DIAGRAMS**

### **Contents**

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Appendix E SYNTAX DIAGRAMS .....	E-1
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KAREL syntax diagrams use the following symbols:

- Rectangle



A rectangle encloses elements that are defined in another syntax diagram or in accompanying text.

- Oval



An oval encloses KAREL reserved words that are entered exactly as shown.

- Circle



A circle encloses special characters that are entered exactly as shown.

- Dot



A dot indicates a mandatory line-end (; or ENTER key) before the next syntax element.

- Caret



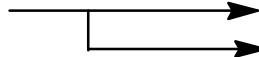
A caret indicates an optional line-end.

- Arrows



Arrows indicate allowed paths and the correct sequence in a diagram.

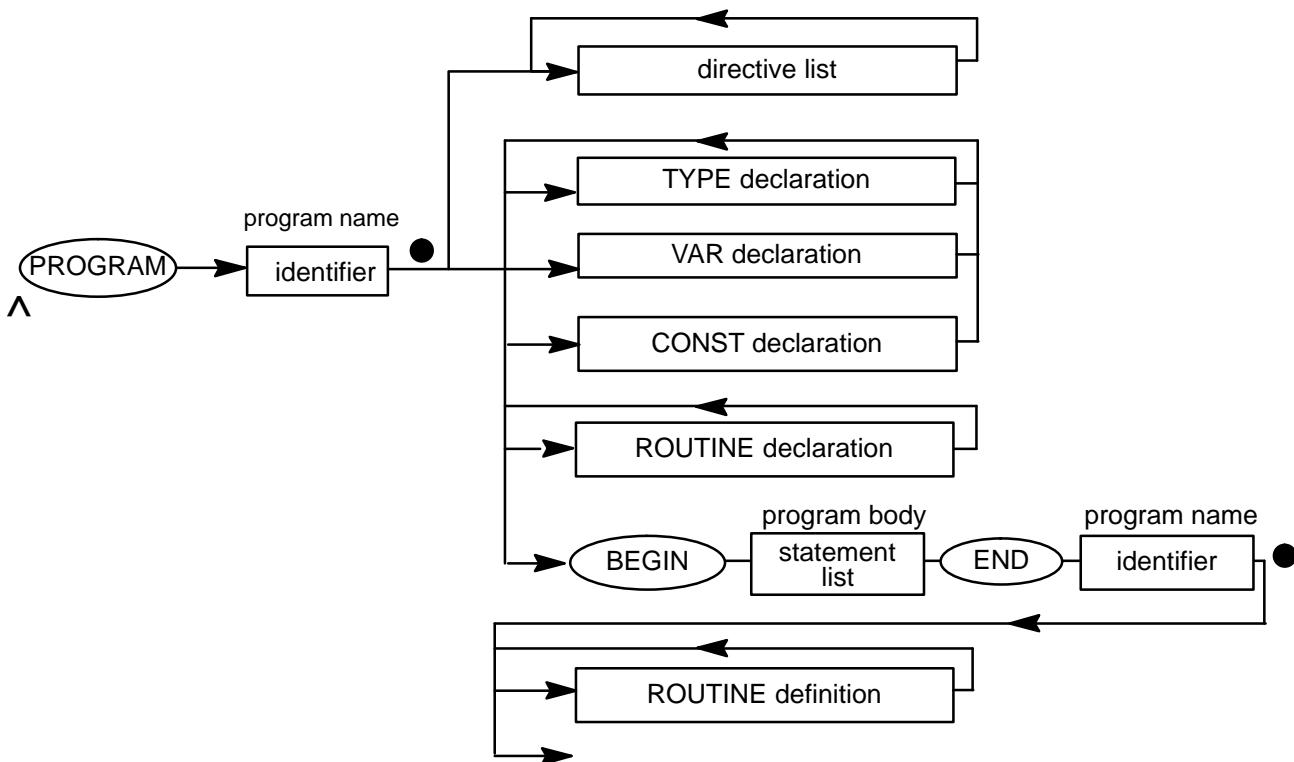
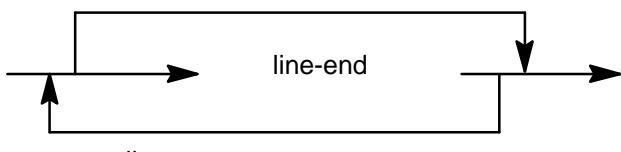
- Branch



Branches indicate optional paths or sequences.

**Figure E-1.**

PROGRAM—module definition

**Λ** -- 0 or more line-ends

● --newline

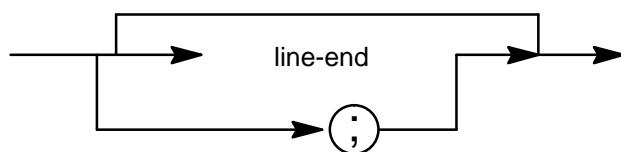


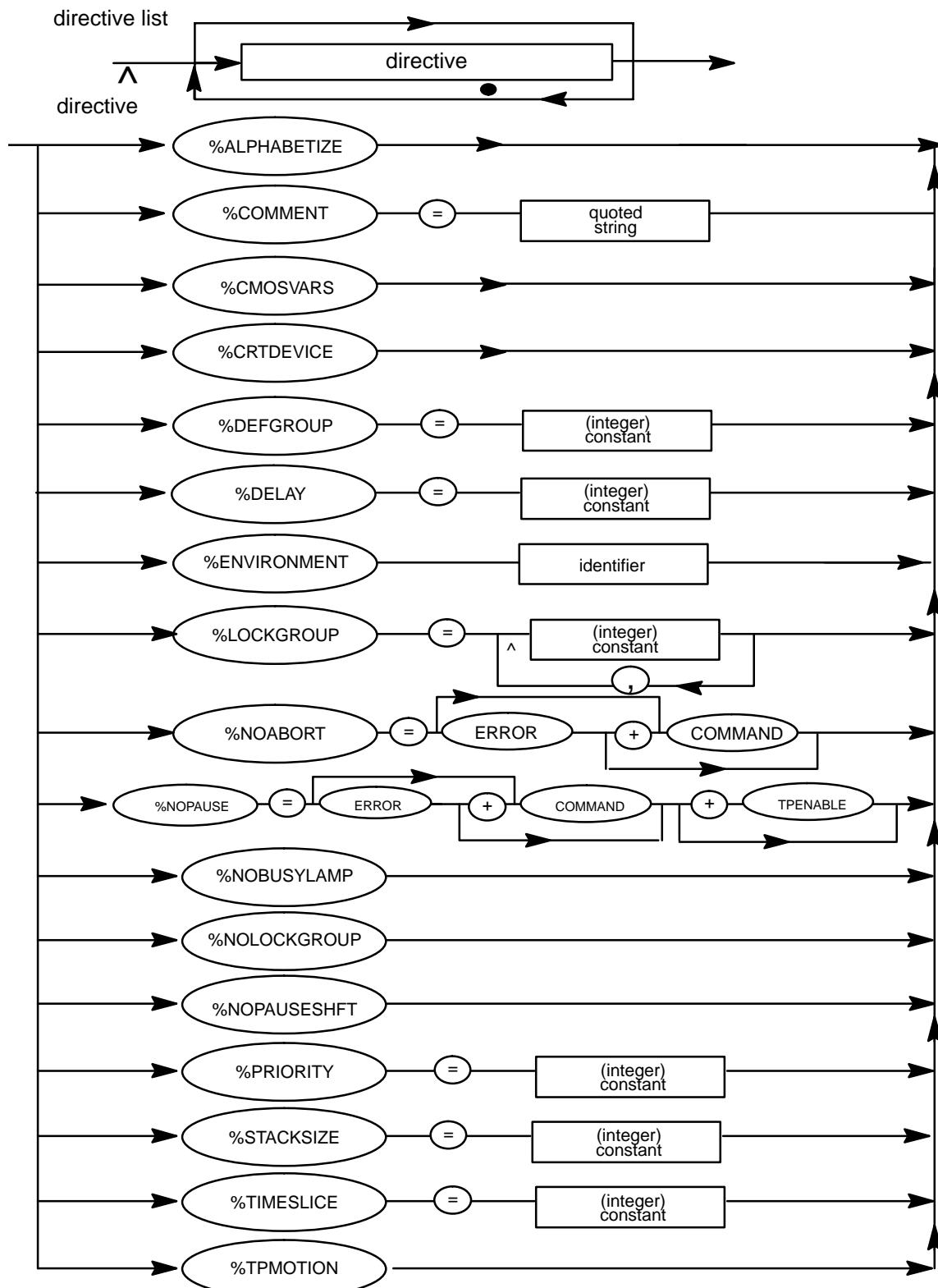
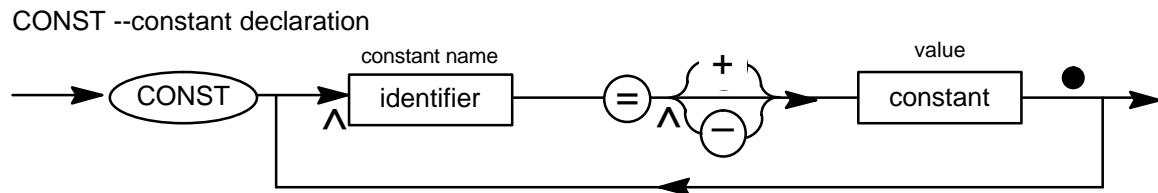
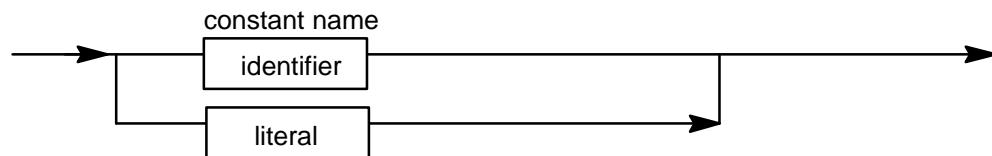
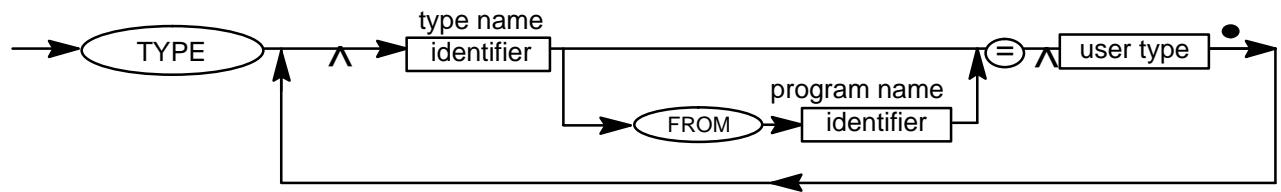
Figure E-2.

Figure E-3.

constant

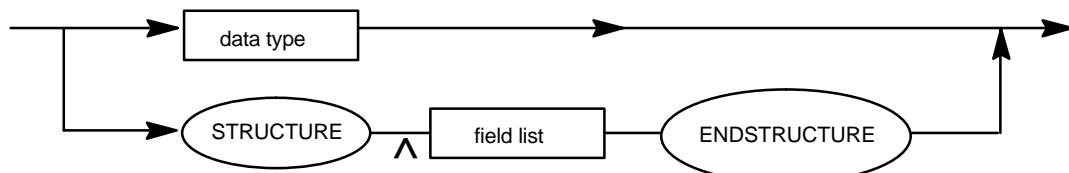


TYPE -- type declaration

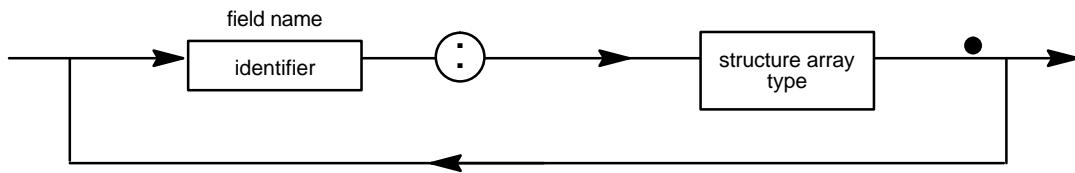


**Figure E-4.**

user type



field list



structure array type

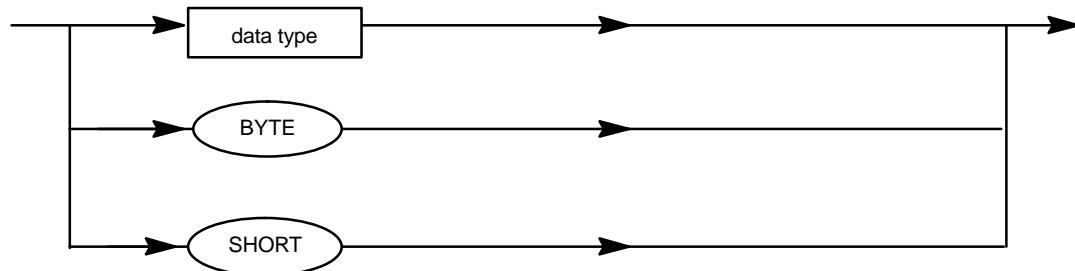
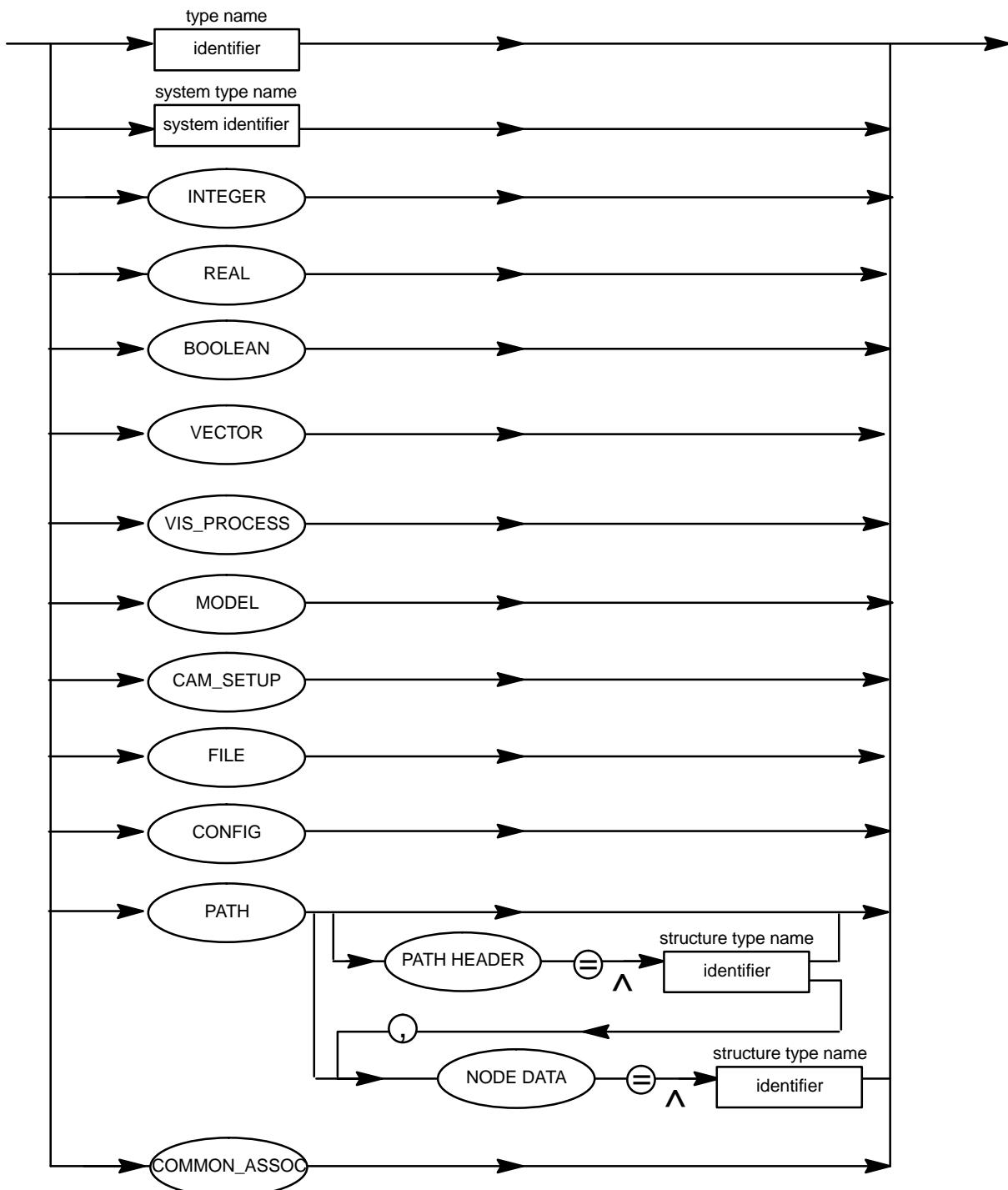


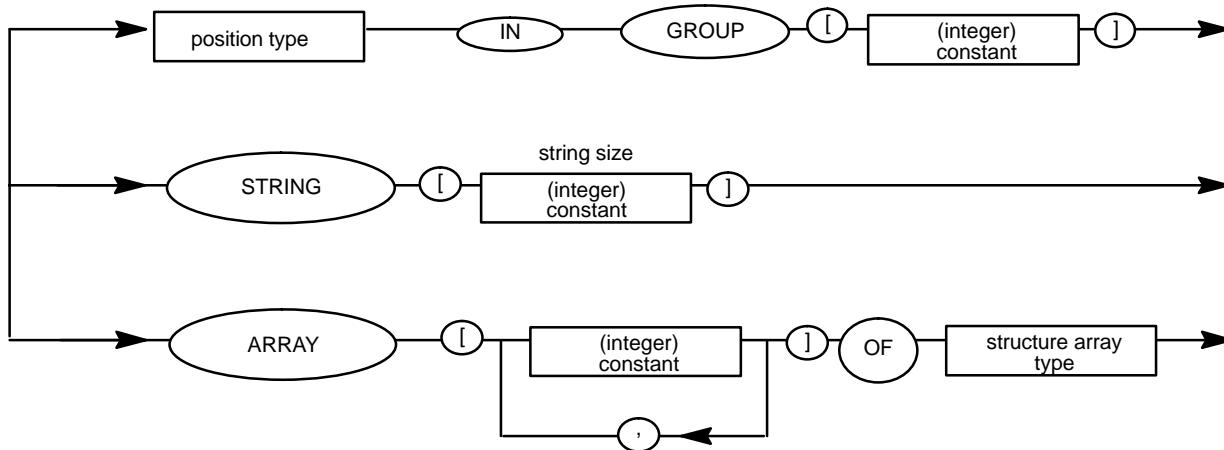
Figure E-5.

data type



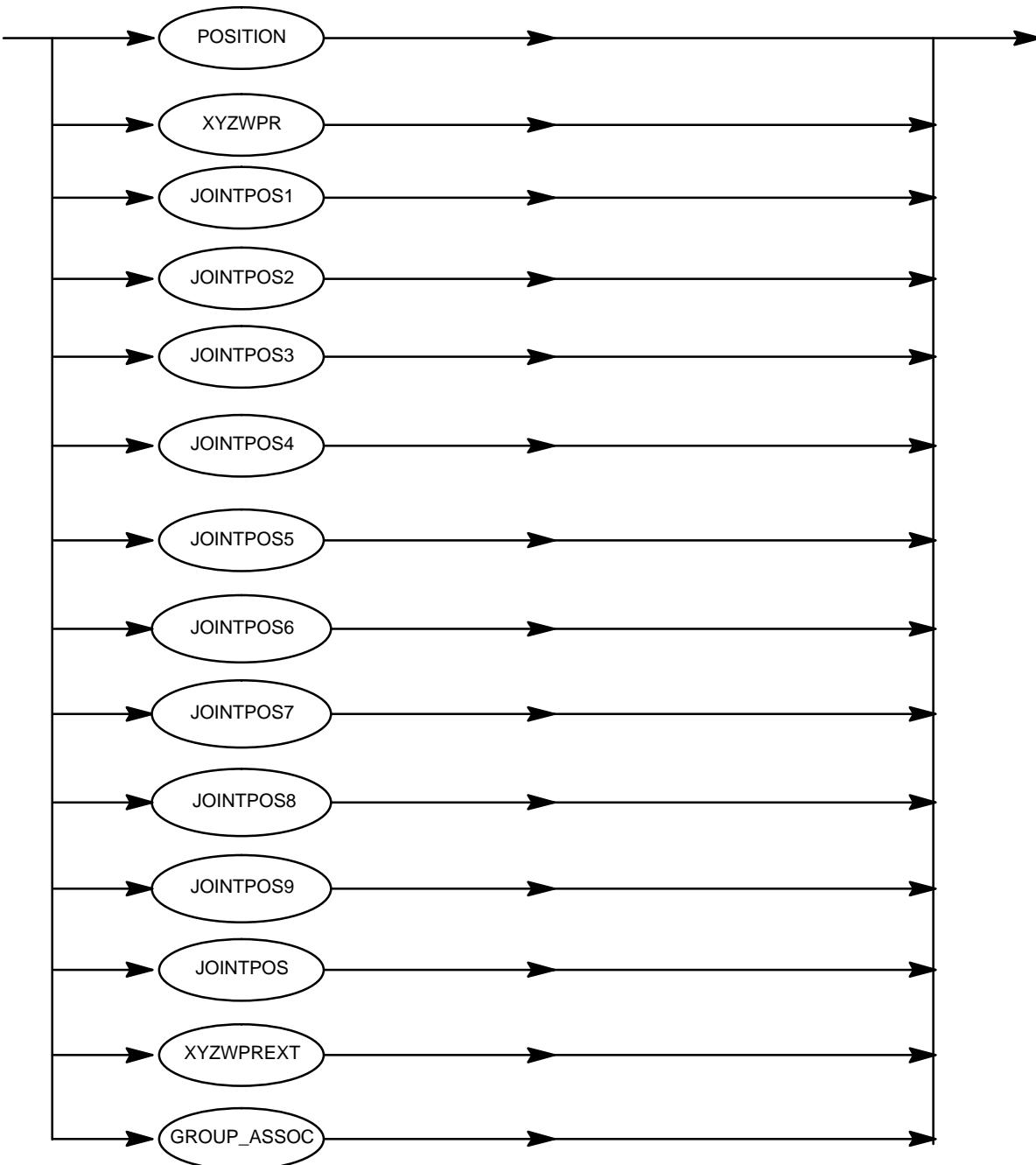
**Figure E-6.**

data type continued



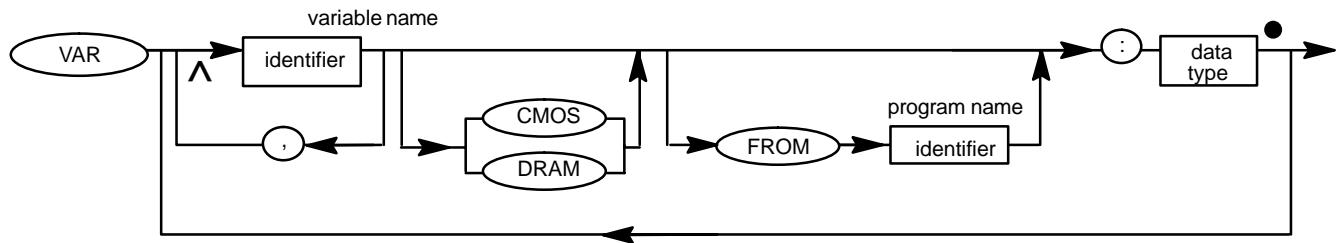
**Figure E-7.**

position type



**Figure E-8.**

VAR -- variable declaration



ROUTINE -- routine declaration

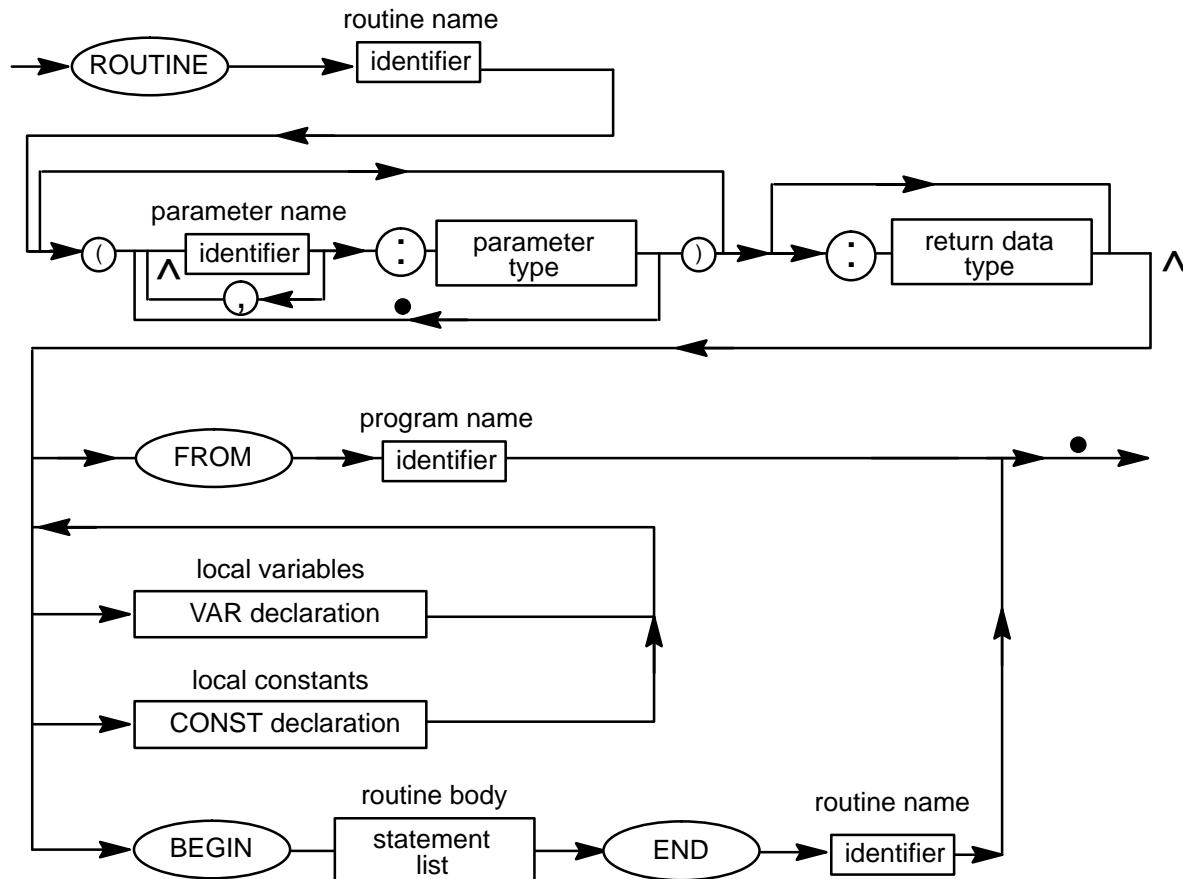


Figure E-9.

return data type

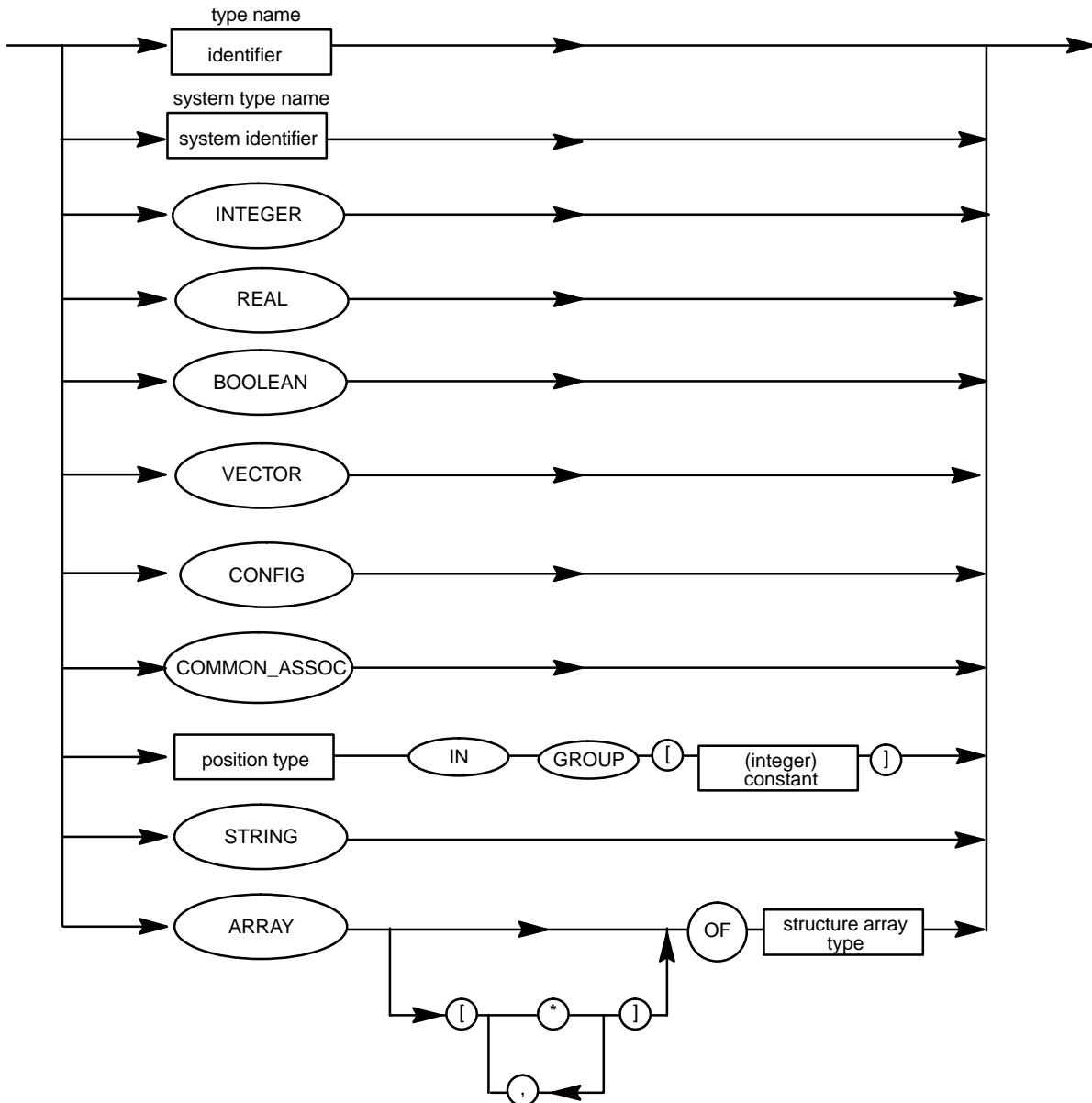
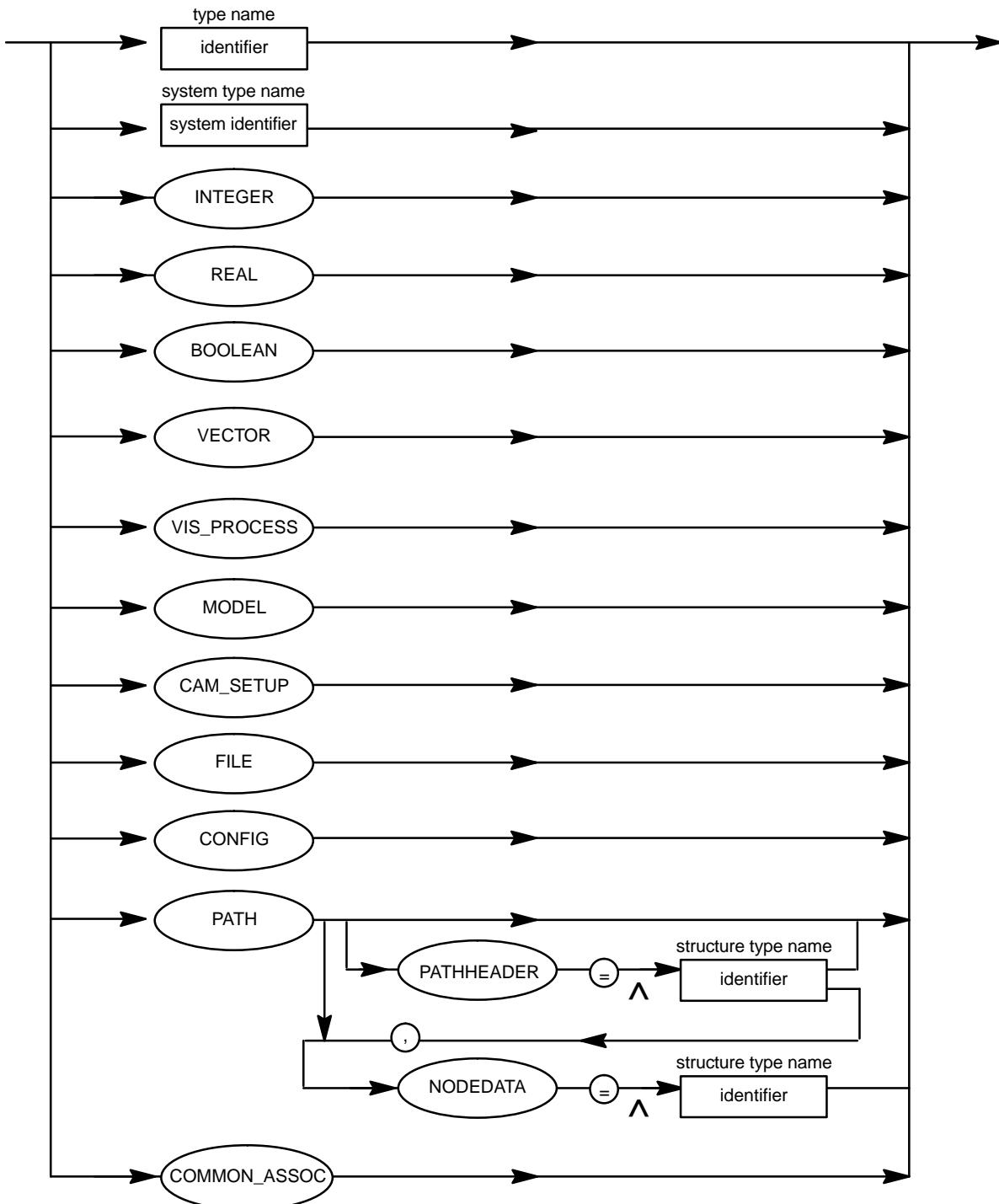


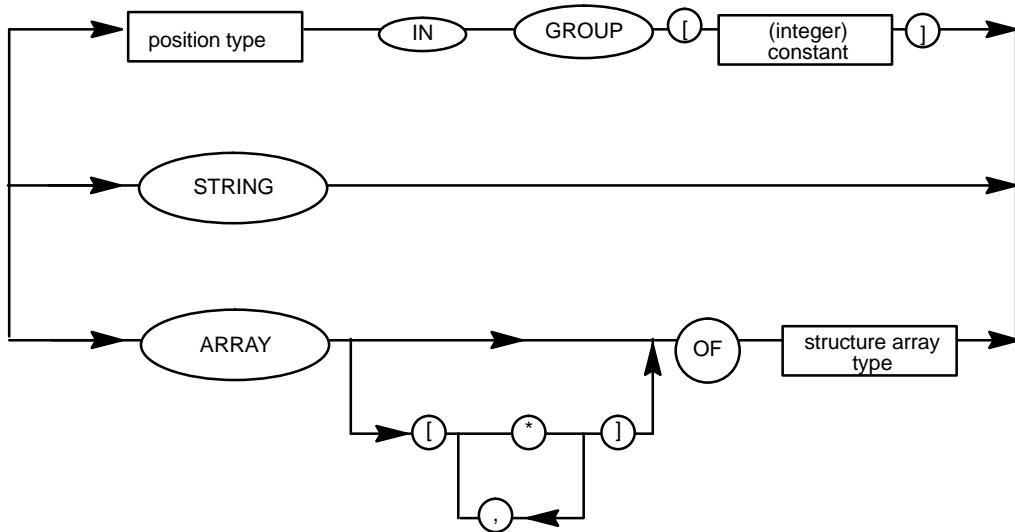
Figure E-10.

parameter type



**Figure E-11.**

parameter type continued



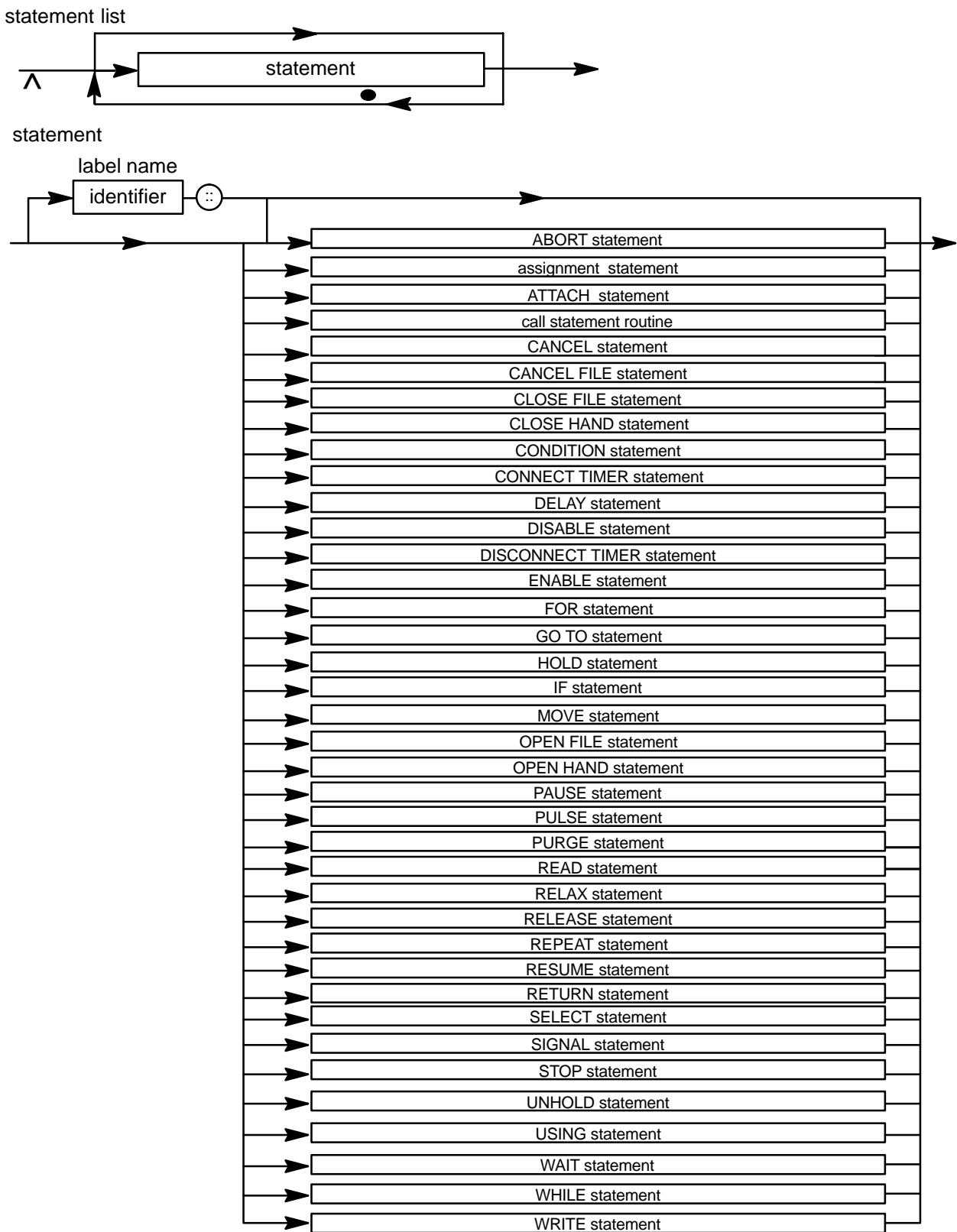
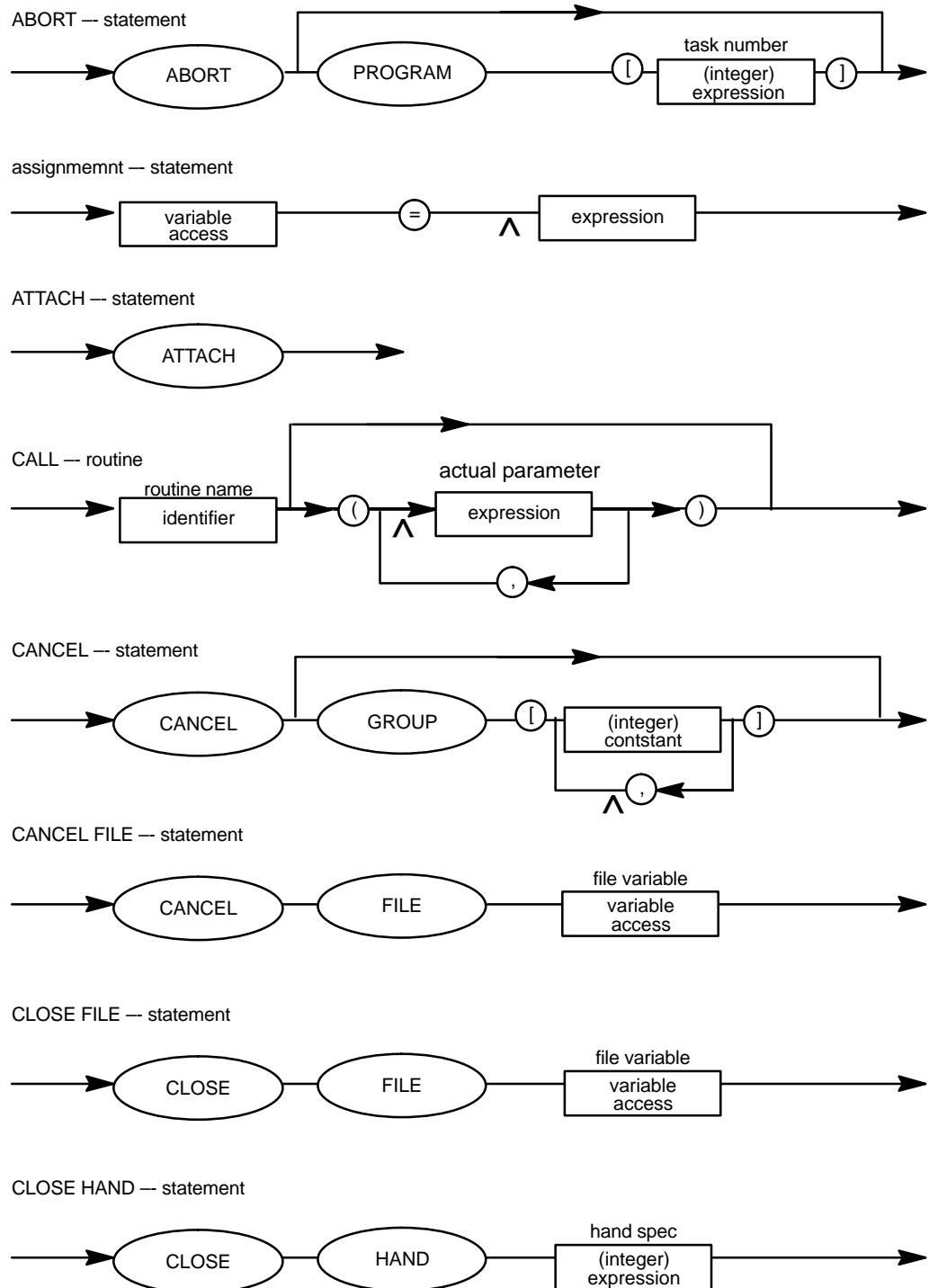
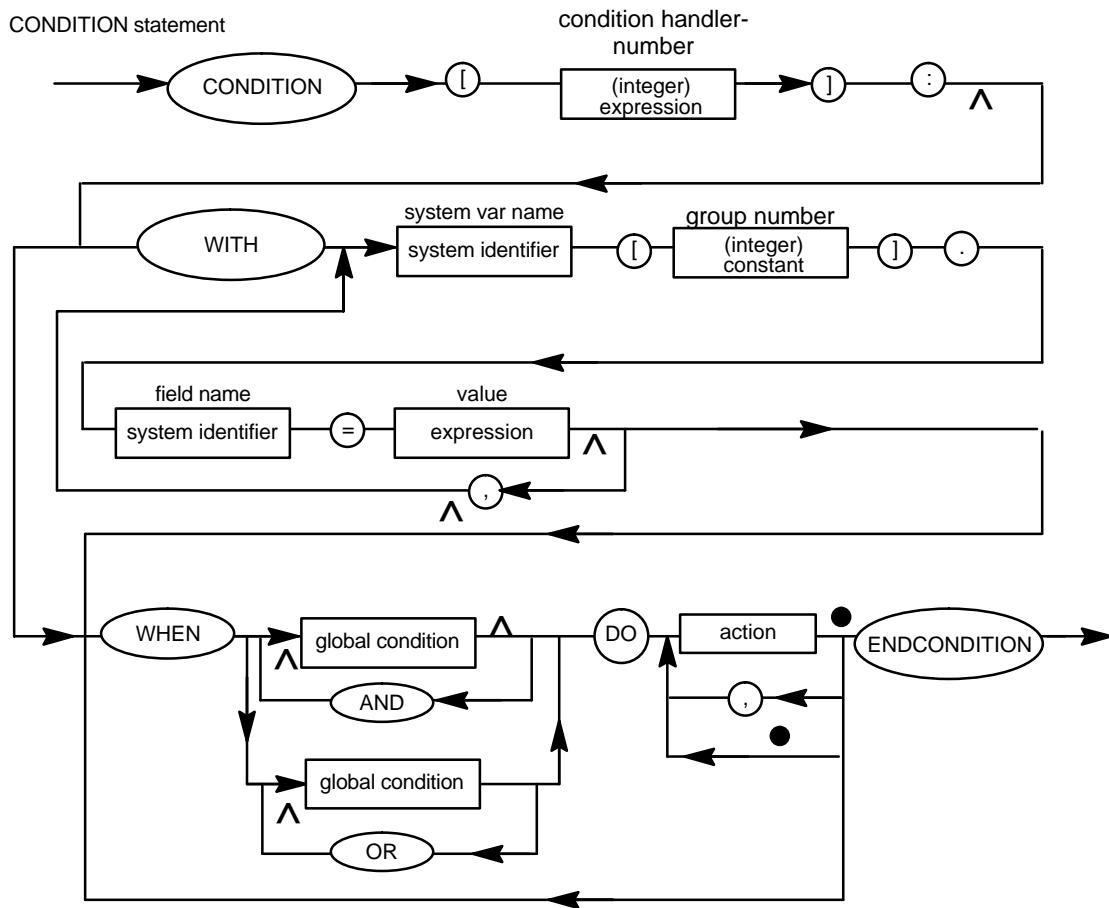
**Figure E-12.**

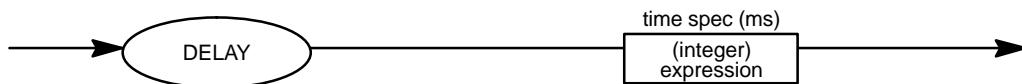
Figure E-13.

**Figure E-14.**

CONNECT TIMER -- statement

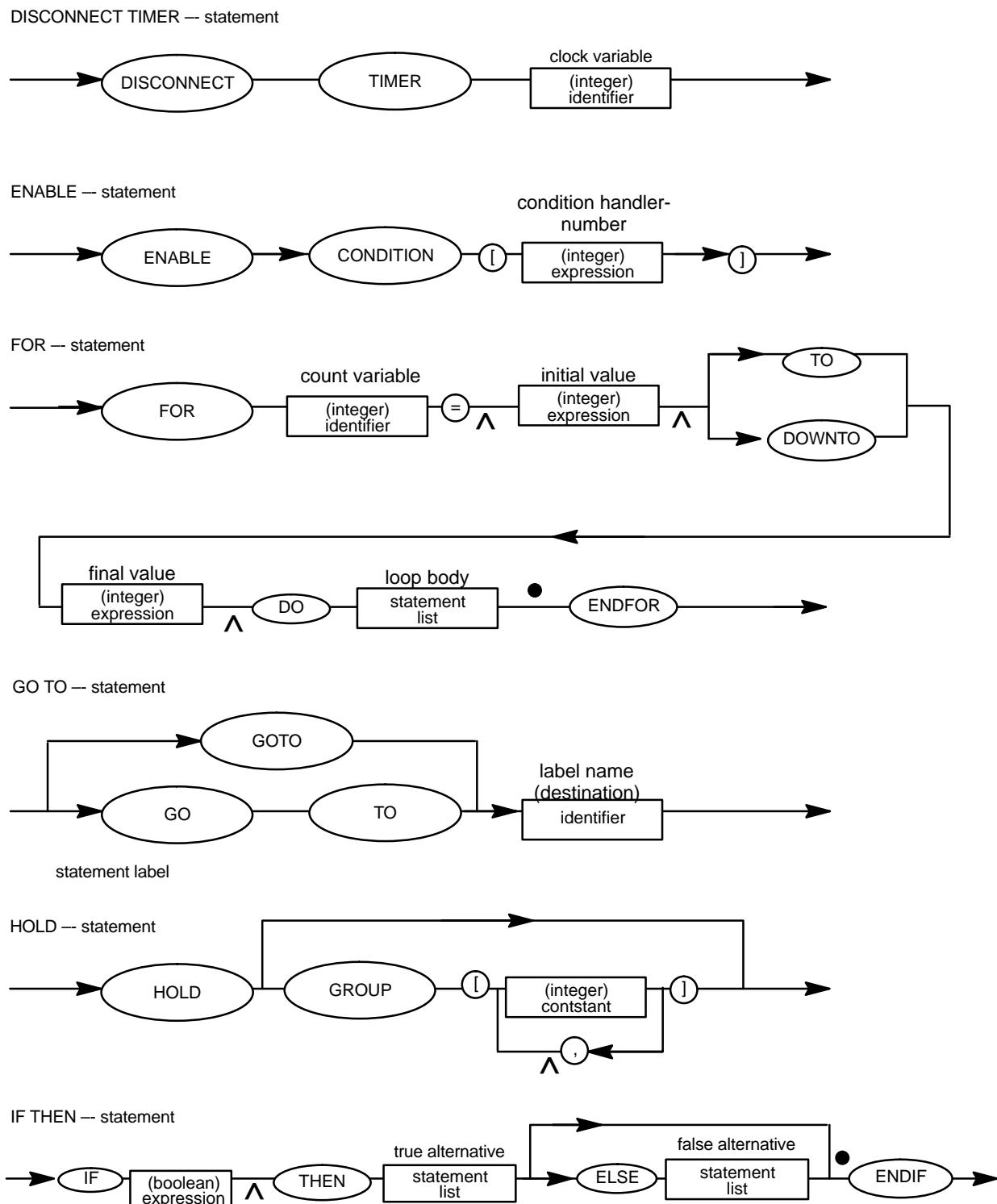


DELAY -- statement



DISABLE -- statement



**Figure E-15.**

**Figure E-16.**

MOVE -- statement

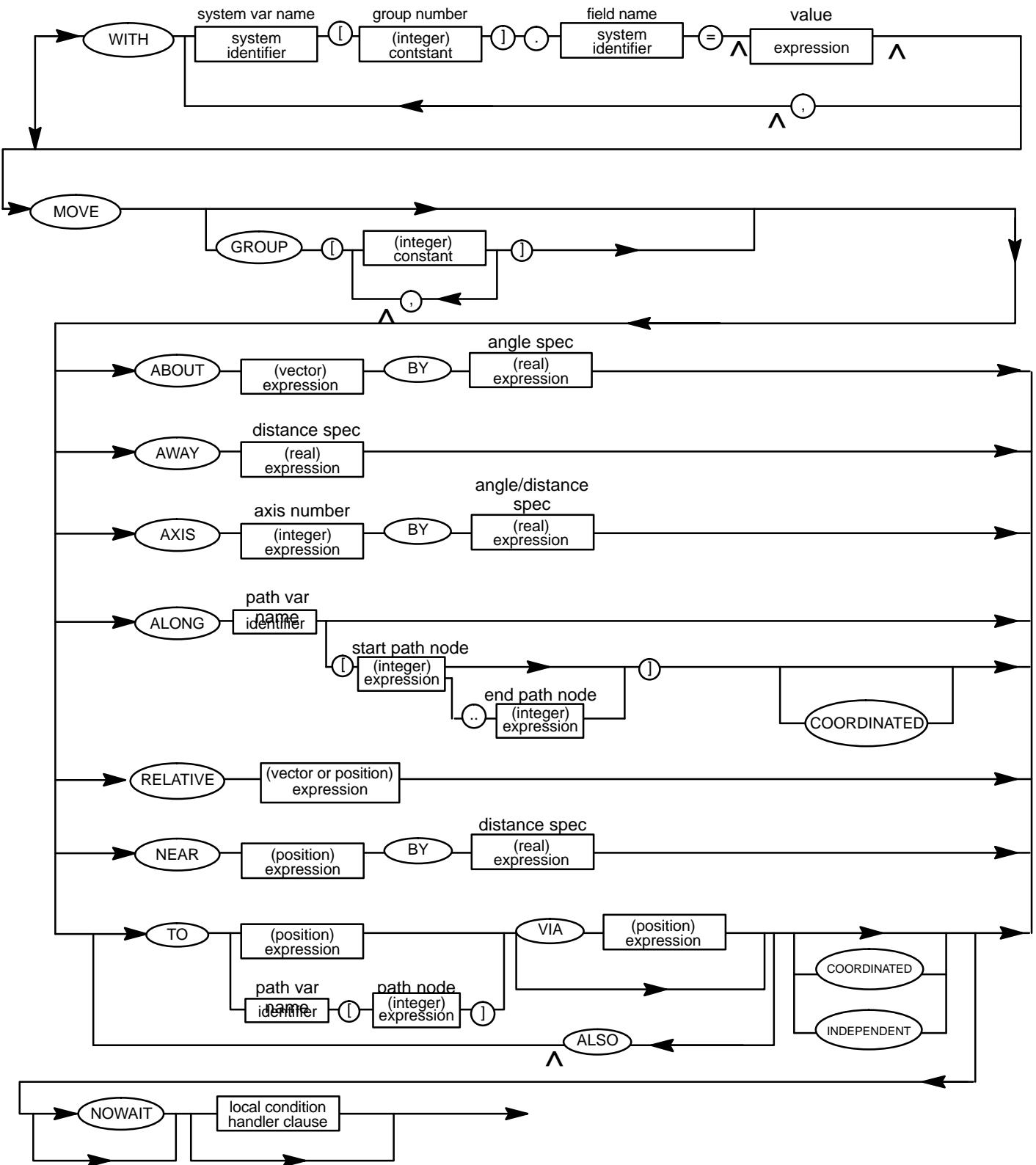
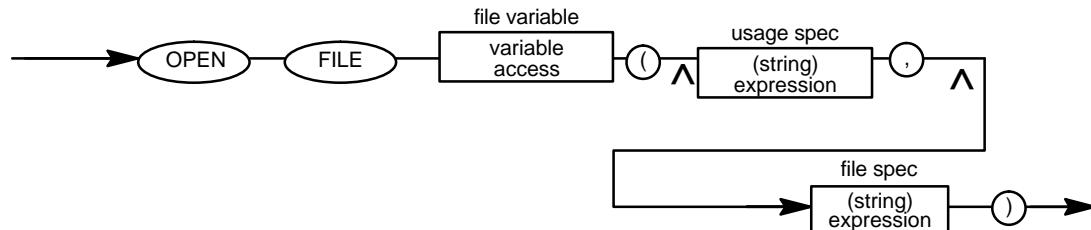
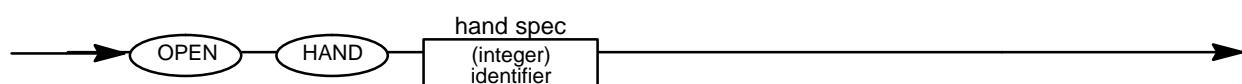


Figure E-17.

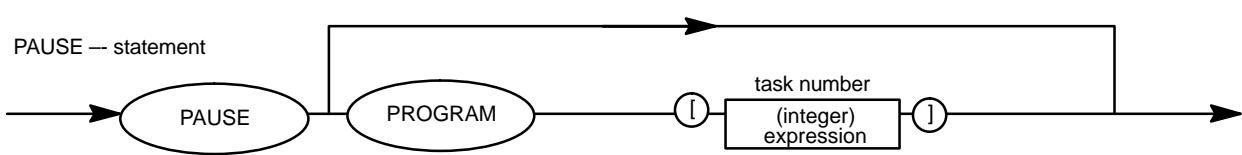
OPEN FILE -- statement



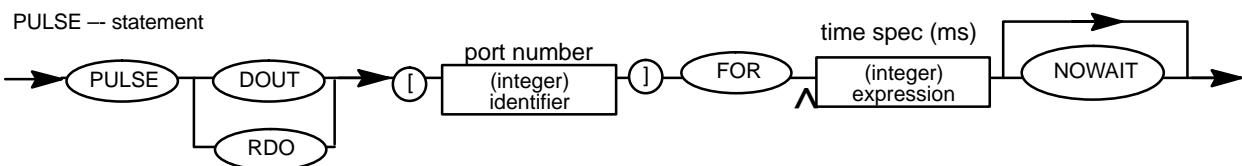
OPEN HAND -- statement



PAUSE -- statement



PULSE -- statement



PURGE -- statement

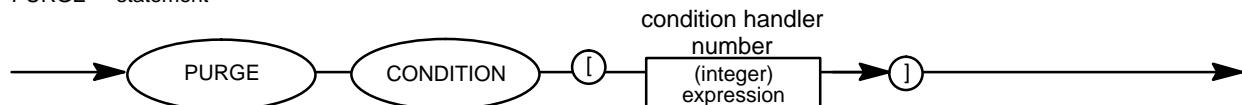
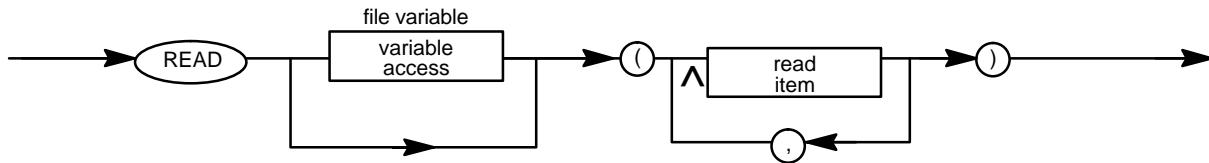
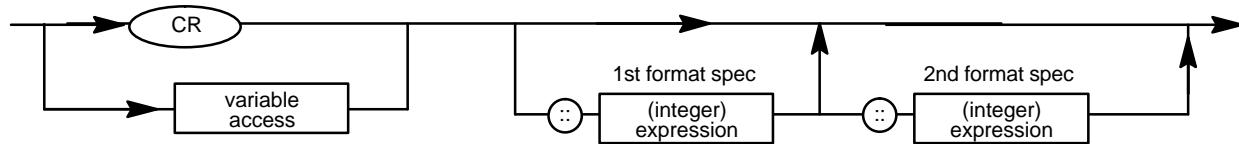


Figure E-18.

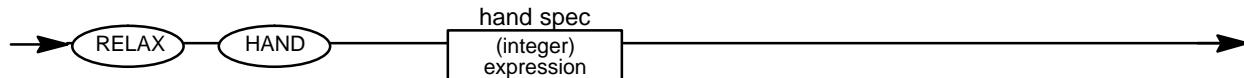
READ — statement



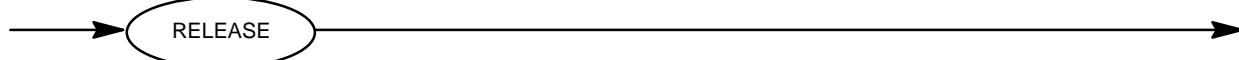
read item — statement



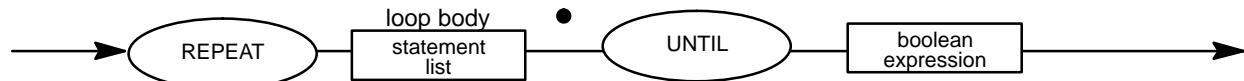
RELAX — statement



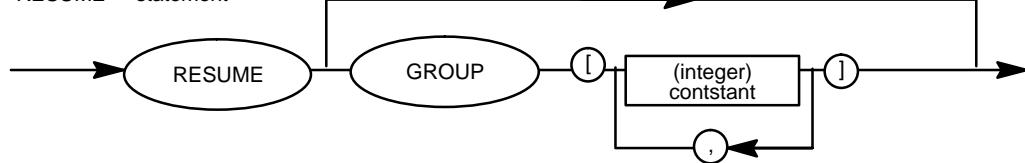
RELEASE — statement



REPEAT — statement

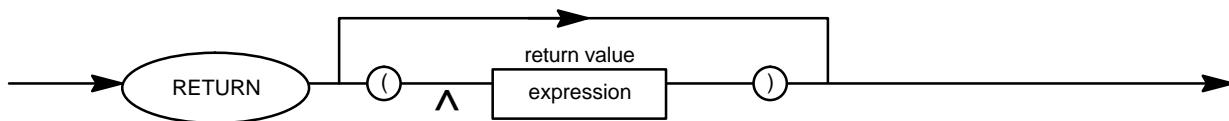


RESUME — statement

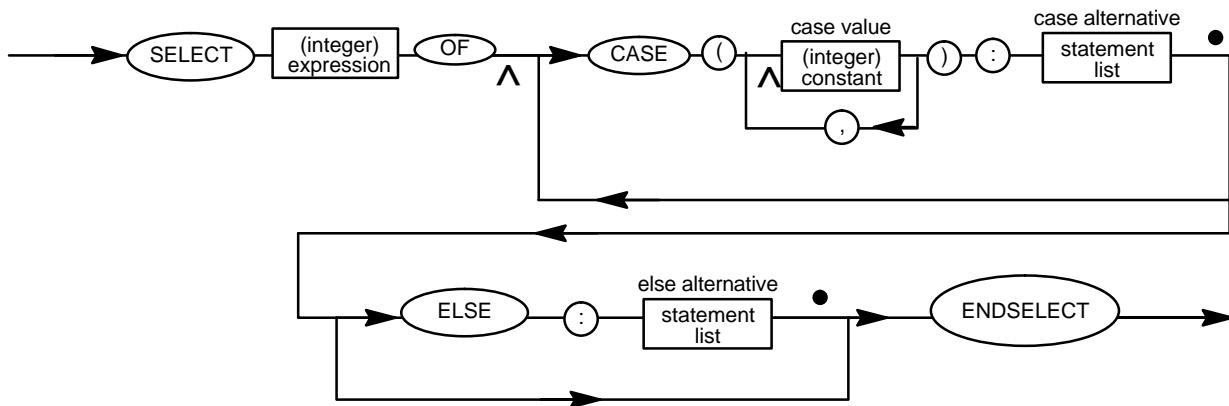


**Figure E-19.**

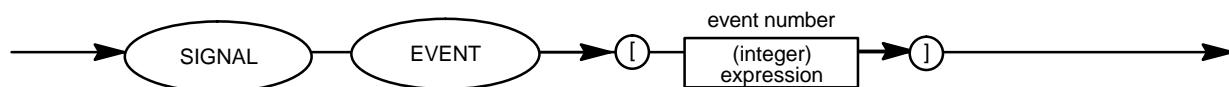
RETURN — statement



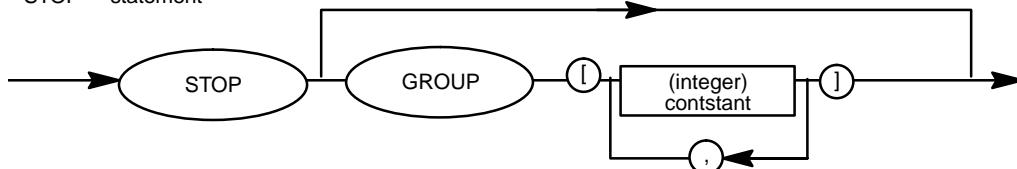
SELECT — statement



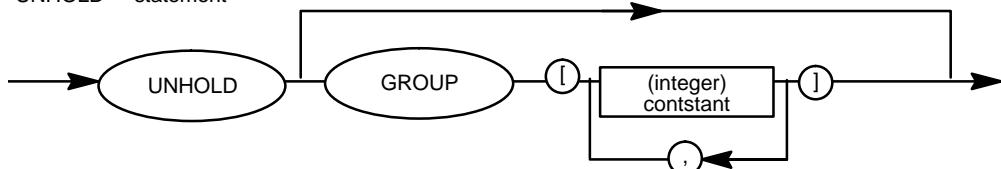
SIGNAL — statement



STOP — statement



UNHOLD — statement



USING — statement

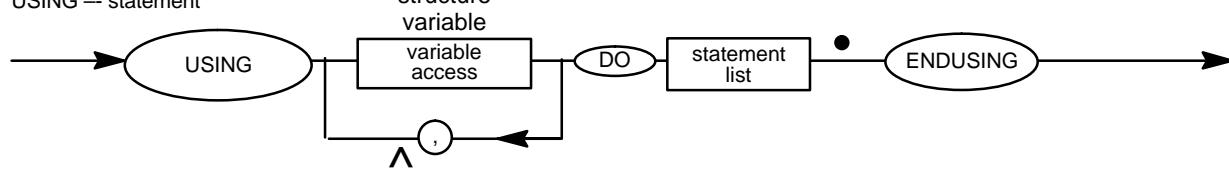
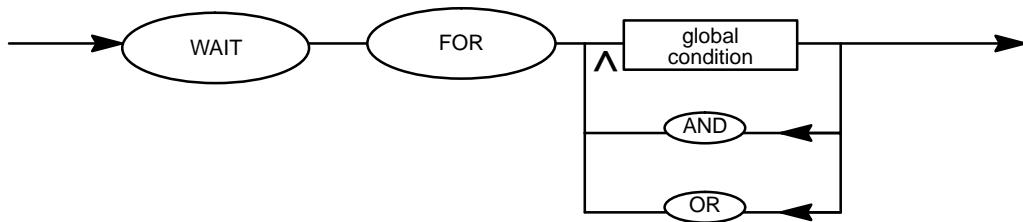


Figure E-20.

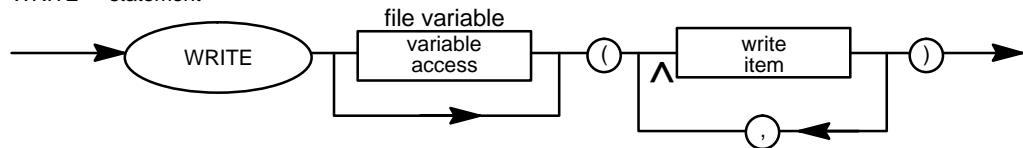
WAIT -- statement



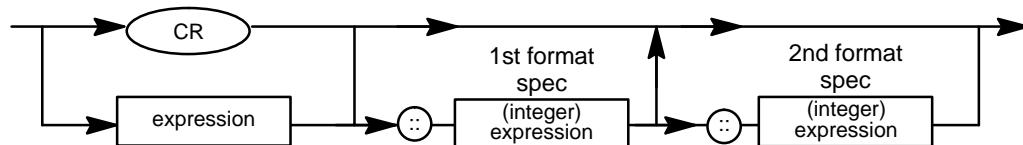
WHILE -- statement



WRITE -- statement



write item



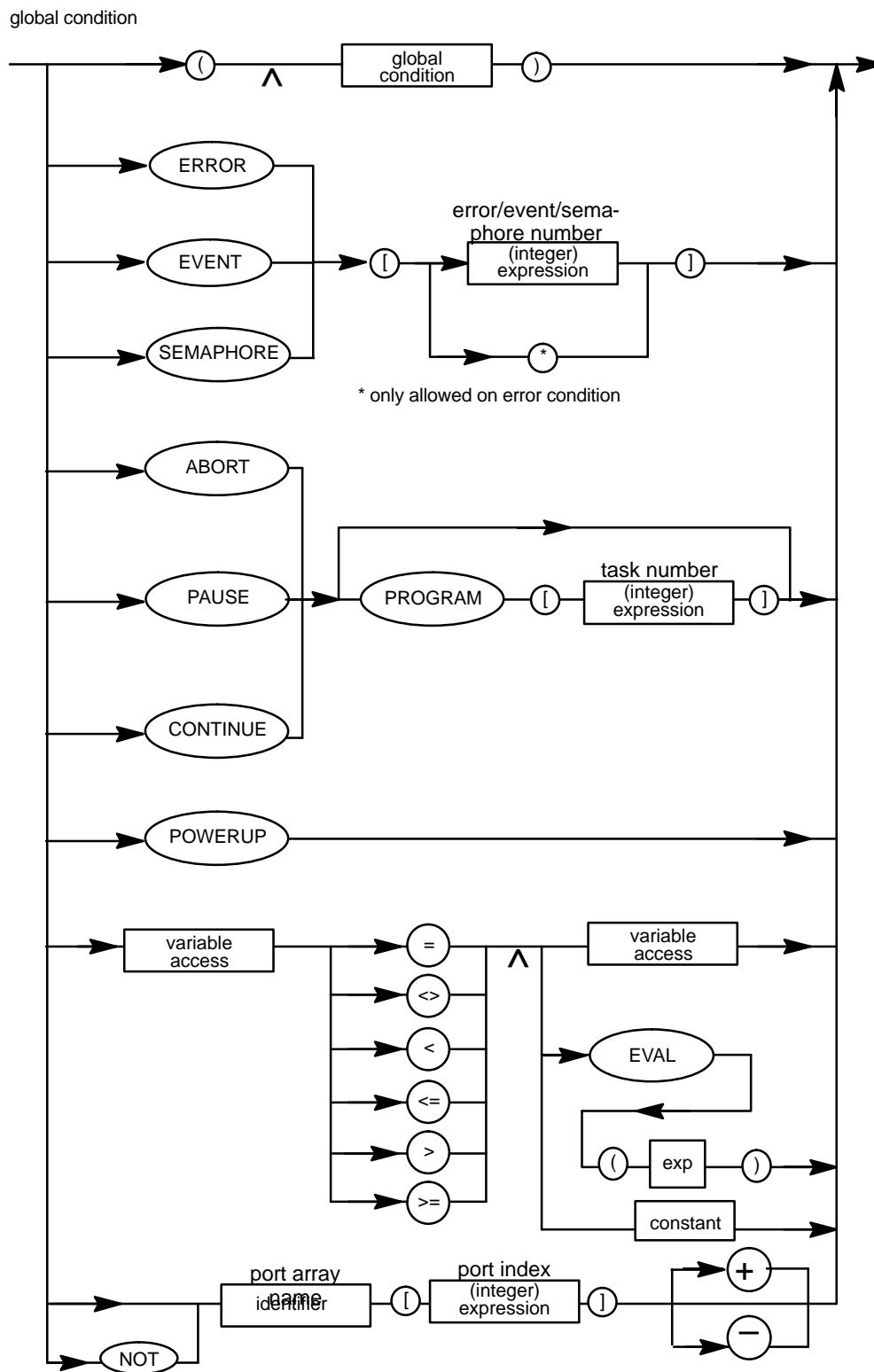
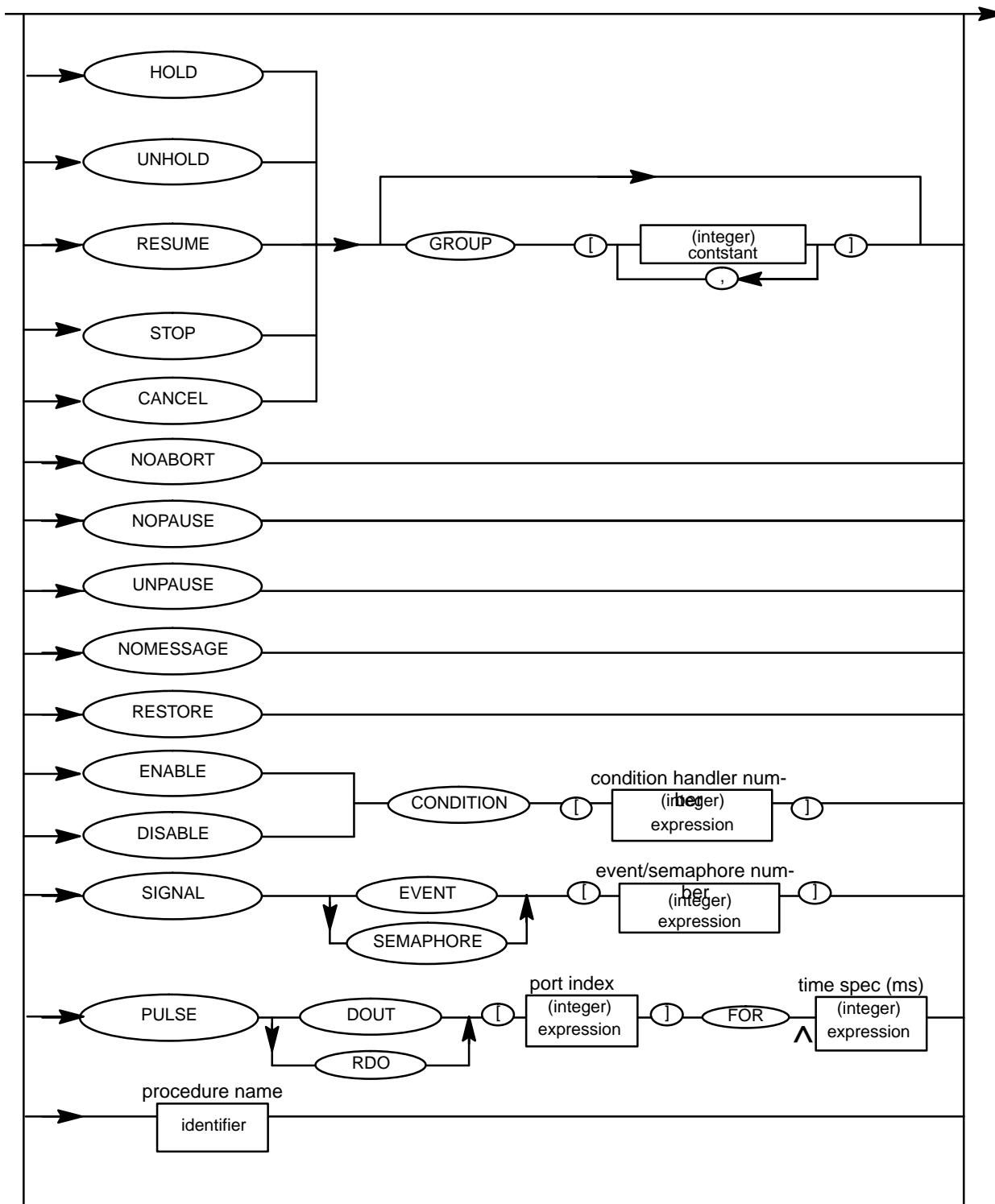
**Figure E-21.**

Figure E-22.

condition handler action



**Figure E-23.**

condition handler action continued

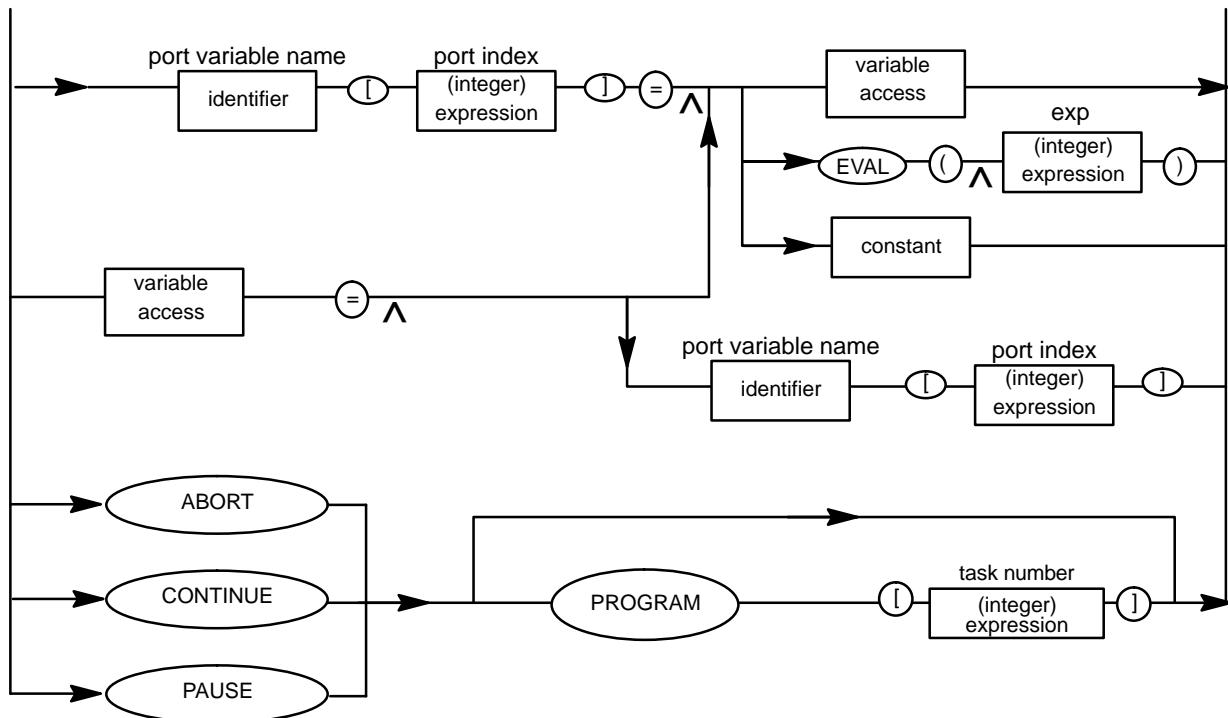
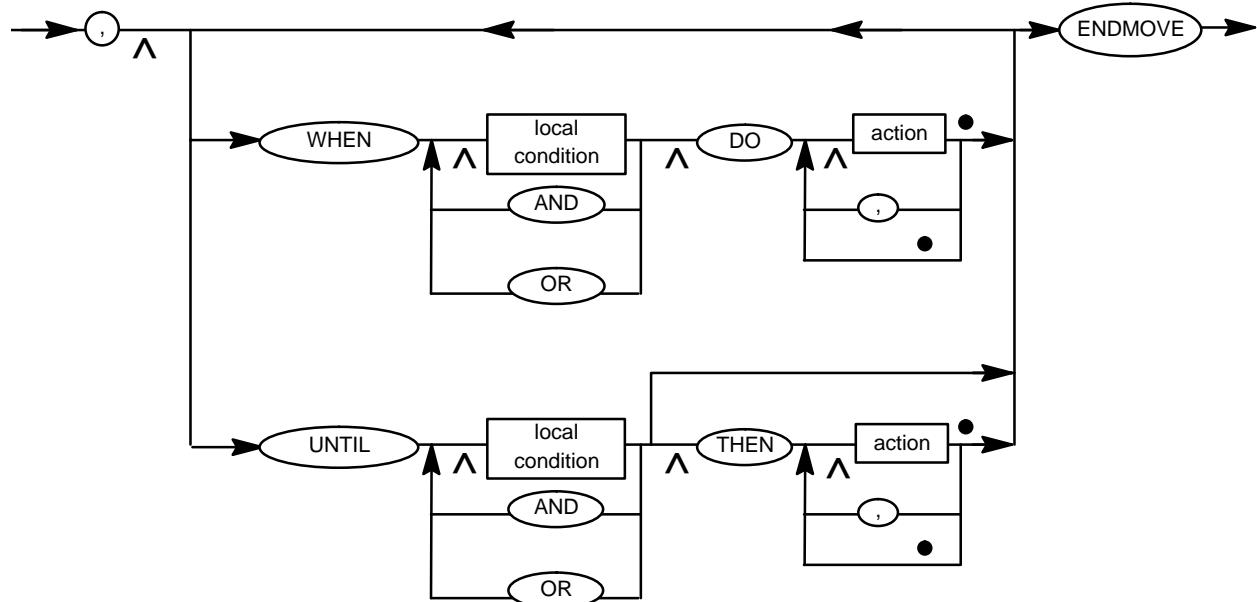
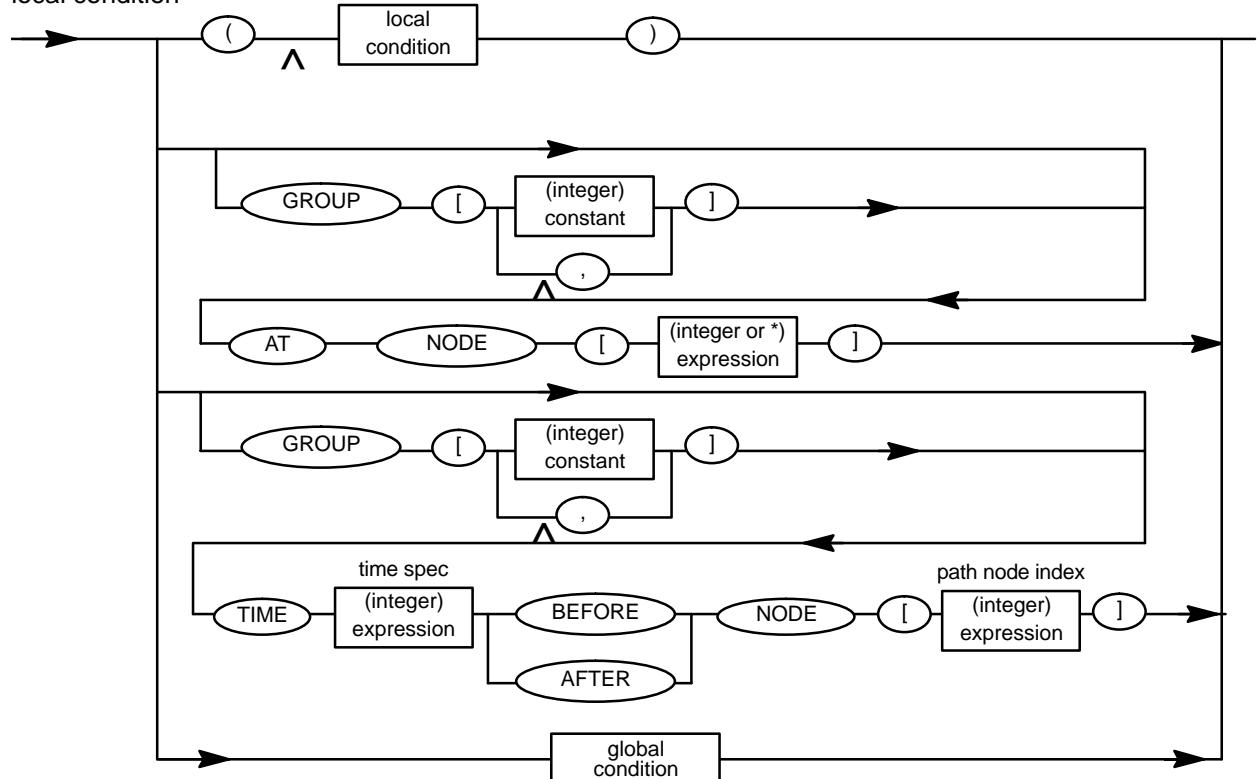


Figure E-24.

local condition handler clause

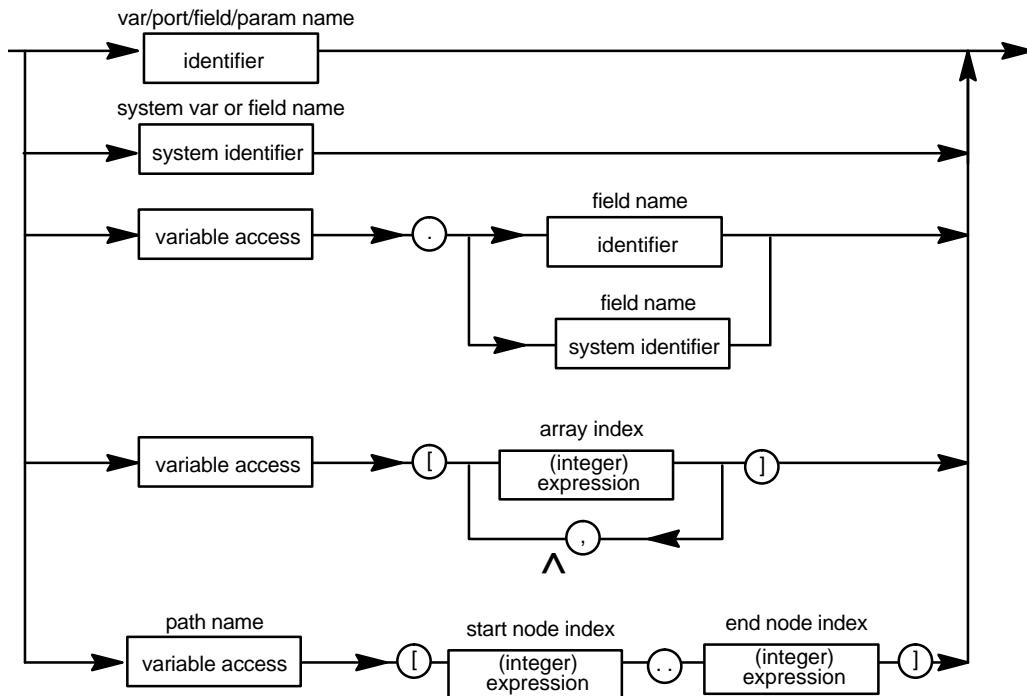


local condition



**Figure E-25.**

variable access



expression

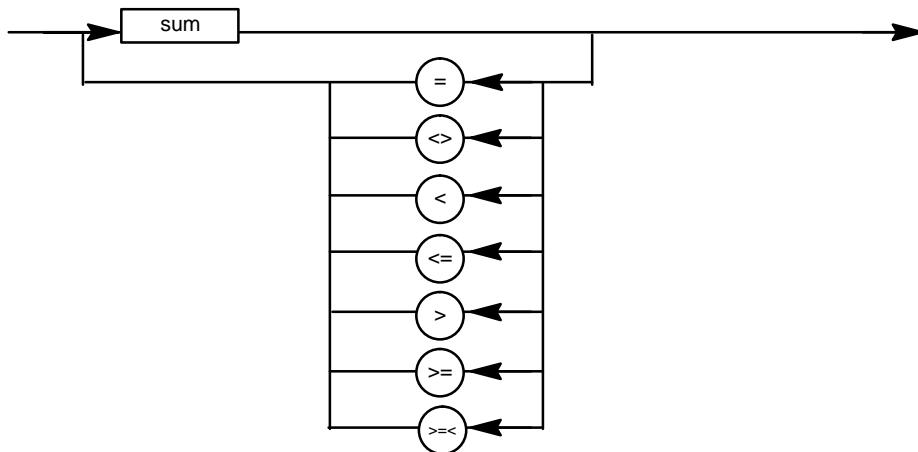
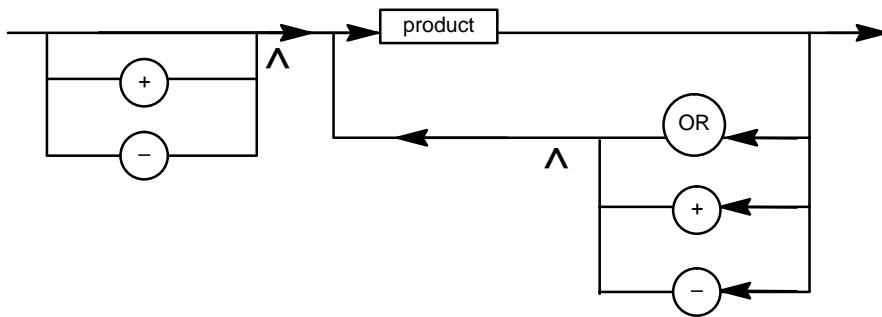
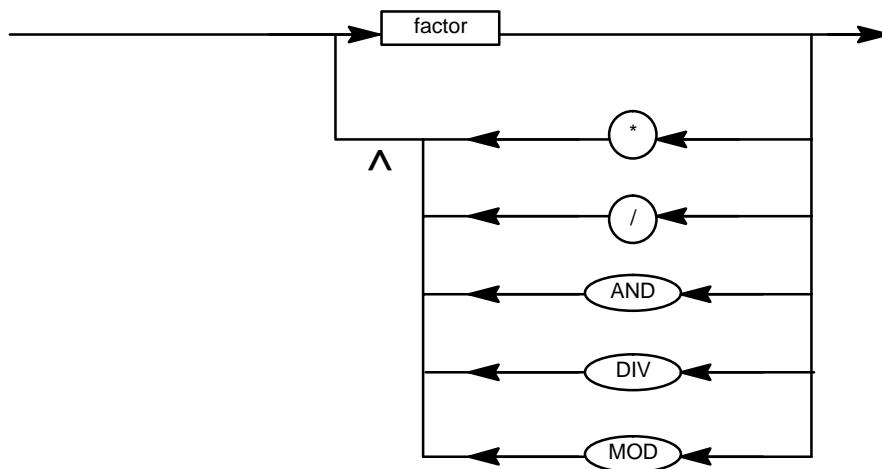


Figure E-26.

sum



product



factor

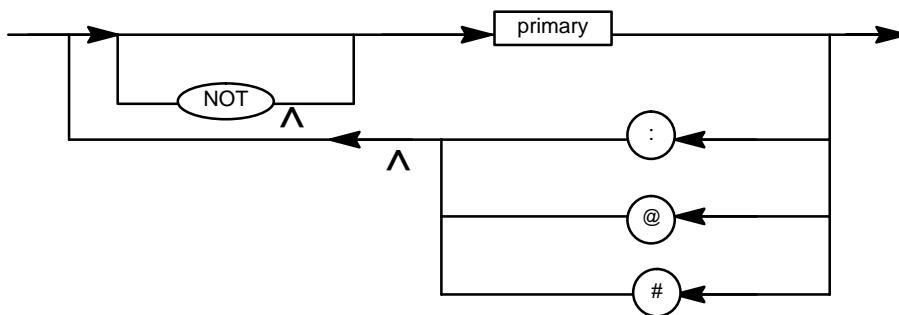
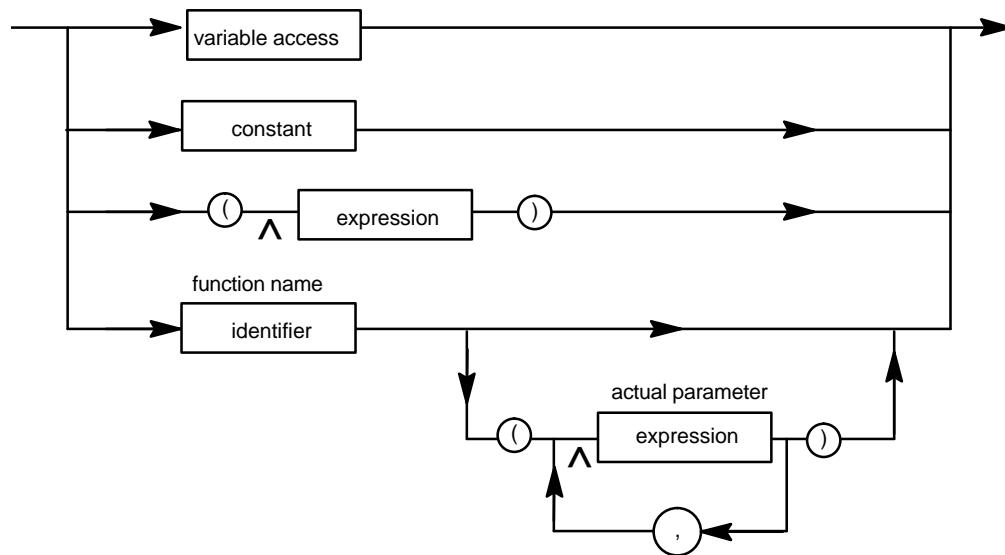


Figure E-27.

primary



literal

