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## ***Introduction***

## Introduction

This is a reference manual containing a detailed explanation of the programming language as well as all *data types*, *instructions* and *functions*. If you are programming off-line, this manual will be particularly useful in this respect.

When you start to program the robot it is normally better to start with the User's Guide until you are familiar with the system.

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### 1 Other Manuals

Before using the robot for the first time, you should read *Basic Operation*. This will provide you with the basics of operating the robot.

*The User's Guide* provides step-by-step instructions on how to perform various tasks, such as how to move the robot manually, how to program, or how to start a program when running production.

*The Product Manual* describes how to install the robot, as well as maintenance procedures and troubleshooting. This manual also contains a *Product Specification* which provides an overview of the characteristics and performance of the robot.

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### 2 How to Read this Manual

To answer the questions *Which instruction should I use?* or *What does this instruction mean?*, see *Chapter 3: RAPID Summary*. This chapter briefly describes all instructions, functions and data types grouped in accordance with the instruction pick-lists you use when programming. It also includes a summary of the syntax, which is particularly useful when programming off-line.

*Chapter 5: Basic Characteristics* explains the inner details of the language. You would not normally read this chapter unless you are an experienced programmer.

*Chapter 6: Motion and I/O Principles* describes the various coordinate systems of the robot, its velocity and other motion characteristics during different types of execution.

*Chapters 7-9* describe all *data types*, *instructions* and *functions*. They are described in alphabetical order for your convenience.

This manual describes all the data and programs provided with the robot on delivery. In addition to these, there are a number of predefined data and programs supplied with the robot, either on diskette or, or sometimes already loaded. *Chapter 10: Predefined Data and Programs* describes what happens when these are loaded into the robot.

If you program off-line, you will find some tips in *Chapter 11: Programming off-line*.

*Chapter 13-15* describes the functionality when the robot is equipped with Process-

## Introduction

Ware, i.e. ArcWare, SpotWare and GlueWare.

If you want to find out what a particular menu command does, you should refer to *Chapter 18: Quick Reference*. This chapter can also be used as a pocket guide when you are working with the robot.

To make things easier to locate and understand, *Chapter 20* contains an *index* and a *glossary*.

If the robot is delivered or upgraded with some extra functionality, this is described in *Chapter 19: Special Functionality in this Robot*.

---

### 2.1 Typographic conventions

The commands located under any of the five menu keys at the top of the teach pendant display are written in the form of **Menu: Command**. For example, to activate the Print command in the File menu, you choose **File: Print**.

The names on the function keys and in the entry fields are specified in bold italic typeface, e.g. ***Modpos***.

Words belonging to the actual programming language, such as instruction names, are written in italics, e.g. *MoveL*.

Examples of programs are always displayed in the same way as they are output to a diskette or printer. This differs from what is displayed on the teach pendant in the following ways:

- Certain control words that are masked in the teach pendant display are printed, e.g. words indicating the start and end of a routine.
- Data and routine declarations are printed in the formal form, e.g. *VAR num reg1;*

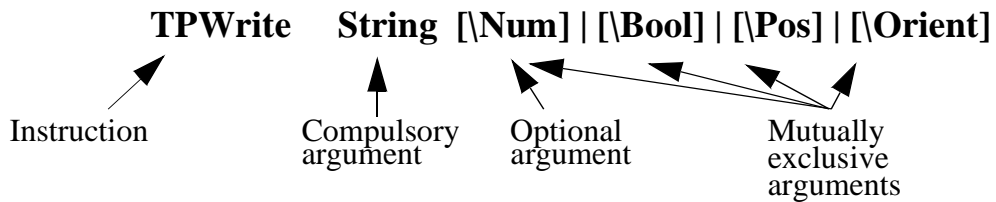
---

### 2.2 Syntax rules

Instructions and functions are described using both simplified syntax and formal syntax. If you use the teach pendant to program, you generally only need to know the simplified syntax, since the robot automatically makes sure that the correct syntax is used.

*Simplified syntax*

Example:



- Optional arguments are enclosed in square brackets [ ]. These arguments can be omitted.
- Arguments that are mutually exclusive, i.e. cannot exist in the instruction at the same time, are separated by a vertical bar |.
- Arguments that can be repeated an arbitrary number of times are enclosed in braces { }.

**2.3 Formal syntax**

Example:

```
TPWrite
[String :=] <expression (IN) of string>
['\Num' := <expression (IN) of num> ] |
['\Bool' := <expression (IN) of bool> ] |
['\Pos' := <expression (IN) of pos> ] |
['\Orient' := <expression (IN) of orient> ]';'
```

- The text within the square brackets [ ] may be omitted.
- Arguments that are mutually exclusive, i.e. cannot exist in the instruction at the same time, are separated by a vertical bar |.
- Arguments that can be repeated an arbitrary number of times are enclosed in braces { }.
- Symbols that are written in order to obtain the correct syntax are enclosed in single quotation marks (apostrophes) ' '.
- The data type of the argument (italics) and other characteristics are enclosed in angle brackets < >. See the description of the parameters of a routine for more detailed information.

The basic elements of the language and certain instructions are written using a special syntax, EBNF. This is based on the same rules, but with some additions.

Example:

```
GOTO <identifier>';'
<identifier> ::= <ident>
                | <ID>
<ident> ::= <letter> {<letter> | <digit> | ' _ '}
```

- The symbol ::= means *is defined as*.
- Text enclosed in angle brackets < > is defined in a separate line.

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## ***RAPID Summary***

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## 1 The Structure of the Language

The program consists of a number of instructions which describe the work of the robot. Thus, there are specific instructions for the various commands, such as one to move the robot, one to set an output, etc.

The instructions generally have a number of associated arguments which define what is to take place in a specific instruction. For example, the instruction for resetting an output contains an argument which defines which output is to be reset; e.g. *Reset do5*. These arguments can be specified in one of the following ways:

- as a numeric value, e.g. *5* or *4.6*
- as a reference to data, e.g. *reg1*
- as an expression, e.g. *5+reg1\*2*
- as a function call, e.g. *Abs(reg1)*
- as a string value, e.g. *"Producing part A"*

There are three types of routines – *procedures*, *functions* and *trap routines*.

- A procedure is used as a subprogram.
- A function returns a value of a specific type and is used as an argument of an instruction.
- Trap routines provide a means of responding to interrupts. A trap routine can be associated with a specific interrupt; e.g. when an input is set, it is automatically executed if that particular interrupt occurs.

Information can also be stored in data, e.g. tool data (which contains all information on a tool, such as its TCP and weight) and numerical data (which can be used, for example, to count the number of parts to be processed). Data is grouped into different data types which describe different types of information, such as tools, positions and loads. As this data can be created and assigned arbitrary names, there is no limit (except that imposed by memory) on the number of data. These data can exist either globally in the program or locally within a routine.

There are three kinds of data – *constants*, *variables* and *persistents*.

- A constant represents a static value and can only be assigned a new value manually.
- A variable can also be assigned a new value during program execution.
- A persistent can be described as a “persistent” variable. When a program is saved the initialization value reflects the current value of the persistent.

Other features in the language are:

- Routine parameters
- Arithmetic and logical expressions
- Automatic error handling
- Modular programs
- Multi tasking

---



---

## 2 Controlling the Program Flow

The program is executed sequentially as a rule, i.e. instruction by instruction. Sometimes, instructions which interrupt this sequential execution and call another instruction are required to handle different situations that may arise during execution.

---

### 2.1 Programming principles

The program flow can be controlled according to five different principles:

- By calling another routine (procedure) and, when that routine has been executed, continuing execution with the instruction following the routine call.
- By executing different instructions depending on whether or not a given condition is satisfied.
- By repeating a sequence of instructions a number of times or until a given condition is satisfied.
- By going to a label within the same routine.
- By stopping program execution.

---

### 2.2 Calling another routine

<u>Instruction</u>	<u>Used to:</u>
<i>ProcCall</i>	Call (jump to) another routine
<i>CallByVar</i>	Call procedures with specific names
<i>RETURN</i>	Return to the original routine

---

### 2.3 Program control within the routine

<u>Instruction</u>	<u>Used to:</u>
<i>Compact IF</i>	Execute one instruction only if a condition is satisfied
<i>IF</i>	Execute a sequence of different instructions depending on whether or not a condition is satisfied
<i>FOR</i>	Repeat a section of the program a number of times
<i>WHILE</i>	Repeat a sequence of different instructions as long as a given condition is satisfied
<i>TEST</i>	Execute different instructions depending on the value of an expression
<i>GOTO</i>	Jump to a label
<i>label</i>	Specify a label (line name)

---

## 2.4 Stopping program execution

<u>Instruction</u>	<u>Used to:</u>
<i>Stop</i>	Stop program execution
<i>EXIT</i>	Stop program execution when a program restart is not allowed
<i>Break</i>	Stop program execution temporarily for debugging purposes

---

## 2.5 Stop current cycle

<u>Instruction</u>	<u>Used to:</u>
<i>Exit cycle</i>	Stop the current cycle and move the program pointer to the first instruction in the main routine. When the execution mode <i>CONT</i> is selected, execution will continue with the next program cycle.

---



---

## 3 Various Instructions

Various instructions are used to

- assign values to data
- wait a given amount of time or wait until a condition is satisfied
- insert a comment into the program
- load program modules.

---

### 3.1 Assigning a value to data

Data can be assigned an arbitrary value. It can, for example, be initialized with a constant value, e.g. 5, or updated with an arithmetic expression, e.g.  $reg1+5*reg3$ .

<u>Instruction</u>	<u>Used to:</u>
<code>:=</code>	Assign a value to data

---

### 3.2 Wait

The robot can be programmed to wait a given amount of time, or to wait until an arbitrary condition is satisfied; for example, to wait until an input is set.

<u>Instruction</u>	<u>Used to:</u>
<code>WaitTime</code>	Wait a given amount of time or to wait until the robot stops moving
<code>WaitUntil</code>	Wait until a condition is satisfied
<code>WaitDI</code>	Wait until a digital input is set
<code>WaitDO</code>	Wait until a digital output is set

---

### 3.3 Comments

Comments are only inserted into the program to increase its readability. Program execution is not affected by a comment.

<u>Instruction</u>	<u>Used to:</u>
<code>comment</code>	Comment on the program

---

### 3.4 Loading program modules

Program modules can be loaded from mass memory or erased from the program memory. In this way large programs can be handled with only a small memory.

<u>Instruction</u>	<u>Used to:</u>
<i>Load</i>	Load a program module into the program memory
<i>UnLoad</i>	Unload a program module from the program memory

---

### 3.5 Various functions

<u>Function</u>	<u>Used to:</u>
<i>OpMode</i>	Read the current operating mode of the robot
<i>RunMode</i>	Read the current program execution mode of the robot
<i>Dim</i>	Obtain the dimensions of an array
<i>Present</i>	Find out whether an optional parameter was present when a routine call was made
<i>IsPers</i>	Check whether a parameter is a persistent
<i>IsVar</i>	Check whether a parameter is a variable

---

### 3.6 Basic data

<u>Data type</u>	<u>Used to define:</u>
<i>bool</i>	Logical data (with the values true or false)
<i>num</i>	Numeric values (decimal or integer)
<i>symnum</i>	Numeric data with symbolic value
<i>string</i>	Character strings
<i>switch</i>	Routine parameters without value

---

### 3.7 Conversion function

<u>Function</u>	<u>Used to:</u>
<i>StrToByte</i>	Convert a byte to a string data with a defined byte data format.
<i>ByteToStr</i>	Convert a string with a defined byte data format to a byte data.

---

---

## 4 Motion Settings

Some of the motion characteristics of the robot are determined using logical instructions that apply to all movements:

- Maximum velocity and velocity override
- Acceleration
- Management of different robot configurations
- Payload
- Behaviour close to singular points
- Program displacement
- Soft servo
- Tuning values

---

### 4.1 Programming principles

The basic characteristics of the robot motion are determined by data specified for each positioning instruction. Some data, however, is specified in separate instructions which apply to all movements until that data changes.

The general motion settings are specified using a number of instructions, but can also be read using the system variable *C\_MOTSET* or *C\_PROGDISP*.

Default values are automatically set (by executing the routine *SYS\_RESET* in system module BASE)

- at a cold start-up,
- when a new program is loaded,
- when the program is started from the beginning.

---

### 4.2 Defining velocity

The absolute velocity is programmed as an argument in the positioning instruction. In addition to this, the maximum velocity and velocity override (a percentage of the programmed velocity) can be defined.

<u>Instruction</u>	<u>Used to define:</u>
<i>VelSet</i>	The maximum velocity and velocity override

---

### 4.3 Defining acceleration

When fragile parts, for example, are handled, the acceleration can be reduced for part of the program.

<u>Instruction</u>	<u>Used to define:</u>
<i>AccSet</i>	The maximum acceleration

---

### 4.4 Defining configuration management

The robot's configuration is normally checked during motion. If joint (axis-by-axis) motion is used, the correct configuration will be achieved. If linear or circular motion are used, the robot will always move towards the closest configuration, but a check is performed to see if it is the same as the programmed one. It is possible to change this, however.

<u>Instruction</u>	<u>Used to define:</u>
<i>ConfJ</i>	Configuration control on/off during joint motion
<i>ConfL</i>	Configuration check on/off during linear motion

---

### 4.5 Defining the payload

To achieve the best robot performance, the correct payload must be defined.

<u>Instruction</u>	<u>Used to define:</u>
<i>GripLoad</i>	The payload of the gripper

---

### 4.6 Defining the behaviour near singular points

The robot can be programmed to avoid singular points by changing the tool orientation automatically.

<u>Instruction</u>	<u>Used to define:</u>
<i>SingArea</i>	The interpolation method through singular points



---

## 4.7 Displacing a program

When part of the program must be displaced, e.g. following a search, a program displacement can be added.

<u>Instruction</u>	<u>Used to:</u>
<i>PDispOn</i>	Activate program displacement
<i>PDispSet</i>	Activate program displacement by specifying a value
<i>PDispOff</i>	Deactivate program displacement
<i>EOffsOn</i>	Activate an external axis offset
<i>EOffsSet</i>	Activate an external axis offset by specifying a value
<i>EOffsOff</i>	Deactivate an external axis offset
<u>Function</u>	<u>Used to:</u>
<i>DefDFrame</i>	Calculate a program displacement from three positions
<i>DefFrame</i>	Calculate a program displacement from six positions
<i>ORobT</i>	Remove program displacement from a position

---

## 4.8 Soft servo

One or more of the robot axes can be made “soft”. When using this function, the robot will be compliant and can replace, for example, a spring tool.

<u>Instruction</u>	<u>Used to:</u>
<i>SoftAct</i>	Activate the soft servo for one or more axes
<i>SoftDeact</i>	Deactivate the soft servo

---

## 4.9 Adjust the robot tuning values

In general, the performance of the robot is self-optimising; however, in certain extreme cases, overrunning, for example, can occur. You can adjust the robot tuning values to obtain the required performance.

<u>Instruction</u>	<u>Used to:</u>
<i>TuneServo</i>	Adjust the robot tuning values
<i>TuneReset</i>	Reset tuning to normal
<i>PathResol</i>	Adjust the geometric path resolution
<u>Data type</u>	<u>Used to:</u>
<i>tunetype</i>	Represent the tuning type as a symbolic constant

---

## 4.10 World Zones

Up to 10 different volumes can be defined within the working area of the robot. These can be used for:

- Indicating that the robot's TCP is a definite part of the working area.
- Delimiting the working area for the robot and preventing a collision with the tool.
- Creating a working area common to two robots. The working area is then available only to one robot at a time.

<u>Instruction</u>	<u>Used to:</u>
<i>WZBoxDef<sup>1</sup></i>	Define a box-shaped global zone
<i>WZCylDef<sup>1</sup></i>	Define a cylindrical global zone
<i>WZSphDef</i>	Define a spherical global zone
<i>WZLimSup<sup>1</sup></i>	Activate limit supervision for a global zone
<i>WZDOSet<sup>1</sup></i>	Activate global zone to set digital outputs
<i>WZDisable<sup>1</sup></i>	Deactivate supervision of a temporary global zone
<i>WZEnable<sup>1</sup></i>	Activate supervision of a temporary global zone
<i>WZFree<sup>1</sup></i>	Erase supervision of a temporary global zone
<u>Data type</u>	<u>Used to:</u>
<i>wztemporary</i>	Identify a temporary global zone
<i>wzstationary</i>	Identify a stationary global zone
<i>shapedata</i>	Describe the geometry of a global zone

---

## 4.11 Data for motion settings

<u>Data type</u>	<u>Used to define:</u>
<i>motsetdata</i>	Motion settings except program displacement
<i>progdisp</i>	Program displacement

---

1. Only when the robot is equipped with the option "Advanced functions"

---

---

## 5 Motion

The robot movements are programmed as pose-to-pose movements, i.e. “move from the current position to a new position”. The path between these two positions is then automatically calculated by the robot.

---

### 5.1 Programming principles

The basic motion characteristics, such as the type of path, are specified by choosing the appropriate positioning instruction.

The remaining motion characteristics are specified by defining data which are arguments of the instruction:

- Position data (end position for robot and external axes)
- Speed data (desired speed)
- Zone data (position accuracy)
- Tool data (e.g. the position of the TCP)
- Work-object data (e.g. the current coordinate system)

Some of the motion characteristics of the robot are determined using logical instructions which apply to all movements (See *Motion Settings* on page 10):

- Maximum velocity and velocity override
- Acceleration
- Management of different robot configurations
- Payload
- Behaviour close to singular points
- Program displacement
- Soft servo
- Tuning values

Both the robot and the external axes are positioned using the same instructions. The external axes are moved at a constant velocity, arriving at the end position at the same time as the robot.

---

## 5.2 Positioning instructions

<u>Instruction</u>	<u>Type of movement:</u>
<i>MoveC</i>	TCP moves along a circular path
<i>MoveJ</i>	Joint movement
<i>MoveL</i>	TCP moves along a linear path
<i>MoveAbsJ</i>	Absolute joint movement

---

## 5.3 Searching

During the movement, the robot can search for the position of a work object, for example. The searched position (indicated by a sensor signal) is stored and can be used later to position the robot or to calculate a program displacement.

<u>Instruction</u>	<u>Type of movement:</u>
<i>SearchC</i>	TCP along a circular path
<i>SearchL</i>	TCP along a linear path

---

## 5.4 Activating outputs or interrupts at specific positions

Normally, logical instructions are executed in the transition from one positioning instruction to another. If, however, special motion instructions are used, these can be executed instead when the robot is at a specific position.

<u>Instruction</u>	<u>Used to:</u>
<i>TriggIO</i> <sup>1</sup>	Define a trigg condition to set an output at a given position
<i>TriggInt</i> <sup>1</sup>	Define a trigg condition to execute a trap routine at a given position
<i>TriggEquip</i> <sup>1</sup>	Define a trigg condition to set an output at a given position with the possibility to include time compensation for the lag in the external equipment
<i>TriggC</i> <sup>1</sup>	Run the robot (TCP) circularly with an activated trigg condition
<i>TriggJ</i> <sup>1</sup>	Run the robot axis-by-axis with an activated trigg condition
<i>TriggL</i> <sup>1</sup>	Run the robot (TCP) linearly with an activated trigg condition
<u>Data type</u>	<u>Used to define:</u>
<i>triggdata</i> <sup>1</sup>	Trigg conditions

---

1. Only if the robot is equipped with the option “Advanced functions”

---

## 5.5 Motion control if an error/interrupt takes place

In order to rectify an error or an interrupt, motion can be stopped temporarily and then restarted again.

<u>Instruction</u>	<u>Used to:</u>
<i>StopMove</i>	Stop the robot movements
<i>StartMove</i>	Restart the robot movements
<i>StorePath</i> <sup>1</sup>	Store the last path generated
<i>RestoPath</i> <sup>1</sup>	Regenerate a path stored earlier

1. Only if the robot is equipped with the option “Advanced Functions”.

---

## 5.6 Controlling external axes

The robot and external axes are usually positioned using the same instructions. Some instructions, however, only affect the external axis movements.

<u>Instruction</u>	<u>Used to:</u>
<i>DeactUnit</i>	Deactivate an external mechanical unit
<i>ActUnit</i>	Activate an external mechanical unit

---

## 5.7 Independent axes

The robot axis 6 (and 4 on IRB 2400 /4400) or an external axis can be moved independently of other movements. The working area of an axis can also be reset, which will reduce the cycle times.

<u>Function</u>	<u>Used to:</u>
<i>IndAMove</i> <sup>2</sup>	Change an axis to independent mode and move the axis to an absolute position
<i>IndCMove</i> <sup>2</sup>	Change an axis to independent mode and start the axis moving continuously
<i>IndDMove</i> <sup>2</sup>	Change an axis to independent mode and move the axis a delta distance
<i>IndRMove</i> <sup>2</sup>	Change an axis to independent mode and move the axis to a relative position (within the axis revolution)
<i>IndReset</i> <sup>2</sup>	Change an axis to dependent mode or/and reset the working area
<i>IndInpos</i> <sup>2</sup>	Check whether an independent axis is in position
<i>IndSpeed</i> <sup>2</sup>	Check whether an independent axis has reached programmed speed

2. Only if the robot is equipped with the option “Advanced Motion”.

---

## 5.8 Position functions

<u>Function</u>	<u>Used to:</u>
<i>Offs</i>	Add an offset to a robot position, expressed in relation to the work object
<i>RelTool</i>	Add an offset, expressed in the tool coordinate system
<i>CPos</i>	Read the current position (only <i>x</i> , <i>y</i> , <i>z</i> of the robot)
<i>CRobT</i>	Read the current position (the complete <i>robtargt</i> )
<i>CJointT</i>	Read the current joint angles
<i>ReadMotor</i>	Read the current motor angles
<i>CTool</i>	Read the current tooldata value
<i>CWObj</i>	Read the current wobjdata value
<i>ORobT</i>	Remove a program displacement from a position
<i>MirPos</i>	Mirror a position

---

## 5.9 Motion data

Motion data is used as an argument in the positioning instructions.

<u>Data type</u>	<u>Used to define:</u>
<i>robtargt</i>	The end position
<i>jointtargt</i>	The end position for a <i>MoveAbsJ</i> instruction
<i>speeddata</i>	The speed
<i>zonedata</i>	The accuracy of the position (stop point or fly-by point)
<i>tooldata</i>	The tool coordinate system and the load of the tool
<i>wobjdata</i>	The work object coordinate system

---

## 5.10 Basic data for movements

<u>Data type</u>	<u>Used to define:</u>
<i>pos</i>	A position (x, y, z)
<i>orient</i>	An orientation
<i>pose</i>	A coordinate system (position + orientation)
<i>confdata</i>	The configuration of the robot axes
<i>extjoint</i>	The position of the external axes
<i>robjoint</i>	The position of the robot axes
<i>o_robtarget</i>	Original robot position when <i>Limit ModPos</i> is used
<i>o_jointtarget</i>	Original robot position when <i>Limit ModPos</i> is used for <i>MoveAbsJ</i>
<i>loaddata</i>	A load
<i>mecunit</i>	An external mechanical unit

---



---

## 6 Input and Output Signals

The robot can be equipped with a number of digital and analog user signals that can be read and changed from within the program.

---

### 6.1 Programming principles

The signal names are defined in the system parameters and, using these names, can be read from the program.

The value of an analog signal or a group of digital signals is specified as a numeric value.

---

### 6.2 Changing the value of a signal

<u>Instruction</u>	<u>Used to:</u>
<i>InvertDO</i>	Invert the value of a digital output signal
<i>PulseDO</i>	Generate a pulse on a digital output signal
<i>Reset</i>	Reset a digital output signal (to 0)
<i>Set</i>	Set a digital output signal (to 1)
<i>SetAO</i>	Change the value of an analog output signal
<i>SetDO</i>	Change the value of a digital output signal (symbolic value; e.g. <i>high/low</i> )
<i>SetGO</i>	Change the value of a group of digital output signals

---

### 6.3 Reading the value of an input signal

The value of an input signal can be read directly, e.g. IF di1=1 THEN ...

---

### 6.4 Reading the value of an output signal

<u>Function</u>	<u>Used to read:</u>
<i>DOutput</i>	The value of a digital output signal
<i>GOutput</i>	The value of a group of digital output signals
<i>AOutput</i>	The current value from an analog output signal



### 6.5 Testing input on output signals

<u>Instruction</u>	<u>Used to:</u>
WaitDI	Wait until a digital input is set or reset
WaitDO	Wait until a digital output is set on reset
<u>Function</u>	<u>Used to:</u>
TestDI	Test whether a digital input is set

### 6.6 Disabling and enabling I/O modules

I/O modules are automatically enabled at start-up, but they can be disabled during program execution and re-enabled later.

<u>Instruction</u>	<u>Used to:</u>
IODisable	Disable an I/O module
IOEnable	Enable an I/O module

### 6.7 Defining input and output signals

<u>Data type</u>	<u>Used to define:</u>
<i>dionum</i>	The symbolic value of a digital signal
<i>signalai</i>	The name of an analog input signal *
<i>signalao</i>	The name of an analog output signal *
<i>signaldi</i>	The name of a digital input signal *
<i>signaldo</i>	The name of a digital output signal *
<i>signalgi</i>	The name of a group of digital input signals *
<i>signalgo</i>	The name of a group of digital output signals *
<u>Instruction</u>	<u>Used to:</u>
<i>AliasIO</i> <sup>1</sup>	Define a signal with an alias name

\* Only to be defined using system parameters.

1. Only if the robot is equipped with the option “Developer’s Functions”

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## 7 Communication

There are four possible ways to communicate via serial channels:

- Messages can be output to the teach pendant display and the user can answer questions, such as about the number of parts to be processed.
- Character-based information can be written to or read from text files on mass memory. In this way, for example, production statistics can be stored and processed later in a PC. Information can also be printed directly on a printer connected to the robot.
- Binary information can be transferred between the robot and a sensor, for example.
- Binary information can be transferred between the robot and another computer, for example, with a link protocol.

---

### 7.1 Programming principles

The decision whether to use character-based or binary information is dependent on how the equipment with which the robot communicates handles that information. A file, for example, can have data that is stored in character-based or binary form.

If communication is required in both directions simultaneously, binary transmission is necessary.

Each serial channel or file used must first be opened. On doing this, the channel/file receives a descriptor that is then used as a reference when reading/writing. The teach pendant can be used at all times and does not need to be opened.

Both text and the value of certain types of data can be printed.

---

### 7.2 Communicating using the teach pendant

<u>Instruction</u>	<u>Used to:</u>
<i>TPErise</i>	Clear the teach pendant operator display
<i>TPWrite</i>	Write text on the teach pendant operator display
<i>ErrWrite</i>	Write text on the teach pendant display and simultaneously store that message in the program's error log.
<i>TPReadFK</i>	Label the function keys and to read which key is pressed
<i>TPReadNum</i>	Read a numeric value from the teach pendant
<i>TPShow</i>	Choose a window on the teach pendant from RAPID

---

### 7.3 Reading from or writing to a character-based serial channel/file

<u>Instruction</u>	<u>Used to:</u>
<i>Open</i> <sup>1</sup>	Open a channel/file for reading or writing
<i>Write</i> <sup>1</sup>	Write text to the channel/file
<i>Close</i> <sup>1</sup>	Close the channel/file

<u>Function</u>	<u>Used to:</u>
<i>ReadNum</i> <sup>1</sup>	Read a numeric value
<i>ReadStr</i> <sup>1</sup>	Read a text string

---

### 7.4 Communicating using binary serial channels/files

<u>Instruction</u>	<u>Used to:</u>
<i>Open</i> <sup>1</sup>	Open a serial channel/file for binary transfer of data
<i>WriteBin</i> <sup>1</sup>	Write to a binary serial channel/file
<i>WriteStrBin</i> <sup>1</sup>	Write a string to a binary serial channel/file
<i>Rewind</i> <sup>1</sup>	Set the file position to the beginning of the file
<i>Close</i> <sup>1</sup>	Close the channel/file

<u>Function</u>	<u>Used to:</u>
<i>ReadBin</i> <sup>1</sup>	Read from a binary serial channel

---

### 7.5 Data for serial channels

<u>Data type</u>	<u>Used to define:</u>
<i>iodev</i>	A reference to a serial channel/file, which can then be used for reading and writing

---

1. Only if the robot is equipped with the option "Advanced functions"

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## 8 Interrupts

Interrupts are used by the program to enable it to deal directly with an event, regardless of which instruction is being run at the time.

The program is interrupted, for example, when a specific input is set to one. When this occurs, the ordinary program is interrupted and a special trap routine is executed. When this has been fully executed, program execution resumes from where it was interrupted.

---

### 8.1 Programming principles

Each interrupt is assigned an interrupt identity. It obtains its identity by creating a variable (of data type *intnum*) and connecting this to a trap routine.

The interrupt identity (variable) is then used to order an interrupt, i.e. to specify the reason for the interrupt. This may be one of the following events:

- An input or output is set to one or to zero.
- A given amount of time elapses after an interrupt is ordered.
- A specific position is reached.

When an interrupt is ordered, it is also automatically enabled, but can be temporarily disabled. This can take place in two ways:

- All interrupts can be disabled. Any interrupts occurring during this time are placed in a queue and then automatically generated when interrupts are enabled again.
- Individual interrupts can be deactivated. Any interrupts occurring during this time are disregarded.

---

### 8.2 Connecting interrupts to trap routines

<u>Instruction</u>	<u>Used to:</u>
CONNECT	Connect a variable (interrupt identity) to a trap routine

### 8.3 Ordering interrupts

<u>Instruction</u>	<u>Used to order:</u>
<i>ISignalDI</i>	An interrupt from a digital input signal
<i>SignalDO</i>	An interrupt from a digital output signal
<i>ITimer</i>	A timed interrupt
<i>TriggInt</i> <sup>1</sup>	A position-fixed interrupt (from the Motion pick list )

### 8.4 Cancelling interrupts

<u>Instruction</u>	<u>Used to:</u>
<i>IDelete</i>	Cancel (delete) an interrupt

### 8.5 Enabling/disabling interrupts

<u>Instruction</u>	<u>Used to:</u>
<i>ISleep</i>	Deactivate an individual interrupt
<i>IWatch</i>	Activate an individual interrupt
<i>IDisable</i>	Disable all interrupts
<i>IEnable</i>	Enable all interrupts

### 8.6 Data type of interrupts

<u>Data type</u>	<u>Used to define:</u>
<i>intnum</i>	The identity of an interrupt

1. Only if the robot is equipped with the option “Advanced functions”

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## 9 Error Recovery

Many of the errors that occur when a program is being executed can be handled in the program, which means that program execution does not have to be interrupted. These errors are either of a type detected by the robot, such as division by zero, or of a type that is detected by the program, such as errors that occur when an incorrect value is read by a bar code reader.

---

### 9.1 Programming principles

When an error occurs, the error handler of the routine is called (if there is one). It is also possible to create an error from within the program and then jump to the error handler.

If the routine does not have an error handler, a call will be made to the error handler in the routine that called the routine in question. If there is no error handler there either, a call will be made to the error handler in the routine that called that routine, and so on until the internal error handler of the robot takes over and outputs an error message and stops program execution.

In the error handler, errors can be handled using ordinary instructions. The system data *ERRNO* can be used to determine the type of error that has occurred. A return from the error handler can then take place in various ways.



In future releases, if the current routine does not have an error handler, the internal error handler of the robot takes over directly. The internal error handler outputs an error message and stops program execution with the program pointer at the faulty instruction.

So, a good rule already in this issue is as follows: if you want to call the error handler of the routine that called the current routine (propagate the error), then:

- Add an error handler in the current routine
- Add the instruction *RAISE* in this error handler.

---

### 9.2 Creating an error situation from within the program

<u>Instruction</u>	<u>Used to:</u>
<i>RAISE</i>	“Create” an error and call the error handler

**9.3 Restarting/returning from the error handler**

<u>Instruction</u>	<u>Used to:</u>
<i>EXIT</i>	Stop program execution in the event of a fatal error
<i>RAISE</i>	Call the error handler of the routine that called the current routine
<i>RETRY</i>	Re-execute the instruction that caused the error
<i>TRYNEXT</i>	Execute the instruction following the instruction that caused the error
<i>RETURN</i>	Return to the routine that called the current routine

---

**9.4 Data for error handling**

<u>Data type</u>	<u>Used to define:</u>
<i>errnum</i>	The reason for the error

---



---

## 10 System & Time

System and time instructions allow the user to measure, inspect and record time.

---

### 10.1 Programming principles

Clock instructions allow the user to use clocks that function as stopwatches. In this way the robot program can be used to time any desired event.

The current time or date can be retrieved in a string. This string can then be displayed to the operator on the teach pendant display or used to time and date-stamp log files.

It is also possible to retrieve components of the current system time as a numeric value. This allows the robot program to perform an action at a certain time or on a certain day of the week.

---

### 10.2 Using a clock to time an event

<u>Instruction</u>	<u>Used to:</u>
<i>ClkReset</i>	Reset a clock used for timing
<i>ClkStart</i>	Start a clock used for timing
<i>ClkStop</i>	Stop a clock used for timing
<u>Function</u>	<u>Used to:</u>
<i>ClkRead</i>	Read a clock used for timing
<u>Data Type</u>	<u>Used for:</u>
<i>clock</i>	Timing – stores a time measurement in seconds

---

### 10.3 Reading current time and date

<u>Function</u>	<u>Used to:</u>
<i>CDate</i>	Read the Current Date as a string
<i>CTime</i>	Read the Current Time as a string
<i>GetTime</i>	Read the Current Time as a numeric value



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## 11 Mathematics

Mathematical instructions and functions are used to calculate and change the value of data.

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### 11.1 Programming principles

Calculations are normally performed using the assignment instruction, e.g.  $reg1 := reg2 + reg3 / 5$ . There are also some instructions used for simple calculations, such as to clear a numeric variable.

---

### 11.2 Simple calculations on numeric data

<u>Instruction</u>	<u>Used to:</u>
<i>Clear</i>	Clear the value
<i>Add</i>	Add or subtract a value
<i>Incr</i>	Increment by 1
<i>Decr</i>	Decrement by 1

---

### 11.3 More advanced calculations

<u>Instruction</u>	<u>Used to:</u>
$:=$	Perform calculations on any type of data

---

## 11.4 Arithmetic functions

<u>Function</u>	<u>Used to:</u>
<i>Abs</i>	Calculate the absolute value
<i>Round</i>	Round a numeric value
<i>Trunc</i>	Truncate a numeric value
<i>Sqrt</i>	Calculate the square root
<i>Exp</i>	Calculate the exponential value with the base “e”
<i>Pow</i>	Calculate the exponential value with an arbitrary base
<i>ACos</i>	Calculate the arc cosine value
<i>ASin</i>	Calculate the arc sine value
<i>ATan</i>	Calculate the arc tangent value in the range [-90,90]
<i>ATan2</i>	Calculate the arc tangent value in the range [-180,180]
<i>Cos</i>	Calculate the cosine value
<i>Sin</i>	Calculate the sine value
<i>Tan</i>	Calculate the tangent value
<i>EulerZYX</i>	Calculate Euler angles from an orientation
<i>OrientZYX</i>	Calculate the orientation from Euler angles
<i>PoseInv</i>	Invert a pose
<i>PoseMult</i>	Multiply a pose
<i>PoseVect</i>	Multiply a pose and a vector

---

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## **12 Spot Welding**

The SpotWare package provides support for spot welding applications that are equipped with a weld timer and on/off weld gun.

The SpotWare application provides fast and accurate positioning combined with gun manipulation, process start and supervision of an external weld timer.

Communication with the welding equipment is carried out by means of digital inputs and outputs. Some serial weld timer interfaces are also supported: Bosch PSS5000, NADEX, ABB Timer. See separate documentation.

It should be noted that SpotWare is a package that can be extensively customised. It is the intention that the user adapts the routines to suit the environmental situation.

---

### **12.1 Spot welding features**

The SpotWare package contains the following features:

- Fast and accurate positioning
- Handling of an on/off gun with two strokes
- Dual/single gun
- Gun pre-closing
- User defined supervision of the surrounding equipment before weld start
- User defined supervision of the surrounding equipment after the weld
- User defined open/close gun and supervision
- User defined pressure setting
- User defined preclose time calculation
- Monitoring of the external weld timer
- Weld error recovery with automatic rewelding
- Return to the spot weld position
- Spot counters
- Time- or signal-dependent motion release after a weld
- Quick start after a weld
- User-defined service routines
- Presetting and checking of gun pressure
- Simulated welding
- Reverse execution with gun control
- Parallel and serial weld timer interfaces
- Supports both program and start triggered weld timers

- SpotL current data information
- Spot identity info: the current spotdata parameter name (string format)
- Spot identity transfer to the serial weld timer BOSCH PSS 5000
- User defined autonomous supervision, such as state-controlled weld current signal and water cooling start. Note: This feature requires the MultiTasking option
- Manual weld, gun open and gun close initiated by digital input
- Weld process start disregarding the in position event, is possible
- Optional user defined error recovery

---

## 12.2 Principles of SpotWare

SpotWare is based on a separate handling of motion, spot welding and, if MultiTasking is installed, continuous supervision. On its way towards the programmed position, the motion task will trigger actions in the spot-welding tasks.

The triggers are activated by virtual digital signals.

The tasks work with their own internal encapsulated variables and with persistents which are fully transparent for all tasks.

For well defined entries, calls to user routines offer adaptations to the plant environment. A number of predefined parameters are also available to shape the behaviour of the SpotL instruction.

A program stop will only stop the motion task execution. The process and supervision carry on their tasks until they come to a well defined process stop. For example, this will make the gun open after a finished weld, although the program has stopped.

The opening and closing of the gun are always executed by RAPID routines, even if activated manually from the I/O window on the teach-pendant. These gun routines may be changed from the simple on/off default functionality to a more complex like analog gun control and they may contain additional gun supervision.

Since the process and supervision tasks are acting on I/O triggers, they will be executed either by the trig that was sent by the motion (SpotL) or by manual activation (teach pendant or external). This offers the possibility of performing a stand-alone weld anywhere without programming a new position.

It is also possible to define new supervision events and to connect them to digital signal triggers. By default, a state dependent weld power and water cooling signal control are implemented.

Supported equipment:

- One weld timer monitoring with standard parallel (some serial) interface. The weld timer may be of the type, program schedule or start signal triggered.
- Any type of single/dual gun close and gun gap control.

- Any type of pressure preset.
- Event controlled SpotL-independent spot weld equipment such as contactors etc. (Note: MultiTasking option required).

### 12.3 Programming principles

Both the robot's linear movement and the spot weld process control are embedded in one instruction, *SpotL*.

The spot welding process is specified by:

- Spotdata: spot weld process data
- Gundata: spot weld gun data
- The system modules SWUSRF and SWUSRC: RAPID routines and global data for customising purposes. See *Predefined Data and Programs ProcessWare*.
- System parameters: the I/O configuration. See User's Guide - System Parameters

### 12.4 Spot welding instructions

<u>Instruction</u>	<u>Used to:</u>
<i>SpotL</i>	Control the motion, gun closure/opening and the welding process Move the TCP along a linear path and perform a spot weld at the end position

### 12.5 Spot welding data

<u>Data type</u>	<u>Used to define:</u>
<i>spotdata</i>	The spot weld process control
<i>gundata</i>	The spot weld gun

## 13 Arc Welding

The ArcWare package supports most welding functions. Crater-filling and scraping starts can, for example, be programmed. Using ArcWare, the whole welding process can be controlled and monitored by the robot via a number of different digital and analog inputs and outputs.

### 13.1 Programming principles

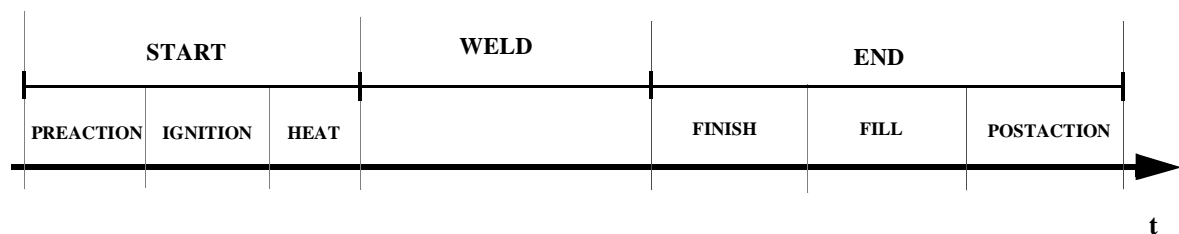
The same instructions are used both to control the robot's movements and the actual welding process. The arc welding instructions indicate which weld data and seam data are used in the weld in question.

The weld settings for the actual weld phase are defined in weld data. The start and end phase are defined in seam data.

Any weaving is defined in weave data, which is also identified by the arc welding instruction.

Certain functions, such as a scraping start, are defined in the system parameters.

The welding process is divided into the following phases:



### 13.2 Arc welding instructions

<u>Instruction</u>	<u>Type of movement:</u>
<i>ArcC</i>	TCP along a circular path
<i>ArcL</i>	TCP along a linear path

**13.3 Arc welding data**

<u>Data type</u>	<u>Used to define:</u>
<i>welldata</i>	The weld phase
<i>seamdata</i>	The start and end phase of a weld
<i>weavedata</i>	The weaving characteristics

---



---

## 14 GlueWare

The GlueWare package provides support for gluing applications that are equipped with one or two gluing guns.

The GlueWare application provides fast and accurate positioning combined with gun manipulation, process start and stop.

Communication with the glueing equipment is carried out by means of digital and analog outputs.

---

### 14.1 Glueing features

The GlueWare package contains the following features:

- Fast and accurate positioning
- Handling of on/off guns as well as proportional guns
- Two different guns can be handled in the same program, each gun controlled by one digital signal (on/off) and two analog signals (flows)
- Gun pre-opening and pre-closing respectively
- Simulated glueing

---

### 14.2 Programming principles

Both the robot's movement and the glue process control are embedded in one instruction, *GlueL* and *GlueC* respectively.

The glueing process is specified by:

- Gundata: glue gun data. See *Data types - ggundata*.
- The system module GLUSER: RAPID routines and global data for customizing purposes. See *Predefined Data and Programs - System Module GLUSER*.
- System parameters: the I/O configuration. See *System Parameters - Glueing*

---

### 14.3 Glue instructions

<u>Instruction</u>	<u>Used to:</u>
<i>GlueL</i>	Move the TCP along a linear path and perform glueing with the given data
<i>GlueC</i>	Move the TCP along a circular path and perform glueing with the given data



**14.4 Glue data**

Data type

*ggundata*

Used to define:

The used glue gun

---

---

## 15 External Computer Communication

The robot can be controlled from a superordinate computer. In this case, a special communications protocol is used to transfer information.

---

### 15.1 Programming principles

As a common communications protocol is used to transfer information from the robot to the computer and vice versa, the robot and computer can understand each other and no programming is required. The computer can, for example, change values in the program's data without any programming having to be carried out (except for defining this data). Programming is only necessary when program-controlled information has to be sent from the robot to the superordinate computer.

---

### 15.2 Sending a program-controlled message from the robot to a computer

<u>Instruction</u>	<u>Used to:</u>
<i>SCWrite</i> <sup>1</sup>	Send a message to the superordinate computer

---

1. Only if the robot is equipped with the option "RAP Serial Link".

---

---

## 16 Service Instructions

A number of instructions are available to test the robot system. See the chapter on Troubleshooting Tools in the Product Manual for more information.

---

### 16.1 Directing a value to the robot's test signal

A reference signal, such as the speed of a motor, can be directed to an analog output signal located on the backplane of the robot.

<u>Instruction</u>	<u>Used to:</u>
<i>TestSign</i>	Define and activate a test signal
<u>Data type</u>	<u>Used to define:</u>
<i>testsignal</i>	The type of test signal

---



---

## 17 String Functions

String functions are used for operations with strings such as copying, concatenation, comparison, searching, conversion, etc.

---

### 17.1 Basic Operations

<u>Data type</u>	<u>Used to define:</u>
<i>string</i>	String. Predefined constants STR_DIGIT, STR_UPPER, STR_LOWER and STR_WHITE
<u>Instruction/Operator</u>	<u>Used to:</u>
<i>:=</i>	Assign a value (copy of string)
<i>+</i>	String concatenation
<u>Function</u>	<u>Used to:</u>
<i>StrLen</i>	Find string length
<i>StrPart</i>	Obtain part of a string

---

### 17.2 Comparison and Searching

<u>Operator</u>	<u>Used to:</u>
<i>=</i>	Test if equal to
<i>&lt;&gt;</i>	Test if not equal to
<u>Function</u>	<u>Used to:</u>
<i>StrMemb</i>	Check if character belongs to a set
<i>StrFind</i>	Search for character in a string
<i>StrMatch</i>	Search for pattern in a string
<i>StrOrder</i>	Check if strings are in order

**17.3 Conversion**

<u>Function</u>	<u>Used to:</u>
<i>NumToStr</i>	Convert a numeric value to a string
<i>ValToStr</i>	Convert a value to a string
<i>StrToVal</i>	Convert a string to a value
<i>StrMap</i>	Map a string
<i>StrToByte</i>	Convert a byte to string data
<i>ByteToStr</i>	Convert a string to a byte

---

---

## 18 Syntax Summary

---

### 18.1 Instructions

**Data** := Value

**AccSet** Acc Ramp

**ActUnit** MecUnit

**Add** Name AddValue

**Break**

**CallBy Var** Name Number

**Clear** Name

**ClkReset** Clock

**ClkStart** Clock

**ClkStop** Clock

**Close** IODevice

**!** Comment

**ConfJ** [\On] | [\Off]

**ConfL** [\On] | [\Off]

**CONNECT** Interrupt **WITH** Trap routine

**CorrCon Descr**

**CorrDiscon Descr**

**CorrWrite Descr Data**

**CorrClear**

**DeactUnit** MecUnit

**Decr** Name

**EOffsSet** EAxOffs

**ErrWrite** [ \W ] Header Reason [ \RL2 ] [ \RL3 ] [ \RL4 ]

**Exit**

**ExitCycle**

**FOR** Loop counter **FROM** Start value **TO** End value  
[STEP Step value] **DO** ... **ENDFOR**

**GOTO** Label

**GripLoad** Load

**IDelete** Interrupt

**IF** Condition ...

**IF** Condition **THEN** ...  
  { **ELSEIF** Condition **THEN** ... }  
[ **ELSE** ... ]

**ENDIF**

**Incr** Name

**IndAMove** MecUnit Axis [ \ToAbsPos ] | [ \ToAbsNum ] Speed  
[ \Ramp ]

**IndCMove** MecUnit Axis Speed [ \Ramp ]

**IndDMove** MecUnit Axis Delta Speed [ \Ramp ]

**IndReset** MecUnit Axis [ \RefPos ] | [ \RefNum ] | [ \Short ] | [ \Fwd ] |  
[ \Bwd ] | [ \Old ]

**IndRMove** MecUnit Axis [ \ToRelPos ] | [ \ToRelNum ] | [ \Short ] |  
[ \Fwd ] | [ \Bwd ] Speed [ \Ramp ]

**InvertDO** Signal

**IODisable** UnitName MaxTime

**IOEnable** UnitName MaxTime

**ISignalDI** [ \Single ] Signal TriggValue Interrupt

**ISignalDO** [ \Single ] Signal TriggValue Interrupt

**ISleep** Interrupt

**ITimer** [ \Single ] Time Interrupt

**IVarValue** VarNo Value, Interrupt

**IWatch** Interrupt

Label:

**MoveAbsJ** [ \Conc ] ToJointPos Speed [ \V ] | [ \T ] Zone [ \Z ]  
Tool [ \WObj ]

**MoveC** [ \Conc ] CirPoint ToPoint Speed [ \V ] | [ \T ] Zone [ \Z ]  
Tool [ \WObj ]

**MoveJ** [ \Conc ] ToPoint Speed [ \V ] | [ \T ] Zone [ \Z ] Tool  
[ \WObj ]

**MoveL** [ \Conc ] ToPoint Speed [ \V ] | [ \T ] Zone [ \Z ] Tool  
[ \WObj ]

**Open** Object [ \File ] IODevice [ \Read ] | [ \Write ] | [ \Append ] | [ \Bin ]

**PathResol** Value

**PDispOn** [ \Rot ] [ \ExeP ] ProgPoint Tool [ \WObj ]

**PDispSet** DispFrame

Procedure { Argument }

**PulseDO** [ \PLength ] Signal

**RAISE** [ Error no ]

**Reset** Signal

**RETURN** [ Return value ]

**Rewind** IODevice

**SearchC** [ \Stop ] | [ \PStop ] | [ \Sup ] Signal SearchPoint CirPoint  
ToPoint Speed [ \V ] | [ \T ] Tool [ \WObj ]

**SearchL** [ \Stop ] | [ \PStop ] | [ \Sup ] Signal SearchPoint ToPoint  
Speed [ \V ] | [ \T ] Tool [ \WObj ]

**Set** Signal

**SetAO** Signal Value



**SetDO** [ \SDelay ] Signal Value  
**SetGO** Signal Value  
**SingArea** [ \Wrist ] | [ \Arm ] | [ \Off ]  
**SoftAct** Axis Softness [ \Ramp ]  
**Stop** [ \NoRegain ]  
**TEST** Test data { **CASE** Test value { , Test value } : ... }  
**[ DEFAULT: ... ] ENDTEST**  
**TPReadFK** Answer String FK1 FK2 FK3 FK4 FK5 [ \MaxTime ]  
[ \DIBreak ] [ \BreakFlag ]  
**TPReadNum** Answer String [ \MaxTime ] [ \DIBreak ] [ \BreakFlag ]  
**TPShow** Window  
**TPWrite** String [ \Num ] | [ \Bool ] | [ \Pos ] | [ \Orient ]  
**TriggC** CirPoint ToPoint Speed [ \T ] Trigg\_1 [ \T2 ] [ \T3 ]  
[ \T4 ] Zone Tool [ \WObj ]  
**TriggInt** TriggData Distance [ \Start ] | [ \Time ] Interrupt  
**TriggIO** TriggData Distance [ \Start ] | [ \Time ] [ \DOp ] | [ \GOp ] |  
[ \AOp ] SetValue [ \DODelay ] | [ \AORamp ]  
**TriggJ** ToPoint Speed [ \T ] Trigg\_1 [ \T2 ] [ \T3 ] [ \T4 ]  
Zone Tool [ \WObj ]  
**TriggL** ToPoint Speed [ \T ] Trigg\_1 [ \T2 ] [ \T3 ] [ \T4 ]  
Zone Tool [ \WObj ]  
**TuneServo** MecUnit Axis TuneValue  
**TuneServo** MecUnit Axis TuneValue [ \Type ]  
**UnLoad** FilePath [ \File ]  
**VelSet** Override Max  
**WaitDI** Signal Value [ \MaxTime ] [ \TimeFlag ]  
**WaitDO** Signal Value [ \MaxTime ] [ \TimeFlag ]  
**WaitTime** [ \InPos ] Time

**WaitUntil** [**\InPos**] **Cond** [**\MaxTime**] [**\TimeFlag**]

**WHILE** **Condition** **DO ... ENDWHILE**

**Write** **IODevice** **String** [**\Num**] | [**\Bool**] | [**\Pos**] | [**\Orient**]  
[**\NoNewLine**]

**WriteBin** **IODevice** **Buffer** **NChar**

**WriteStrBin** **IODevice** **Str**

**WZBoxDef** [**\Inside**] | [**\Outside**] **Shape** **LowPoint** **HighPoint** **1**

**WZCylDef** [**\Inside**] | [**\Outside**] **Shape** **CentrePoint** **Radius** **Height**

**WZDisable** **WorldZone**

**WZDOSet** [**\Temp**] | [**\Stat**] **WorldZone** [**\Inside**] | [**\Before**] **Shape**  
**Signal** **SetValue**

**WZEnable** **WorldZone**

**WZFree** **WorldZone**

**WZLimSup** [**\Temp**] | [**\Stat**] **WorldZone** **Shape**

**WZSphDef** [**\Inside**] | [**\Outside**] **Shape** **CentrePoint** **Radius**

## 18.2 Functions

**Abs** (**Input**)

**ACos** (**Value**)

**AOutput** (**Signal**)

**ArgName** (**Parameter**)

**ASin** (**Value**)

**ATan** (**Value**)

**ATan2** (**Y** **X**)

**ByteToStr** (**ByteData** [**\Hex**] | [**\Okt**] | [**\Bin**] | [**\Char**])

**ClkRead** (**Clock**)

**CorrRead**

**Cos** (Angle)

**CPos** ([Tool] [\WObj])

**CRobT** ([Tool] [\WObj])

**DefDFrame** (OldP1 OldP2 OldP3 NewP1 NewP2 NewP3)

**DefFrame** (NewP1 NewP2 NewP3 [\Origin])

**Dim** (ArrPar DimNo)

**DOutput** (Signal)

**EulerZYX** ([\X] | [\Y] | [\Z] Rotation)

**Exp** (Exponent)

**GOutput** (Signal)

**GetTime** ( [\WDay] | [\Hour] | [\Min] | [\Sec] )

**IndInpos** MecUnit Axis

**IndSpeed** MecUnit Axis [\InSpeed] | [\ZeroSpeed]

**IsPers** (DatObj)

**IsVar** (DatObj)

**MirPos** (Point MirPlane [\WObj] [\MirY])

**NumToStr** (Val Dec [\Exp])

**Offs** (Point XOffset YOffset ZOffset)

**OrientZYX** (ZAngle YAngle XAngle)

**ORobT** (OrgPoint [\InPDisp] | [\InEOffs])

**PoseInv** (Pose)

**PoseMult** (Pose1 Pose2)

**PoseVect** (Pose Pos)

**Pow** (Base Exponent)

**Present** (OptPar)  
**ReadBin** (IODevice [\Time])  
**ReadMotor** [\MecUnit ] **Axis**  
**ReadNum** (IODevice [\Time])  
**ReadStr** (IODevice [\Time])  
**RelTool** (Point Dx Dy Dz [\Rx] [\Ry] [\Rz])  
**Round** ( Val [\Dec])  
**Sin** (Angle)  
**Sqrt** (Value)  
**StrFind** (Str ChPos Set [\NotInSet])  
**StrLen** (Str)  
**StrMap** ( Str FromMap ToMap)  
**StrMatch** (Str ChPos Pattern)  
**StrMemb** (Str ChPos Set)  
**StrOrder** ( Str1 Str2 Order)  
**StrPart** (Str ChPos Len)  
**StrToByte** (ConStr [\Hex] | [\Okt] | [\Bin] | [\Char])  
**StrToVal** ( Str Val )  
**Tan** (Angle)  
**TestDI** (Signal)  
**Trunc** ( Val [\Dec] )  
**ValToStr** ( Val )



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---



---

# 1 Basic Elements

---

## 1.1 Identifiers

Identifiers are used to name modules, routines, data and labels;

e.g.            MODULE *module\_name*  
                   PROC *routine\_name*()  
                   VAR pos *data\_name*;  
                   *label\_name*:

The first character in an identifier must be a letter. The other characters can be letters, digits or underscores “\_”.

The maximum length of any identifier is 16 characters, each of these characters being significant. Identifiers that are the same except that they are typed in the upper case, and vice versa, are considered the same.

### *Reserved words*

The words listed below are reserved. They have a special meaning in the RAPID language and thus must not be used as identifiers.

There are also a number of predefined names for data types, system data, instructions, and functions, that must not be used as identifiers. See Chapters 7, 8, 9, 10 ,13, 14 and 15 in this manual.

ALIAS	AND	BACKWARD	CASE
CONNECT	CONST	DEFAULT	DIV
DO	ELSE	ELSEIF	ENDFOR
ENDFUNC	ENDIF	ENDMODULE	ENDPROC
ENDRECORD	ENDTEST	ENDTRAP	ENDWHILE
ERROR	EXIT	FALSE	FOR
FROM	FUNC	GOTO	IF
INOUT	LOCAL	MOD	MODULE
NOSTEPIN	NOT	NOVIEW	OR
PERS	PROC	RAISE	READONLY
RECORD	RETRY	RETURN	STEP
SYSMODULE	TEST	THEN	TO
TRAP	TRUE	TRYNEXT	VAR
VIEWONLY	WHILE	WITH	XOR



## 1.2 Spaces and new-line characters

The RAPID programming language is a free format language, meaning that spaces can be used anywhere except for in:

- identifiers
- reserved words
- numerical values
- placeholders.

New-line, tab and form-feed characters can be used wherever a space can be used, except for within comments.

Identifiers, reserved words and numeric values must be separated from one another by a space, a new-line, tab or form-feed character.

Unnecessary spaces and new-line characters will automatically be deleted from a program loaded into the program memory. Consequently, programs loaded from diskette and then stored again might not be identical.

---

## 1.3 Numeric values

A numeric value can be expressed as

- an integer, e.g. 3, -100, 3E2
- a decimal number, e.g. 3.5, -0.345, -245E-2

The value must be in the range specified by the ANSI IEEE 754-1985 standard (single precision) float format.

---

## 1.4 Logical values

A logical value can be expressed as TRUE or FALSE.

---

## 1.5 String values

A string value is a sequence of characters (ISO 8859-1) and control characters (non-ISO 8859-1 characters in the numeric code range 0-255). Character codes can be included, making it possible to include non-printable characters (binary data) in the string as well. String length max. 80 characters.

Example:            "This is a string"  
                      "This string ends with the BEL control character \07"

If a backslash (which indicates character code) or double quote character is included, it must be written twice.

Example:            "This string contains a "" character"  
                      "This string contains a \\ character"

---

## 1.6 Comments

Comments are used to make the program easier to understand. They do not affect the meaning of the program in any way.

A comment starts with an exclamation mark “!” and ends with a new-line character. It occupies an entire line and cannot occur between two modules;

e.g.                   ! comment  
                           IF reg1 > 5 THEN  
                               ! comment  
                               reg2 := 0;  
                           ENDIF

---

## 1.7 Placeholders

Placeholders can be used to temporarily represent parts of a program that are “not yet defined”. A program that contains placeholders is syntactically correct and may be loaded into the program memory.

<u>Placeholder</u>	<u>Represents:</u>
<TDN>	data type definition
<DDN>	data declaration
<RDN>	routine declaration
<PAR>	formal optional alternative parameter
<ALT>	optional formal parameter
<DIM>	formal (conformant) array dimension
<SMT>	instruction
<VAR>	data object (variable, persistent or parameter) reference
<EIT>	else if clause of if instruction
<CSE>	case clause of test instruction
<EXP>	expression
<ARG>	procedure call argument
<ID>	identifier

---

## 1.8 File header

A program file starts with the following file header:

```
%%%
VERSION:1                (Program version M94 or M94A)
LANGUAGE:ENGLISH        (or some other language:
%%%                      GERMAN or FRENCH)
```

---

## 1.9 Syntax

**Identifiers**

```

<identifier> ::=
    <ident>
    | <ID>
<ident> ::= <letter> { <letter> | <digit> | '_' }

```

**Numeric values**

```

<num literal> ::=
    <integer> [ <exponent> ]
    | <integer> '.' [ <integer> ] [ <exponent> ]
    | [ <integer> ] '.' <integer> [ <exponent> ]
<integer> ::= <digit> { <digit> }
<exponent> ::= ('E' | 'e') [ '+' | '-' ] <integer>

```

**Logical values**

```

<bool literal> ::= TRUE | FALSE

```

**String values**

```

<string literal> ::= ''' { <character> | <character code> } '''
<character code> ::= '\ ' <hex digit> <hex digit>
<hex digit> ::= <digit> | A | B | C | D | E | F | a | b | c | d | e | f

```

**Comments**

```

<comment> ::=
    '!' { <character> | <tab> } <newline>

```

**Characters**

```

<character> ::= -- ISO 8859-1 --
<newline> ::= -- newline control character --
<digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
<letter> ::=
    <upper case letter>
    | <lower case letter>

```

<upper case letter> ::=

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 | À | Á | Â | Ã  
 | Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í  
 | Î | Ï |<sup>1)</sup> | Ñ | Ò | Ó | Ô | Õ | Ö | Ø  
 | Ù | Ú | Û | Ü |<sup>2)</sup> |<sup>3)</sup> | ß

<lower case letter> ::=

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 | ß | à | á | â  
 | ã | ä | å | æ | ç | è | é | ê | ë | ì  
 | í | î | ï |<sup>1)</sup> | ñ | ò | ó | ô | õ | ö  
 | ø | ù | ú | û | ü |<sup>2)</sup> |<sup>3)</sup> | ÿ

- 1) Icelandic letter eth.
- 2) Letter Y with acute accent.
- 3) Icelandic letter thorn.

## 2 Modules

The program is divided into *program* and *system modules*. The program can also be divided into *modules* (see Figure 1).

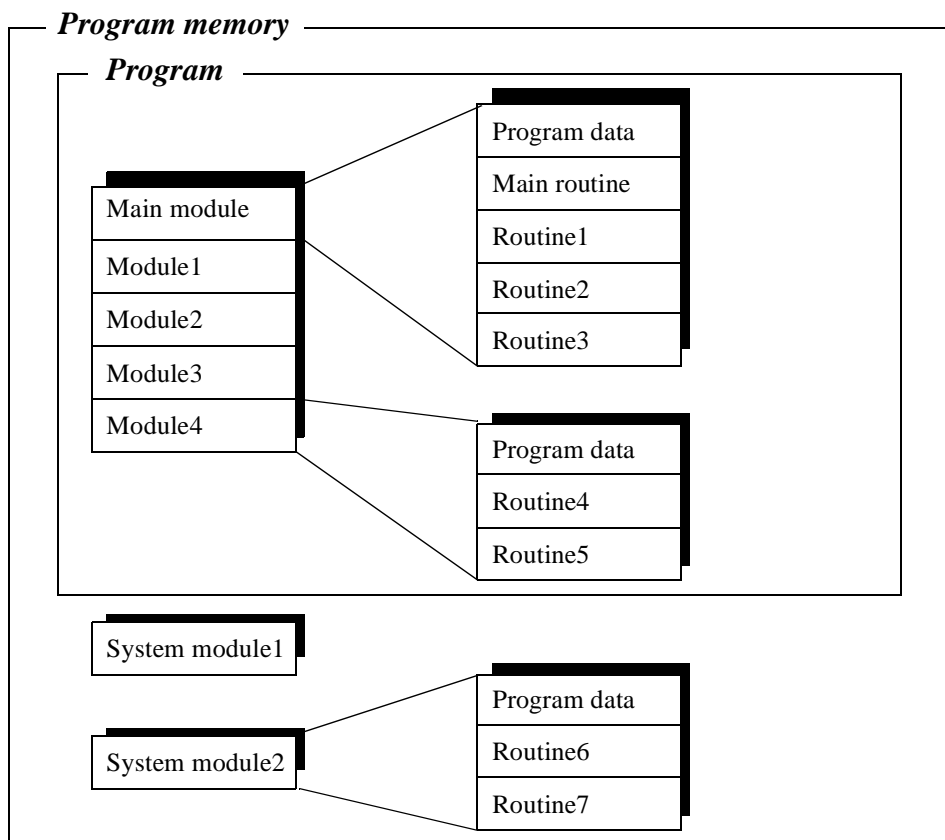


Figure 1 The program can be divided into modules.

### 2.1 Program modules

A program module can consist of different data and routines. Each module, or the whole program, can be copied to diskette, RAM disk, etc., and vice versa.

One of the modules contains the entry procedure, a global procedure called *main*. Executing the program means, in actual fact, executing the main procedure. The program can include many modules, but only one of these will have a main procedure.

A module may, for example, define the interface with external equipment or contain geometrical data that is either generated from CAD systems or created on-line by digitizing (teach programming).

Whereas small installations are often contained in one module, larger installations may have a main module that references routines and/or data contained in one or several other modules.

---

## 2.2 System modules

System modules are used to define common, system-specific data and routines, such as tools. They are not included when a program is saved, meaning that any update made to a system module will affect all existing programs currently in, or loaded at a later stage into the program memory.

---

## 2.3 Module declarations

A module declaration specifies the name and attributes of that module. These attributes can only be added off-line, not using the teach pendant. The following are examples of the attributes of a module:

<u>Attribute</u>	<u>If specified, the module:</u>
SYSMODULE	is a system module, otherwise a program module
NOSTEPIN	cannot be entered during stepwise execution
VIEWONLY	cannot be modified
READONLY	cannot be modified, but the attribute can be removed
NOVIEW	cannot be viewed, only executed. Global routines can be reached from other modules and are always run as NOSTEPIN. The current values for global data can be reached from other modules or from the data window on the teach pendant. A module or a program containing a NOVIEW program module cannot be saved. Therefore, NOVIEW should primarily be used for system modules. NOVIEW can only be defined off-line from a PC.
e.g.	<pre> MODULE module_name (SYSMODULE, VIEWONLY) !data type definition !data declarations !routine declarations ENDMODULE </pre>

A module may not have the same name as another module or a global routine or data.

---

## 2.4 Syntax

### *Module declaration*

```

<module declaration> ::=
    MODULE <module name> [ <module attribute list> ]
    <type definition list>
    <data declaration list>
    <routine declaration list>
    ENDMODULE

```

<module name> ::= <identifier>  
<module attribute list> ::= '( ' <module attribute> { ' , ' <module attribute> } ' )'  
<module attribute> ::=  
    **SYSMODULE**  
    | **NOVIEW**  
    | **NOSTEPIN**  
    | **VIEWONLY**  
    | **READONLY**

(*Note.* If two or more attributes are used they must be in the above order, the NOVIEW attribute can only be specified alone or together with the attribute SYSMODULE.)

<type definition list> ::= { <type definition> }  
<data declaration list> ::= { <data declaration> }  
<routine declaration list> ::= { <routine declaration> }

---



---

### 3 Routines

There are three types of routines (subprograms): *procedures*, *functions* and *traps*.

- Procedures do not return a value and are used in the context of instructions.
- Functions return a value of a specific type and are used in the context of expressions.
- Trap routines provide a means of dealing with interrupts. A trap routine can be associated with a specific interrupt and then, if that particular interrupt occurs at a later stage, will automatically be executed. A trap routine can never be explicitly called from the program.

---

#### 3.1 Routine scope

The scope of a routine denotes the area in which the routine is visible. The optional local directive of a routine declaration classifies a routine as local (within the module), otherwise it is global.

Example:        LOCAL PROC local\_routine (...  
                  PROC global\_routine (...

The following scope rules apply to routines (see the example in Figure 2):

- The scope of a global routine may include any module.
- The scope of a local routine comprises the module in which it is contained.
- Within its scope, a local routine hides any global routine or data with the same name.
- Within its scope, a routine hides instructions and predefined routines and data with the same name.

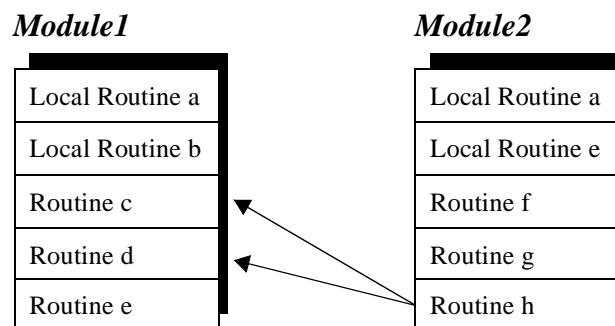


Figure 2 Example: The following routines can be called from Routine h:  
Module1 - Routine c, d.  
Module2 - All routines.

A routine may not have the same name as another routine or data in the same module. A global routine may not have the same name as a module or a global routine or global data in another module.



---

## 3.2 Parameters

The parameter list of a routine declaration specifies the arguments (actual parameters) that must/can be supplied when the routine is called.

There are four different types of parameters (in the access mode):

- Normally, a parameter is used only as an input and is treated as a routine variable. Changing this variable will not change the corresponding argument.
- An INOUT parameter specifies that a corresponding argument must be a variable (entire, element or component) or an entire persistent which can be changed by the routine.
- A VAR parameter specifies that a corresponding argument must be a variable (entire, element or component) which can be changed by the routine.
- A PERS parameter specifies that a corresponding argument must be an entire persistent which can be changed by the routine.

If an INOUT, VAR or PERS parameter is updated, this means, in actual fact, that the argument itself is updated, i.e. it makes it possible to use arguments to return values to the calling routine.

Example:           PROC routine1 (num in\_par, INOUT num inout\_par,  
  VAR num var\_par, PERS num pers\_par)

A parameter can be optional and may be omitted from the argument list of a routine call. An optional parameter is denoted by a backslash “\” before the parameter.

Example:           PROC routine2 (num required\_par \num optional\_par)

The value of an optional parameter that is omitted in a routine call may not be referenced. This means that routine calls must be checked for optional parameters before an optional parameter is used.

Two or more optional parameters may be mutually exclusive (i.e. declared to exclude each other), which means that only one of them may be present in a routine call. This is indicated by a stroke “|” between the parameters in question.

Example:           PROC routine3 (\num exclude1 | num exclude2)

The special type, *switch*, may (only) be assigned to optional parameters and provides a means to use switch arguments, i.e. arguments that are only specified by names (not values). A value cannot be transferred to a switch parameter. The only way to use a switch parameter is to check for its presence using the predefined function, *Present*.

Example:           PROC routine4 (\switch on | switch off)  
                                ...  
                                IF Present (off ) THEN  
                                ...  
                                ENDPROC

Arrays may be passed as arguments. The degree of an array argument must comply

with the degree of the corresponding formal parameter. The dimension of an array parameter is “conformant” (marked with “\*”). The actual dimension thus depends on the dimension of the corresponding argument in a routine call. A routine can determine the actual dimension of a parameter using the predefined function, *Dim*.

Example:           PROC routine5 (VAR num pallet{\*,\*})

### 3.3 Routine termination

The execution of a procedure is either explicitly terminated by a RETURN instruction or implicitly terminated when the end (ENDPROC, BACKWARD or ERROR) of the procedure is reached.

The evaluation of a function must be terminated by a RETURN instruction.

The execution of a trap routine is explicitly terminated using the RETURN instruction or implicitly terminated when the end (ENDTRAP or ERROR) of that trap routine is reached. Execution continues from the point where the interrupt occurred.

### 3.4 Routine declarations

A routine can contain routine declarations (including parameters), data, a body, a backward handler (only procedures) and an error handler (see Figure 3). Routine declarations cannot be nested, i.e. it is not possible to declare a routine within a routine.

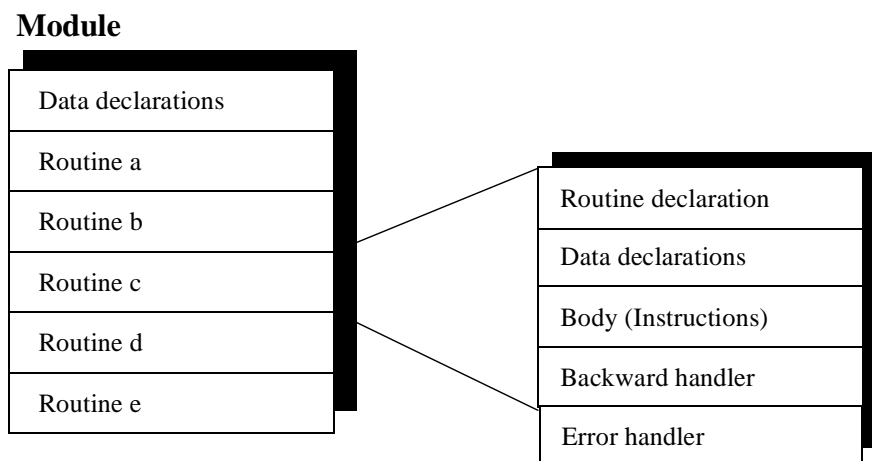


Figure 3 A routine can contain declarations, data, a body, a backward handler and an error handler.

***Procedure declaration***

Example: Multiply all elements in a num array by a factor;

```
PROC arrmul( VAR num array{ * }, num factor)
  FOR index FROM 1 TO dim( array, 1 ) DO
    array{index} := array{index} * factor;
  ENDFOR
ENDPROC
```

***Function declaration***

A function can return any data type value, but not an array value.

Example: Return the length of a vector;

```
FUNC num veclen (pos vector)
  RETURN Sqrt(Pow(vector.x,2)+Pow(vector.y,2)+Pow(vector.z,2));
ENDFUNC
```

***Trap declaration***

Example: Respond to feeder empty interrupt;

```
TRAP feeder_empty
  wait_feeder;
  RETURN;
ENDTRAP
```

---

### 3.5 Procedure call

When a procedure is called, the arguments that correspond to the parameters of the procedure shall be used:

- Mandatory parameters must be specified. They must also be specified in the correct order.
- Optional arguments can be omitted.
- Conditional arguments can be used to transfer parameters from one routine call to another.

See the Chapter *Using function calls in expressions* on page 29 for more details.

The procedure name may either be statically specified by using an identifier (*early binding*) or evaluated during runtime from a string type expression (*late binding*). Even though early binding should be considered to be the “normal” procedure call form, late binding sometimes provides very efficient and compact code. Late binding is defined by putting percent signs before and after the string that denotes the name of the procedure.

```

Example:      ! early binding
              TEST products_id
              CASE 1:
                proc1 x, y, z;
              CASE 2:
                proc2 x, y, z;
              CASE 3:
                ...

              ! same example using late binding
              % "proc" + NumToStr(product_id, 0) % x, y, z;
              ...

              ! same example again using another variant of late binding
              VAR string procname {3} :=["proc1", "proc2", "proc3"];
              ...
              % procname{product_id} % x, y, z;
              ...

```

Note that the late binding is available for procedure calls only, and not for function calls. If a reference is made to an unknown procedure using late binding, the system variable ERRNO is set to ERR\_REFUNKPRC. If a reference is made to a procedure call error (syntax, not procedure) using late binding, the system variable ERRNO is set to ERR\_CALLPROC.

---

## 3.6 Syntax

### *Routine declaration*

```

<routine declaration> ::=
    [LOCAL] ( <procedure declaration>
              | <function declaration>
              | <trap declaration> )
    | <comment>
    | <RDN>

```

### *Parameters*

```

<parameter list> ::=
    <first parameter declaration> { <next parameter declaration> }
<first parameter declaration> ::=
    <parameter declaration>
    | <optional parameter declaration>
    | <PAR>
<next parameter declaration> ::=
    ',' <parameter declaration>
    | <optional parameter declaration>
    | ',' <PAR>

```

```

<optional parameter declaration> ::=
    '\ ( <parameter declaration> | <ALT> )
      { '|' ( <parameter declaration> | <ALT> ) }
<parameter declaration> ::=
    [ VAR | PERS | INOUT ] <data type>
      <identifier> [ '{' ( '*' { ',' '*' } ) | <DIM> ] ','
    | 'switch' <identifier>

```

***Procedure declaration***

```

<procedure declaration> ::=
    PROC <procedure name>
    '(' [ <parameter list> ] ')'
    <data declaration list>
    <instruction list>
    [ BACKWARD <instruction list> ]
    [ ERROR <instruction list> ]
    ENDPROC
<procedure name> ::= <identifier>
<data declaration list> ::= { <data declaration> }

```

***Function declaration***

```

<function declaration> ::=
    FUNC <value data type>
    <function name>
    '(' [ <parameter list> ] ')'
    <data declaration list>
    <instruction list>
    [ ERROR <instruction list> ]
    ENDFUNC
<function name> ::= <identifier>

```

***Trap routine declaration***

```

<trap declaration> ::=
    TRAP <trap name>
    <data declaration list>
    <instruction list>
    [ ERROR <instruction list> ]
    ENDTRAP
<trap name> ::= <identifier>

```

***Procedure call***

```

<procedure call> ::= <procedure> [ <procedure argument list> ] ','
<procedure> ::=
    <identifier>
    | '%' <expression> '%'

```

```
<procedure argument list> ::= <first procedure argument> { <procedure argument> }
<first procedure argument> ::=
    <required procedure argument>
    | <optional procedure argument>
    | <conditional procedure argument>
    | <ARG>
<procedure argument> ::=
    ',' <required procedure argument>
    | <optional procedure argument>
    | <conditional procedure argument>
    | ',' <ARG>
<required procedure argument> ::= [ <identifier> '=' ] <expression>
<optional procedure argument> ::= '\ ' <identifier> [ '=' <expression> ]
<conditional procedure argument> ::= '\ ' <identifier> '?' ( <parameter> | <VAR> )
```

---



---

## 4 Data Types

There are two different kinds of data types:

- An *atomic* type is atomic in the sense that it is not defined based on any other type and cannot be divided into parts or components, e.g. *num*.
- A *record* data type is a composite type with named, ordered components, e.g. *pos*. A component may be of an atomic or record type.

A record value can be expressed using an *aggregate* representation;

e.g.            [ 300, 500, depth ]            pos record aggregate value.

A specific component of a record data can be accessed by using the name of that component;

e.g.            pos1.x := 300;            assignment of the x-component of pos1.

---

### 4.1 Non-value data types

Each available data type is either a *value* data type or a *non-value* data type. Simply speaking, a value data type represents some form of “value”. Non-value data cannot be used in value-oriented operations:

- Initialisation
- Assignment (:=)
- Equal to (=) and not equal to (<>) checks
- TEST instructions
- IN (access mode) parameters in routine calls
- Function (return) data types

The input data types (*signalai*, *signal di*, *signal gi*) are of the data type *semi value*. These data can be used in value-oriented operations, except initialisation and assignment.

In the description of a data type it is only specified when it is a semi value or a non-value data type.

---

### 4.2 Equal (alias) data types

An *alias* data type is defined as being equal to another type. Data with the same data types can be substituted for one another.

Example:	VAR dionum high:=1; VAR num level; level:= high;	This is OK since dionum is an alias data type for num
----------	--	--

---

### 4.3 Syntax

```
<type definition> ::=  
[LOCAL] ( <record definition>  
          | <alias definition> )  
| <comment>  
| <TDN>
```

```
<record definition> ::=  
    RECORD <identifier>  
        <record component list> ';' ;  
    ENDRECORD
```

```
<record component list> ::=  
    <record component definition> |  
    <record component definition> <record component list>
```

```
<record component definition> ::=  
    <data type> <record component name>
```

```
<alias definition> ::=  
    ALIAS <data type> <identifier> ';' ;
```

```
<data type> ::= <identifier>
```



---

---

## 5 Data

There are three kinds of data: *variables*, *persistents* and *constants*.

- A variable can be assigned a new value during program execution.
- A persistent can be described as a “persistent” variable. This is accomplished by letting an update of the value of a persistent automatically cause the initialisation value of the persistent declaration to be updated. (When a program is saved the initialisation value of any persistent declaration reflects the current value of the persistent.)
- A constant represents a static value and cannot be assigned a new value.

A data declaration introduces data by associating a name (identifier) with a data type. Except for predefined data and loop variables, all data used must be declared.

---

### 5.1 Data scope

The scope of data denotes the area in which the data is visible. The optional local directive of a data declaration classifies data as local (within the module), otherwise it is global. Note that the local directive may only be used at module level, not inside a routine.

Example:           LOCAL VAR num local\_variable;  
                      VAR num global\_variable;

Data declared outside a routine is called *program data*. The following scope rules apply to program data:

- The scope of predefined or global program data may include any module.
- The scope of local program data comprises the module in which it is contained.
- Within its scope, local program data hides any global data or routine with the same name (including instructions and predefined routines and data).

Program data may not have the same name as other data or a routine in the same module. Global program data may not have the same name as other global data or a routine in another module. A persistent may not have the same name as another persistent in the same program.

Data declared inside a routine is called *routine data*. Note that the parameters of a routine are also handled as routine data. The following scope rules apply to routine data:

- The scope of routine data comprises the routine in which it is contained.
- Within its scope, routine data hides any other routine or data with the same name.

See the example in Figure 4.

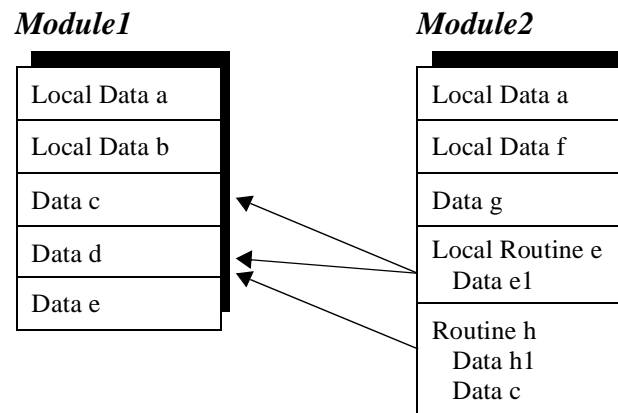


Figure 4 Example: The following data can be called from routine e:  
 Module1: Data c, d.  
 Module2: Data a, f, g, e1.  
 The following data can be called from routine h:  
 Module1: Data d.  
 Module2: Data a, f, g, h1, c.

Routine data may not have the same name as other data or a label in the same routine.

---

## 5.2 Variable declaration

A variable is introduced by a variable declaration.

Example:       VAR num x;

Variables of any type can be given an array (of degree 1, 2 or 3) format by adding dimensional information to the declaration. A dimension is an integer value greater than 0.

Example:       VAR pos pallet{14, 18};

Variables with value types may be initialised (given an initial value). The expression used to initialise a program variable must be constant. Note that the value of an uninitialized variable may be used, but it is undefined, i.e. set to zero.

Example:       VAR string author\_name := "John Smith";  
                   VAR pos start := [100, 100, 50];  
                   VAR num maxno{10} := [1, 2, 3, 9, 8, 7, 6, 5, 4, 3];

The initialisation value is set when:

- the program is opened,
- the program is executed from the beginning of the program.

---

### 5.3 Persistent declaration

Persistents can only be declared at module level, not inside a routine, and must be given an initial value. The initialisation value must be a single value (without data or operands), or a single aggregate with members which, in turn, are single values or single aggregates.

Example:            PERS pos refpnt := [100.23, 778.55, 1183.98];

Persistents of any type can be given an array (of degree 1, 2 or 3) format by adding dimensional information to the declaration. A dimension is an integer value greater than 0.

Example:            PERS pos pallet{ 14, 18};

Note that if the value of a persistent is updated, this automatically causes the initialisation value of the persistent declaration to be updated.

Example:            PERS num reg1 := 0;  
                           ...  
                           reg1 := 5;  
                           After execution, the program looks like this:  
                           PERS num reg1 := 5;  
                           ...  
                           reg1 := 5;

---

### 5.4 Constant declaration

A constant is introduced by a constant declaration. The value of a constant cannot be modified.

Example:            CONST num pi := 3.141592654;

A constant of any type can be given an array (of degree 1, 2 or 3) format by adding dimensional information to the declaration. A dimension is an integer value greater than 0.

Example:            CONST pos seq{3} :=            [[614, 778, 1020],  
   [914, 998, 1021],  
   [814, 998, 1022]];

---

### 5.5 Initiating data

In the table below, you can see what is happening in various activities such as warm start, new program, program start etc.

Table 1

System event Affects	Power on (Warm start)	Open, Close or New program	Start program (Move PP to main)	Start program (Move PP to Routine)	Start program (Move PP to cursor)	Start program (Call Routine)	Start program (After cycle)	Start program (After stop)
Constant	Unchanged	Init	Init	Init	Unchanged	Unchanged	Unchanged	Unchanged
Variable	Unchanged	Init	Init	Init	Unchanged	Unchanged	Unchanged	Unchanged
Persistent	Unchanged	Init	Init	Init	Unchanged	Unchanged	Unchanged	Unchanged
Commanded interrupts	Re-ordered	Disappears	Disappears	Disappears	Unchanged	Unchanged	Unchanged	Unchanged
Start up routine SYS_RESET (with motion settings)	Not run	Run*	Run	Not run	Not run	Not run	Not run	Not run
Files	Closes	Closes	Closes	Closes	Unchanged	Unchanged	Unchanged	Unchanged
Path	Recreated at power on	Disappears	Disappears	Disappears	Disappears	Unchanged	Unchanged	Unchanged

\* Generates an error when there is a semantic error in the actual task program.

---

## 5.6 Syntax

### Data declaration

```
<data declaration> ::=
    [LOCAL] ( <variable declaration>
              | <persistent declaration>
              | <constant declaration> )
    | <comment>
    | <DDN>
```

### Variable declaration

```
<variable declaration> ::=
    VAR <data type> <variable definition> ';'
<variable definition> ::=
    <identifier> [ '{' <dim> { ',' <dim> } '}' ]
    [ ':' <constant expression> ]
<dim> ::= <constant expression>
```

### Persistent declaration

```
<persistent declaration> ::=
    PERS <data type> <persistent definition> ';'

```

<persistent definition> ::=  
    <identifier> [ '{' <dim> { ',' <dim> } }' ]  
    ':=' <literal expression>

***Constant declaration***

<constant declaration> ::=  
    **CONST** <data type> <constant definition> ';' ;  
<constant definition> ::=  
    <identifier> [ '{' <dim> { ',' <dim> } }' ]  
    ':=' <constant expression>  
<dim> ::= <constant expression>

---



---

## 6 Instructions

Instructions are executed in succession unless a program flow instruction or an interrupt or error causes the execution to continue at some other place.

Most instructions are terminated by a semicolon “;”. A label is terminated by a colon “:”. Some instructions may contain other instructions and are terminated by specific keywords:

<u>Instruction</u>	<u>Termination word</u>
IF	ENDIF
FOR	ENDFOR
WHILE	ENDWHILE
TEST	ENDTEST

Example:            WHILE index < 100 DO  
                               .  
                               index := index + 1;  
                               ENDWHILE

---

### 6.1 Syntax

```
<instruction list> ::= { <instruction> }
<instruction> ::=
    [<instruction according to separate chapter in this manual>
    | <SMT>
```

---



---

## 7 Expressions

An expression specifies the evaluation of a value. It can be used, for example:

- in an assignment instruction e.g.  $a:=3*b/c$ ;
- as a condition in an IF instruction e.g. IF  $a \geq 3$  THEN ...
- as an argument in an instruction e.g. WaitTime *time*;
- as an argument in a function call e.g.  $a:=\text{Abs}(3*b)$ ;

---

### 7.1 Arithmetic expressions

An arithmetic expression is used to evaluate a numeric value.

Example:  $2*\text{pi}*\text{radius}$

Table 2 shows the different types of operations possible.

Table 2

Operator	Operation	Operand types	Result type
+	addition	num + num	num <sup>3)</sup>
+	unary plus; keep sign	+num or +pos	same <sup>1)3)</sup>
+	vector addition	pos + pos	pos
-	subtraction	num - num	num <sup>3)</sup>
-	unary minus; change sign	-num or -pos	same <sup>1)3)</sup>
-	vector subtraction	pos - pos	pos
*	multiplication	num * num	num <sup>3)</sup>
*	scalar vector multiplication	num * pos or pos * num	pos
*	vector product	pos * pos	pos
*	linking of rotations	orient * orient	orient
/	division	num / num	num
DIV <sup>2)</sup>	integer division	num DIV num	num
MOD <sup>2)</sup>	integer modulo; remainder	num MOD num	num

1. The result receives the same type as the operand. If the operand has an alias data type, the result receives the alias "base" type (num or pos).
2. Integer operations, e.g.  $14 \text{ DIV } 4=3$ ,  $14 \text{ MOD } 4=2$ .  
(Non-integer operands are illegal.)
3. Preserves integer (exact) representation as long as operands and result are kept within the integer subdomain of the num type.

## 7.2 Logical expressions

A logical expression is used to evaluate a logical value (TRUE/FALSE).

Example: `a>5 AND b=3`

Table 3 shows the different types of operations possible.

Table 3

Operator	Operation	Operand types	Result type
<	less than	num < num	bool
<=	less than or equal to	num <= num	bool
=	equal to	any <sup>1)</sup> = any <sup>1)</sup>	bool
>=	greater than or equal to	num >= num	bool
>	greater than	num > num	bool
<>	not equal to	any <sup>1)</sup> <> any <sup>1)</sup>	bool
AND	and	bool AND bool	bool
XOR	exclusive or	bool XOR bool	bool
OR	or	bool OR bool	bool
NOT	unary not; negation	NOT bool	bool

1) Only value data types. Operands must have equal types.

a AND b

a \ b	True	False
True	True	False
False	False	False

a XOR b

a \ b	True	False
True	False	True
False	True	False

a OR b

a \ b	True	False
True	True	True
False	True	False

NOT b

b	
True	False
False	True

## 7.3 String expressions

A string expression is used to carry out operations on strings.

Example: `“IN” + “PUT”` gives the result `“INPUT”`



Table 4 shows the one operation possible.

*Table 4*

Operator	Operation	Operand types	Result type
+	string concatenation	string + string	string

## 7.4 Using data in expressions

An entire variable, persistent or constant can be a part of an expression.

Example:           2\*pi\*radius

### **Arrays**

A variable, persistent or constant declared as an array can be referenced to the whole array or a single element.

An array element is referenced using the index number of the element. The index is an integer value greater than 0 and may not violate the declared dimension. Index value 1 selects the first element. The number of elements in the index list must fit the declared degree (1, 2 or 3) of the array.

Example:           VAR num row{3};  
                     VAR num column{3};  
                     VAR num value;  
                     .  
                     value := column{3};           only one element in the array  
                     row := column;               all elements in the array

### **Records**

A variable, persistent or constant declared as a record can be referenced to the whole record or a single component.

A record component is referenced using the component name.

Example:           VAR pos home;  
                     VAR pos pos1;  
                     VAR num yvalue;  
                     ..  
                     yvalue := home.y;           the Y component only  
                     pos1 := home;               the whole position

---

## 7.5 Using aggregates in expressions

An aggregate is used for record or array values.

Example:            `pos := [x, y, 2*x];`                            `pos` record aggregate  
                       `posarr := [[0, 0, 100], [0,0,z]];`               `pos` array aggregate

It must be possible to determine the data type of an aggregate by the context. The data type of each aggregate member must be equal to the type of the corresponding member of the determined type.

Example            `VAR pos pl;`  
                       `p1 :=[1, -100, 12];`    aggregate type `pos` - determined by `p1`  
                       `IF [1, -100, 12] = [a,b,b,] THEN`                            illegal since the data type of neither of the aggregates can be determined by the context.

---

## 7.6 Using function calls in expressions

A function call initiates the evaluation of a specific function and receives the value returned by the function.

Example:            `Sin(angle)`

The arguments of a function call are used to transfer data to (and possibly from) the called function. The data type of an argument must be equal to the type of the corresponding parameter of the function. Optional arguments may be omitted but the order of the (present) arguments must be the same as the order of the formal parameters. In addition, two or more optional arguments may be declared to exclude each other, in which case, only one of them may be present in the argument list.

A required (compulsory) argument is separated from the preceding argument by a comma “,”. The formal parameter name may be included or omitted.

Example:            `Polar(3.937, 0.785398)`                            two required arguments  
                       `Polar(Dist:=3.937, Angle:=0.785398)...` using names

An optional argument must be preceded by a backslash “\” and the formal parameter name. A switch type argument is somewhat special; it may not include any argument expression. Instead, such an argument can only be either "present" or "not present".

Example:            `Cosine(45)`    one required argument  
                       `Cosine(0.785398\Rad)`    ... and one switch  
                       `Dist(p2)`    one required argument  
                       `Dist(\distance:=pos1, p2)`    ... and one optional

Conditional arguments are used to support smooth propagation of optional arguments through chains of routine calls. A conditional argument is considered to be “present” if the specified optional parameter (of the calling function) is present, otherwise it is

simply considered to be omitted. Note that the specified parameter must be optional.

```

Example:      PROC Read_from_file (iodev File \num Maxtime)
               ..
               character:=ReadBin (File \Time?Maxtime);
               ! Max. time is only used if specified when calling the routine
               ! Read_from_file
               ..
               ENDPROC
    
```

The parameter list of a function assigns an *access mode* to each parameter. The access mode can be either *in*, *inout*, *var* or *pers*:

- An IN parameter (default) allows the argument to be any expression. The called function views the parameter as a constant.
- An INOUT parameter requires the corresponding argument to be a variable (entire, array element or record component) or an entire persistent. The called function gains full (read/write) access to the argument.
- A VAR parameter requires the corresponding argument to be a variable (entire, array element or record component). The called function gains full (read/write) access to the argument.
- A PERS parameter requires the corresponding argument to be an entire persistent. The called function gains full (read/update) access to the argument.

### 7.7 Priority between operators

The relative priority of the operators determines the order in which they are evaluated. Parentheses provide a means to override operator priority. The rules below imply the following operator priority:

- \* / DIV MOD - highest
- + -
- <> <> <= >= =
- AND
- XOR OR NOT - lowest

An operator with high priority is evaluated prior to an operator with low priority. Operators of the same priority are evaluated from left to right.

**Example**

<u>Expression</u>	<u>Evaluation order</u>	<u>Comment</u>
a + b + c	(a + b) + c	left to right rule
a + b * c	a + (b * c)	* higher than +
a OR b OR c	(a OR b) OR c	Left to right rule

a AND b OR c AND d	(a AND b) OR (c AND d)	AND higher than OR
a < b AND c < d	(a < b) AND (c < d)	< higher than AND

---

## 7.8 Syntax

### *Expressions*

```

<expression> ::=
    <expr>
    | <EXP>
<expr> ::= [ NOT ] <logical term> { ( OR | XOR ) <logical term> }
<logical term> ::= <relation> { AND <relation> }
<relation> ::= <simple expr> [ <relop> <simple expr> ]
<simple expr> ::= [ <addop> ] <term> { <addop> <term> }
<term> ::= <primary> { <mulop> <primary> }
<primary> ::=
    <literal>
    | <variable>
    | <persistent>
    | <constant>
    | <parameter>
    | <function call>
    | <aggregate>
    | '(' <expr> ')'

```

### *Operators*

```

<relop> ::= '<' | '<=' | '=' | '>' | '>=' | '<>'
<addop> ::= '+' | '-'
<mulop> ::= '*' | '/' | DIV | MOD

```

### *Constant values*

```

<literal> ::= <num literal>
    | <string literal>
    | <bool literal>

```

### *Data*

```

<variable> ::=
    <entire variable>
    | <variable element>
    | <variable component>
<entire variable> ::= <ident>
<variable element> ::= <entire variable> '{' <index list> '}'

```

<index list> ::= <expr> { ',' <expr> }  
 <variable component> ::= <variable> '.' <component name>  
 <component name> ::= <ident>  
 <persistent> ::=  
     <entire persistent>  
     | <persistent element>  
     | <persistent component>  
 <constant> ::=  
     <entire constant>  
     | <constant element>  
     | <constant component>

**Aggregates**

<aggregate> ::= '[' <expr> { ',' <expr> } ']'

**Function calls**

<function call> ::= <function> '(' [ <function argument list> ] )'  
 <function> ::= <ident>  
 <function argument list> ::= <first function argument> { <function argument> }  
 <first function argument> ::=  
     <required function argument>  
     | <optional function argument>  
     | <conditional function argument>  
 <function argument> ::=  
     ',' <required function argument>  
     | <optional function argument>  
     | <conditional function argument>  
 <required function argument> ::= [ <ident> ':' ] <expr>  
 <optional function argument> ::= '\ ' <ident> [ ':' ] <expr>  
 <conditional function argument> ::= '\ ' <ident> '?' <parameter>

**Special expressions**

<constant expression> ::= <expression>  
 <literal expression> ::= <expression>  
 <conditional expression> ::= <expression>

**Parameters**

<parameter> ::=  
     <entire parameter>  
     | <parameter element>  
     | <parameter component>

---



---

## 8 Error Recovery

An execution error is an abnormal situation, related to the execution of a specific piece of a program. An error makes further execution impossible (or at least hazardous). “Overflow” and “division by zero” are examples of errors. Errors are identified by their unique *error number* and are always recognized by the robot. The occurrence of an error causes suspension of the normal program execution and the control is passed to an *error handler*. The concept of error handlers makes it possible to respond to and, possibly, recover from errors that arise during program execution. If further execution is not possible, the error handler can at least assure that the program is given a graceful abortion.

---

### 8.1 Error handlers

Any routine may include an error handler. The error handler is really a part of the routine, and the scope of any routine data also comprises the error handler of the routine. If an error occurs during the execution of the routine, control is transferred to its error handler.

```
Example:      FUNC num safediv( num x, num y)
              RETURN x / y;
              ERROR
              IF ERRNO = ERR_DIVZERO THEN
                TPWrite "The number cannot be equal to 0";
                RETURN x;
              ENDIF
              ENDFUNC
```

The system variable *ERRNO* contains the error number of the (most recent) error and can be used by the error handler to identify that error. After any necessary actions have been taken, the error handler can:

- Resume execution, starting with the instruction in which the error occurred. This is done using the **RETRY** instruction. If this instruction causes the same error again, up to four error recoveries will take place; after that execution will stop.
- Resume execution, starting with the instruction following the instruction in which the error occurred. This is done using the **TRYNEXT** instruction.
- Return control to the caller of the routine using the **RETURN** instruction. If the routine is a function, the **RETURN** instruction must specify an appropriate return value.
- Propagate the error to the caller of the routine using the **RAISE** instruction.

When an error occurs in a routine that does not contain an error handler or when the end of the error handler is reached (**ENDFUNC**, **ENDPROC** or **ENDTRAP**), the *system error handler* is called. The system error handler just reports the error and stops the execution.

In a chain of routine calls, each routine may have its own error handler. If an error occurs in a routine with an error handler, and the error is explicitly propagated using the RAISE instruction, the same error is raised again at the point of the call of the routine - the error is *propagated*. When the top of the call chain (the entry routine of the task) is reached without any error handler being found or when the end of any error handler is reached within the call chain, the system error handler is called. The system error handler just reports the error and stops the execution. Since a trap routine can only be called by the system (as a response to an interrupt), any propagation of an error from a trap routine is made to the system error handler.

Error recovery is not available for instructions in the backward handler. Such errors are always propagated to the system error handler.

In addition to errors detected and raised by the robot, a program can explicitly raise errors using the RAISE instruction. This facility can be used to recover from complex situations. It can, for example, be used to escape from deeply-nested code positions. Error numbers 1-90 may be used in the raise instruction. Explicitly-raised errors are treated exactly like errors raised by the system.

Note that it is not possible to recover from or respond to errors that occur within an error clause. Such errors are always propagated to the system error handler.

---



---

## 9 Interrupts

Interrupts are program-defined events, identified by *interrupt numbers*. An interrupt occurs when an *interrupt condition* is true. Unlike errors, the occurrence of an interrupt is not directly related to (synchronous with) a specific code position. The occurrence of an interrupt causes suspension of the normal program execution and control is passed to a *trap routine*.

Even though the robot immediately recognizes the occurrence of an interrupt (only delayed by the speed of the hardware), its response – calling the corresponding trap routine – can only take place at specific program positions, namely:

- when the next instruction is entered,
- any time during the execution of a waiting instruction, e.g. *WaitUntil*,
- any time during the execution of a movement instruction, e.g. *MoveL*.

This normally results in a delay of 5-120 ms between interrupt recognition and response, depending on what type of movement is being performed at the time of the interrupt.

The raising of interrupts may be *disabled* and *enabled*. If interrupts are disabled, any interrupt that occurs is queued and not raised until interrupts are enabled again. Note that the interrupt queue may contain more than one waiting interrupt. Queued interrupts are raised in *FIFO* order. Interrupts are always disabled during the execution of a trap routine.

When running stepwise and when the program has been stopped, no interrupts will be handled. Interrupts that are generated under these circumstances are not dealt with.

The maximum number of interrupts at any one time are 40 **per task**. The **total limitation** set by the I/O CPU is 100 interrupts.

---

### 9.1 Interrupt manipulation

Defining an interrupt makes it known to the robot. The definition specifies the interrupt condition and enables the interrupt.

```
Example:      VAR intnum sig1int;
              .
              ISignalDI di1, high, sig1int;
```

An enabled interrupt may in turn be disabled (and vice versa).

```
Example:      ISleep sig1int;                disabled
              .
              IWatch sig1int;                enabled
```

Deleting an interrupt removes its definition. It is not necessary to explicitly remove an interrupt definition, but a new interrupt cannot be defined to an interrupt variable until



the previous definition has been deleted.

Example:            IDelete sig1int;

## 9.2 Trap routines

Trap routines provide a means of dealing with interrupts. A trap routine can be connected to a particular interrupt using the CONNECT instruction. When an interrupt occurs, control is immediately transferred to the associated trap routine (if any). If an interrupt occurs, that does not have any connected trap routine, this is treated as a fatal error, i.e. causes immediate termination of program execution.

```

Example:            VAR intnum empty;
                   VAR intnum full;

                   .PROC main()

                   CONNECT empty WITH etrap;            connect trap routines
                   CONNECT full WITH ftrap;            connect trap routines
                   ISignalDI di1, high, empty;        define feeder interrupts
                   ISignalDI di3, high, full;
                   .
                   IDelete empty;
                   IDelete full;
                   ENDPROC

                   TRAP etrap                            responds to "feeder
                   open_valve;                        empty" interrupt
                   RETURN;
                   ENDTRAP

                   TRAP ftrap                            responds to "feeder full"
                   close_valve;                        interrupt
                   RETURN;
                   ENDTRAP
    
```

Several interrupts may be connected to the same trap routine. The system variable *INTNO* contains the interrupt number and can be used by a trap routine to identify an interrupt. After the necessary action has been taken, a trap routine can be terminated using the RETURN instruction or when the end (ENDTRAP or ERROR) of the trap routine is reached. Execution continues from the place where the interrupt occurred.

---



---

## 10 Backward execution

A program can be executed backwards one instruction at a time. The following general restrictions are valid for backward execution:

- The instructions IF, FOR, WHILE and TEST cannot be executed backwards.
- It is not possible to step backwards out of a routine when reaching the beginning of the routine.

---

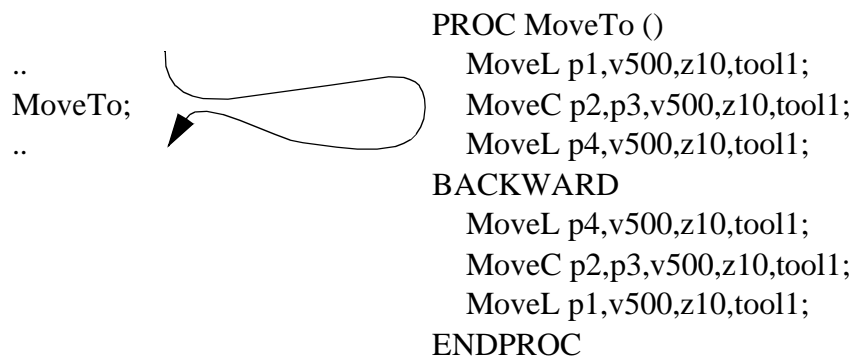
### 10.1 Backward handlers

Procedures may contain a backward handler that defines the backward execution of a procedure call.

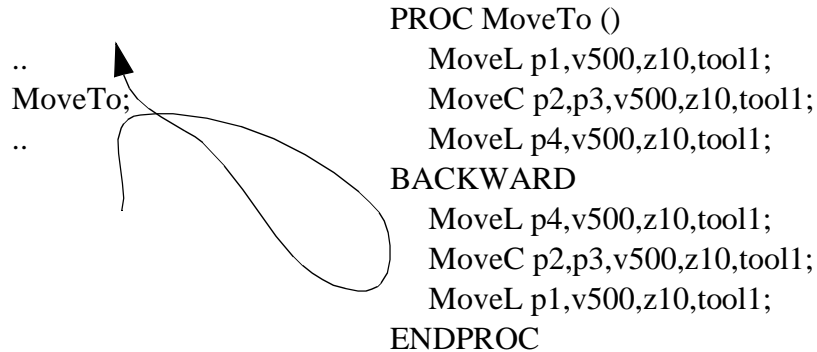
The backward handler is really a part of the procedure and the scope of any routine data also comprises the backward handler of the procedure.

```
Example:      PROC MoveTo ()
                MoveL p1,v500,z10,tool1;
                MoveC p2,p3,v500,z10,tool1;
                MoveL p4,v500,z10,tool1;
                BACKWARD
                MoveL p4,v500,z10,tool1;
                MoveC p2,p3,v500,z10,tool1;
                MoveL p1,v500,z10,tool1;
                ENDPROC
```

When the procedure is called during forward execution, the following occurs:



When the procedure is called during backwards execution, the following occurs:

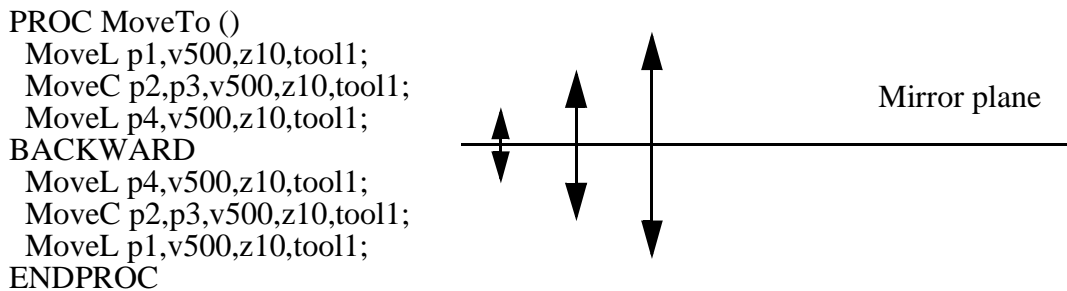


Instructions in the backward or error handler of a routine may not be executed backwards. Backward execution cannot be nested, i.e. two instructions in a call chain may not simultaneously be executed backwards.

A procedure with no backward handler cannot be executed backwards. A procedure with an empty backward handler is executed as “no operation”.

### 10.2 Limitation of move instructions in the backward handler

The move instruction type and sequence in the backward handler must be a mirror of the move instruction type and sequence for forward execution in the same routine:



Note that the order of CirPoint *p2* and ToPoint *p3* in the MoveC should be the same.

By move instructions is meant all instructions that result in some movement of the robot or external axes such as MoveL, SearchC, TriggJ, ArcC, PaintL ...



**Any departures from this programming limitation in the backward handler can result in faulty backward movement. Linear movement can result in circular movement and vice versa, for some part of the backward path.**

---

---

## 11 Multitasking

The events in a robot cell are often in parallel, so why are the programs not in parallel?

**Multitasking RAPID** is a way to execute programs in (pseudo) parallel with the normal execution. The execution is started at power on and will continue for ever, unless an error occurs in that program. One parallel program can be placed in the background or foreground of another program. It can also be on the same level as another program.

To use this function the robot must be configured with one extra TASK for each background program.

Up to 10 different tasks can be run in pseudo parallel. Each task consists of a set of modules, in the same way as the normal program. All the modules are local in each task.

Variables and constants are local in each task, but persistents are not. A persistent with the same name and type is reachable in all tasks. If two persistents have the same name, but their type or size (array dimension) differ, a runtime error will occur.

A task has its own trap handling and the event routines are triggered only on its own task system states (e.g. Start/Stop/Restart....).

There are a few restrictions on the use of Multitasking RAPID.

- Do not mix up parallel programs with a PLC. The response time is the same as the interrupt response time for one task. This is true, of course, when the task is not in the background of another busy program
- There is only one physical Teach Pendant, so be careful that a TPWrite request is not mixed in the Operator Window for all tasks.
- When running a Wait instruction in manual mode, a simulation box will come up after 3 seconds. This will only occur in the main task.
- Move instructions can only be executed in the main task (the task bind to program instance 0, see User's guide - System parameters).
- The execution of a task will halt during the time that some other tasks are accessing the file system, that is if the operator chooses to save or open a program, or if the program in a task uses the load/erase/read/write instructions.
- The Teach Pendant cannot access other tasks than the main task. So, the development of RAPID programs for other tasks can only be done if the code is loaded into the main task, or off-line.

For all settings, see User's Guide - System parameters.

---

### 11.1 Synchronising the tasks

In many applications a parallel task only supervises some cell unit, quite independently of the other tasks being executed. In such cases, no synchronisation mechanism is necessary. But there are other applications which need to know what the main task is doing,

for example.

**Synchronising using polling**

This is the easiest way to do it, but the performance will be the slowest.

Persistents are then used together with the instructions *WaitUntil*, *IF*, *WHILE* or *GOTO*.

If the instruction *WaitUntil* is used, it will poll internally every 100 ms. Do not poll more frequently in other implementations.

***Example*****TASK 0**

```
MODULE module1
PERS bool startsync:=FALSE;
PROC main()

    startsync:= TRUE;
    .

ENDPROC
ENDMODULE
```

**TASK 1**

```
MODULE module2
PERS bool startsync:=FALSE;
PROC main()

    WaitUntil startsync;
    .

ENDPROC
ENDMODULE
```

**Synchronising using an interrupt**

The instruction *SetDO* and *ISignalDO* are used.

***Example*****TASK 0**

```
MODULE module1
PROC main()

SetDO do1,1;
    .
```

```

ENDPROC
ENDMODULE

TASK 1

MODULE module2
VAR intnum isiint1;
PROC main()

CONNECT isiint1 WITH isi_trap;
ISignalDO do1, 1, isiint1;

WHILE TRUE DO
    WaitTime 200;
ENDWHILE

IDelete isiint1;

ENDPROC

TRAP isi_trap

.

ENDTRAP
ENDMODULE

```

---

## 11.2 Intertask communication

All types of data can be sent between two (or more) tasks with persistent variables.

A persistent variable is global in all tasks. The persistent variable must be of the same type and size (array dimension) in all tasks that declared it. Otherwise a runtime error will occur.

All declarations must specify an init value to the persistent variable, but only the first module loaded with the declaration will use it.

### *Example*

```

TASK 0

MODULE module1
PERS bool startsync:=FALSE;
PERS string stringtosend:="";
PROC main()

    stringtosend:="this is a test";

    startsync:= TRUE

```

```
ENDPROC
ENDMODULE
```

### **TASK 1**

```
MODULE module2
PERS bool startsync:=FALSE;
PERS string stringtosend:="";
PROC main()

    WaitUntil startsync;

    !read string
    IF stringtosend = "this is a test" THEN

ENDPROC
ENDMODULE
```

---

## 11.3 Type of task

Each extra task (not 0) is started in the system start sequence. If the task is of type **STATIC**, it will be restarted at the current position (where PP was when the system was powered off), but if the type is set to **SEMISTATIC**, it will be restarted from the beginning each time the power is turned on.

It is also possible to set the task to type **NORMAL**, then it will behave in the same way as task 0 (the main task, controlling the robot movement). The teach pendant can only be used to start task 0, so the only way to start other **NORMAL** tasks is to use **CommunicationWare**.

---

## 11.4 Priorities

The way to run the tasks as default is to run all tasks at the same level in a round robin way (one basic step on each instance). But it is possible to change the priority of one task by putting the task in the background of another. Then the background will only execute when the foreground is waiting for some events, or has stopped the execution (idle). A robot program with move instructions will be in an idle state most of the time.

The example below describes some situations where the system has 10 tasks (see Figure 5)

Round robin chain 1: tasks 0, 1, and 8 are busy

Round robin chain 2: tasks 0, 3, 4, 5 and 8 are busy  
tasks 1 and 2 are idle

Round robin chain 3: tasks 2, 4 and 5 are busy  
tasks 0, 1, 8 and 9 are idle.

Round robin chain 4: tasks 6 and 7 are busy  
 tasks 0, 1, 2, 3, 4, 5, 8 and 9 are idle

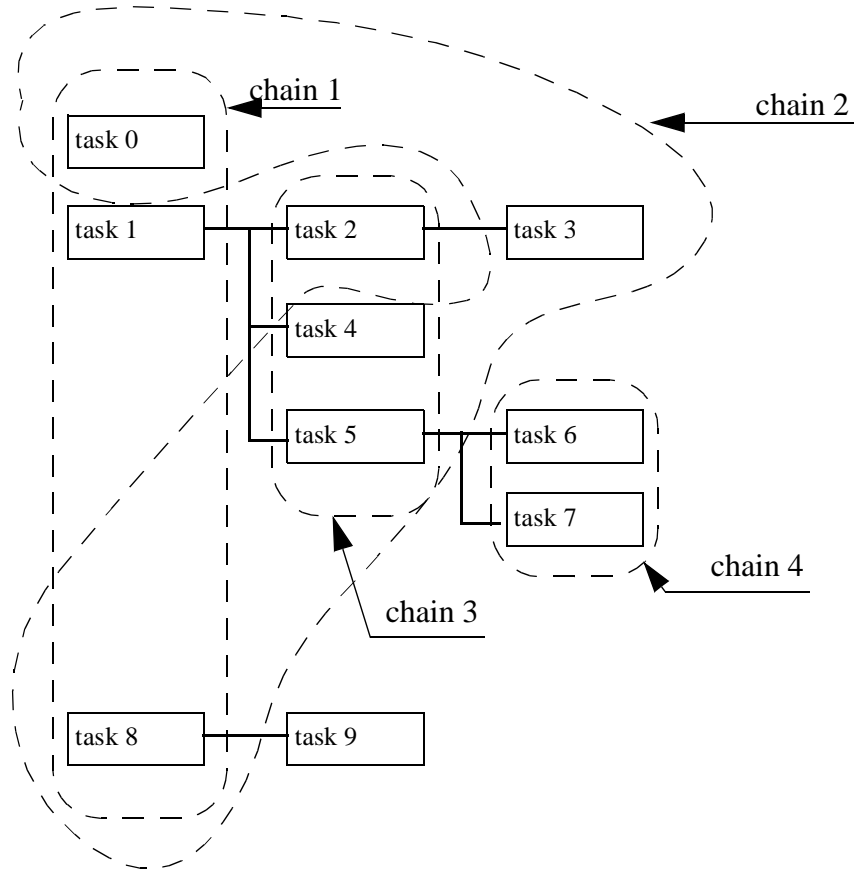


Figure 5 The tasks can have different priorities.

---

## 11.5 Task sizes

The system will supply a memory area with an installation depending on size. That area is shared by all tasks.

The value of a persistent variable will be stored in a separate part of the system, and not affect the memory area above. See System parameters - *AveragePers*.

---

## 11.6 Something to think about

When you specify task priorities, you must think about the following:



- Always use the interrupt mechanism or loops with delays in supervision tasks. Otherwise the teach pendant will never get any time to interact with the user. And if the supervision task is in foreground, it will never allow another task in background to execute.

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---

---

# 1 Coordinate Systems

---

## 1.1 The robot's tool centre point (TCP)

The position of the robot and its movements are always related to the tool centre point. This point is normally defined as being somewhere on the tool, e.g. in the muzzle of a glue gun, at the centre of a gripper or at the end of a grading tool.

Several TCPs (tools) may be defined, but only one may be active at any one time. When a position is recorded, it is the position of the TCP that is recorded. This is also the point that moves along a given path, at a given velocity.

If the robot is holding a work object and working on a stationary tool, a stationary TCP is used. If that tool is active, the programmed path and speed are related to the work object. See *Stationary TCPs* on page 10.

---

## 1.2 Coordinate systems used to determine the position of the TCP

The tool (TCP's) position can be specified in different coordinate systems to facilitate programming and readjustment of programs.

The coordinate system defined depends on what the robot has to do. When no coordinate system is defined, the robot's positions are defined in the base coordinate system.

---

### 1.2.1 Base coordinate system

In a simple application, programming can be done in the base coordinate system; here the z-axis is coincident with axis 1 of the robot (see Figure 1).

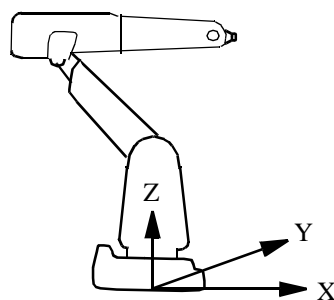


Figure 1 The base coordinate system.

The base coordinate system is located on the base of the robot:

- The origin is situated at the intersection of axis 1 and the base mounting surface.
- The *xy* plane is the same as the base mounting surface.
- The *x*-axis points forwards.
- The *y*-axis points to the left (from the perspective of the robot).
- The *z*-axis points upwards.

### 1.2.2 World coordinate system

If the robot is floor-mounted, programming in the base coordinate system is easy. If, however, the robot is mounted upside down (suspended), programming in the base coordinate system is more difficult because the directions of the axes are not the same as the principal directions in the working space. In such cases, it is useful to define a world coordinate system. The world coordinate system will be coincident with the base coordinate system, if it is not specifically defined.

Sometimes, several robots work within the same working space at a plant. A common world coordinate system is used in this case to enable the robot programs to communicate with one another. It can also be advantageous to use this type of system when the positions are to be related to a fixed point in the workshop. See the example in Figure 2.

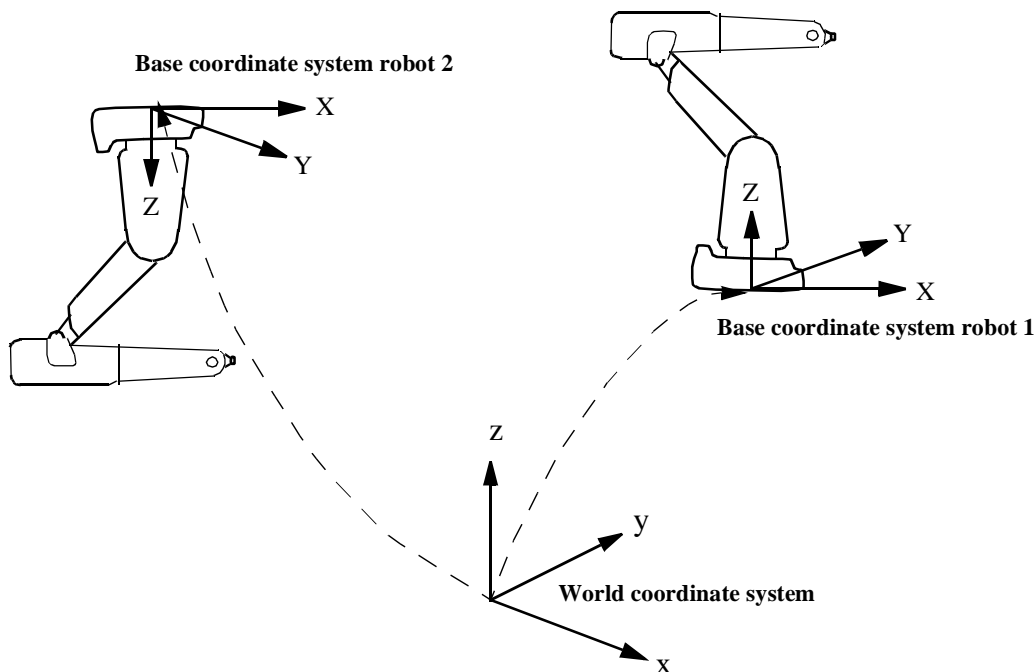


Figure 2 Two robots (one of which is suspended) with a common world coordinate system.

### 1.2.3 User coordinate system

A robot can work with different fixtures or working surfaces having different positions and orientations. A user coordinate system can be defined for each fixture. If all positions are stored in object coordinates, you will not need to reprogram if a fixture must be moved or turned. By moving/turning the user coordinate system as much as the fixture has been moved/turned, all programmed positions will follow the fixture and no reprogramming will be required.

The user coordinate system is defined based on the world coordinate system (see Figure 3).

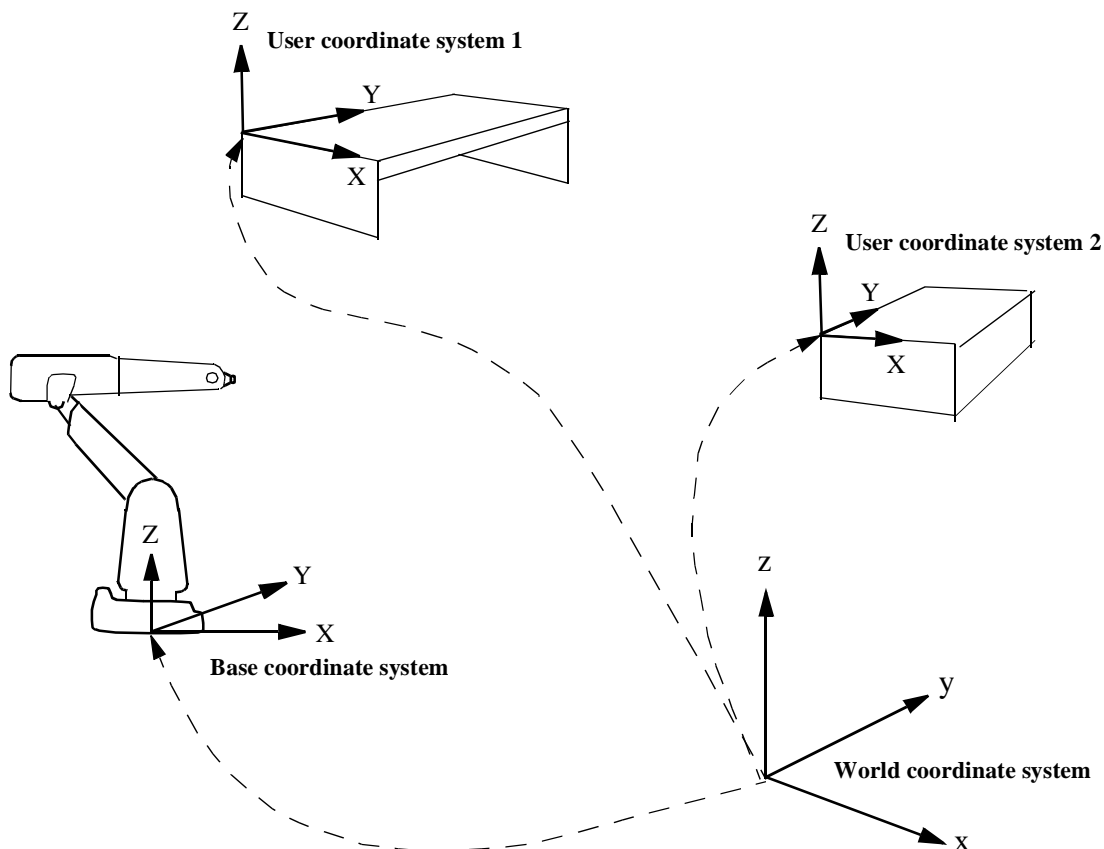


Figure 3 Two user coordinate systems describe the position of two different fixtures.

### 1.2.4 Object coordinate system

The user coordinate system is used to get different coordinate systems for different fixtures or working surfaces. A fixture, however, may include several work objects that are to be processed or handled by the robot. Thus, it often helps to define a coordinate system for each object in order to make it easier to adjust the program if the object is moved or if a new object, the same as the previous one, is to be programmed at a different location. A coordinate system referenced to an object is called an object coordinate system. This coordinate system is also very suited to off-line programming since the positions specified can usually be taken directly from a drawing of the work object. The object coordinate system can also be used when jogging the robot.

The object coordinate system is defined based on the user coordinate system (see Figure 4).

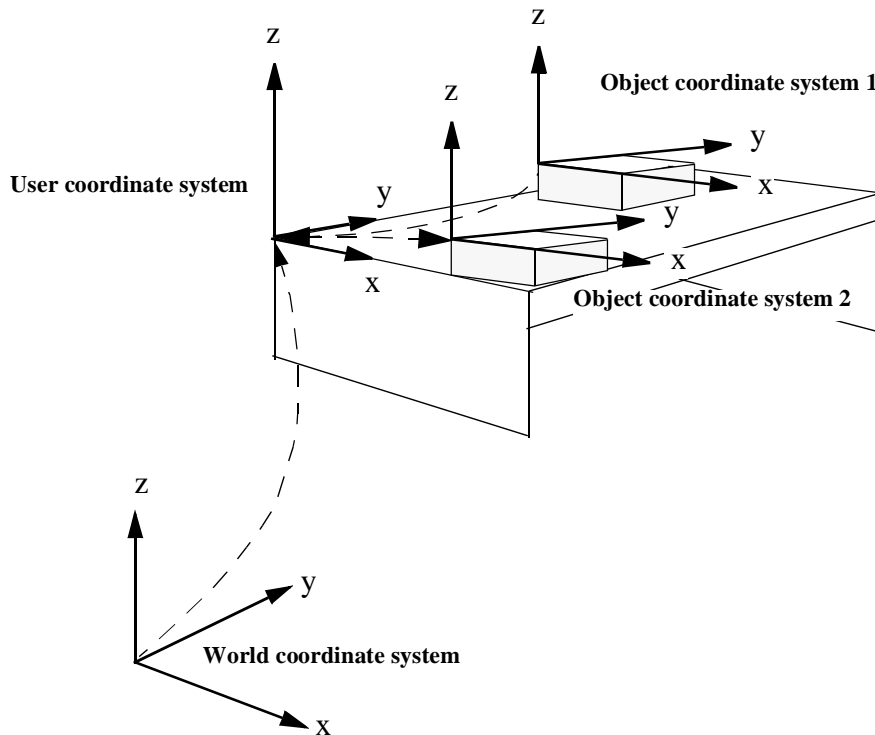


Figure 4 Two object coordinate systems describe the position of two different work objects located in the same fixture.

The programmed positions are always defined relative to an object coordinate system. If a fixture is moved/turned, this can be compensated for by moving/turning the user coordinate system. Neither the programmed positions nor the defined object coordinate systems need to be changed. If the work object is moved/turned, this can be compensated for by moving/turning the object coordinate system.

If the user coordinate system is movable, that is, coordinated external axes are used, then the object coordinate system moves with the user coordinate system. This makes it possible to move the robot in relation to the object even when the workbench is being manipulated.

---

### 1.2.5 Displacement coordinate system

Sometimes, the same path is to be performed at several places on the same object. To avoid having to re-program all positions each time, a coordinate system, known as the displacement coordinate system, is defined. This coordinate system can also be used in conjunction with searches, to compensate for differences in the positions of the individual parts.

The displacement coordinate system is defined based on the object coordinate system (see Figure 5).

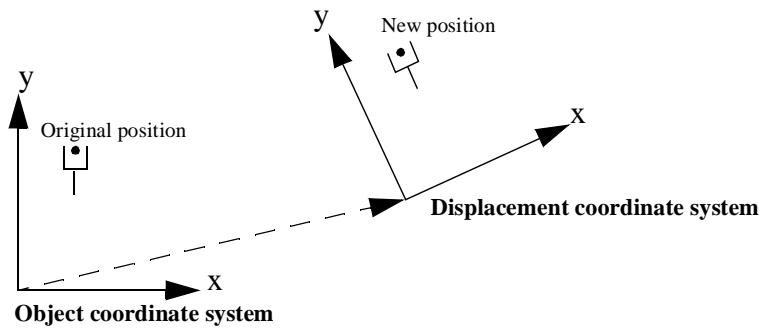


Figure 5 If program displacement is active, all positions are displaced.

### 1.2.6 Coordinated external axes

#### Coordination of user coordinate system

If a work object is placed on an external mechanical unit, that is moved whilst the robot is executing a path defined in the object coordinate system, a movable user coordinate system can be defined. The position and orientation of the user coordinate system will, in this case, be dependent on the axes rotations of the external unit. The programmed path and speed will thus be related to the work object (see Figure 6) and there is no need to consider the fact that the object is moved by the external unit.

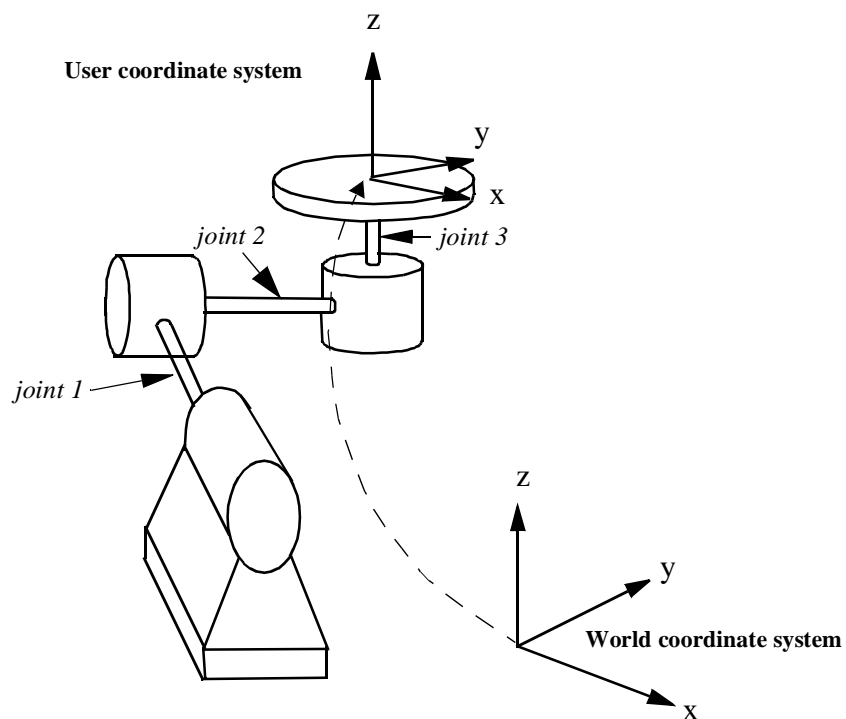


Figure 6 A user coordinate system, defined to follow the movements of a 3-axis external mechanical unit.



*Coordination of base coordinate system*

A movable coordinate system can also be defined for the base of the robot. This is of interest for the installation when the robot is mounted on a track or a gantry, for example. The position and orientation of the base coordinate system will, as for the moveable user coordinate system, be dependent on the movements of the external unit. The programmed path and speed will be related to the object coordinate system (Figure 7) and there is no need to think about the fact that the robot base is moved by an external unit. A coordinated user coordinate system and a coordinated base coordinate system can both be defined at the same time.

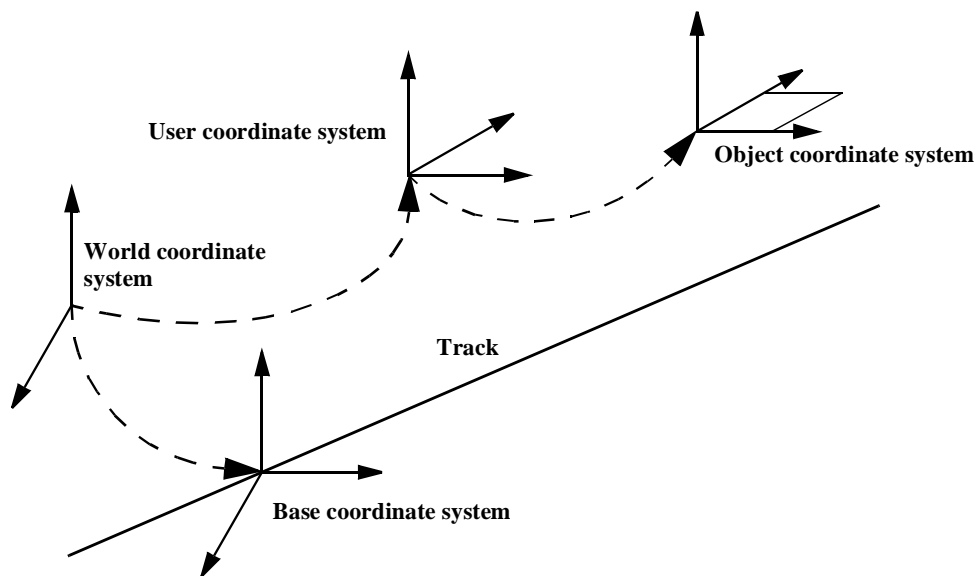


Figure 7 Coordinated interpolation with a track moving the base coordinate system of the robot.

To be able to calculate the user and the base coordinate systems when involved units are moved, the robot must be aware of:

- The calibration positions of the user and the base coordinate systems
- The relations between the angles of the external axes and the translation/rotation of the user and the base coordinate systems.

These relations are defined in the system parameters.

---

### 1.3 Coordinate systems used to determine the direction of the tool

The orientation of a tool at a programmed position is given by the orientation of the tool coordinate system. The tool coordinate system is referenced to the wrist coordinated system, defined at the mounting flange on the wrist of the robot.

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### 1.3.1 Wrist coordinate system

In a simple application, the wrist coordinate system can be used to define the orientation of the tool; here the z-axis is coincident with axis 6 of the robot (see Figure 8).

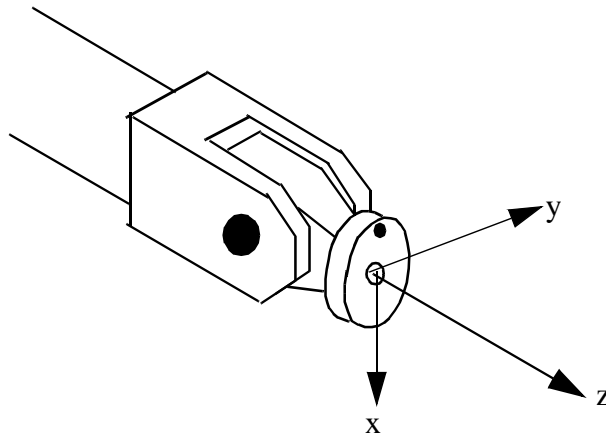


Figure 8 The wrist coordinate system.

The wrist coordinate system cannot be changed and is always the same as the mounting flange of the robot in the following respects:

- *The origin* is situated at the centre of the mounting flange (on the mounting surface).
- *The x-axis* points in the opposite direction, towards the control hole of the mounting flange.
- *The z-axis* points outwards, at right angles to the mounting flange.

---

### 1.3.2 Tool coordinate system

The tool mounted on the mounting flange of the robot often requires its own coordinate system to enable definition of its TCP, which is the origin of the tool coordinate system. The tool coordinate system can also be used to get appropriate motion directions when jogging the robot.

If a tool is damaged or replaced, all you have to do is redefine the tool coordinate system. The program does not normally have to be changed.

The TCP (origin) is selected as the point on the tool that must be correctly positioned, e.g. the muzzle on a glue gun. The tool coordinate axes are defined as those natural for the tool in question.

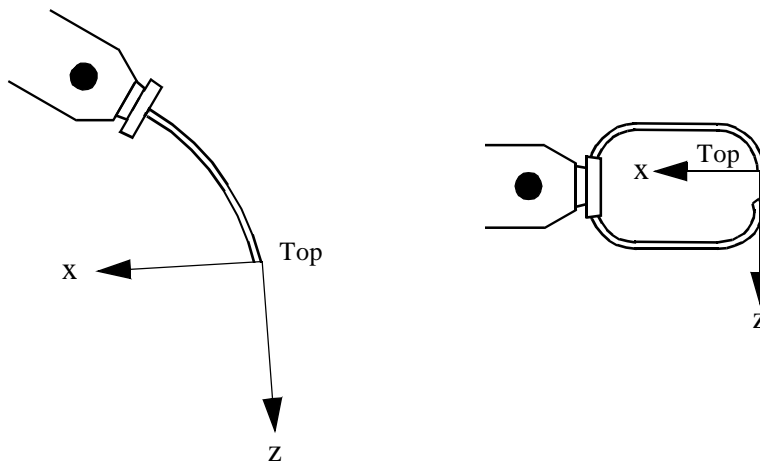


Figure 9 Tool coordinate system, as usually defined for an arc-welding gun (left) and a spot welding gun (right).

The tool coordinate system is defined based on the wrist coordinate system (see Figure 10).

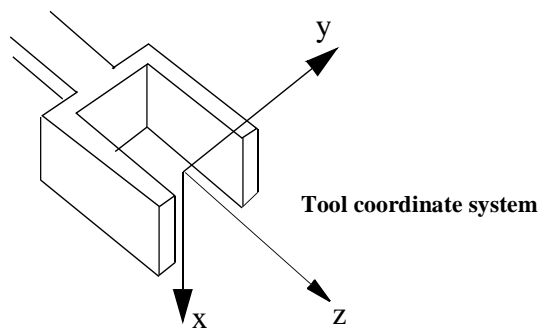


Figure 10 The tool coordinate system is defined relative to the wrist coordinate system, here for a gripper.

---

### 1.3.3 Stationary TCPs

If the robot is holding a work object and working on a stationary tool, a stationary TCP is used. If that tool is active, the programmed path and speed are related to the work object held by the robot.

This means that the coordinate systems will be reversed, as in Figure 11.

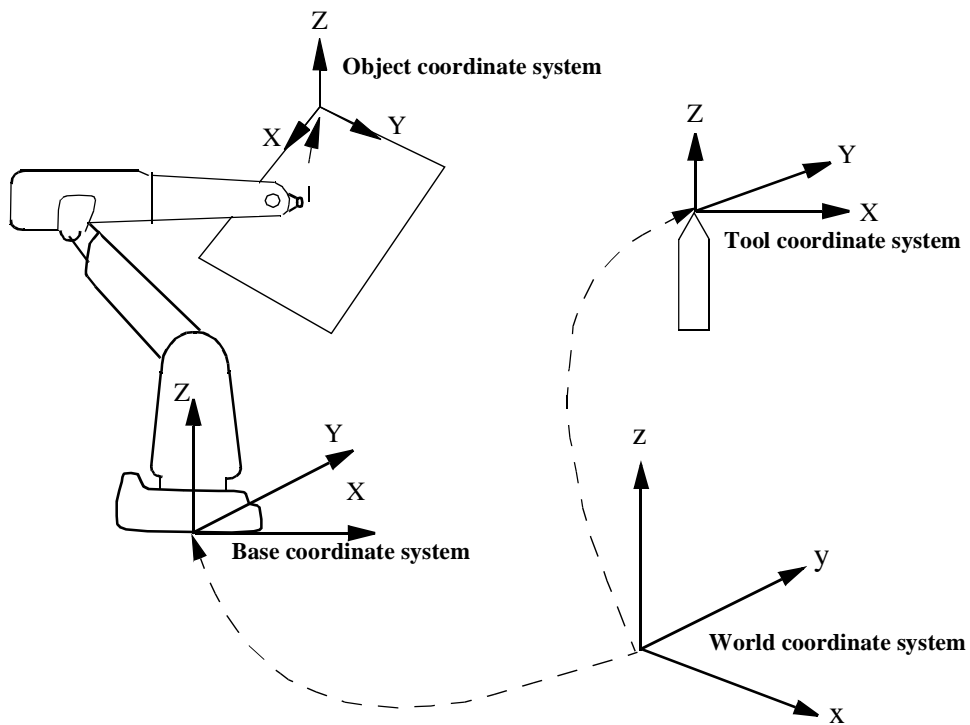


Figure 11 If a stationary TCP is used, the object coordinate system is usually based on the wrist coordinate system.

In the example in Figure 11, neither the user coordinate system nor program displacement is used. It is, however, possible to use them and, if they are used, they will be related to each other as shown in Figure 12.

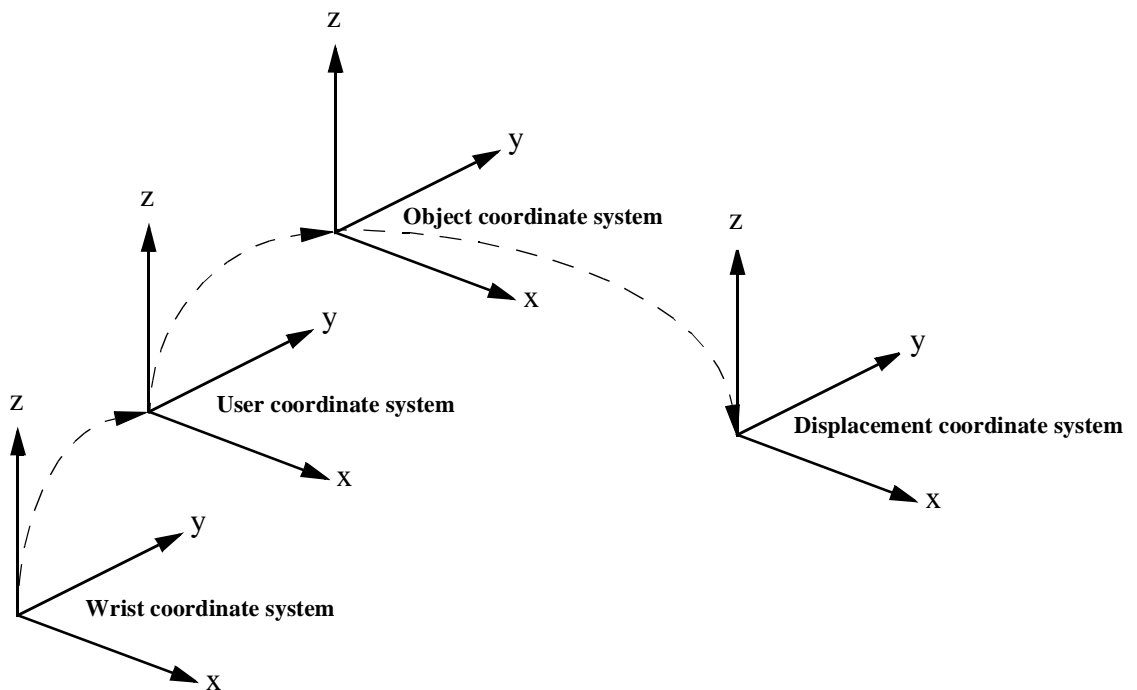


Figure 12 Program displacement can also be used together with stationary TCPs.

**1.4 Related information**

	<u>Described in:</u>
Definition of the world coordinate system	User's Guide - System Parameters
Definition of the user coordinate system	User's Guide - Calibration Data Types - <i>wobjdata</i>
Definition of the object coordinate system	User's Guide - Calibration Data Types - <i>wobjdata</i>
Definition of the tool coordinate system	User's Guide - Calibration Data Types - <i>tooldata</i>
Definition of a tool centre point	User's Guide - Calibration Data Types - <i>tooldata</i>
Definition of displacement frame	User's Guide - Calibration RAPID Summary - <i>Motion Settings</i>
Jogging in different coordinate systems	User's Guide - Jogging

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## 2 Positioning during Program Execution

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### 2.1 General

During program execution, positioning instructions in the robot program control all movements. The main task of the positioning instructions is to provide the following information on how to perform movements:

- The destination point of the movement (defined as the position of the tool centre point, the orientation of the tool, the configuration of the robot and the position of the external axes).
- The interpolation method used to reach the destination point, e.g. joint interpolation, linear interpolation or circle interpolation.
- The velocity of the robot and external axes.
- The zone data (defines how the robot and the external axes are to pass the destination point).
- The coordinate systems (tool, user and object) used for the movement.

As an alternative to defining the velocity of the robot and the external axes, the time for the movement can be programmed. This should, however, be avoided if the weaving function is used. Instead the velocities of the orientation and external axes should be used to limit the speed, when small or no TCP-movements are made.



**In material handling and pallet applications with intensive and frequent movements, the drive system supervision may trip out and stop the robot in order to prevent overheating of drives or motors. If this occurs, the cycle time needs to be slightly increased by reducing programmed speed or acceleration.**

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### 2.2 Interpolation of the position and orientation of the tool

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#### 2.2.1 Joint interpolation

When path accuracy is not too important, this type of motion is used to move the tool quickly from one position to another. Joint interpolation also allows an axis to move from any location to another within its working space, in a single movement.

All axes move from the start point to the destination point at constant axis velocity (see Figure 13).

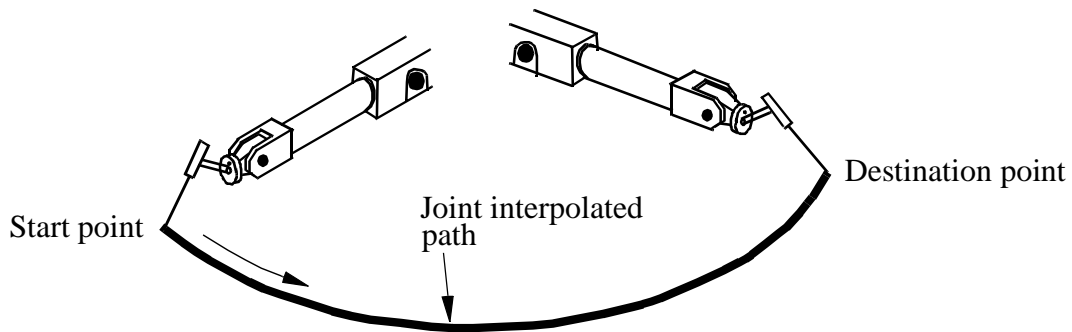


Figure 13 Joint interpolation is often the fastest way to move between two points as the robot axes follow the closest path between the start point and the destination point (from the perspective of the axis angles).

The velocity of the tool centre point is expressed in mm/s (in the object coordinate system). As interpolation takes place axis-by-axis, the velocity will not be exactly the programmed value.

During interpolation, the velocity of the limiting axis, i.e. the axis that travels fastest relative to its maximum velocity in order to carry out the movement, is determined. Then, the velocities of the remaining axes are calculated so that all axes reach the destination point at the same time.

All axes are coordinated in order to obtain a path that is independent of the velocity. Acceleration is automatically optimised to the max performance of the robot.

### 2.2.2 Linear interpolation

During linear interpolation, the TCP travels along a straight line between the start and destination points (see Figure 14).

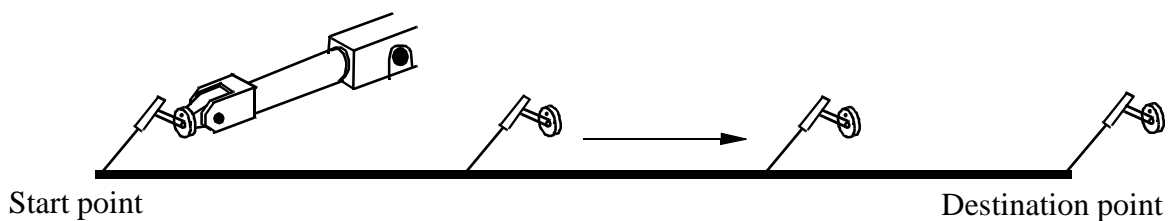


Figure 14 Linear interpolation without reorientation of the tool.

To obtain a linear path in the object coordinate system, the robot axes must follow a non-linear path in the axis space. The more non-linear the configuration of the robot is, the more accelerations and decelerations are required to make the tool move in a straight line and to obtain the desired tool orientation. If the configuration is extremely non-linear (e.g. in the proximity of wrist and arm singularities), one or more of the axes will require more torque than the motors can give. In this case, the velocity of all axes will automatically be reduced.

The orientation of the tool remains constant during the entire movement unless a reorientation has been programmed. If the tool is reorientated, it is rotated at constant velocity.

A maximum rotational velocity (in degrees per second) can be specified when rotating the tool. If this is set to a low value, reorientation will be smooth, irrespective of the velocity defined for the tool centre point. If it is a high value, the reorientation velocity is only limited by the maximum motor speeds. As long as no motor exceeds the limit for the torque, the defined velocity will be maintained. If, on the other hand, one of the motors exceeds the current limit, the velocity of the entire movement (with respect to both the position and the orientation) will be reduced.

All axes are coordinated in order to obtain a path that is independent of the velocity. Acceleration is optimised automatically.

---

### 2.2.3 Circular interpolation

A circular path is defined using three programmed positions that define a circle segment. The first point to be programmed is the start of the circle segment. The next point is a support point (circle point) used to define the curvature of the circle, and the third point denotes the end of the circle (see Figure 15).

The three programmed points should be dispersed at regular intervals along the arc of the circle to make this as accurate as possible.

The orientation defined for the support point is used to select between the short and the long twist for the orientation from start to destination point.

If the programmed orientation is the same relative to the circle at the start and the destination points, and the orientation at the support is close to the same orientation relative to the circle, the orientation of the tool will remain constant relative to the path.

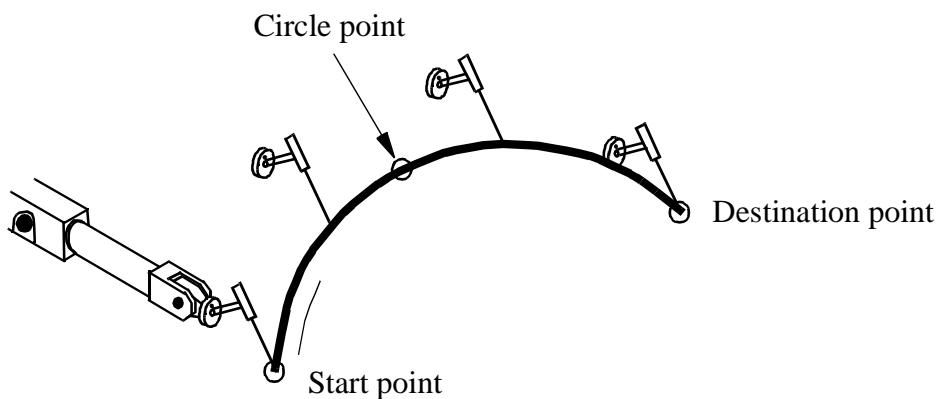


Figure 15 Circular interpolation with a short twist for part of a circle (circle segment) with a start point, circle point and destination point.

However, if the orientation at the support point is programmed closer to the orientation rotated 180°, the alternative twist is selected (see Figure 16).



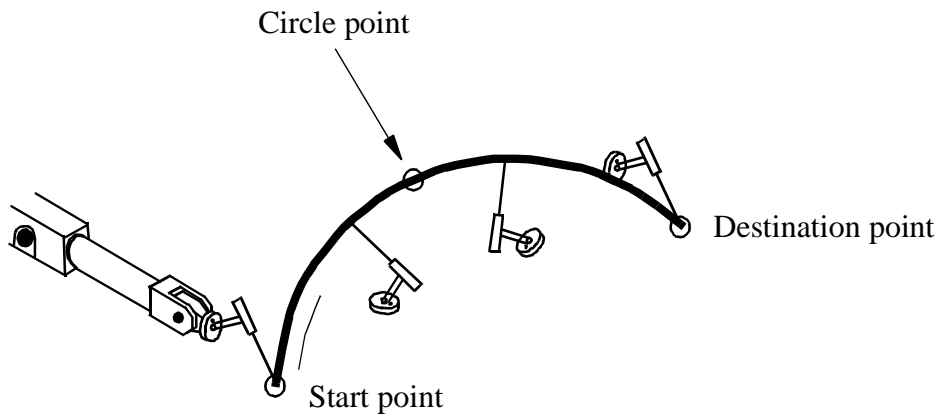


Figure 16 Circular interpolation with a long twist for orientation is achieved by defining the orientation in the circle point in the opposite direction compared to the start point.

As long as all motor torques do not exceed the maximum permitted values, the tool will move at the programmed velocity along the arc of the circle. If the torque of any of the motors is insufficient, the velocity will automatically be reduced at those parts of the circular path where the motor performance is insufficient.

All axes are coordinated in order to obtain a path that is independent of the velocity. Acceleration is optimised automatically.

#### 2.2.4 SingArea\Wrist

During execution in the proximity of a singular point, linear or circular interpolation may be problematic. In this case, it is best to use modified interpolation, which means that the wrist axes are interpolated axis-by-axis, with the TCP following a linear or circular path. The orientation of the tool, however, will differ somewhat from the programmed orientation.

In the *SingArea\Wrist* case the orientation in the circle support point will be the same as programmed. However, the tool will not have a constant direction relative to the circle plane as for normal circular interpolation. If the circle path passes a singularity, the orientation in the programmed positions sometimes must be modified to avoid big wrist movements, which can occur if a complete wrist reconfiguration is generated when the circle is executed (joints 4 and 6 moved 180 degrees each).

### 2.3 Interpolation of corner paths

The destination point is defined as a stop point in order to get point-to-point movement. This means that the robot and any external axes will stop and that it will not be possible to continue positioning until the velocities of all axes are zero and the axes are close to their destinations.

Fly-by points are used to get continuous movements past programmed positions. In this way, positions can be passed at high speed without having to reduce the speed unnecessarily. A fly-by point generates a corner path (parabola path) past the programmed

position, which generally means that the programmed position is never reached. The beginning and end of this corner path are defined by a zone around the programmed position (see Figure 17).

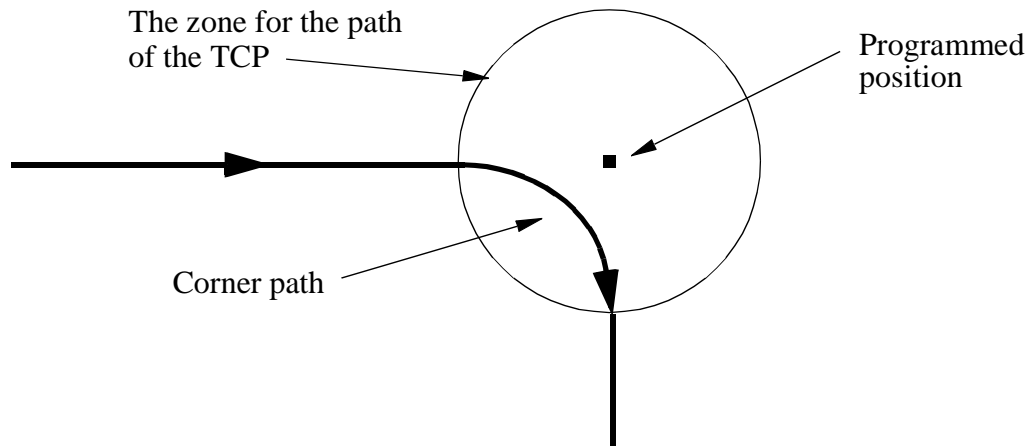


Figure 17 A fly-by point generates a corner path to pass the programmed position.

All axes are coordinated in order to obtain a path that is independent of the velocity. Acceleration is optimised automatically.

### 2.3.1 Joint interpolation in corner paths

The size of the corner paths (zones) for the TCP movement is expressed in mm (see Figure 18). Since the interpolation is performed axis-by-axis, the size of the zones (in mm) must be recalculated in axis angles (radians). This calculation has an error factor (normally max. 10%), which means that the true zone will deviate somewhat from the one programmed.

If different speeds have been programmed before or after the position, the transition from one speed to the other will be smooth and take place within the corner path without affecting the actual path.

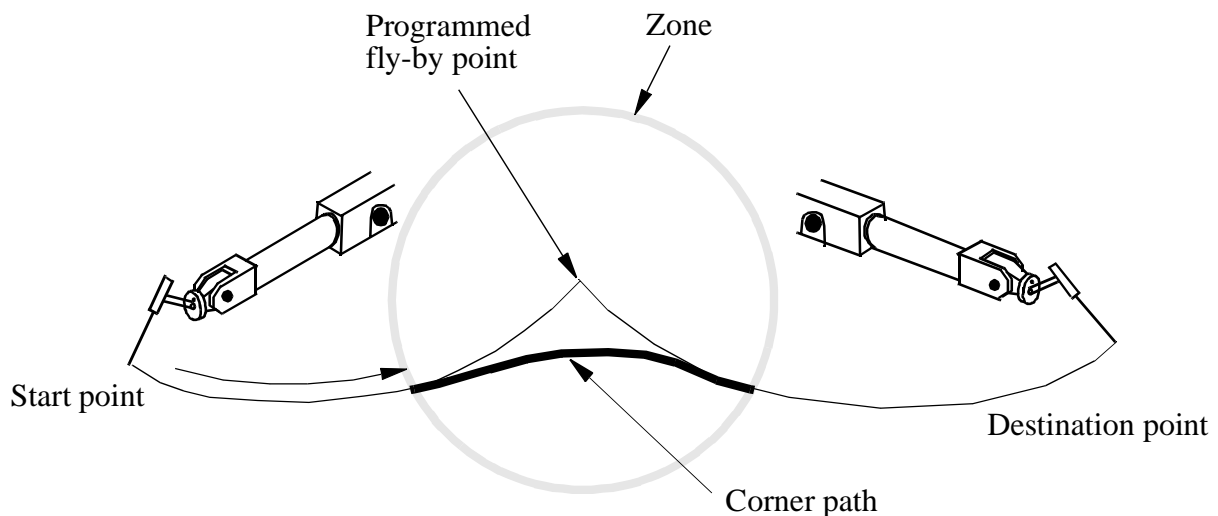


Figure 18 During joint interpolation, a corner path is generated in order to pass a fly-by point.

### 2.3.2 Linear interpolation of a position in corner paths

The size of the corner paths (zones) for the TCP movement is expressed in mm (see Figure 19).

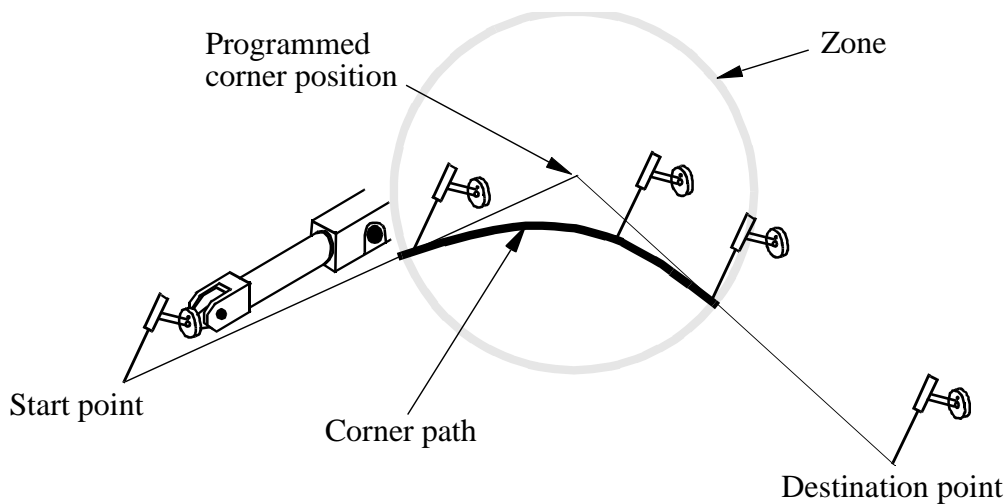


Figure 19 During linear interpolation, a corner path is generated in order to pass a fly-by point.

If different speeds have been programmed before or after the corner position, the transition will be smooth and take place within the corner path without affecting the actual path.

If the tool is to carry out a process (such as arc-welding, gluing or water cutting) along the corner path, the size of the zone can be adjusted to get the desired path. If the shape of the parabolic corner path does not match the object geometry, the programmed positions can be placed closer together, making it possible to approximate the desired path using two or more smaller parabolic paths.

### 2.3.3 Linear interpolation of the orientation in corner paths

Zones can be defined for tool orientations, just as zones can be defined for tool positions. The orientation zone is usually set larger than the position zone. In this case, the reorientation will start interpolating towards the orientation of the next position before the corner path starts. The reorientation will then be smoother and it will probably not be necessary to reduce the velocity to perform the reorientation.

The tool will be reorientated so that the orientation at the end of the zone will be the same as if a stop point had been programmed (see Figure 20a-c).

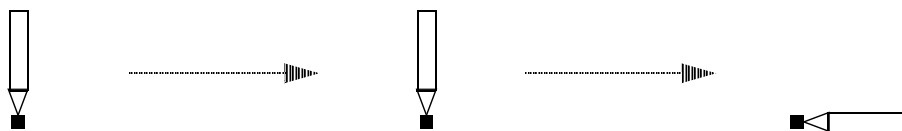


Figure 20a Three positions with different tool orientations are programmed as above.

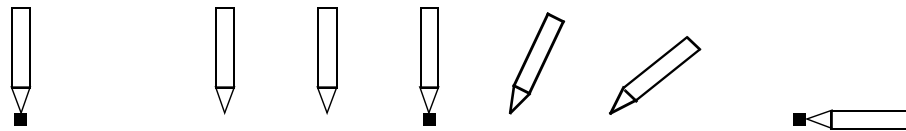


Figure 20b If all positions were stop points, program execution would look like this.

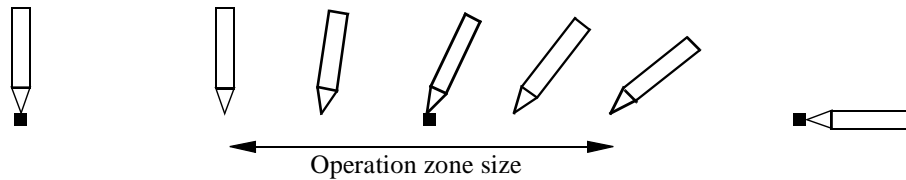


Figure 20c If the middle position was a fly-by point, program execution would look like this.

The orientation zone for the tool movement is normally expressed in mm. In this way, you can determine directly where on the path the orientation zone begins and ends. If the tool is not moved, the size of the zone is expressed in angle of rotation degrees instead of TCP-mm.

If different reorientation velocities are programmed before and after the fly-by point, and if the reorientation velocities limit the movement, the transition from one velocity to the other will take place smoothly within the corner path.

#### 2.3.4 Interpolation of external axes in corner paths

Zones can also be defined for external axes, in the same manner as for orientation. If the external axis zone is set to be larger than the TCP zone, the interpolation of the external axes towards the destination of the next programmed position, will be started before the TCP corner path starts. This can be used for smoothing external axes movements in the same way as the orientation zone is used for the smoothing of the wrist movements.

#### 2.3.5 Corner paths when changing the interpolation method

Corner paths are also generated when one interpolation method is exchanged for another. The interpolation method used in the actual corner paths is chosen in such a way as to make the transition from one method to another as smooth as possible. If the corner path zones for orientation and position are not the same size, more than one interpolation method may be used in the corner path (see Figure 21).

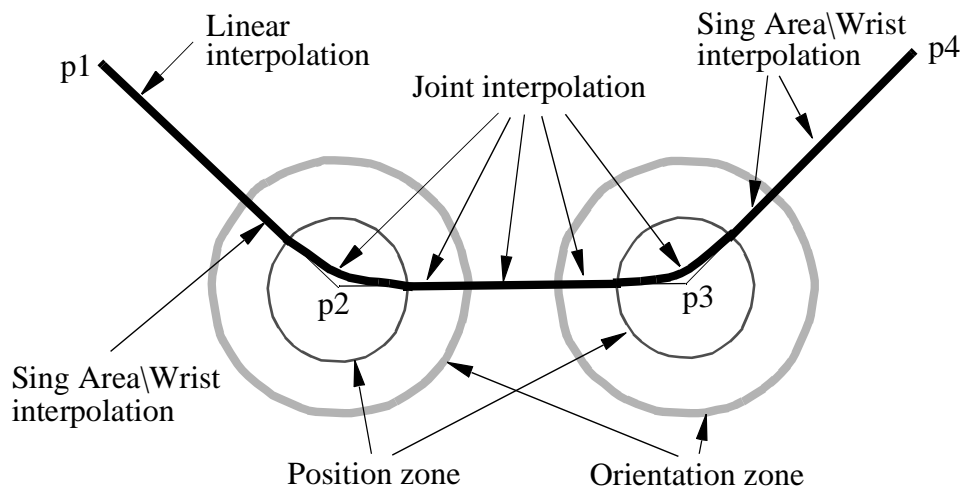


Figure 21 Interpolation when changing from one interpolation method to another. Linear interpolation has been programmed between p1 and p2; joint interpolation between p2 and p3; and Sing Area\Wrist interpolation between p3 and p4.

If the interpolation is changed from a normal TCP-movement to a reorientation without a TCP-movement or vice versa, no corner zone will be generated. The same will be the case if the interpolation is changed to or from an external joint movement without TCP-movement.

### 2.3.6 Interpolation when changing coordinate system

When there is a change of coordinate system in a corner path, e.g. a new TCP or a new work object, joint interpolation of the corner path is used. This is also applicable when changing from coordinated operation to non-coordinated operation, or vice versa.

### 2.3.7 Corner paths with overlapping zones

If programmed positions are located close to each other, it is not unusual for the programmed zones to overlap. To get a well-defined path and to achieve optimum velocity at all times, the robot reduces the size of the zone to half the distance from one overlapping programmed position to the other (see Figure 22). The same zone radius is always used for inputs to or outputs from a programmed position, in order to obtain symmetrical corner paths.

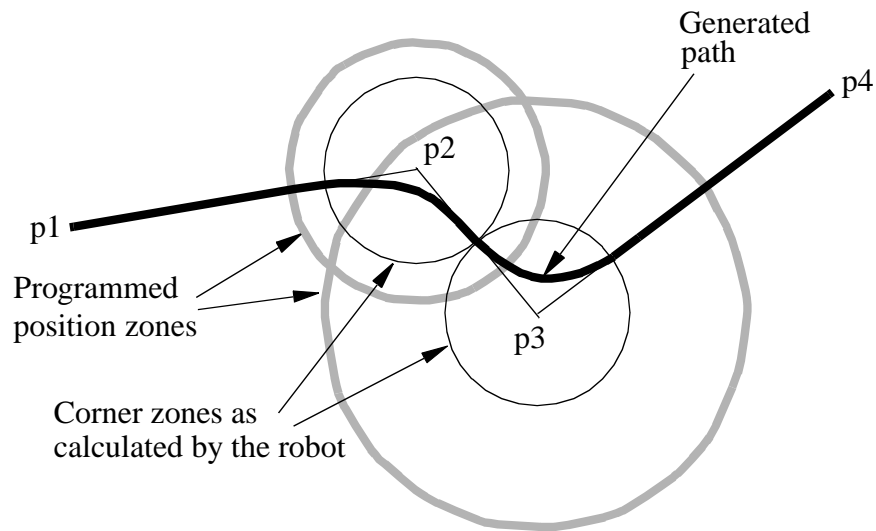


Figure 22 Interpolation with overlapping position zones. The zones around p2 and p3 are larger than half the distance from p2 to p3. Thus, the robot reduces the size of the zones to make them equal to half the distance from p2 to p3, thereby generating symmetrical corner paths within the zones.

Both position and orientation corner path zones can overlap. As soon as one of these corner path zones overlap, that zone is reduced (see Figure 23).

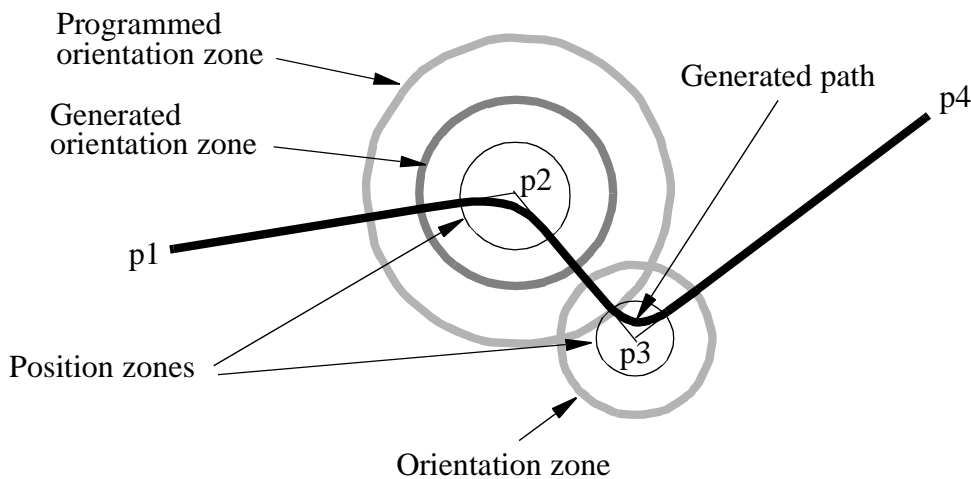


Figure 23 Interpolation with overlapping orientation zones. The orientation zone at p2 is larger than half the distance from p2 to p3 and is thus reduced to half the distance from p2 to p3. The position zones do not overlap and are consequently not reduced; the orientation zone at p3 is not reduced either.

---

### 2.3.8 Planning time for fly-by points

Occasionally, if the next movement is not planned in time, programmed fly-by points can give rise to a stop point. This may happen when:

- A number of logical instructions with long program execution times are

programmed between short movements.

- The points are very close together at high speeds.

If stop points are a problem then use concurrent program execution.

---

## 2.4 Independent axes

An independent axis is an axis moving independently of other axes in the robot system. It is possible to change an axis to independent mode and later back to normal mode again.

A special set of instructions handles the independent axes. Four different move instructions specify the movement of the axis. For instance, the *IndCMove* instruction starts the axis for continuous movement. The axis then keeps moving at a constant speed (regardless of what the robot does) until a new independent-instruction is executed.

To change back to normal mode a reset instruction, *IndReset*, is used. The reset instruction can also set a new reference for the measurement system - a type of new synchronization of the axis. Once the axis is changed back to normal mode it is possible to run it as a normal axis.

---

### 2.4.1 Program execution

An axis immediately changes to independent mode when an *Ind\_Move* instruction is executed. This takes place even if the axis is being moved at the time, such as when a previous point has been programmed as a fly-by point, or when simultaneous program execution is used.

If a new *Ind\_Move* instruction is executed before the last one is finished, the new instruction immediately overrides the old one.

If a program execution is stopped when an independent axis is moving, that axis will stop. When the program is restarted the independent axis starts automatically. No active coordination between independent and other axes in normal mode takes place.

If a loss of voltage occurs when an axis is in independent mode, the program cannot be restarted. An error message is then displayed, and the program must be started from the beginning.

Note that a mechanical unit may not be deactivated when one of its axes is in independent mode.

---

### 2.4.2 Stepwise execution

During stepwise execution, an independent axis is executed only when another instruction is being executed. The movement of the axis will also be stepwise in line with the execution of other instruments, see Figure 24.

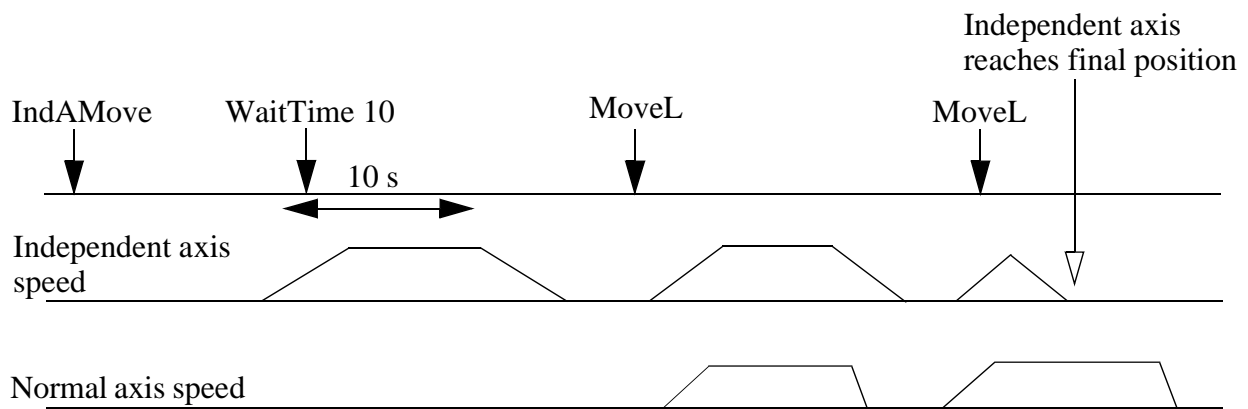


Figure 24 Stepwise execution of independent axes.

### 2.4.3 Jogging

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually, the axis does not move and an error message is displayed. Execute an *IndReset* instruction or move the program pointer to main, in order to leave the independent mode.

### 2.4.4 Working range

The physical working range is the total movement of the axis.

The logical working range is the range used by RAPID instructions and read in the jogging window.

After synchronization (updated revolution counter), the physical and logical working range coincide. By using the *IndReset* instruction the logical working area can be moved, see Figure 25.

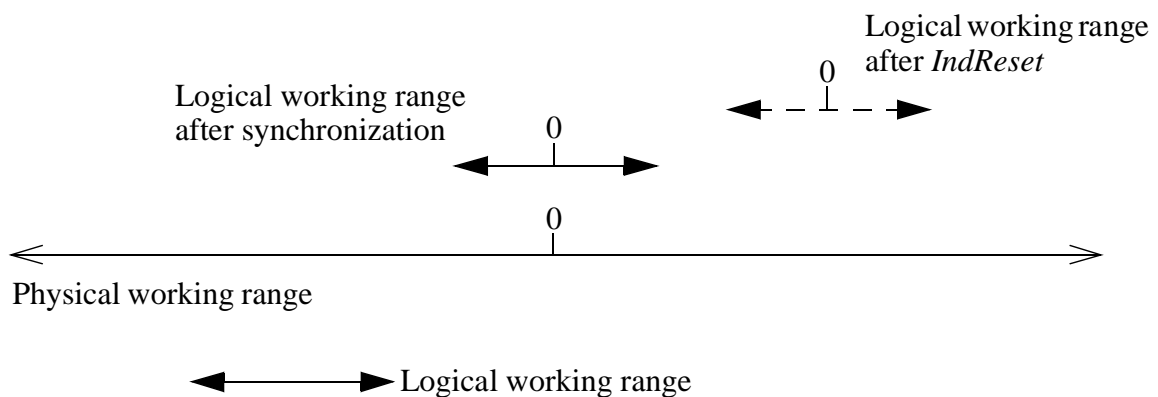


Figure 25 The logical working range can be moved, using the instruction *IndReset*.

The resolution of positions is decreased when moving away from logical position 0.



Low resolution together with stiff tuned controller can result in unacceptable torque, noise and controller instability. Check the controller tuning and axis performance close to the working range limit at installation. Also check if the position resolution and path performance are acceptable.

---

### 2.4.5 Speed and acceleration

In manual mode with reduced speed, the speed is reduced to the same level as if the axis was running as non-independent. Note that the *IndSpeed*\InSpeed function will not be TRUE if the axis speed is reduced.

The *VelSet* instruction and speed correction in percentage via the production window, are active for independent movement. Note that correction via the production window inhibits TRUE value from the *IndSpeed*\InSpeed function.

In independent mode, the lowest value of acceleration and deceleration, specified in the configuration file, is used both for acceleration and deceleration. This value can be reduced by the ramp value in the instruction (1 - 100%). The *AccSet* instruction does not affect axes in independent mode.

---

### 2.4.6 Robot axes

Only robot axis 6 can be used as an independent axis. Normally the *IndReset* instruction is used only for this axis. However, the *IndReset* instruction can also be used for axis 4 on IRB 2400 and 4400 models. If *IndReset* is used for robot axis 4, then axis 6 must not be in the independent mode.

If axis 6 is used as an independent axis, singularity problems may occur because the normal 6-axes coordinate transform function is still used. If a problem occurs, execute the same program with axis 6 in normal mode. Modify the points or use *SingArea*\Wrist or *MoveJ* instructions.

The axis 6 is also internally active in the path performance calculation. A result of this is that an internal movement of axis 6 can reduce the speed of the other axes in the system.

The independent working range for axis 6 is defined with axis 4 and 5 in home position. If axis 4 or 5 is out of home position the working range for axis 6 is moved due to the gear coupling. However, the position read from teach pendant for axis 6 is compensated with the positions of axis 4 and 5 via the gear coupling.

---

## 2.5 Soft Servo

In some applications there is a need for a servo, which acts like a mechanical spring. This means that the force from the robot on the work object will increase as a function of the distance between the programmed position (behind the work object) and the contact position (robot tool - work object).

The relationship between the position deviation and the force, is defined by a parameter called *softness*. The higher the softness parameter, the larger the position deviation required to obtain the same force.

The softness parameter is set in the program and it is possible to change the softness values anywhere in the program. Different softness values can be set for different joints and it is also possible to mix joints having normal servo with joints having soft servo.

Activation and deactivation of soft servo as well as changing of softness values can be made when the robot is moving. When this is done, a tuning will be made between the different servo modes and between different softness values to achieve smooth transitions. The tuning time can be set from the program with the parameter *ramp*. With  $ramp = 1$ , the transitions will take 0.5 seconds, and in the general case the transition time will be  $ramp \times 0.5$  in seconds.

Note that deactivation of soft servo should not be done when there is a force between the robot and the work object.

With high softness values there is a risk that the servo position deviations may be so big that the axes will move outside the working range of the robot.

---

## 2.6 Stop and restart

A movement can be stopped in three different ways:

1. *For a normal stop* the robot will stop on the path, which makes a restart easy.
2. *For a stiff stop* the robot will stop in a shorter time than for the normal stop, but the deceleration path will not follow the programmed path. This stop method is, for example, used for search stop when it is important to stop the motion as soon as possible.
3. *For a quick-stop* the mechanical brakes are used to achieve a deceleration distance, which is as short as specified for safety reasons. The path deviation will usually be bigger for a quick-stop than for a stiff stop.

After a stop (any of the types above) a restart can always be made on the interrupted path. If the robot has stopped outside the programmed path, the restart will begin with a return to the position on the path, where the robot should have stopped.

A restart following a power failure is equivalent to a restart after a quick-stop. It should be noted that the robot will always return to the path before the interrupted program operation is restarted, even in cases when the power failure occurred while a logical instruction was running. When restarting, all times are counted from the beginning; for example, positioning on time or an interruption in the instruction *WaitTime*.

**2.7 Related information**

	<u>Described in:</u>
Definition of speed	Data Types - <i>speeddata</i>
Definition of zones (corner paths)	Data Types - <i>zonedata</i>
Instruction for joint interpolation	Instructions - <i>MoveJ</i>
Instruction for linear interpolation	Instructions - <i>MoveL</i>
Instruction for circular interpolation	Instructions - <i>MoveC</i>
Instruction for modified interpolation	Instructions - <i>SingArea</i>
Singularity	Motion and I/O Principles- <i>Singularity</i>
Concurrent program execution	Motion and I/O Principles- <i>Synchronisation with logical instructions</i>
CPU Optimization	User's Guide - System parameters

### 3 Synchronization with logical instructions

Instructions are normally executed sequentially in the program. Nevertheless, logical instructions can also be executed at specific positions or during an ongoing movement.

A logical instruction is any instruction that does not generate a robot movement or an external axis movement, e.g. an I/O instruction.

#### 3.1 Sequential program execution at stop points

If a positioning instruction has been programmed as a stop point, the subsequent instruction is not executed until the robot and the external axes have come to a standstill, i.e. when the programmed position has been attained (see Figure 26).

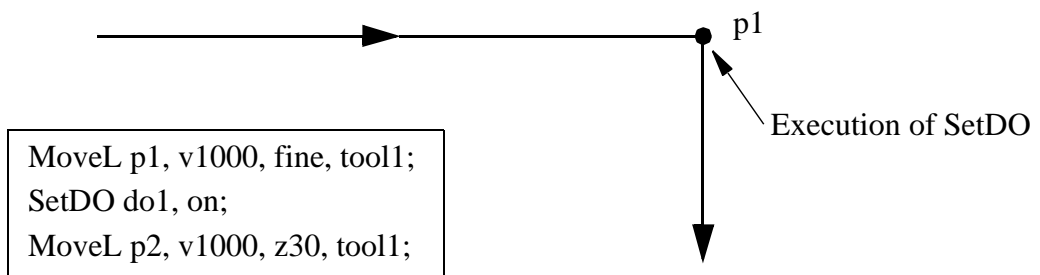


Figure 26 A logical instruction after a stop point is not executed until the destination position has been reached.

#### 3.2 Sequential program execution at fly-by points

If a positioning instruction has been programmed as a fly-by point, the subsequent logical instructions are executed some time before reaching the largest zone (for position, orientation or external axes). See Figure 27 and Figure 28. These instructions are then executed in order.

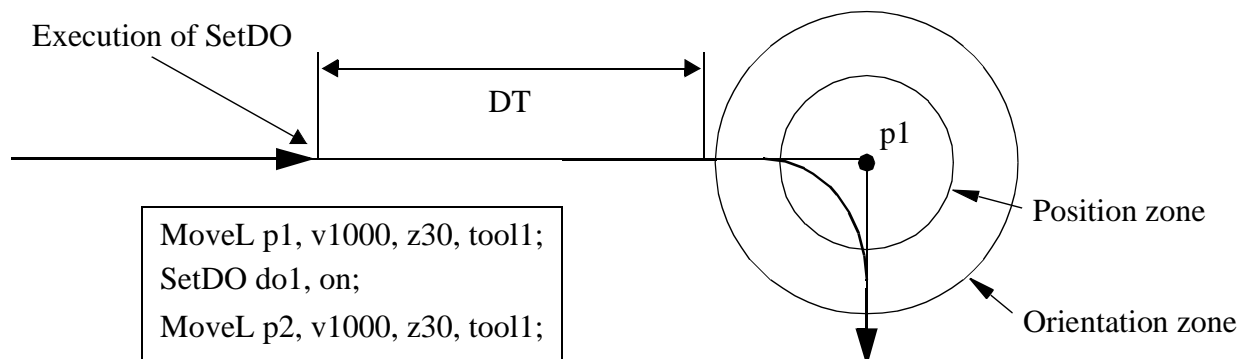


Figure 27 A logical instruction following a fly-by point is executed before reaching the largest zone.

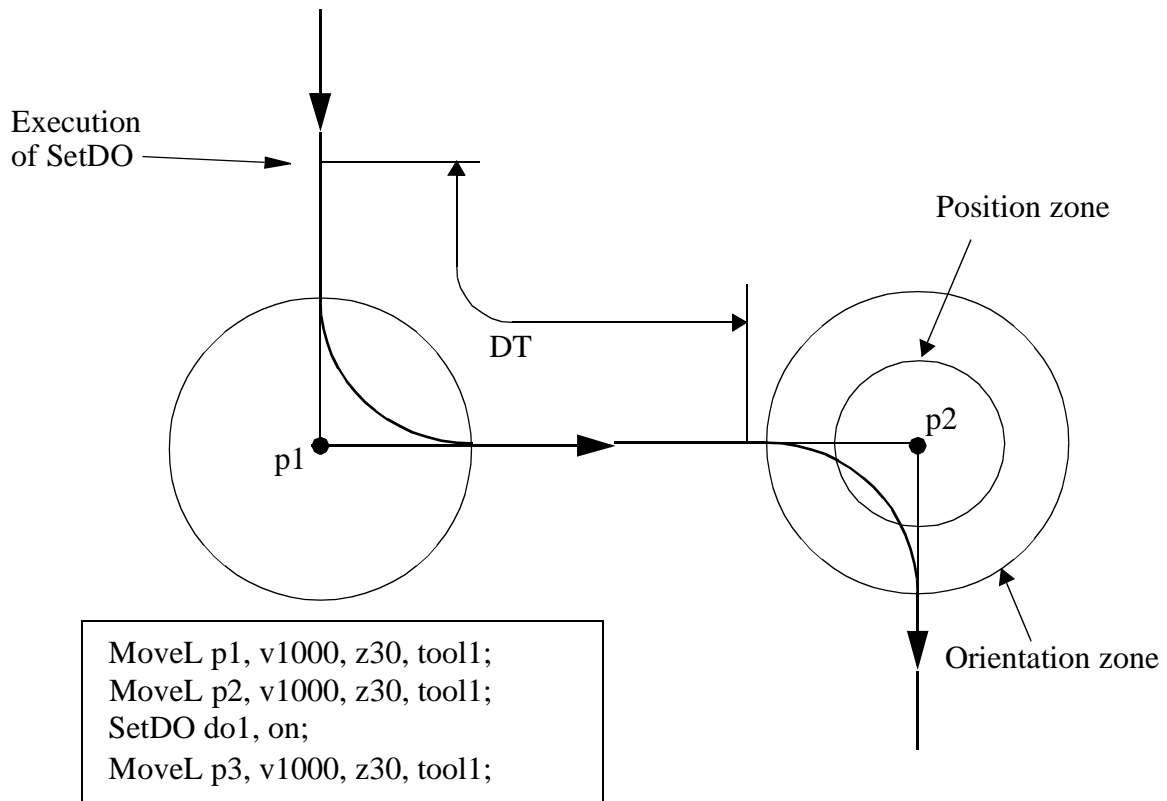


Figure 28 A logical instruction following a fly-by point is executed before reaching the largest zone.

The time at which they are executed (*DT*) comprises the following time components:

- The time it takes for the robot to plan the next move: approx. 0.1 seconds.
- The robot delay (servo lag) in seconds: 0 - 1.0 seconds depending on the velocity and the actual deceleration performance of the robot.

---

### 3.3 Concurrent program execution

Concurrent program execution can be programmed using the argument `\Conc` in the positioning instruction. This argument is used to:

- Execute one or more logical instructions at the same time as the robot moves in order to reduce the cycle time (e.g. used when communicating via serial channels).

When a positioning instruction with the argument `\Conc` is executed, the following

logical instructions are also executed (in sequence):

- If the robot is not moving, or if the previous positioning instruction ended with a stop point, the logical instructions are executed as soon as the current positioning instruction starts (at the same time as the movement). See Figure 29.
- If the previous positioning instruction ends at a fly-by point, the logical instructions are executed at a given time ( $DT$ ) before reaching the largest zone (for position, orientation or external axes). See Figure 30.

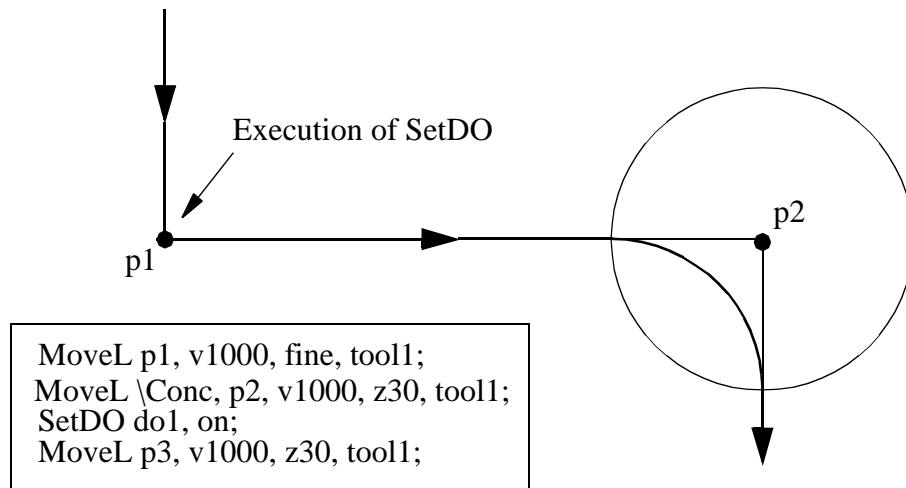
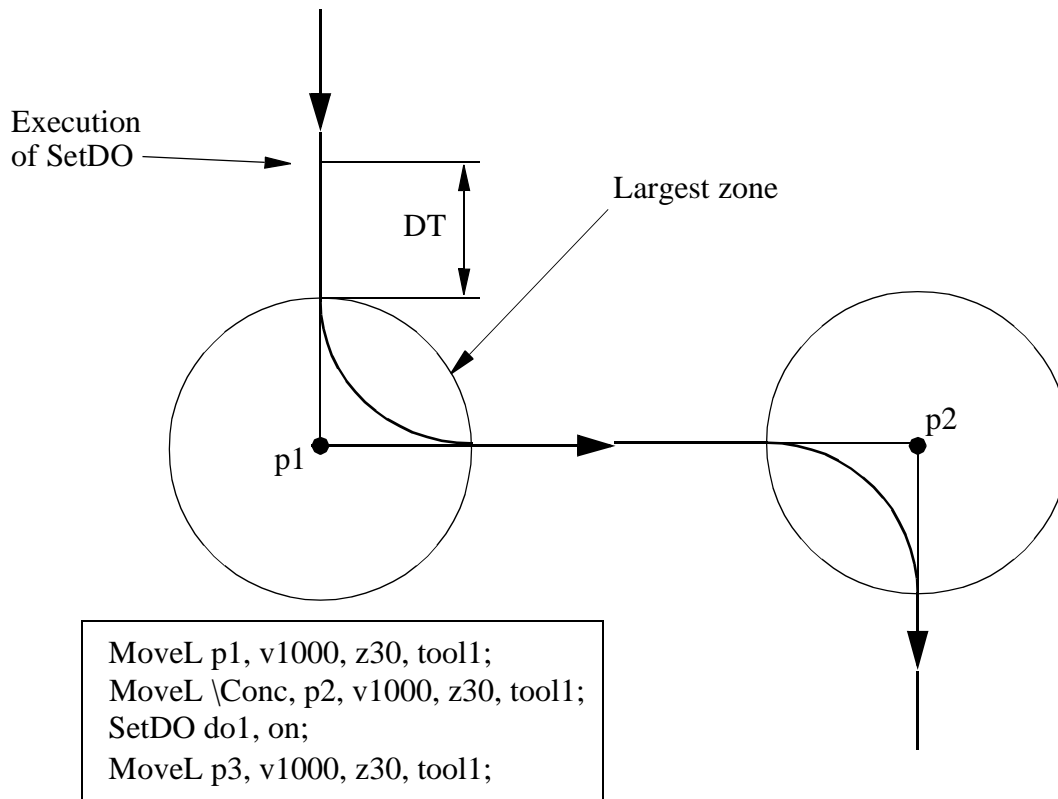


Figure 29 In the case of concurrent program execution after a stop point, a positioning instruction and subsequent logical instructions are started at the same time.



*Figure 30 In the case of concurrent program execution after a fly-by point, the logical instructions start executing before the positioning instructions with the argument \Conc are started.*

Instructions which indirectly affect movements, such as *ConfL* and *SingArea*, are executed in the same way as other logical instructions. They do not, however, affect the movements ordered by previous positioning instructions.

If several positioning instructions with the argument *\Conc* and several logical instructions in a long sequence are mixed, the following applies:

- Logical instructions are executed directly, in the order they were programmed. This takes place at the same time as the movement (see Figure 31) meaning that logical instructions are executed at an earlier stage on the path than they were programmed.

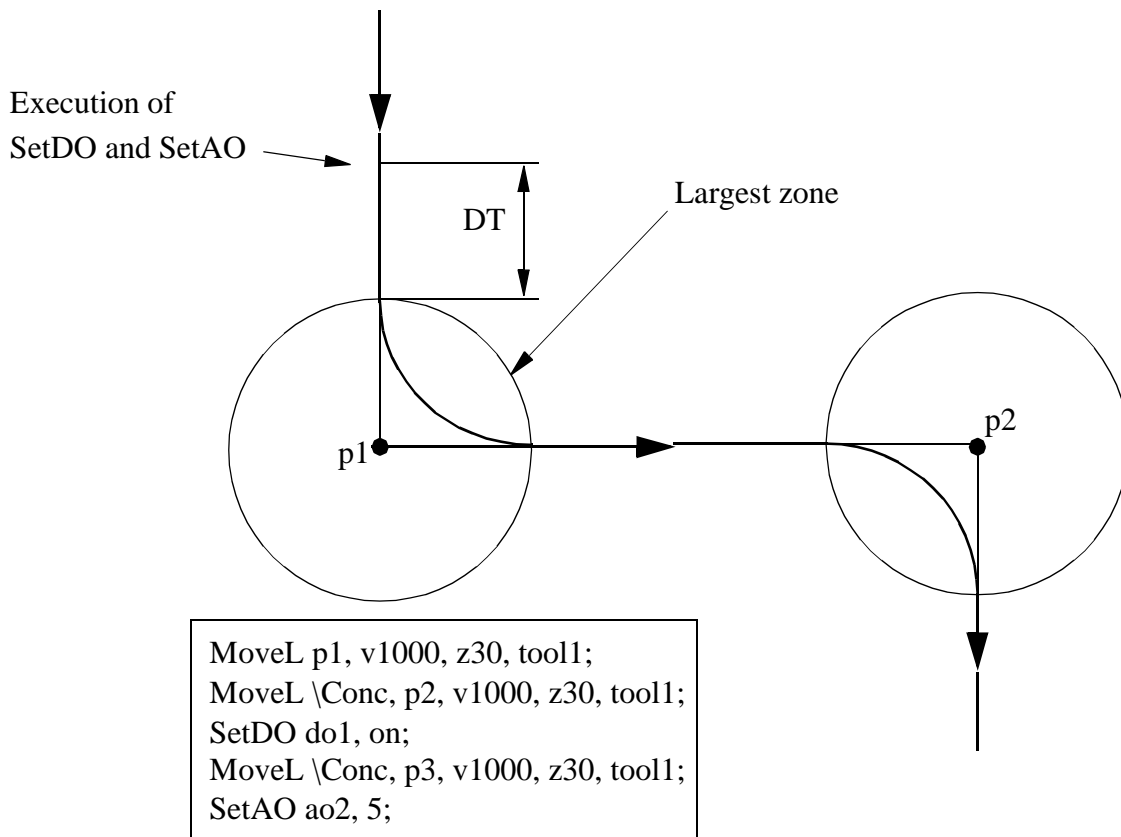


Figure 31 If several positioning instructions with the argument `\Conc` are programmed in sequence, all connected logical instructions are executed at the same time as the first position is executed.

During concurrent program execution, the following instructions are programmed to end the sequence and subsequently re-synchronize positioning instructions and logical instructions:

- a positioning instruction without the argument `\Conc`,
- the instruction `WaitTime` or `WaitUntil` with the argument `\Inpos`.

### 3.4 Path synchronization

In order to synchronize process equipment (for applications such as gluing, painting and arc welding) with the robot movements, different types of path synchronization signals can be generated.

With a so-called positions event, a trig signal will be generated when the robot passes a predefined position on the path. With a time event, a signal will be generated in a predefined time before the robot stops in a stop position. Moreover, the control system also handles weave events, which generate pulses at predefined phase angles of a weave motion.

All the position synchronized signals can be achieved both before (look ahead time) and after (delay time) the time that the robot passes the predefined position. The



position is given by a programmed position and can be tuned as a path distance before the programmed position.

Typical repeat accuracy for set of digital outputs on the path is +/-2ms.

If power failure, restart in a Trigg instruction, all trigg events will be generated once again on the remaining movement path for the trigg instruction .

---

### **3.5 Related information**

Positioning instructions

Definition of zone size

Described in:

RAPID Summary - *Motion*

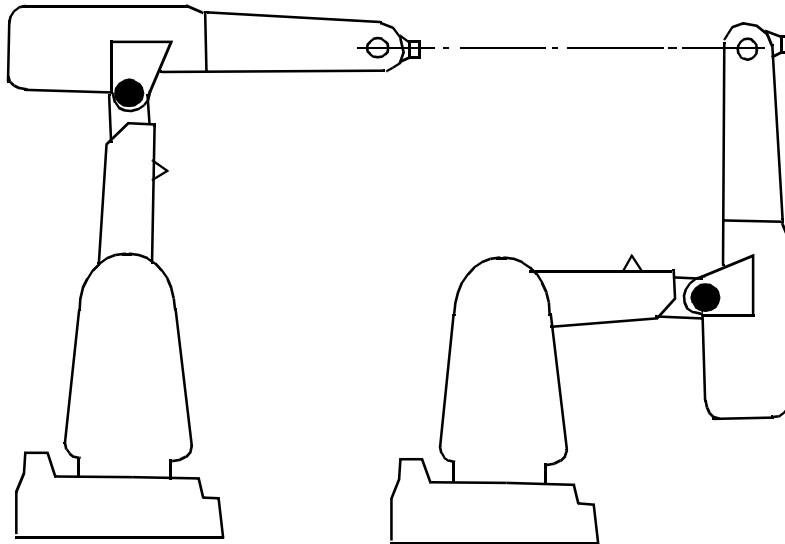
Data Types - *zonedata*

---

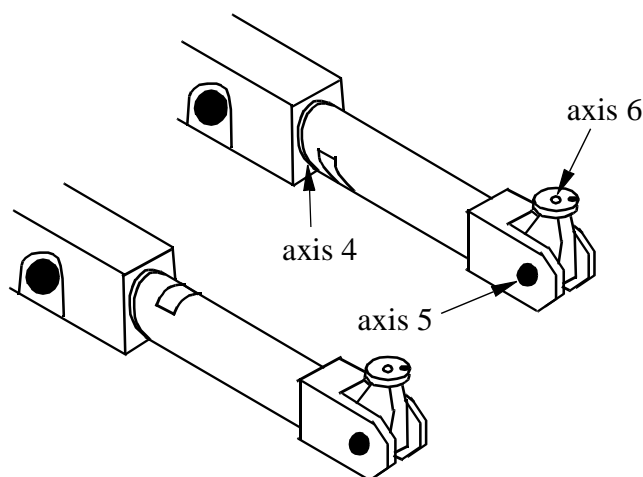
---

## 4 Robot Configuration

It is usually possible to attain the same robot tool position and orientation in several different ways, using different sets of axis angles. We call these different robot configurations. If, for example, a position is located approximately in the middle of a work cell, some robots can get to that position from above and from below (see Figure 32). This can also be achieved by turning the front part of the robot upper arm (axis 4) upside down while rotating axes 5 and 6 to the desired position and orientation (see Figure 33).



*Figure 32 Two different arm configurations used to attain the same position and orientation. In one of the configurations, the arms point upwards and to attain the other configuration, axis 1 must be rotated 180 degrees.*



*Figure 33 Two different wrist configurations used to attain the same position and orientation. In the configuration in which the front part of the upper arm points upwards (lower), axis 4 has been rotated 180 degrees, axis 5 through 180 degrees and axis 6 through 180 degrees in order to attain the configuration in which the front part of the upper arm points downwards (upper).*

Usually you want the robot to attain the same configuration during program execution as the one you programmed. To do this, you can make the robot check the configuration and, if the correct configuration is not attained, program execution will stop. If the configuration is not checked, the robot may unexpectedly start to move its arms and wrists which, in turn, may cause it to collide with peripheral equipment.

The robot configuration is specified by defining the appropriate quarter revolutions of axes 1, 4 and 6. If both the robot and the programmed position have the same quarter revolution for these axes, the robot configuration is correct.

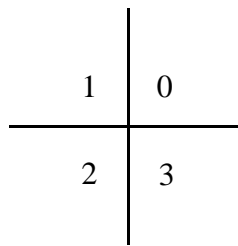


Figure 34 Quarter revolution for a positive joint angle:  $\text{int}\left(\text{joint} - \frac{\text{angle}}{\pi/2}\right)$ .

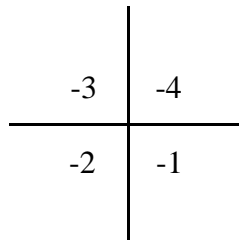


Figure 35 Quarter revolution for a negative joint angle:  $\text{int}\left(\text{joint} - \frac{\text{angle}}{\pi/2} - 1\right)$ .

The configuration check involves comparing the configuration of the programmed position with that of the robot.

During linear movement, the robot always moves to the closest possible configuration. If, however, the configuration check is active, program execution stops as soon as any one of the axes deviates more than the specified number of degrees.

During axis-by-axis or modified linear movement using a configuration check, the robot always moves to the programmed axis configuration. If the programmed position and orientation are not achieved, program execution stops before starting the movement. If the configuration check is not active, the robot moves to the specified position and orientation with the closest configuration.

When the execution of a programmed position is stopped because of a configuration

error, it may often be caused by one or more of the following reasons:

- The position is programmed off-line with a faulty configuration.
- The robot tool has been changed causing the robot to take another configuration than was programmed.
- The position is subject to an active frame operation (displacement, user, object, base).

The correct configuration in the destination position can be found by positioning the robot near it and reading the configuration on the teach pendant.

If the configuration parameters change because of active frame operation, the configuration check can be deactivated.

---

## 4.1 Robot configuration data for 6400C

The IRB 6400C is slightly different in its way of unambiguously denoting one robot configuration. The difference is the interpretation of the confdata *cf1*.

*cf1* is used to select one of two possible main axes (axis 1, 2 and 3) configurations:

- *cf1* = 0 is the forward configuration
- *cf1* = 1 is the backward configuration.

Figure 36 shows an example of a forward configuration and a backward configuration giving the same position and orientation.

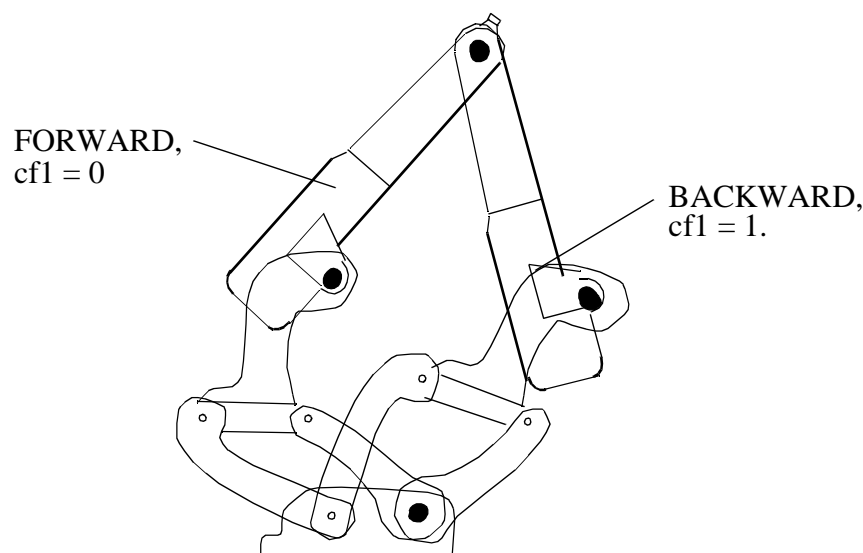


Figure 36 Same position and orientation with two different main axes configuration.

The forward configuration is the front part of the robot's working space with the arm directed forward. The backward configuration is the service part for the working space

with the arm directed backwards.

---

## **4.2 Related information**

Definition of robot configuration

Activating/deactivating the configuration  
check

Described in:

Data Types - *confdata*

RAPID Summary - *Motion Settings*

---

---

## 5 Singularities

Some positions in the robot working space can be attained using an infinite number of robot configurations to position and orient the tool. These positions, known as singular points (singularities), constitute a problem when calculating the robot arm angles based on the position and orientation of the tool.

Generally speaking, a robot has two types of singularities: arm singularities and wrist singularities. Arm singularities are all configurations where the wrist centre (the intersection of axes 4, 5 and 6) ends up directly above axis 1 (see Figure 37). Wrist singularities are configurations where axis 4 and axis 6 are on the same line, i.e. axis 5 has an angle equal to 0 (see Figure 38).

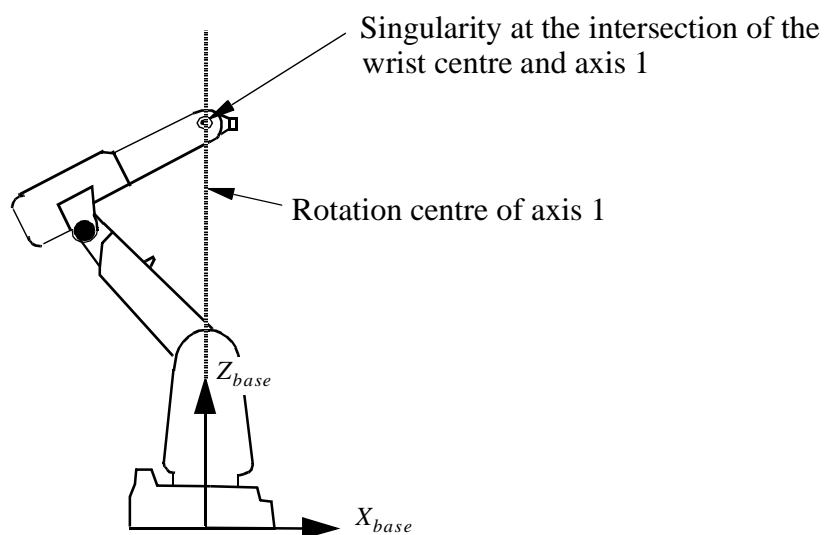


Figure 37 Arm singularity occurs where the wrist centre and axis 1 intersect.

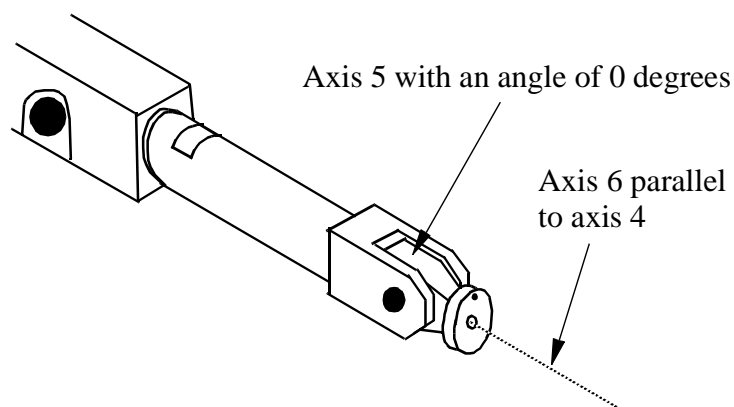


Figure 38 Wrist singularity occurs when axis 5 is 0 degrees.

---

## 5.1 Singularity points/TRB 6400C

Between the robot's working space, with the arm directed forward and the arm directed backward, there is a singularity point above the robot. There is also a singularity point on the sides of the robot. These points contain a singularity and have kinematic limitations. A position in these points cannot be specified as forward/backward and can only be reached with *MoveAbsJ*. When the robot is in a singular point:

- It is only possible to use *MoveAbsJ* or to jog the robot axis by axis.

---

## 5.2 Program execution through singularities

During joint interpolation, the robot never has any problem passing singular points.

When executing a linear or circular path close to a singularity, the velocities in some joints (1 and 6/4 and 6) may be very high. In order not to exceed the maximum joint velocities, the linear path velocity is reduced.

The high joint velocities may be reduced by using the mode (*Sing Area\Wrist*) when the wrist axes are interpolated in joint angles while still maintaining the linear path of the robot tool. An orientation error compared to the full linear interpolation is however introduced.

Note that the robot configuration changes dramatically when the robot passes close to a singularity with linear or circular interpolation. In order to avoid the reconfiguration, the first position on the other side of the singularity should be programmed with an orientation that makes the reconfiguration unnecessary.

Also note that the robot should not be in its singularity when external joints only are moved, as this may cause robot joints to make unnecessary movements.

---

## 5.3 Jogging through singularities

During joint interpolation, the robot never has any problem passing singular points.

During linear interpolation the robot can pass singular points but at a decreased speed.

---

## 5.4 Related information

Controlling how the robot is to act on execution near singular points

Described in:

Instructions - *SingArea*

---

---

## 6 World Zones

---

### 6.1 Using global zones

When using this function, the robot stops or an output is automatically set if the robot is inside a special user-defined area. Here are some examples of applications:

- When two robots share a part of their respective work areas. The possibility of the two robots colliding can be safely eliminated by the supervision of these signals.
- When external equipment is located inside the robot's work area. A forbidden work area can be created to prevent the robot colliding with this equipment.
- Indication that the robot is at a position where it is permissible to start program execution from a PLC.

---

### 6.2 Using World Zones

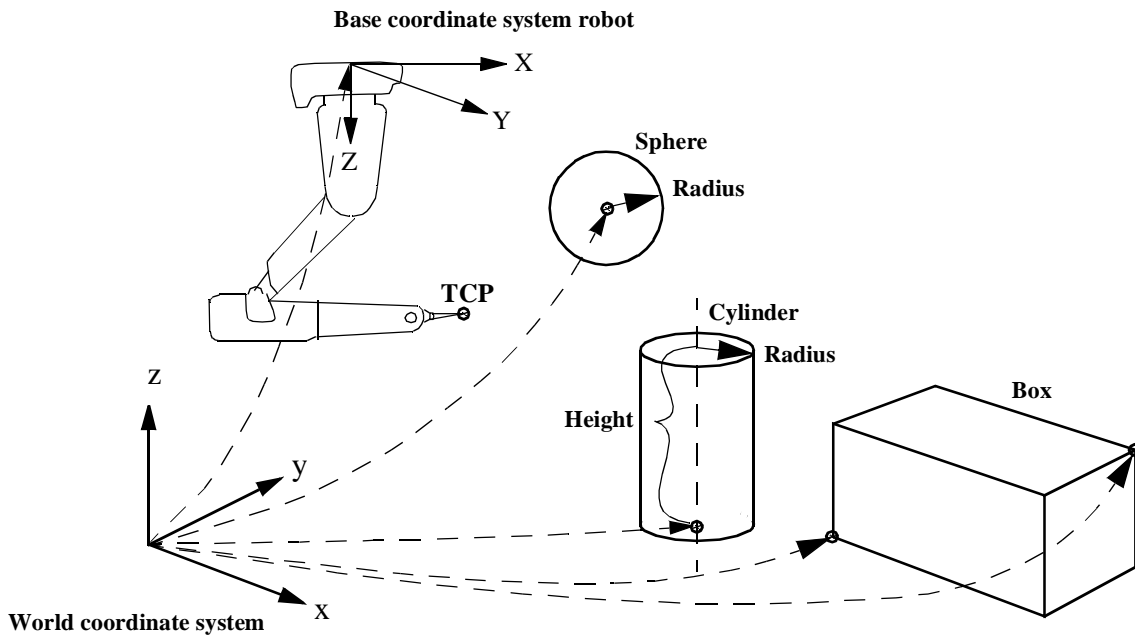
To indicate that the tool centre point is in a specific part of the working area.  
To limit the working area of the robot in order to avoid collision with the tool.  
To make a common work area for two robots available to only one robot at a time.

---

### 6.3 Definition of World Zones in the world coordinate system

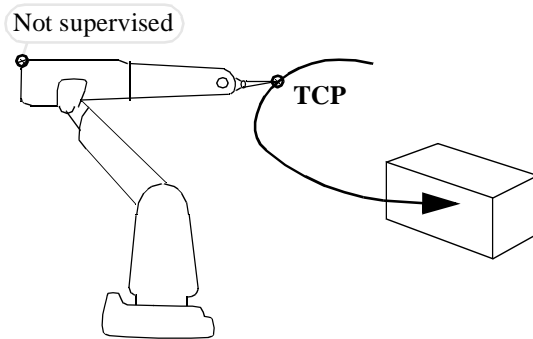
All World Zones are to be defined in the world coordinate system.  
The sides of the Boxes are parallel to the coordinate axes and Cylinder axis is parallel to the Z axis of the world coordinate system.





A World Zone can be defined to be inside or outside the shape of the Box, Sphere or the Cylinder.

## 6.4 Supervision of the Robot TCP



The movement of the tool centre point is supervised and not any other points on the robot.

The TCP is always supervised irrespective of the mode of operation, for example, program execution and jogging.

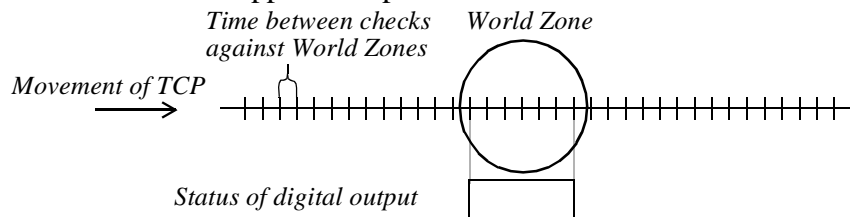
### 6.4.1 Stationary TCPs

If the robot is holding a work object and working on a stationary tool, a stationary TCP is used. If that tool is active, the tool will not move and if it is inside a World Zone then it is always inside.

## 6.5 Actions

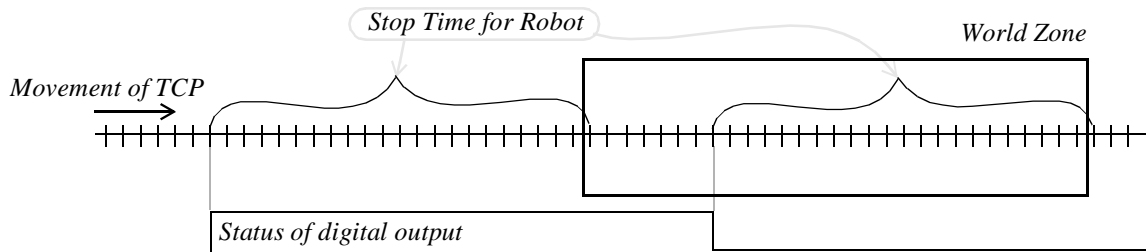
### 6.5.1 Set a digital output when the tcp is inside a World Zone.

This action sets a digital output when the tcp is inside a World Zone. It is useful to indicate that the robot has stopped in a specified area.



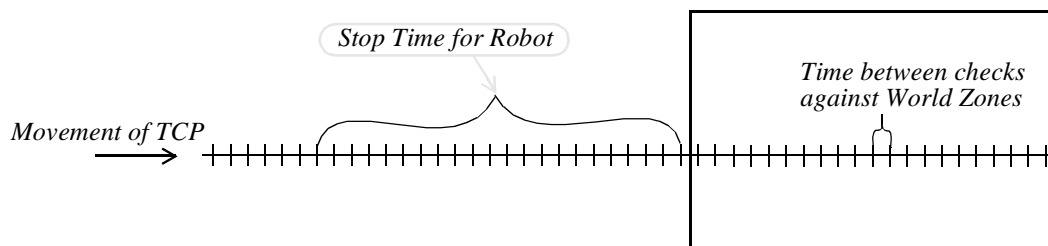
### 6.5.2 Set a digital output before the tcp reaches a World Zone.

This action sets a digital output before the tcp reaches a World Zone. It can be used to stop the robot just inside a World Zone



### 6.5.3 Stop the robot before the tcp reaches a World Zone.

A World Zone can be defined to be outside the work area. The robot will then stop with the Tool Centre Point just outside the World Zone, when heading towards the Zone



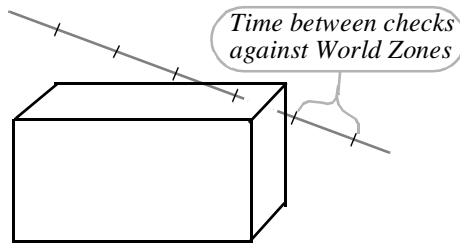
When the robot has been moved into a World Zone defined as an outside work area, for example, by releasing the brakes and manually pushing, then the only ways to get out of the Zone are by jogging or by manual pushing with the brakes released.

### 6.6 Minimum size of World Zones.

Supervision of the movement of the tool centre points is done at discrete points with a time interval between them that depends on the path resolution. It is up to the user to make the zones large enough so the robot cannot move right through a zone without being checked inside the Zone.

Min. size of zone for used path_resolution and max. speed			
Speed Resol.	1000 mm/s	2000 mm/s	4000 mm/s
1	25 mm	50 mm	100 mm
2	50 mm	100 mm	200 mm
3	75 mm	150 mm	300 mm

If the same digital output is used for more than one World Zone, the distance between the Zones must exceed the minimum size, as shown in the table above, to avoid an incorrect status for the output.



It is possible that the robot can pass right through a corner of a zone without it being noticed, if the time that the robot is inside the zone is too short. Therefore, make the size of the zone larger than the dangerous area.

### 6.7 Power failure, restart, and run on

*Stationary World Zones* will be deleted at power off and must be reinserted at power on by an event routine connected to the event POWER ON.

*Temporary World Zones* will survive a power failure but will be erased when a new program is loaded or when a program is started from the main program.

The digital outputs for the World Zones will be updated first at *Motors on*.

---

## **6.8 Related information**

RAPID Reference Manual	
Motion and I/O Principles:	Coordinate Systems
Data Types:	wztemporary
	wzstationary
	shapedata
Instructions:	WZBoxDef
	WZSphDef
	WZCylDef
	WZLimSup
	WZDOSet
	WZDisable
	WZEnable
	WZFree
	WZTempFree

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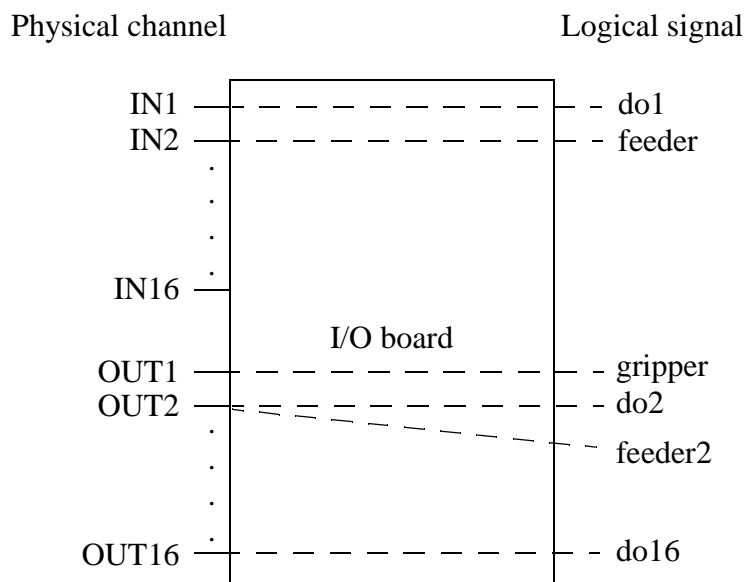


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## 7 I/O Principles

The robot generally has one or more I/O boards. Each of the boards has several digital and/or analog channels which must be connected to logical signals before they can be used. This is carried out in the system parameters and has usually already been done using standard names before the robot is delivered. Logical names must always be used during programming.

A physical channel can be connected to several logical names, but can also have no logical connections (see Figure 39).



*Figure 39 To be able to use an I/O board, its channels must be given logical names. In the above example, the physical output 2 is connected to two different logical names. IN16, on the other hand, has no logical name and thus cannot be used.*

---

### 7.1 Signal characteristics

The characteristics of a signal are depend on the physical channel used as well as how the channel is defined in the system parameters. The physical channel determines time delays and voltage levels (see the Product Specification). The characteristics, filter times and scaling between programmed and physical values, are defined in the system parameters.

When the power supply to the robot is switched on, all signals are set to zero. They are not, however, affected by emergency stops or similar events.

An output can be set to one or zero from within the program. This can also be done using a delay or in the form of a pulse. If a pulse or a delayed change is ordered for an output, program execution continues. The change is then carried out without affecting the rest of the program execution. If, on the other hand, a new change is ordered for the same output before the given time elapses, the first change is not carried out (see Figure 40).

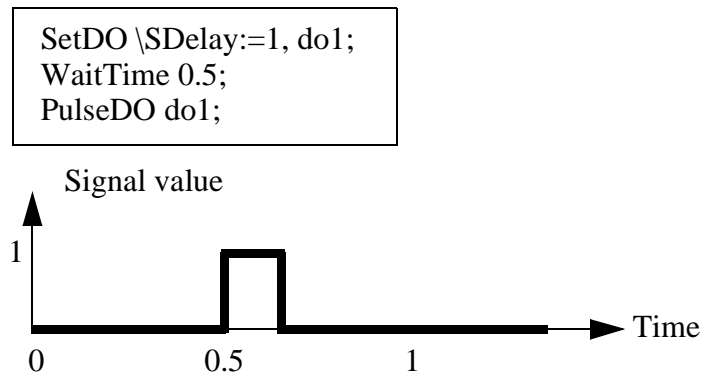


Figure 40 The instruction `SetDO` is not carried out at all because a new command is given before the time delay has elapsed.

---

## 7.2 System signals

Logical signals can be interconnected by means of special system functions. If, for example, an input is connected to the system function *Start*, a program start is automatically generated as soon as this input is enabled. These system functions are generally only enabled in automatic mode. For more information, see Chapter 9, System Parameters, or the chapter on *Installation and Commissioning - PLC Communication* in the Product Manual.

---

## 7.3 Cross connections

Digital signals can be interconnected in such a way that they automatically affect one another:

- An output signal can be connected to one or more input or output signals.
- An input signal can be connected to one or more input or output signals.
- If the same signal is used in several cross connections, the value of that signal is the same as the value that was last enabled (changed).
- Cross connections can be interlinked, in other words, one cross connection can affect another. They must not, however, be connected in such a way so as to form a "vicious circle", e.g. cross-connecting *di1* to *di2* whilst *di2* is cross-connected to *di1*.
- If there is a cross connection on an input signal, the corresponding physical connection is automatically disabled. Any changes to that physical channel will thus not be detected.

- Pulses or delays are not transmitted over cross connections.
- Logical conditions can be defined using NOT, AND and OR (Option: Advanced functions).

Examples:

- $di2=di1$
- $di3=di2$
- $do4=di2$

If  $di1$  changes,  $di2$ ,  $di3$  and  $do4$  will be changed to the corresponding value.

- $do8=do7$
- $do8=di5$

If  $do7$  is set to 1,  $do8$  will also be set to 1. If  $di5$  is then set to 0,  $do8$  will also be changed (in spite of the fact that  $do7$  is still 1).

- $do5=di6$  and  $do1$

$Do5$  is set to 1 if both  $di6$  and  $do1$  is set to 1.

---

## 7.4 Limitations

A maximum of 10 signals can be pulsed at the same time and a maximum of 20 signals can be delayed at the same time.

---

## 7.5 Related information

	<u>Described in:</u>
Definition of I/O boards and signals	User's Guide - System Parameters
Instructions for handling I/O	RAPID Summary - <i>Input and Output Signals</i>
Manual manipulation of I/O	User's Guide - Inputs and Outputs

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bool	Logical values
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errnum	Error number
extjoint	Position of external joints
intnum	Interrupt identity
iodev	Serial channels and files
jointtarget	Joint position data
loaddata	Load data
mecunit	Mechanical unit
motsetdata	Motion settings data
num	Numeric values (registers)
orient	Orientation
o_jointtarget	Original joint position data
o_robtargt	Original position data
pos	Positions (only X, Y and Z)
pose	Coordinate transformations
progdisp	Program displacement
robjoint	Joint position of robot axes
robtargt	Position data
shapedata	World zone shape data
signalxx	Digital and analog signals
speeddata	Speed data
string	Strings
symnum	Symbolic number
tooldata	Tool data
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wztemporary	Temporary world zone data
zonedata	Zone data
System Data	



## *Data Types*

---

---

**bool** **Logical values**

*Bool* is used for logical values (true/false).

---

**Description**

The value of data of the type *bool* can be either *TRUE* or *FALSE*.

---

**Examples**

```
flag1 := TRUE;
```

flag is assigned the value *TRUE*.

```
VAR bool highvalue;
```

```
VAR num reg1;
```

```
highvalue := reg1 > 100;
```

*highvalue* is assigned the value *TRUE* if *reg1* is greater than 100; otherwise, *FALSE* is assigned.

```
IF highvalue Set do1;
```

The *do1* signal is set if *highvalue* is *TRUE*.

```
highvalue := reg1 > 100;
```

```
mediumvalue := reg1 > 20 AND NOT highvalue;
```

*mediumvalue* is assigned the value *TRUE* if *reg1* is between 20 and 100.

---

**Related information**

Logical expressions

Operations using logical values

Described in:

Basic Characteristics - *Expressions*

Basic Characteristics - *Expressions*



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---

## clock Time measurement

*Clock* is used for time measurement. A *clock* functions like a stopwatch used for timing.

---

### Description

Data of the type *clock* stores a time measurement in seconds and has a resolution of 0.01 seconds.

---

### Example

```
VAR clock clock1;  
  
    ClkReset clock1;
```

The clock, *clock1*, is declared and reset. Before using *ClkReset*, *ClkStart*, *ClkStop* and *ClkRead*, you must declare a variable of data type *clock* in your program.

---

### Limitations

The maximum time that can be stored in a clock variable is approximately 49 days (4,294,967 seconds). The instructions *ClkStart*, *ClkStop* and *ClkRead* report clock overflows in the very unlikely event that one occurs.

A clock must be declared as a *VAR* variable type, not as a *persistent* variable type.

---

### Characteristics

*Clock* is a non-value data type and cannot be used in value-oriented operations.

---

### Related Information

	<u>Described in:</u>
Summary of Time and Date Instructions	RAPID Summary - <i>System &amp; Time</i>
Non-value data type characteristics	Basic Characteristics - <i>Data Types</i>



---



---

## confdata                      Robot configuration data

*Confdata* is used to define the axis configurations of the robot.

---

### Description

All positions of the robot are defined and stored using rectangular coordinates. When calculating the corresponding axis positions, there will often be two or more possible solutions. This means that the robot is able to achieve the same position, i.e. the tool is in the same position and with the same orientation, with several different positions or configurations of the robots axes.

To unambiguously denote one of these possible configurations, the robot configuration is specified using four axis values. These values define the current quadrant of four robot axes. The quadrants are numbered 0, 1, 2, etc. (they can also be negative). The quadrant number is connected to the current joint angle of the axis. For each axis, quadrant 0 is the first quarter revolution, 0 to 90°, in a positive direction from the zero position; quadrant 1 is the next revolution, 90 to 180°, etc. Quadrant -1 is the revolution 0° to (-90°), etc. (see Figure 1).

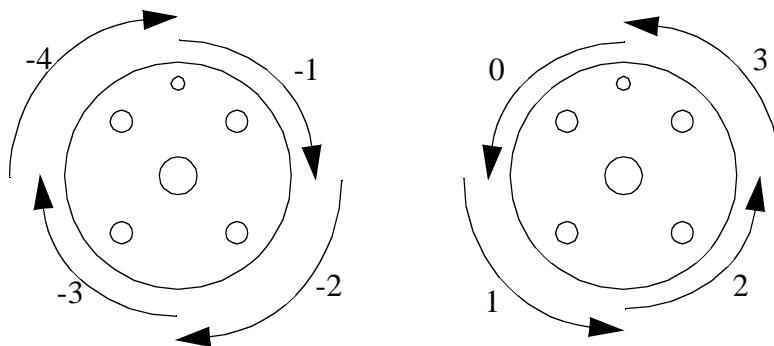


Figure 1 The configuration quadrants for axis 6.

---

### Robot Configuration data for IRB540

Only the configuration parameter cf6 is used.

---

### Robot Configuration data for IRB1400, 2400, 3400, 4400, 6400

Only the three configuration parameters cf1, cf4 and cf6 are used.

---

## Robot Configuration data for IRB5400

All four configuration parameters are used. *cf1*, *cf4*, *cf6* for joints 1, 4, and 6 respectively and *cfx* for joint 5.

---

## Robot configuration data for 6400C

The IRB 6400C requires a slightly different way of unambiguously denoting one robot configuration. The difference lies in the interpretation of the confdata *cf1*.

*cf1* is used to select one of two possible main axes (axis 1, 2 and 3) configurations:

- *cf1* = 0 is the forward configuration
- *cf1* = 1 is the backward configuration.

Figure 2 shows an example of a forward configuration and a backward configuration giving the same position and orientation.

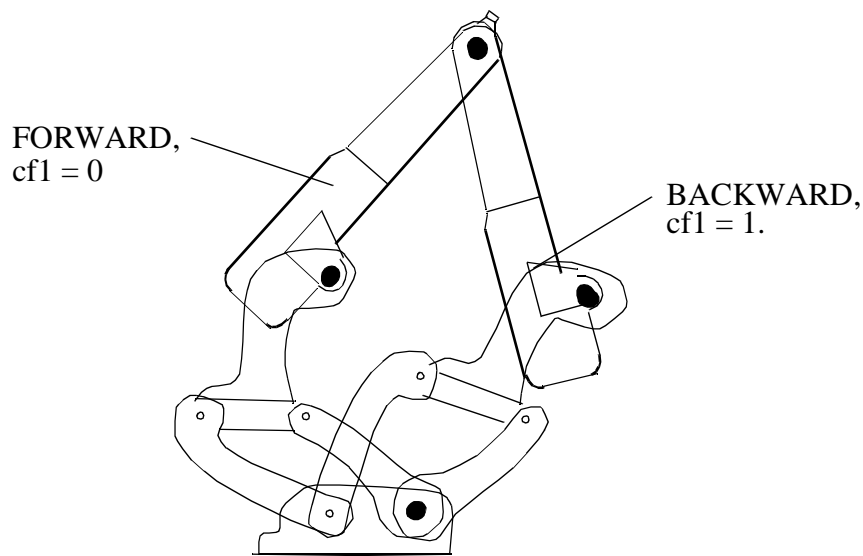


Figure 2 Same position and orientation with two different main axes configurations.

The forward configuration is the front part of the robot's working area with the arm directed forward. The backward configuration is the service part of the working area with the arm directed backwards.

---

## Components

**cf1**

Data type: *num*

The current quadrant of axis 1, expressed as a positive or negative integer.

<b>cf4</b>	Data type: <i>num</i>
The current quadrant of axis 4, expressed as a positive or negative integer.	
<b>cf6</b>	Data type: <i>num</i>
The current quadrant of axis 6, expressed as a positive or negative integer.	
<b>cfx</b>	Data type: <i>num</i>
The current quadrant of axis 5 for IRB5400 robot, expressed as a positive or negative integer.	

## Example

VAR confdata conf15 := [1, -1, 0, 0]

A robot configuration *conf15* is defined as follows:

- The axis configuration of the robot axis 1 is quadrant *1*, i.e. 90-180°.
- The axis configuration of the robot axis 4 is quadrant *-1*, i.e. 0-(-90°).
- The axis configuration of the robot axis 6 is quadrant *0*, i.e. 0 - 90°.
- The axis configuration of the robot axis 5 is quadrant *0*, i.e. 0 - 90°.

## Structure

```
< dataobject of confdata >
  < cf1 of num >
  < cf4 of num >
  < cf6 of num >
  < cfx of num >
```

## Related information

	<u>Described in:</u>
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
Handling configuration data	Motion and I/O Principles - <i>Robot Configuration</i>





**corrdescr**      **Correction generator descriptor**

*Corrdescr* (*Correction generator descriptor*) is used by correction generators. A correction generator adds geometric offsets in the path coordinate system.

---

**Description**

Data of the type *corrdescr* contains a reference to a correction generator.

Connection to a correction generator is done by the instruction *CorrCon* and the descriptor (the reference to the correction generator) can be used to deliver geometric offsets in the path coordinate system with the instruction *CorrWrite*.

Offsets provided earlier can be removed by disconnecting a correction generator with the instruction *CorrDiscon*. All connected correction generators can be removed with the instruction *CorrClear*.

The function *CorrRead* returns the sum of all the delivered offsets so far (includes all connected correction generators).

---

**Example**

```
VAR corrdescr id;  
VAR pos offset;  
...  
CorrCon id;  
offset := [1, 2 ,3];  
CorrWrite id, offset;
```

A correction generator is connected with the instruction *CorrCon* and referenced by the descriptor *id*. Offsets are then delivered to the correction generator (with reference *id*) using the instruction *CorrWrite*.

---

**Characteristics**

*Corrdescr* is a non-value data type.

---

**Related information**

	<u>Described in:</u>
Connects to a correction generator	Instructions - <i>CorrCon</i>
Disconnects from a correction generator	Instructions - <i>CorrDiscon</i>
Writes to a correction generator	Instructions - <i>CorrWrite</i>
Reads the current total offsets	Functions - <i>CorrRead</i>
Removes all correction generators	Instructions - <i>CorrClear</i>
Characteristics of non-value data types	Basic Characteristics - <i>Data Types</i>

---

---

**dionum****Digital values 0 - 1**

*Dionum* (*digital input output numeric*) is used for digital values (0 or 1).

This data type is used in conjunction with instructions and functions that handle digital input or output signals.

---

**Description**

Data of the type *dionum* represents a digital value 0 or 1.

---

**Examples**

```
CONST dionum close := 1;
```

Definition of a constant *close* with a value equal to 1.

```
SetDO grip1, close;
```

The signal *grip1* is set to *close*, i.e. 1.

---

**Error handling**

If an argument of the type *dionum* has a value that is neither equal to 0 nor 1, an error is returned on program execution.

---

**Characteristics**

*Dionum* is an alias data type for *num* and consequently inherits its characteristics.

---

**Related information**

Summary input/output instructions

Configuration of I/O

Alias data types

Described in:

RAPID Summary -  
*Input and Output Signals*

User's Guide - *System Parameters*

Basic Characteristics- *Data Types*



---

---

**errnum****Error number**

*Errnum* is used to describe all recoverable (non fatal) errors that occur during program execution, such as division by zero.

---

**Description**

If the robot detects an error during program execution, this can be dealt with in the error handler of the routine. Examples of such errors are values that are too high and division by zero. The system variable *ERRNO*, of type *errnum*, is thus assigned different values depending on the nature of an error. The error handler may be able to correct an error by reading this variable and then program execution can continue in the correct way.

An error can also be created from within the program using the RAISE instruction. This particular type of error can be detected in the error handler by specifying an error number (within the range 1-90 or booked with instruction *BookErrNo*) as an argument to RAISE.

---

**Examples**

```
reg1 := reg2 / reg3;
.
ERROR
  IF ERRNO = ERR_DIVZERO THEN
    reg3 := 1;
    RETRY;
  ENDIF
```

If *reg3* = 0, the robot detects an error when division is taking place. This error, however, can be detected and corrected by assigning *reg3* the value 1. Following this, the division can be performed again and program execution can continue.

```
CONST errnum machine_error := 1;
.
IF di1=0 RAISE machine_error;
.
ERROR
  IF ERRNO=machine_error RAISE;
```

An error occurs in a machine (detected by means of the input signal *di1*). A jump is made to the error handler in the routine which, in turn, calls the error handler of the calling routine where the error may possibly be corrected. The constant, *machine\_error*, is used to let the error handler know exactly what type of error has occurred.

---

## Predefined data

The system variable ERRNO can be used to read the latest error that occurred. A number of predefined constants can be used to determine the type of error that has occurred.

<u>Name</u>	<u>Cause of error</u>
ERR_ALRDYCNT	The interrupt variable is already connected to a TRAP routine
ERR_ARGDUPCND	More than one present conditional argument for the same parameter
ERR_ARGNAME	Argument is expression, not present or of type switch when executing ArgName
ERR_ARGNOTPER	Argument is not a persistent reference
ERR_ARGNOTVAR	Argument is not a variable reference
ERR_AXIS_ACT	Axis is not active
ERR_AXIS_IND	Axis is not independent
ERR_AXIS_MOVING	Axis is moving
ERR_AXIS_PAR	Parameter axis in instruction TestSign and SetCurrRef is wrong.
ERR_CALLIO_INTER	If an IOEnable or IODisable request is interrupted by another request to the same unit
ERR_CALLPROC	Procedure call error (not procedure) at runtime (late binding)
ERR_CNTNOTVAR	CONNECT target is not a variable reference
ERR_CNV_NOT_ACT	The conveyor is not activated.
ERR_CNV_CONNECT	The <i>WaitWobj</i> instruction is already active.
ERR_CNV_DROPPED	The object that the instruction <i>WaitWobj</i> was waiting for has been dropped.
ERR_DEV_MAXTIME	Timeout when executing a ReadBin, ReadNum or a ReadStr instruction
ERR_DIVZERO	Division by zero
ERR_EXCRTYMAX	Max. number of retries exceeded
ERR_EXECPHR	An attempt was made to execute an instruction using a place holder
ERR_FILEACC	A file is accessed incorrectly
ERR_FILNOTFND	File not found
ERR_FILEOPEN	A file cannot be opened
ERR_FNCNORET	No return value
ERR_ILLDIM	Incorrect array dimension
ERR_ILLQUAT	Attempt to use illegal orientation (quaternion) valve
ERR_ILLRAISE	Error number in RAISE out of range

ERR_INOMAX	No more interrupt numbers available
ERR_IOENABLE	Timeout when executing IOEnable
ERR_IODISABLE	Timeout when executing IODisable
ERR_MAXINTVAL	The integer value is too large
ERR_NAME_INVALID	If the unit name does not exist or if the unit is not allowed to be disabled
ERR_NEGARG	Negative argument is not allowed
ERR_NOTARR	Data is not an array
ERR_NOTEQDIM	The array dimension used when calling the routine does not coincide with its parameters
ERR_NOTINTVAL	Not an integer value
ERR_NOTPRES	A parameter is used, despite the fact that the corresponding argument was not used at the routine call
ERR_OUTOFBND	The array index is outside the permitted limits
ERR_REFUNKDAT	Reference to unknown entire data object
ERR_REFUNKFUN	Reference to unknown function
ERR_REFUNKPRC	Reference to unknown procedure at linking time or at run time (late binding)
ERR_REFUNKTRP	Reference to unknown trap
ERR_PATHDIST	Too long regain distance for StartMove instruction
ERR_RCVDATA	An attempt was made to read non numeric data with ReadNum
ERR_SC_WRITE	Error when sending to external computer
ERR_SIGSUPSEARCH	The signal has already a positive value at the beginning of the search process
ERR_STEP_PAR	Parameter Step in SetCurrRef is wrong
ERR_STRTOOLNG	The string is too long
ERR_SYM_ACCESS	Symbol read/write access error
ERR_TP_DIBREAK	A TPRead instruction was interrupted by a digital input
ERR_TP_MAXTIME	Timeout when executing a TPRead instruction
ERR_UNIT_PAR	Parameter Mech_unit in TestSign and SetCurrRef is wrong
ERR_UNKINO	Unknown interrupt number
ERR_UNLOAD	Unload error
ERR_WAIT_MAXTIME	Timeout when executing a WaitDI or WaitUntil instruction
ERR_WHLSEARCH	No search stop

---

## Characteristics

*Errnum* is an alias data type for *num* and consequently inherits its characteristics.



---

**Related information**

	<u>Described in:</u>
Error recovery	RAPID Summary - <i>Error Recovery</i> Basic Characteristics - <i>Error Recovery</i>
Data types in general, alias data types	Basic Characteristics - <i>Data Types</i>

---



---

## extjoint                      Position of external joints

*Extjoint* is used to define the axis positions of external axes, positioners or workpiece manipulators.

---

### Description

The robot can control up to six external axes in addition to its six internal axes, i.e. a total of twelve axes. The six external axes are logically denoted: a, b, c, d, e, f. Each such logical axis can be connected to a physical axis and, in this case, the connection is defined in the system parameters.

Data of the type *extjoint* is used to hold position values for each of the logical axes a - f.

For each logical axis connected to a physical axis, the position is defined as follows:

- For rotating axes – the position is defined as the rotation in degrees from the calibration position.
- For linear axes – the position is defined as the distance in mm from the calibration position.

If a logical axis is not connected to a physical one, the value 9E9 is used as a position value, indicating that the axis is not connected. At the time of execution, the position data of each axis is checked and it is checked whether or not the corresponding axis is connected. If the stored position value does not comply with the actual axis connection, the following applies:

- If the position is not defined in the position data (value is 9E9), the value will be ignored if the axis is connected and not activated. But if the axis is activated, it will result in an error.
- If the position is defined in the position data, although the axis is not connected, the value will be ignored.

If an external axis offset is used (instruction *EOffsOn* or *EOffsSet*), the positions are specified in the ExtOffs coordinate system.

---

### Components

<b>eax_a</b>	<i>(external axis a)</i>	Data type: <i>num</i>
	The position of the external logical axis “a”, expressed in degrees or mm (depending on the type of axis).	
<b>eax_b</b>	<i>(external axis b)</i>	Data type: <i>num</i>
	The position of the external logical axis “b”, expressed in degrees or mm (depending on the type of axis).	

...

**eax\_f** (external axis f) Data type: *num*

The position of the external logical axis “f”, expressed in degrees or mm (depending on the type of axis).

### Example

VAR extjoint axpos10 := [ 11, 12.3, 9E9, 9E9, 9E9, 9E9] ;

The position of an external positioner, *axpos10*, is defined as follows:

- The position of the external logical axis “a” is set to 11, expressed in degrees or mm (depending on the type of axis).
- The position of the external logical axis “b” is set to 12.3, expressed in degrees or mm (depending on the type of axis).
- Axes c to f are undefined.

### Structure

< dataobject of *extjoint* >  
 < *eax\_a* of *num* >  
 < *eax\_b* of *num* >  
 < *eax\_c* of *num* >  
 < *eax\_d* of *num* >  
 < *eax\_e* of *num* >  
 < *eax\_f* of *num* >

### Related information

Position data	<u>Described in:</u>
ExtOffs coordinate system	Data Types - <i>robtarg</i>
	Instructions - <i>EOffsOn</i>

---

---

**intnum**                      **Interrupt identity**

*Intnum* (*interrupt numeric*) is used to identify an interrupt.

---

**Description**

When a variable of type *intnum* is connected to a trap routine, it is given a specific value identifying the interrupt. This variable is then used in all dealings with the interrupt, such as when ordering or disabling an interrupt.

More than one interrupt identity can be connected to the same trap routine. The system variable *INTNO* can thus be used in a trap routine to determine the type of interrupt that occurs.

---

**Examples**

```
VAR intnum feeder_error;  
.  
CONNECT feeder_error WITH correct_feeder;  
ISignalDI di1, 1, feeder_error;
```

An interrupt is generated when the input *di1* is set to *1*. When this happens, a call is made to the *correct\_feeder* trap routine.

```

VAR intnum feeder1_error;
VAR intnum feeder2_error;
.
PROC init_interrupt();
.
  CONNECT feeder1_error WITH correct_feeder;
  ISignalDI di1, 1, feeder1_error;
  CONNECT feeder2_error WITH correct_feeder;
  ISignalDI di2, 1, feeder2_error;
.
ENDPROC
.
TRAP correct_feeder
  IF INTNO=feeder1_error THEN
.
  ELSE
.
  ENDIF
.
ENDTRAP

```

An interrupt is generated when either of the inputs *di1* or *di2* is set to *1*. A call is then made to the *correct\_feeder* trap routine. The system variable INTNO is used in the trap routine to find out which type of interrupt has occurred.

## Limitations

The maximum number of active variables of type *intnum* at any one time (between *CONNECT* and *IDelete*) is limited to 40. The maximum number of interrupts, in the queue for execution of *TRAP* routine at any one time, is limited to 30.

## Characteristics

*Intnum* is an alias data type for *num* and thus inherits its properties.

## Related information

	<u>Described in:</u>
Summary of interrupts	RAPID Summary - <i>Interrupts</i>
Alias data types	Basic Characteristics- <i>Data Types</i>

---

---

## **iodev**                      **Serial channels and files**

*Iodev (I/O device)* is used for serial channels, such as printers and files.

---

### **Description**

Data of the type *iodev* contains a reference to a file or serial channel. It can be linked to the physical unit by means of the instruction *Open* and then used for reading and writing.

---

### **Example**

```
VAR iodev file;  
.  
Open "flp1:LOGDIR/INFILE.DOC", file\Read;  
input := ReadNum(file);
```

The file *INFILE.DOC* is opened for reading. When reading from the file, *file* is used as a reference instead of the file name.

---

### **Characteristics**

*Iodev* is a non-value data type.

---

### **Related information**

	<u>Described in:</u>
Communication via serial channels	RAPID Summary - <i>Communication</i>
Configuration of serial channels	User's Guide - <i>System Parameters</i>
Characteristics of non-value data types	Basic Characteristics - <i>Data Types</i>



---

---

**jointtarget****Joint position data**

*Jointtarget* is used to define the position that the robot and the external axes will move to with the instruction *MoveAbsJ*.

---

**Description**

*Jointtarget* defines each individual axis position, for both the robot and the external axes.

---

**Components**

**robax** *(robot axes)* Data type: *robjoint*

Axis positions of the robot axes in degrees.

Axis position is defined as the rotation in degrees for the respective axis (arm) in a positive or negative direction from the axis calibration position.

**extax** *(external axes)* Data type: *extjoint*

The position of the external axes.

The position is defined as follows for each individual axis (*eax\_a*, *eax\_b* ... *eax\_f*):

- For rotating axes, the position is defined as the rotation in degrees from the calibration position.
- For linear axes, the position is defined as the distance in mm from the calibration position.

External axes *eax\_a* ... are logical axes. How the logical axis number and the physical axis number are related to each other is defined in the system parameters.

The value 9E9 is defined for axes which are not connected. If the axes defined in the position data differ from the axes that are actually connected on program execution, the following applies:

- If the position is not defined in the position data (value 9E9) the value will be ignored, if the axis is connected and not activated. But if the axis is activated it will result in error.
- If the position is defined in the position data yet the axis is not connected, the value is ignored.



---

## Examples

```
CONST jointtarget calib_pos := [ [ 0, 0, 0, 0, 0, 0 ], [ 0, 9E9, 9E9, 9E9, 9E9, 9E9 ] ];
```

The normal calibration position for IRB2400 is defined in *calib\_pos* by the data type *jointtarget*. The normal calibration position 0 (degrees or mm) is also defined for the external logical axis a. The external axes b to f are undefined.

---

## Structure

```
< dataobject of jointtarget >
  < robax of robjoint >
    < rax_1 of num >
    < rax_2 of num >
    < rax_3 of num >
    < rax_4 of num >
    < rax_5 of num >
    < rax_6 of num >
  < extax of extjoint >
    < eax_a of num >
    < eax_b of num >
    < eax_c of num >
    < eax_d of num >
    < eax_e of num >
    < eax_f of num >
```

---

## Related information

Move to joint position  
Positioning instructions  
Configuration of external axes

### Described in:

Instructions - *MoveAbsJ*  
RAPID Summary - *Motion*  
User's Guide - *System Parameters*

---

---

**loaddata****Load data**

*Loaddata* is used to describe loads attached to the mechanical interface of the robot (the robot's mounting flange).

Load data usually defines the payload (grip load is defined by the instruction *GripLoad*) of the robot, i.e. the load held in the robot gripper. The tool load is specified in the tool data (*tooldata*) which includes load data.

---

**Description**

Specified loads are used to set up a model of the dynamics of the robot so that the robot movements can be controlled in the best possible way.



**It is important to always define the actual tool load and when used, the payload of the robot too. Incorrect definitions of load data can result in overloading of the robot mechanical structure.**

When incorrect load data is specified, it can often lead to the following consequences:

- If the value in the specified load data is greater than that of the value of the true load;
  - > The robot will not be used to its maximum capacity
  - > Impaired path accuracy including a risk of overshooting
  - > Risk of overloading the mechanical structure
- If the value in the specified load data is less than the value of the true load;
  - > Impaired path accuracy including a risk of overshooting
  - > Risk of overloading the mechanical structure

The payload is connected/disconnected using the instruction *GripLoad*.

---

**Components****mass**Data type: *num*

The weight of the load in kg.

**cog***(centre of gravity)*Data type: *pos*

The centre of gravity of a tool load expressed in the wrist coordinate system. If a stationary tool is used, it means the centre of gravity for the tool holding the work object.

The centre of gravity of a payload expressed in the tool coordinate system. The object coordinate system when a stationary tool is used.

**aom** (axes of moment) Data type: *orient*

The orientation of the coordinate system defined by the inertial axes of the tool load. **It should always be set to 1, 0, 0, 0.** Expressed in the wrist coordinate system as a quaternion (q1, q2, q3, q4). If a stationary tool is used, it means the inertial axes for the tool holding the work object.

The orientation of the coordinate system defined by the inertial axes of the payload. **It should always be set to 1, 0, 0, 0.** Expressed in the tool coordinate system as a quaternion (q1, q2, q3, q4). The object coordinate system if a stationary tool is used.

**Restriction on orientation of tool load and payload coordinate system (axes of moment - aom):**

The orientation of the tool load coordinate system must coincide with the orientation of the wrist coordinate system.

The orientation of the payload coordinate system must coincide with the orientation of the wrist coordinate system. Because of this, the best way is to define the orientation of the tool coordinate system (*tool frame*) to coincide with the orientation of the wrist coordinate system.

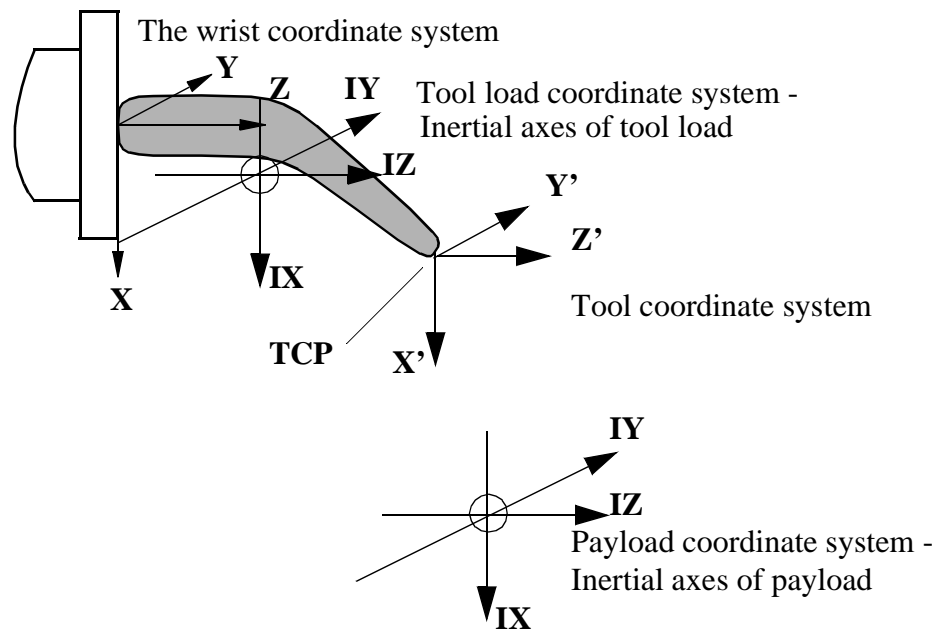


Figure 1 Restriction on the orientation of tool load and payload coordinate system.

**ix** (inertia x) Data type: *num*

The moment of inertia of the load about the x'-axis relative to its centre of mass about the axes of the tool load or payload coordinate system in kgm<sup>2</sup>.

Correct definition of the inertial moments of inertia will allow optimal utilisation of the path planner and axes control. This may be of special importance when handling large sheets of metal, etc. All inertial moments of inertia *ix*, *iy* and *iz* equal to 0 kgm<sup>2</sup> implies a point mass.

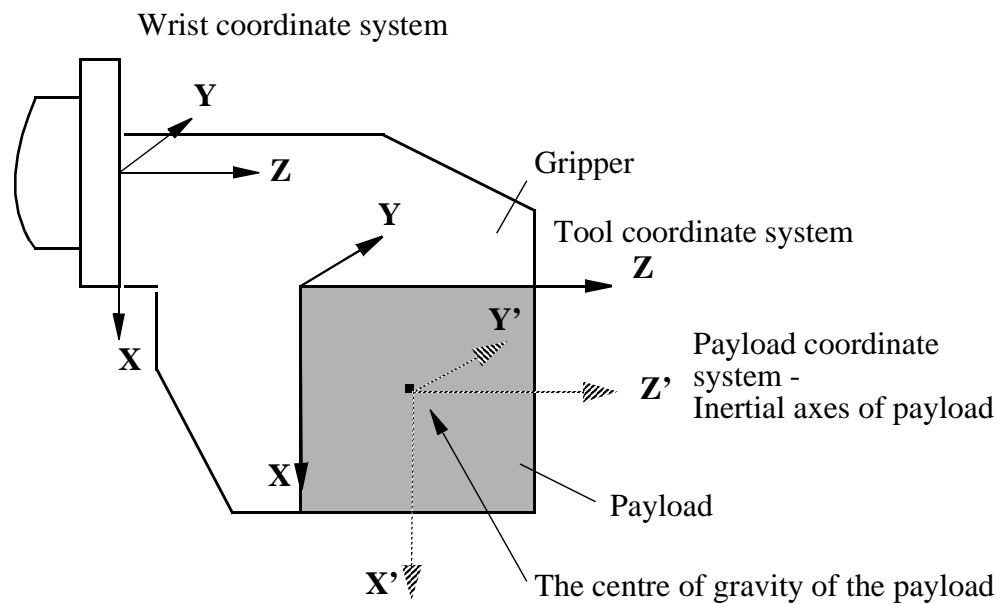


Figure 2 The centre of gravity and inertial axes of the payload.

Normally, the inertial moments of inertia must only be defined when the distance from the mounting flange to the centre of gravity is less than the dimension of the load (see Figure 3).

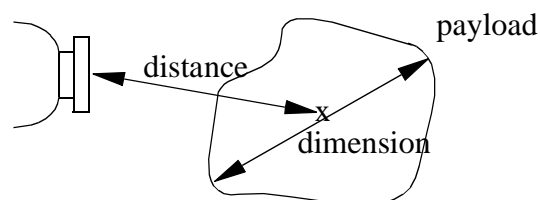


Figure 3 The moment of inertia must normally be defined when the distance is less than the load dimension.

**iy** (inertia y) Data type: *num*

The inertial moment of inertia of the load about the  $y'$ -axis, expressed in  $\text{kgm}^2$ .

For more information, see *ix*.

**iz** (inertia z) Data type: *num*

The inertial moment of inertia of the load about the  $z'$ -axis, expressed in  $\text{kgm}^2$ .

For more information, see *ix*.

---

## Examples

```
PERS loaddata piece1 := [ 5, [50, 0, 50], [1, 0, 0, 0], 0, 0, 0];
```

The payload in Figure 1 is described using the following values:

- Weight 5 kg.
- The centre of gravity is  $x = 50$ ,  $y = 0$  and  $z = 50$  mm in the tool coordinate system.
- The payload is a point mass.

```
Set gripper;  
WaitTime 0.3;  
GripLoad piece1;
```

Connection of the payload, *piece1*, specified at the same time as the robot grips the load *piece1*.

```
Reset gripper;  
WaitTime 0.3;  
GripLoad load0;
```

Disconnection of a payload, specified at the same time as the robot releases a payload.

---

## Limitations

The payload should only be defined as a persistent variable (PERS) and not within a routine. Current values are then saved when storing the program on diskette and are retrieved on loading.

Arguments of the type load data in the *GripLoad* instruction should only be an entire persistent (not array element or record component).

---

## Predefined data

The load *load0* defines a payload, the weight of which is equal to 0 kg, i.e. no load at all. This load is used as the argument in the instruction *GripLoad* to disconnect a payload.

The load *load0* can always be accessed from the program, but cannot be changed (it is stored in the system module *BASE*).

```
PERS loaddata load0 := [ 0.001, [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0 ];
```

---

**Structure**

< dataobject of *loaddata* >  
    < *mass* of *num* >  
    < *cog* of *pos* >  
        < *x* of *num* >  
        < *y* of *num* >  
        < *z* of *num* >  
    < *aom* of *orient* >  
        < *q1* of *num* >  
        < *q2* of *num* >  
        < *q3* of *num* >  
        < *q4* of *num* >  
    < *ix* of *num* >  
    < *iy* of *num* >  
    < *iz* of *num* >

---

**Related information**

Coordinate systems

Definition of tool loads

Activation of payload

Described in:

Motion and I/O Principles -  
*Coordinate Systems*

Data Types - *tooldata*

Instructions - *GripLoad*



---

---

**mecunit****Mechanical unit**

*Mecunit* is used to define the different mechanical units which can be controlled and accessed from the robot and the program.

The names of the mechanical units are defined in the system parameters and, consequently, must not be defined in the program.

---

**Description**

Data of the type *mecunit* only contains a reference to the mechanical unit.

---

**Limitations**

Data of the type *mecunit* must not be defined in the program. The data type can, on the other hand, be used as a parameter when declaring a routine.

---

**Predefined data**

The mechanical units defined in the system parameters can always be accessed from the program (installed data).

---

**Characteristics**

*Mecunit* is a *non-value* data type. This means that data of this type does not permit value-oriented operations.

---

**Related information**

	<u>Described in:</u>
Activating/Deactivating mechanical units	Instructions - <i>ActUnit</i> , <i>DeactUnit</i>
Configuration of mechanical units	User's Guide - <i>System Parameters</i>
Characteristics of non-value data types	Basic Characteristics - <i>Data Types</i>





---

---

**motsetdata****Motion settings data**

*Motsetdata* is used to define a number of motion settings that affect all positioning instructions in the program:

- Max. velocity and velocity override
- Acceleration data
- Behaviour around singular points
- Management of different robot configurations
- Payload
- Override of path resolution

This data type does not normally have to be used since these settings can only be set using the instructions *VelSet*, *AccSet*, *SingArea*, *ConfJ*, *ConfL*, *GripLoad* and *PathResol*.

The current values of these motion settings can be accessed using the system variable *C\_MOTSET*.

---

**Description**

The current motion settings (stored in the system variable *C\_MOTSET*) affect all movements.

---

**Components**

<b>vel.oride</b>	Data type: <i>veldata/num</i>
Velocity as a percentage of programmed velocity.	
<b>vel.max</b>	Data type: <i>veldata/num</i>
Maximum velocity in mm/s.	
<b>acc.acc</b>	Data type: <i>accdata/num</i>
Acceleration and deceleration as a percentage of the normal values.	
<b>acc.ramp</b>	Data type: <i>accdata/num</i>
The rate by which acceleration and deceleration increases as a percentage of the normal values.	

<b>sing.wrist</b>	Data type: <i>singdata/bool</i>
The orientation of the tool is allowed to deviate somewhat in order to prevent wrist singularity.	
<b>sing.arm</b>	Data type: <i>singdata/bool</i>
The orientation of the tool is allowed to deviate somewhat in order to prevent arm singularity (not implemented).	
<b>sing.base</b>	Data type: <i>singdata/bool</i>
The orientation of the tool is not allowed to deviate.	
<b>conf.jsup</b>	Data type: <i>confsupdata/bool</i>
Supervision of joint configuration is active during joint movement.	
<b>conf.lsup</b>	Data type: <i>confsupdata/bool</i>
Supervision of joint configuration is active during linear and circular movement.	
<b>conf.ax1</b>	Data type: <i>confsupdata/num</i>
Maximum permitted deviation in degrees for axis 1 (not used in this version).	
<b>conf.ax4</b>	Data type: <i>confsupdata/num</i>
Maximum permitted deviation in degrees for axis 4 (not used in this version).	
<b>conf.ax6</b>	Data type: <i>confsupdata/num</i>
Maximum permitted deviation in degrees for axis 6 (not used in this version).	
<b>grip.load</b>	Data type: <i>gripdata/loaddata</i>
The payload of the robot (not including the gripper).	
<b>pathresol</b>	Data type: <i>num</i>
Current override in percentage of the configured path resolution.	

---

## Limitations

One and only one of the components *sing.wrist*, *sing.arm* or *sing.base* may have a value equal to TRUE.

**Example**

```
IF C_MOTSET.vel.oride > 50 THEN
  ...
ELSE
  ...
ENDIF
```

Different parts of the program are executed depending on the current velocity override.

---

**Predefined data**

*C\_MOTSET* describes the current motion settings of the robot and can always be accessed from the program (installed data). *C\_MOTSET*, on the other hand, can only be changed using a number of instructions, not by assignment.

The following default values for motion parameters are set

- at a cold start-up
- when a new program is loaded
- when starting program execution from the beginning.

```
PERS motsetdata C_MOTSET := [
  [ 100, 500 ],           -> veldata
  [ 100, 100 ],          -> accdata
  [ FALSE, FALSE, TRUE ], -> singdata
  [ TRUE, TRUE, 30, 45, 90], -> confsupdata
  [ [ 0, [ 0, 0, 0 ], [ 1, 0, 0, 0 ], 0, 0, 0 ], -> gripdata
  100 ]                  -> path resolution
```

---

**Structure**

<dataobject of <i>motsetdata</i> >	
<vel of <i>veldata</i> >	-> Affected by instruction VelSet
<oride of num>	
<max of num>	
<acc of <i>accddata</i> >	-> Affected by instruction AccSet
<acc of num>	
<ramp of num>	
<sing of <i>singdata</i> >	-> Affected by instruction SingArea
<wrist of bool>	
<arm of bool>	
<base of bool>	
<conf of <i>confsupdata</i> >	-> Affected by instructions ConfJ and ConfL
<jsup of bool>	
<lsup of bool>	
<ax1 of num>	
<ax4 of num>	
<ax6 of num>	
<grip of <i>gripdata</i> >	-> Affected by instruction GripLoad
<load of <i>loaddata</i> >	
<mass of num>	
<cog of pos>	
<x of num>	
<y of num>	
<z of num>	
<aom of orient>	
<q1 of num>	
<q2 of num>	
<q3 of num>	
<q4 of num>	
<ix of num>	
<iy of num>	
<iz of num>	
<pathresol of num>	-> Affected by instruction PathResol

---

**Related information**

	<u>Described in:</u>
Instructions for setting motion parameters	RAPID Summary - <i>Motion Settings</i>

---



---

**num**                      **Numeric values (registers)**

*Num* is used for numeric values; e.g. counters.

---

**Description**

The value of the *num* data type may be

- an integer; e.g. -5,
- a decimal number; e.g. 3.45.

It may also be written exponentially; e.g. 2E3 (=  $2 \times 10^3 = 2000$ ), 2.5E-2 (= 0.025).

Integers between -8388607 and +8388608 are always stored as exact integers.

Decimal numbers are only approximate numbers and should not, therefore, be used in *is equal to* or *is not equal to* comparisons. In the case of divisions, and operations using decimal numbers, the result will also be a decimal number; i.e. not an exact integer.

E.g.	<pre>a := 10; b := 5; IF a/b=2 THEN ... </pre>	<p>As the result of a/b is not an integer, this condition is not necessarily satisfied.</p>
------	--	---

---

**Example**

```
VAR num reg1;
reg1 := 3;
```

*reg1* is assigned the value 3.

```
a := 10 DIV 3;
b := 10 MOD 3;
```

Integer division where *a* is assigned an integer (=3) and *b* is assigned the remainder (=1).

---

**Predefined data**

The constant pi ( $\pi$ ) is already defined in the system module *BASE*.

```
CONST num pi := 3.1415926;
```

---

**Related information**

Numeric expressions  
Operations using numeric values

Described in:  
Basic Characteristics - *Expressions*  
Basic Characteristics - *Expressions*

---



---

## o\_jointtarget      Original joint position data

*o\_jointtarget* (original joint target) is used in combination with the function *Absolute Limit Modpos*. When this function is used to modify a position, the original position is stored as a data of the type *o\_jointtarget*.

---

### Description

If the function *Absolute Limit Modpos* is activated and a named position in a movement instruction is modified with the function *Modpos*, then the original programmed position is saved.

Example of a program before *Modpos*:

```
CONST jointtarget jpos40 := [[0, 0, 0, 0, 0, 0],
                             [0, 9E9, 9E9, 9E9, 9E9, 9E9]];
...
MoveAbsJ jpos40, v1000, z50, tool1;
```

The same program after *ModPos* in which the point *jpos40* is corrected to 2 degrees for robot axis 1:

```
CONST jointtarget jpos40      := [[2, 0, 0, 0, 0, 0],
                                  [0, 9E9, 9E9, 9E9, 9E9, 9E9]];
CONST o_jointtarget o_jpos40 := [[0, 0, 0, 0, 0, 0],
                                  [0, 9E9, 9E9, 9E9, 9E9, 9E9]];
...
MoveAbsJ jpos40, v1000, z50, tool1;
```

The original programmed point has now been saved in *o\_jpos40* (by the data type *o\_jointtarget*) and the modified point saved in *jpos40* (by the data type *jointtarget*).

By saving the original programmed point, the robot can monitor that further *Modpos* of the point in question are within the acceptable limits from the original programmed point.

The fixed name convention means that an original programmed point with the name *xxxxx* is saved with the name *o\_xxxxx* by using *Absolute Limit Modpos*.

---

### Components

**robax**                              (*robot axes*)                              Data type: *robjoint*

Axis positions of the robot axes in degrees.



**extax**

*(external axes)*

Data type: *extjoint*

The position of the external axes.

---

## Structure

< dataobject of *o\_jointtarget* >  
  < *robax* of *robjoint* >  
    < *rax\_1* of *num* >  
    < *rax\_2* of *num* >  
    < *rax\_3* of *num* >  
    < *rax\_4* of *num* >  
    < *rax\_5* of *num* >  
    < *rax\_6* of *num* >  
  < *extax* of *extjoint* >  
    < *eax\_a* of *num* >  
    < *eax\_b* of *num* >  
    < *eax\_c* of *num* >  
    < *eax\_d* of *num* >  
    < *eax\_e* of *num* >  
    < *eax\_f* of *num* >

---

## Related information

Position data

Configuration of Limit Modpos

Described in:

Data Types - *Jointtarget*

User's Guide - *System Parameters*

---

---

**orient****Orientation**

*Orient* is used for orientations (such as the orientation of a tool) and rotations (such as the rotation of a coordinate system).

---

**Description**

The orientation is described in the form of a quaternion which consists of four elements:  $q1$ ,  $q2$ ,  $q3$  and  $q4$ . For more information on how to calculate these, see below.

---

**Components**

<b>q1</b>	Data type: <i>num</i>
Quaternion 1.	
<b>q2</b>	Data type: <i>num</i>
Quaternion 2.	
<b>q3</b>	Data type: <i>num</i>
Quaternion 3.	
<b>q4</b>	Data type: <i>num</i>
Quaternion 4.	

---

**Example**

```
VAR orient orient1;  
orient1 := [1, 0, 0, 0];
```

The *orient1* orientation is assigned the value  $q1=1$ ,  $q2=q3=q4=0$ ; this corresponds to no rotation.

---

**Limitations**

The orientation must be normalised; i.e. the sum of the squares must equal 1:

$$q_1^2 + q_2^2 + q_3^2 + q_4^2 = 1$$

## What is a Quaternion?

The orientation of a coordinate system (such as that of a tool) can be described by a rotational matrix that describes the direction of the axes of the coordinate system in relation to a reference system (see Figure 1).

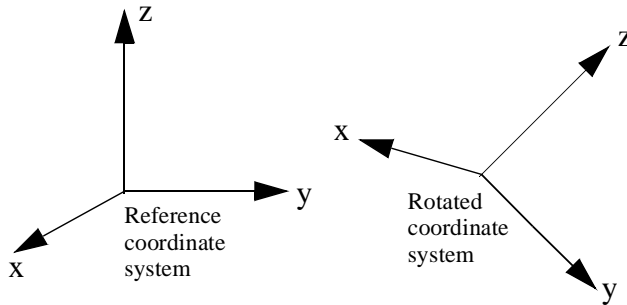


Figure 1 The rotation of a coordinate system is described by a quaternion.

The rotated coordinate systems axes ( $\mathbf{x}$ ,  $\mathbf{y}$ ,  $\mathbf{z}$ ) are vectors which can be expressed in the reference coordinate system as follows:

$$\mathbf{x} = (x_1, x_2, x_3)$$

$$\mathbf{y} = (y_1, y_2, y_3)$$

$$\mathbf{z} = (z_1, z_2, z_3)$$

This means that the x-component of the x-vector in the reference coordinate system will be  $x_1$ , the y-component will be  $x_2$ , etc.

These three vectors can be put together in a matrix, a rotational matrix, where each of the vectors form one of the columns:

$$\begin{bmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{bmatrix}$$

A quaternion is just a more concise way to describe this rotational matrix; the quaternions are calculated based on the elements of the rotational matrix:

$$q1 = \frac{\sqrt{x_1 + y_2 + z_3 + 1}}{2}$$

$$q2 = \frac{\sqrt{x_1 - y_2 - z_3 + 1}}{2}$$

$$q3 = \frac{\sqrt{y_2 - x_1 - z_3 + 1}}{2}$$

$$q4 = \frac{\sqrt{z_3 - x_1 - y_2 + 1}}{2}$$

$$\text{sign } q2 = \text{sign } (y_3 - z_2)$$

$$\text{sign } q3 = \text{sign } (z_1 - x_3)$$

$$\text{sign } q4 = \text{sign } (x_2 - y_1)$$

**Example 1**

A tool is orientated so that its  $Z'$ -axis points straight ahead (in the same direction as the  $X$ -axis of the base coordinate system). The  $Y'$ -axis of the tool corresponds to the  $Y$ -axis of the base coordinate system (see Figure 2). How is the orientation of the tool defined in the position data (robtargt)?

The orientation of the tool in a programmed position is normally related to the coordinate system of the work object used. In this example, no work object is used and the base coordinate system is equal to the world coordinate system. Thus, the orientation is related to the base coordinate system.

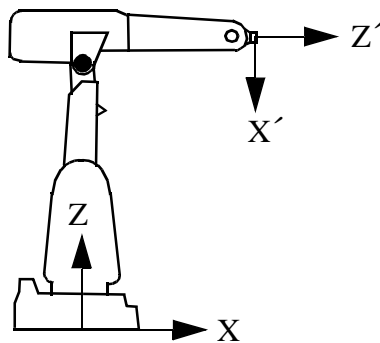


Figure 2 The direction of a tool in accordance with example 1.

The axes will then be related as follows:

$$\mathbf{x}' = -\mathbf{z} = (0, 0, -1)$$

$$\mathbf{y}' = \mathbf{y} = (0, 1, 0)$$

$$\mathbf{z}' = \mathbf{x} = (1, 0, 0)$$

Which corresponds to the following rotational matrix:

$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix}$$

The rotational matrix provides a corresponding quaternion:

$$q1 = \frac{\sqrt{0+1+0+1}}{2} = \frac{\sqrt{2}}{2} = 0,707$$

$$q2 = \frac{\sqrt{0-1-0+1}}{2} = 0$$

$$q3 = \frac{\sqrt{1-0-0+1}}{2} = \frac{\sqrt{2}}{2} = 0,707$$

$$\text{sign } q3 = \text{sign } (1+1) = +$$

$$q4 = \frac{\sqrt{0-0-1+1}}{2} = 0$$

**Example 2**

The direction of the tool is rotated  $30^\circ$  about the  $X'$ - and  $Z'$ -axes in relation to the wrist coordinate system (see Figure 2). How is the orientation of the tool defined in the tool data?

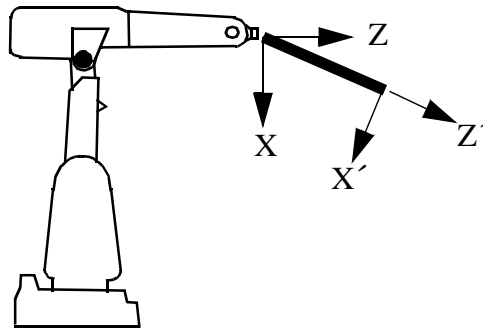


Figure 3 The direction of the tool in accordance with example 2.

The axes will then be related as follows:

$$\mathbf{x}' = (\cos 30^\circ, 0, -\sin 30^\circ)$$

$$\mathbf{y}' = (0, 1, 0)$$

$$\mathbf{z}' = (\sin 30^\circ, 0, \cos 30^\circ)$$

Which corresponds to the following rotational matrix:

$$\begin{bmatrix} \cos 30^\circ & 0 & \sin 30^\circ \\ 0 & 1 & 0 \\ -\sin 30^\circ & 0 & \cos 30^\circ \end{bmatrix}$$

The rotational matrix provides a corresponding quaternion:

$$q1 = \frac{\sqrt{\cos 30^\circ + 1 + \cos 30^\circ + 1}}{2} = 0,965926$$

$$q2 = \frac{\sqrt{\cos 30^\circ - 1 - \cos 30^\circ + 1}}{2} = 0$$

$$q3 = \frac{\sqrt{1 - \cos 30^\circ - \cos 30^\circ + 1}}{2} = 0,258819$$

$$\text{sign } q3 = \text{sign}(\sin 30^\circ + \sin 30^\circ) = +$$

$$q4 = \frac{\sqrt{\cos 30^\circ - \cos 30^\circ - 1 + 1}}{2} = 0$$

## Structure

<dataobject of orient>

<q1 of num>

<q2 of num>

<q3 of num>

<q4 of num>

## Related information

Operations on orientations

Described in:

Basic Characteristics - *Expressions*

---

---

**o\_robtarget****Original position data**

*o\_robtarget* (original robot target) is used in combination with the function *Absolute Limit Modpos*. When this function is used to modify a position, the original position is stored as a data of the type *o\_robtarget*.

---

**Description**

If the function *Absolute Limit Modpos* is activated and a named position in a movement instruction is modified with the function *Modpos*, then the original programmed position is saved.

Example of a program before *Modpos*:

```
CONST robtarget p50      := [[500, 500, 500], [1, 0, 0, 0], [1, 1, 0, 0],
                           [500, 9E9, 9E9, 9E9, 9E9, 9E9] ];
...
MoveL p50, v1000, z50, tool1;
```

The same program after *ModPos* in which the point *p50* is corrected to 502 in the x-direction:

```
CONST robtarget p50      := [[502, 500, 500], [1, 0, 0, 0], [1, 1, 0, 0],
                           [500, 9E9, 9E9, 9E9, 9E9, 9E9] ];
CONST o_robtarget o_p50  := [[500, 500, 500], [1, 0, 0, 0], [1, 1, 0, 0],
                           [500, 9E9, 9E9, 9E9, 9E9, 9E9] ];
...
MoveL p50, v1000, z50, tool1;
```

The original programmed point has now been saved in *o\_p50* (by the data type *o\_robtarget*) and the modified point saved in *p50* (by the data type *robtarget*).

By saving the original programmed point, the robot can monitor that further *Modpos* of the point in question are within the acceptable limits from the original programmed point.

The fixed name convention means that an original programmed point with the name *xxxxx* is saved with the name *o\_xxxxx* by using *Absolute Limit Modpos*.

---

**Components**

**trans** (translation) Data type: *pos*

The position (x, y and z) of the tool centre point expressed in mm.

<b>rot</b>	<i>(rotation)</i>	Data type: <i>orient</i>
The orientation of the tool, expressed in the form of a quaternion (q1, q2, q3 and q4).		
<b>robconf</b>	<i>(robot configuration)</i>	Data type: <i>confdata</i>
The axis configuration of the robot (cf1, cf4, cf6 and cfx).		
<b>extax</b>	<i>(external axes)</i>	Data type: <i>extjoint</i>
The position of the external axes.		

---

## Structure

```
< dataobject of o_robtarget >  
  < trans of pos >  
    < x of num >  
    < y of num >  
    < z of num >  
  < rot of orient >  
    < q1 of num >  
    < q2 of num >  
    < q3 of num >  
    < q4 of num >  
  < robconf of confdata >  
    < cf1 of num >  
    < cf4 of num >  
    < cf6 of num >  
    < cfx of num >  
  < extax of extjoint >  
    < eax_a of num >  
    < eax_b of num >  
    < eax_c of num >  
    < eax_d of num >  
    < eax_e of num >  
    < eax_f of num >
```

---

## Related information

Position data

Configuration of Limit Modpos

Described in:

Data Types - *Robtarget*

User's Guide - *System Parameters*

---

---

**pos**                      **Positions (only X, Y and Z)**

*Pos* is used for positions (only X, Y and Z).

The *robtarget* data type is used for the robot's position including the orientation of the tool and the configuration of the axes.

---

**Description**

Data of the type *pos* describes the coordinates of a position: X, Y and Z.

---

**Components**

<b>x</b>	Data type: <i>num</i>
The X-value of the position.	
<b>y</b>	Data type: <i>num</i>
The Y-value of the position.	
<b>z</b>	Data type: <i>num</i>
The Z-value of the position.	

---

**Examples**

```
VAR pos pos1;
```

```
.  
pos1 := [500, 0, 940];
```

The *pos1* position is assigned the value: X=500 mm, Y=0 mm, Z=940 mm.

```
pos1.x := pos1.x + 50;
```

The *pos1* position is shifted 50 mm in the X-direction.

---

**Structure**

```
<dataobject of pos>  
  <x of num>  
  <y of num>  
  <z of num>
```



---

**Related information**

Operations on positions

Robot position including orientation

Described in:

Basic Characteristics - *Expressions*

Data Types- *robtarget*

---

---

**pose**                      **Coordinate transformations**

*Pose* is used to change from one coordinate system to another.

---

**Description**

Data of the type *pose* describes how a coordinate system is displaced and rotated around another coordinate system. The data can, for example, describe how the tool coordinate system is located and oriented in relation to the wrist coordinate system.

---

**Components**

<b>trans</b>	( <i>translation</i> )	Data type: <i>pos</i>
	The displacement in position (x, y and z) of the coordinate system.	
<b>rot</b>	( <i>rotation</i> )	Data type: <i>orient</i>
	The rotation of the coordinate system.	

---

**Example**

```
VAR pose frame1;  
.  
frame1.trans := [50, 0, 40];  
frame1.rot := [1, 0, 0, 0];
```

The *frame1* coordinate transformation is assigned a value that corresponds to a displacement in position, where X=50 mm, Y=0 mm, Z=40 mm; there is, however, no rotation.

---

**Structure**

```
<dataobject of pose>  
  <trans of pos>  
  <rot of orient>
```

---

**Related information**

What is a Quaternion?

Described in:

Data Types - *orient*



---



---

## progdisp                      Program displacement

*Progdisp* is used to store the current program displacement of the robot and the external axes.

This data type does not normally have to be used since the data is set using the instructions *PDispSet*, *PDispOn*, *PDispOff*, *EOffsSet*, *EOffsOn* and *EOffsOff*. It is only used to temporarily store the current value for later use.

---

### Description

The current values for program displacement can be accessed using the system variable *C\_PROGDISP*.

For more information, see the instructions *PDispSet*, *PDispOn*, *EOffsSet* and *EOffsOn*.

---

### Components

<b>pdisp</b>	<i>(program displacement)</i>	Data type: <i>pose</i>
	The program displacement for the robot, expressed using a translation and an orientation. The translation is expressed in mm.	
<b>eoffs</b>	<i>(external offset)</i>	Data type: <i>extjoint</i>
	The offset for each of the external axes. If the axis is linear, the value is expressed in mm; if it is rotating, the value is expressed in degrees.	

---

### Example

```

VAR progdisp progdisp1;
.
SearchL sen1, psearch, p10, v100, tool1;
PDispOn \ExeP:=psearch, *, tool1;
EOffsOn \ExeP:=psearch, *;
.
progdisp1:=C_PROGDISP;
PDispOff;
EOffsOff;
.
PDispSet progdisp1.pdisp;
EOffsSet progdisp1.eoffs;

```

First, a program displacement is activated from a searched position. Then, it is temporarily deactivated by storing the value in the variable *progdisp1* and, later on, re-activated using the instructions *PDispSet* and *EOffsSet*.

## Predefined data

The system variable *C\_PROGDISP* describes the current program displacement of the robot and external axes, and can always be accessed from the program (installed data). *C\_PROGDISP*, on the other hand, can only be changed using a number of instructions, not by assignment.

## Structure

< dataobject of *progdisp* >  
  < *pdisp* of *pose* >  
    < *trans* of *pos* >  
      < *x* of *num* >  
      < *y* of *num* >  
      < *z* of *num* >  
    < *rot* of *orient* >  
      < *q1* of *num* >  
      < *q2* of *num* >  
      < *q3* of *num* >  
      < *q4* of *num* >  
    < *eoffs* of *extjoint* >  
      < *eax\_a* of *num* >  
      < *eax\_b* of *num* >  
      < *eax\_c* of *num* >  
      < *eax\_d* of *num* >  
      < *eax\_e* of *num* >  
      < *eax\_f* of *num* >

## Related information

Described in:

Instructions for defining program displacement	RAPID Summary - <i>Motion Settings</i>
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>

---

---

**robjoint**                      **Joint position of robot axes**

*Robjoint* is used to define the axis position in degrees of the robot axes.

---

**Description**

Data of the type *robjoint* is used to store axis positions in degrees of the robot axes 1 to 6. Axis position is defined as the rotation in degrees for the respective axis (arm) in a positive or negative direction from the axis calibration position.

---

**Components**

**rax\_1**                                      (*robot axis 1*)                                      Data type: *num*

The position of robot axis 1 in degrees from the calibration position.

...

**rax\_6**                                      (*robot axis 6*)                                      Data type: *num*

The position of robot axis 6 in degrees from the calibration position.

---

**Structure**

```
< dataobject of robjoint >  
  < rax_1 of num >  
  < rax_2 of num >  
  < rax_3 of num >  
  < rax_4 of num >  
  < rax_5 of num >  
  < rax_6 of num >
```

---

**Related information**

Joint position data

Move to joint position

Described in:

Data Types - *jointtarget*

Instructions - *MoveAbsJ*



---

---

**robtarget****Position data**

*Robtarget (robot target)* is used to define the position of the robot and external axes.

---

**Description**

Position data is used to define the position in the positioning instructions to which the robot and external axes are to move.

As the robot is able to achieve the same position in several different ways, the axis configuration is also specified. This defines the axis values if these are in any way ambiguous, for example:

- if the robot is in a forward or backward position,
- if axis 4 points downwards or upwards,
- if axis 6 has a negative or positive revolution.



**The position is defined based on the coordinate system of the work object, including any program displacement. If the position is programmed with some other work object than the one used in the instruction, the robot will not move in the expected way. Make sure that you use the same work object as the one used when programming positioning instructions. Incorrect use can injure someone or damage the robot or other equipment.**

---

**Components****trans***(translation)*Data type: *pos*

The position (x, y and z) of the tool centre point expressed in mm.

The position is specified in relation to the current object coordinate system, including program displacement. If no work object is specified, this is the world coordinate system.

**rot***(rotation)*Data type: *orient*

The orientation of the tool, expressed in the form of a quaternion (q1, q2, q3 and q4).

The orientation is specified in relation to the current object coordinate system, including program displacement. If no work object is specified, this is the world coordinate system.

**robconf***(robot configuration)*Data type: *confdata*

The axis configuration of the robot (cf1, cf4, cf6 and cfx). This is defined in the form of the current quarter revolution of axis 1, axis 4 and axis 6. The first



positive quarter revolution 0 to 90 ° is defined as 0. The component *cfx* is only used for the robot model IRB5400.

For more information, see data type *confdata*.

**extax** (external axes) Data type: *extjoint*

The position of the external axes.

The position is defined as follows for each individual axis (*eax\_a*, *eax\_b* ... *eax\_f*):

- For rotating axes, the position is defined as the rotation in degrees from the calibration position.
- For linear axes, the position is defined as the distance in mm from the calibration position.

External axes *eax\_a* ... are logical axes. How the logical axis number and the physical axis number are related to each other is defined in the system parameters.

The value 9E9 is defined for axes which are not connected. If the axes defined in the position data differ from the axes that are actually connected on program execution, the following applies:

- If the position is not defined in the position data (value 9E9), the value will be ignored, if the axis is connected and not activated. But if the axis is activated, it will result in an error.
- If the position is defined in the position data although the axis is not connected, the value is ignored.

## Examples

```
CONST robtarget p15 := [ [600, 500, 225.3], [1, 0, 0, 0], [1, 1, 0, 0],
[ 11, 12.3, 9E9, 9E9, 9E9, 9E9] ];
```

A position *p15* is defined as follows:

- The position of the robot:  $x = 600$ ,  $y = 500$  and  $z = 225.3$  mm in the object coordinate system.
- The orientation of the tool in the same direction as the object coordinate system.
- The axis configuration of the robot: axes 1 and 4 in position 90-180°, axis 6 in position 0-90°.
- The position of the external logical axes, a and b, expressed in degrees or mm (depending on the type of axis). Axes c to f are undefined.

```
VAR robtarget p20;  
...  
p20 := CRobT();  
p20 := Offs(p20,10,0,0);
```

The position *p20* is set to the same position as the current position of the robot by calling the function *CRobT*. The position is then moved *10* mm in the x-direction.

---

## Limitations

When using the configurable edit function *Absolute Limit Modpos*, the number of characters in the name of the data of the type *robtarget*, is limited to 14 (in other cases 16).

---

## Structure

```
< dataobject of robtarget >  
  < trans of pos >  
    < x of num >  
    < y of num >  
    < z of num >  
  < rot of orient >  
    < q1 of num >  
    < q2 of num >  
    < q3 of num >  
    < q4 of num >  
  < robconf of confdata >  
    < cf1 of num >  
    < cf4 of num >  
    < cf6 of num >  
    < cfx of num >  
  < extax of extjoint >  
    < eax_a of num >  
    < eax_b of num >  
    < eax_c of num >  
    < eax_d of num >  
    < eax_e of num >  
    < eax_f of num >
```

---

**Related information**

	<u>Described in:</u>
Positioning instructions	RAPID Summary - <i>Motion</i>
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
Handling configuration data	Motion and I/O Principles - <i>Robot Configuration</i>
Configuration of external axes	User's Guide - <i>System Parameters</i>
What is a quaternion?	Data Types - <i>Orient</i>

---

---

**shapedata****World zone shape data**

*shapedata* is used to describe the geometry of a world zone.

---

**Description**

World zones can be defined in 3 different geometrical shapes:

- a straight box, with all sides parallel to the world coordinate system and defined by a *WZBoxDef* instruction
- a sphere, defined by a *WZSphDef* instruction
- a cylinder, parallel to the z axis of the world coordinate system and defined by a *WZCylDef* instruction

The geometry of a world zone is defined by one of the previous instructions and the action of a world zone is defined by the instruction *WZLimSup* or *WZDOSet*.

---

**Example**

```
VAR wzstationary pole;  
VAR wzstationary conveyor;  
...  
PROC ...  
  VAR shapedata volume;  
  ...  
  WZBoxDef \Inside, volume, p_corner1, p_corner2;  
  WZLimSup \Stat, conveyor, volume;  
  WZCylDef \Inside, volume, p_center, 200, 2500;  
  WZLimSup \Stat, pole, volume;  
ENDPROC
```

A *conveyor* is defined as a box and the supervision for this area is activated. A *pole* is defined as a cylinder and the supervision of this zone is also activated. If the robot reaches one of these areas, the motion is stopped.

---

**Characteristics**

*shapedata* is a non-value data type.

---

**Related information**

Define box-shaped world zone

Define sphere-shaped world zone

Define cylinder-shaped world zone

Activate world zone limit supervision

Activate world zone digital output set

Described in:

Instructions - *WZBoxDef*

Instructions - *WZSphDef*

Instructions - *WZCylDef*

Instructions - *WZLimSup*

Instructions - *WZDOSet*

---



---

## signalxx                      Digital and analog signals

Data types within *signalxx* are used for digital and analog input and output signals.

The names of the signals are defined in the system parameters and are consequently not to be defined in the program.

---

### Description

<u>Data type</u>	<u>Used for</u>
<b>signalai</b>	analog input signals
<b>signalao</b>	analog output signals
<b>signaldi</b>	digital input signals
<b>signaldo</b>	digital output signals
<b>signalgi</b>	groups of digital input signals
<b>signalgo</b>	groups of digital output signals

Variables of the type *signalxo* only contain a reference to the signal. The value is set using an instruction, e.g. *DOutput*.

Variables of the type *signalxi* contain a reference to a signal as well as a method to retrieve the value. The value of the input signal is returned when a function is called, e.g. *DInput*, or when the variable is used in a value context, e.g. *IF signal\_y=1 THEN*.

---

### Limitations

Data of the data type *signalxx* may not be defined in the program. However, if this is in fact done, an error message will be displayed as soon as an instruction or function that refers to this signal is executed. The data type can, on the other hand, be used as a parameter when declaring a routine.

---

### Predefined data

The signals defined in the system parameters can always be accessed from the program by using the predefined signal variables (installed data). It should however be noted that if other data with the same name is defined, these signals cannot be used.

---

### Characteristics

*Signalxo* is a *non-value* data type. Thus, data of this type does not permit value-oriented operations.

*Signalxi* is a *semi-value* data type.

---

**Related information**

	<u>Described in:</u>
Summary input/output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	User's Guide - <i>System Parameters</i>
Characteristics of non-value data types	Basic Characteristics - <i>Data Types</i>

---

---

**speeddata****Speed data**

*Speeddata* is used to specify the velocity at which both the robot and the external axes move.

---

**Description**

Speed data defines the velocity:

- at which the tool centre point moves,
- of the reorientation of the tool,
- at which linear or rotating external axes move.

When several different types of movement are combined, one of the velocities often limits all movements. The velocity of the other movements will be reduced in such a way that all movements will finish executing at the same time.

The velocity is also restricted by the performance of the robot. This differs, depending on the type of robot and the path of movement.

---

**Components**

**v\_tcp**                      (*velocity tcp*)                      Data type: *num*

The velocity of the tool centre point (TCP) in mm/s.

If a stationary tool or coordinated external axes are used, the velocity is specified relative to the work object.

**v\_ori**                      (*velocity orientation*)                      Data type: *num*

The velocity of reorientation about the TCP expressed in degrees/s.

If a stationary tool or coordinated external axes are used, the velocity is specified relative to the work object.

**v\_leax**                      (*velocity linear external axes*)                      Data type: *num*

The velocity of linear external axes in mm/s.

**v\_reax**                      (*velocity rotational external axes*)                      Data type: *num*

The velocity of rotating external axes in degrees/s.



---

**Example**

```
VAR speeddata vmedium := [ 1000, 30, 200, 15 ];
```

The speed data *vmedium* is defined with the following velocities:

- 1000 mm/s for the TCP.
- 30 degrees/s for reorientation of the tool.
- 200 mm/s for linear external axes.
- 15 degrees/s for rotating external axes.

```
vmedium.v_tcp := 900;
```

The velocity of the TCP is changed to 900 mm/s.

---

**Predefined data**

A number of speed data are already defined in the system module *BASE*.

<u>Name</u>	<u>TCP speed</u>	<u>Orientation</u>	<u>Linear ext. axis</u>	<u>Rotating ext. axis</u>
<b>v5</b>	5 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v10</b>	10 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v20</b>	20 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v30</b>	30 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v40</b>	40 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v50</b>	50 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v60</b>	60 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v80</b>	80 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v100</b>	100 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v150</b>	150 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v200</b>	200 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v300</b>	300 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v400</b>	400 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v500</b>	500 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v600</b>	600 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v800</b>	800 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v1000</b>	1000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v1500</b>	1500 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v2000</b>	2000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v2500</b>	2500 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v3000</b>	3000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v4000</b>	4000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v5000</b>	5000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>vmax</b>	5000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v6000</b>	6000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s
<b>v7000</b>	7000 mm/s	500 <sup>o</sup> /s	5000 mm/s	1000 <sup>o</sup> /s

**Structure**

< dataobject of *speeddata* >  
  < *v\_tcp* of *num* >  
  < *v\_ori* of *num* >  
  < *v\_leax* of *num* >  
  < *v\_reax* of *num* >

---

**Related information**

Positioning instructions  
Motion/Speed in general  
  
Defining maximum velocity  
Configuration of external axes  
Motion performance

**Described in:**

RAPID Summary - *Motion*  
Motion and I/O Principles - *Positioning during Program Execution*  
Instructions - *VelSet*  
User's Guide - *System Parameters*  
Product Specification



---

---

**string****Strings**

*String* is used for character strings.

---

**Description**

A character string consists of a number of characters (a maximum of 80) enclosed by quotation marks ("),

e.g.                    "This is a character string".

If the quotation marks are to be included in the string, they must be written twice,

e.g.                    "This string contains a ""character".

---

**Example**

```
VAR string text;  
.  
text := "start welding pipe 1";  
TPWrite text;
```

The text *start welding pipe 1* is written on the teach pendant.

---

**Limitations**

A string may have from 0 to 80 characters; inclusive of extra quotation marks.

A string may contain any of the characters specified by ISO 8859-1 as well as control characters (non-ISO 8859-1 characters with a numeric code between 0-255).

---

## Predefined data

A number of predefined string constants (installed data) can be used together with string functions.

<u>Name</u>	<u>Character set</u>
STR_DIGIT	<digit> ::= 0   1   2   3   4   5   6   7   8   9
STR_UPPER	<upper case letter> ::= 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   Á   Á   Á   Á   Ä   Å   Æ   Ç   È   É   Ê   Ë   Ì   Í   Î   Î   1)   Ñ   Ò   Ó   Ô   Õ   Ö   Ø   Ù   Ú   Û   Ü   2)   3)
STR_LOWER	<lower case letter> ::= 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   à   á   â   ã   ä   å   æ   ç   è   é   ê   ë   ì   í   î   î   1)   ñ   ò   ó   ô   õ   ö   ø   ù   ú   û   ü   2)   3)   ß   ÿ
STR_WHITE	<blank character> ::=

- 1) Icelandic letter eth.
- 2) Letter Y with acute accent.
- 3) Icelandic letter thorn.

---

## Related information

Operations using strings  
String values

### Described in:

Basic Characteristics - *Expressions*  
Basic Characteristics - *Basic Elements*

**symnum****Symbolic number**

*Symnum* is used to represent an integer with a symbolic constant.

**Description**

A *symnum* constant is intended to be used when checking the return value from the functions *OpMode* and *RunMode*. See example below.

**Example**

```

IF RunMode() = RUN_CONT_CYCLE THEN
.
.
ELSE
.
.
ENDIF

```

**Predefined data**

The following symbolic constants of the data type *symnum* are predefined and can be used when checking return values from the functions *OpMode* and *RunMode*.

Value	Symbolic constant	Comment
0	RUN_UNDEF	Undefined running mode
1	RUN_CONT_CYCLE	Continuous or cycle running mode
2	RUN_INSTR_FWD	Instruction forward running mode
3	RUN_INSTR_BWD	Instruction backward running mode
4	RUN_SIM	Simulated running mode

Value	Symbolic constant	Comment
0	OP_UNDEF	Undefined operating mode
1	OP_AUTO	Automatic operating mode
2	OP_MAN_PROG	Manual operating mode max. 250 mm/s
3	OP_MAN_TEST	Manual operating mode full speed, 100%

---

**Characteristics**

*Symnum* is an alias data type for *num* and consequently inherits its characteristics.

---

**Related information**

Data types in general, alias data types

Described in:

Basic Characteristics - *Data Types*

---

---

**tooldata****Tool data**

*Tooldata* is used to describe the characteristics of a tool, e.g. a welding gun or a gripper.

If the tool is fixed in space (a stationary tool), common tool data is defined for this tool and the gripper holding the work object.

---

**Description**

Tool data affects robot movements in the following ways:

- The tool centre point (TCP) refers to a point that will satisfy the specified path and velocity performance. If the tool is reorientated or if coordinated external axes are used, only this point will follow the desired path at the programmed velocity.
- If a stationary tool is used, the programmed speed and path will relate to the work object.
- Programmed positions refer to the position of the current TCP and the orientation in relation to the tool coordinate system. This means that if, for example, a tool is replaced because it is damaged, the old program can still be used if the tool coordinate system is redefined.

Tool data is also used when jogging the robot to:

- Define the TCP that is not to move when the tool is reorientated.
- Define the tool coordinate system in order to facilitate moving in or rotating about the tool directions.



**It is important to always define the actual tool load and when used, the payload of the robot too. Incorrect definitions of load data can result in overloading of the robot mechanical structure.**

When incorrect tool load data is specified, it can often lead to the following consequences:

- If the value in the specified load is greater than that of the value of the true load;
  - > The robot will not be used to its maximum capacity
  - > Impaired path accuracy including a risk of overshooting
- If the value in the specified load is less than the value of the true load;
  - > Impaired path accuracy including a risk of overshooting
  - > Risk of overloading the mechanical structure



**Components**

**robhold** (robot hold) Data type: *bool*

Defines whether or not the robot is holding the tool:

- *TRUE* -> The robot is holding the tool.
- *FALSE* -> The robot is not holding the tool, i.e. a stationary tool.

**tframe** (tool frame) Data type: *pose*

The tool coordinate system, i.e.:

- The position of the TCP (x, y and z) in mm, expressed in the wrist coordinate system (See figure 1).
- The orientation of the tool coordinate system, expressed in the wrist coordinate system as a quaternion (q1, q2, q3 and q4) (See figure 1).

If a stationary tool is used, the definition is defined in relation to the world coordinate system.

If the direction of the tool is not specified, the tool coordinate system and the wrist coordinate system will coincide.

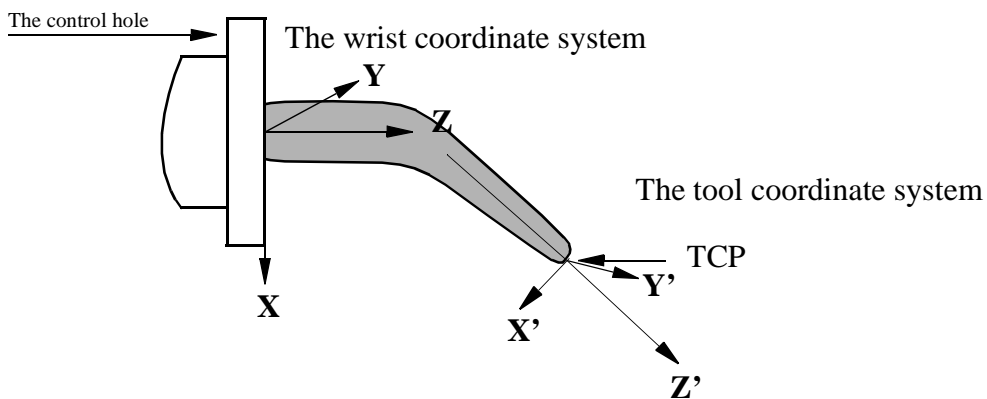


Figure 1 Definition of the tool coordinate system.

**tload** (tool load) Data type: *loaddata*

The load of the tool, i.e.:

- The weight of the tool in kg.
- The centre of gravity of the tool (x, y and z) in mm, expressed in the wrist coordinate system
- The orientation of the tool load coordinate system defined by the inertial axes of the tool, expressed in the wrist coordinate system. **This should always be set to 1, 0, 0, 0.**
- The moments of inertia of the tool relative to its centre of mass about the axes parallel (restriction) with the axes of the wrist coordinate system in  $\text{kgm}^2$ . If all inertial components are defined as being  $0 \text{ kgm}^2$ , the tool is handled as a point mass.

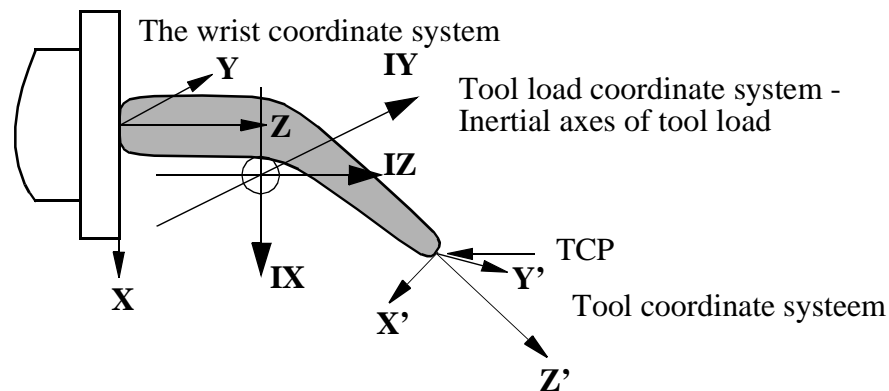


Figure 2 Tool load parameter definitions

For more information (such as coordinate system for stationary tool or restrictions), see the data type *loaddata*.

If a stationary tool is used, the load of the gripper holding the work object must be defined.

Note that only the load of the tool is to be specified. The payload handled by a gripper is connected and disconnected by means of the instruction *GripLoad*.

## Examples

```
PERS tooldata gripper := [ TRUE, [[97.4, 0, 223.1], [0.924, 0, 0.383 ,0]],
    [5, [23, 0, 75], [1, 0, 0, 0], 0, 0, 0];
```

The tool in Figure 1 is described using the following values:

- The robot is holding the tool.
- The TCP is located at a point 223.1 mm straight out from axis 6 and 97.4 mm along the X-axis of the wrist coordinate system.
- The X and Z directions of the tool are rotated 45° in relation to the wrist coordinate system.
- The tool weighs 5 kg.
- The centre of gravity is located at a point 75 mm straight out from axis 6 and 23 mm along the X-axis of the wrist coordinate system.
- The load can be considered a point mass, i.e. without any moment of inertia.

```
gripper.tframe.trans.z := 225.2;
```

The TCP of the tool, *gripper*, is adjusted to 225.2 in the z-direction.

## Limitations

The tool data should be defined as a persistent variable (*PERS*) and should not be defined within a routine. The current values are then saved when the program is stored on diskette and are retrieved on loading.

Arguments of the type tool data in any motion instruction should only be an entire persistent (not array element or record component).

## Predefined data

The tool *tool0* defines the wrist coordinate system, with the origin being the centre of the mounting flange. *Tool0* can always be accessed from the program, but can never be changed (it is stored in system module *BASE*).

```
PERS tooldata tool0 := [ TRUE, [ [0, 0, 0], [1, 0, 0 ,0] ],
    [0.001, [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0] ];
```

---

**Structure**

```

< dataobject of tooldata >
  < robhold of bool >
  < tframe of pose >
    < trans of pos >
      < x of num >
      < y of num >
      < z of num >
    < rot of orient >
      < q1 of num >
      < q2 of num >
      < q3 of num >
      < q4 of num >
  < tload of loaddata >
    < mass of num >
    < cog of pos >
      < x of num >
      < y of num >
      < z of num >
    < aom of orient >
      < q1 of num >
      < q2 of num >
      < q3 of num >
      < q4 of num >
    < ix of num >
    < iy of num >
    < iz of num >

```

---

**Related information**

Positioning instructions	<u>Described in:</u>
Coordinate systems	RAPID Summary - <i>Motion</i>
Definition of payload	Motion and I/O Principles - <i>Coordinate Systems</i>
Definition of load	Instructions - <i>Griplload</i>
	Data types - <i>Load data</i>



---



---

## tpnum Teach Pendant Window number

*tpnum* is used to represent the Teach Pendant Window number with a symbolic constant.

---

### Description

A *tpnum* constant is intended to be used in instruction *TPShow*. See example below.

---

### Example

```
TPShow TP_PROGRAM;
```

The *Production Window* will be active if the system is in *AUTO* mode and the *Program Window* will be active if the system is in *MAN* mode, after execution of this instruction.

---

### Predefined data

The following symbolic constants of the data type *tpnum* are predefined and can be used in instruction *TPShow*:

Value	Symbolic constant	Comment
1	TP_PROGRAM	AUTO: Production Window MAN: Program Window
2	TP_LATEST	Latest used Teach Pendant Window

---

### Characteristics

*tpnum* is an alias data type for *num* and consequently inherits its characteristics.

---

### Related information

	<u>Described in:</u>
Data types in general, alias data types	Basic Characteristics - <i>Data Types</i>
Communicating using the teach pendant	RAPID Summary - <i>Communication</i>
Switch window on the teach pendant	Instructions - <i>TPShow</i>



---



---

## triggdata                      Positioning events - trigg

*Triggdata* is used to store data about a positioning event during a robot movement.

A positioning event can take the form of setting an output signal or running an interrupt routine at a specific position along the movement path of the robot.

---

### Description

To define the conditions for the respective measures at a positioning event, variables of the type *triggdata* are used. The data contents of the variable are formed in the program using one of the instructions *TriggIO* or *TriggInt*, and are used by one of the instructions *TriggL*, *TriggC* or *TriggJ*.

---

### Example

```
VAR triggdata gunoff;

TriggIO gunoff, 5 \DOP:=gun, off;

TriggL p1, v500, gunoff, fine, gun1;
```

The digital output signal *gun* is set to the value *off* when the TCP is at a position 5 mm before the point *p1*.

---

### Characteristics

*Triggdata* is a non-value data type.

---

### Related information

Definition of triggs	<u>Described in:</u>
Use of triggs	Instructions - <i>TriggIO</i> , <i>TriggInt</i>
Characteristics of non-value data types	Instructions - <i>TriggL</i> , <i>TriggC</i> , <i>TriggJ</i>
	Basic Characteristics- <i>Data Types</i>





---

---

**tunetype****Servo tune type**

*Tunetype* is used to represent an integer with a symbolic constant.

---

**Description**

A *tunetype* constant is intended to be used as an argument to the instruction *TuneServo*. See example below.

---

**Example**

```
TuneServo MHA160R1, 1, 110 \Type:= TUNE_KP;
```

---

**Predefined data**

The following symbolic constants of the data type *tunetype* are predefined and can be used as argument for the instruction *TuneServo*.

Value	Symbolic constant	Comment
0	TUNE_DF	Reduces overshoots
1	TUNE_KP	Affects position control gain
2	TUNE_KV	Affects speed control gain
3	TUNE_TI	Affects speed control integration time

The following symbolic constants of the data type *tunetype* are predefined and can be used as arguments for the instruction *SpeedPrioAct* (only available on request).

Value	Symbolic constant	Comment
1	SP_MODE1	Speed priority interpolation mode 1
2	SP_MODE2	Speed priority interpolation mode 2

---

**Characteristics**

*Tunetype* is an alias data type for *num* and consequently inherits its characteristics.

---

**Related information**

Data types in general, alias data types

Described in:

Basic Characteristics - *Data Types*

---

---

**wobjdata****Work object data**

*Wobjdata* is used to describe the work object that the robot welds, processes, moves within, etc.

---

**Description**

If work objects are defined in a positioning instruction, the position will be based on the coordinates of the work object. The advantages of this are as follows:

- If position data is entered manually, such as in off-line programming, the values can often be taken from a drawing.
- Programs can be reused quickly following changes in the robot installation. If, for example, the fixture is moved, only the user coordinate system has to be redefined.
- Variations in how the work object is attached can be compensated for. For this, however, some sort of sensor will be required to position the work object.

If a stationary tool or coordinated external axes are used the work object must be defined, since the path and velocity would then be related to the work object instead of the TCP.

Work object data can also be used for jogging:

- The robot can be jogged in the directions of the work object.
- The current position displayed is based on the coordinate system of the work object.

---

**Components****robhold***(robot hold)*Data type: *bool*

Defines whether or not the robot is holding the work object:

- *TRUE* -> The robot is holding the work object, i.e. using a stationary tool.
- *FALSE* -> The robot is not holding the work object, i.e. the robot is holding the tool.

**ufprog***(user frame programmed)*Data type: *bool*

Defines whether or not a fixed user coordinate system is used:

- *TRUE* -> Fixed user coordinate system.
- *FALSE* -> Movable user coordinate system, i.e. coordinated external axes are used.

**ufmec** (user frame mechanical unit) Data type: *string*

The mechanical unit with which the robot movements are coordinated. Only specified in the case of movable user coordinate systems (*ufprog* is *FALSE*).

Specified with the name that is defined in the system parameters, e.g. "orbit\_a".

**uframe** (user frame) Data type: *pose*

The user coordinate system, i.e. the position of the current work surface or fixture (see Figure 1):

- The position of the origin of the coordinate system (x, y and z) in mm.
- The rotation of the coordinate system, expressed as a quaternion (q1, q2, q3, q4).

If the robot is holding the tool, the user coordinate system is defined in the world coordinate system (in the wrist coordinate system if a stationary tool is used).

When coordinated external axes are used (*ufprog* is *FALSE*), the user coordinate system is defined in the system parameters.

**oframe** (object frame) Data type: *pose*

The object coordinate system, i.e. the position of the current work object (see Figure 1):

- The position of the origin of the coordinate system (x, y and z) in mm.
- The rotation of the coordinate system, expressed as a quaternion (q1, q2, q3, q4).

The object coordinate system is defined in the user coordinate system.

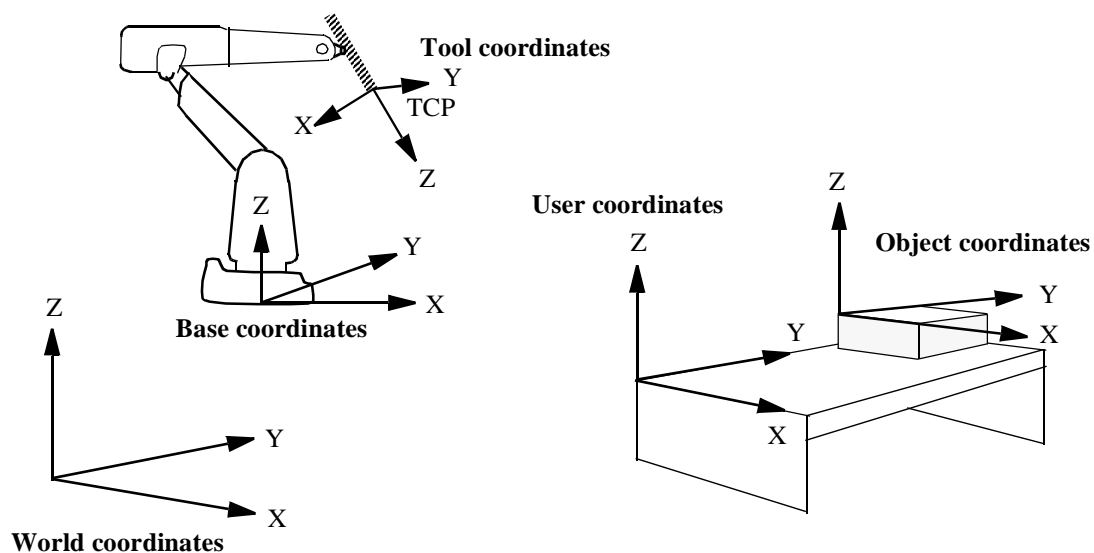


Figure 1 The various coordinate systems of the robot (when the robot is holding the tool).

---

## Example

```
PERS wobjdata wobj2 :=[ FALSE, TRUE, "", [ [300, 600, 200], [1, 0, 0 ,0] ],
  [ [0, 200, 30], [1, 0, 0 ,0] ] ];
```

The work object in Figure 1 is described using the following values:

- The robot is not holding the work object.
- The fixed user coordinate system is used.
- The user coordinate system is not rotated and the coordinates of its origin are  $x = 300$ ,  $y = 600$  and  $z = 200$  mm in the world coordinate system.
- The object coordinate system is not rotated and the coordinates of its origin are  $x = 0$ ,  $y = 200$  and  $z = 30$  mm in the user coordinate system.

```
wobj2.oframe.trans.z := 38.3;
```

- The position of the work object *wobj2* is adjusted to 38.3 mm in the z-direction.

---

## Limitations

The work object data should be defined as a persistent variable (*PERS*) and should not be defined within a routine. The current values are then saved when the program is stored on diskette and are retrieved on loading.

Arguments of the type work object data in any motion instruction should only be an entire persistent (not array element or record component).

---

## Predefined data

The work object data *wobj0* is defined in such a way that the object coordinate system coincides with the world coordinate system. The robot does not hold the work object.

*Wobj0* can always be accessed from the program, but can never be changed (it is stored in system module *BASE*).

```
PERS wobjdata wobj0 := [ FALSE, TRUE, "", [ [0, 0, 0], [1, 0, 0 ,0] ],
  [ [0, 0, 0], [1, 0, 0 ,0] ] ];
```

---

**Structure**

```

< dataobject of wobjdata >
  < robhold of bool >
  < ufprog of bool >
  < ufmec of string >
  < uframe of pose >
    < trans of pos >
      < x of num >
      < y of num >
      < z of num >
    < rot of orient >
      < q1 of num >
      < q2 of num >
      < q3 of num >
      < q4 of num >
  < oframe of pose >
    < trans of pos >
      < x of num >
      < y of num >
      < z of num >
    < rot of orient >
      < q1 of num >
      < q2 of num >
      < q3 of num >
      < q4 of num >

```

---

**Related information**

	<u>Described in:</u>
Positioning instructions	RAPID Summary - <i>Motion</i>
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
Coordinated external axes	Motion and I/O Principles - <i>Coordinate Systems</i>
Calibration of coordinated external axes	User's Guide - <i>System Parameters</i>

---

---

## wzstationary      Stationary world zone data

*wzstationary* (*world zone stationary*) is used to identify a stationary world zone and can only be used in an event routine connected to the event POWER ON.

A world zone is supervised during robot movements both during program execution and jogging. If the robot's TCP reaches this world zone, the movement is stopped or a digital output signal is set or reset.

---

### Description

A *wzstationary* world zone is defined and activated by a *WZLimSup* or a *WZDOSet* instruction.

*WZLimSup* or *WZDOSet* gives the variable or persistent variable for *wzstationary* a numeric value that identifies the world zone.

A stationary world zone is always active and is only erased by a warm start (switch power off then on, or change system parameters). It is not possible to deactivate, activate or erase a stationary world zone via RAPID instructions.

Stationary world zones should be active from power on and should be defined in a POWER ON event routine or a semistatic task.

---

### Example

```
VAR wzstationary conveyor;  
...  
PROC ...  
  VAR shapedata volume;  
  ...  
  WZBoxDef \Inside, volume, p_corner1, p_corner2;  
  WZLimSup \Stat, conveyor, volume;  
ENDPROC
```

A *conveyor* is defined as a straight box (the volume below the belt). If the robot reaches this volume, the movement is stopped.

---

### Limitations

A *wzstationary* data can only be defined as a global (not local within module or routine) variable (VAR) or as a persistent data (PERS).

Arguments of the type *wzstationary* should only be entire data (not array element or record component).



Init value for data of type *wzstationary* is not used by the system. When using a persistent variable in a multitasking system, set the init value to 0, e.g. PERS *wzstationary* share\_workarea := [0];

---

**Example**

For a complete example see instruction *WZLimSup*.

---

**Characteristics**

*wzstationary* is an alias data type of *wztemporary* and inherits its characteristics.

---

**Related information**

	<u>Described in:</u>
Temporary world zone	Data Types - <i>wztemporary</i>
Activate world zone limit supervision	Instructions - <i>WZLimSup</i>
Activate world zone digital output set	Instructions - <i>WZDOSet</i>

---



---

## wztemporary      Temporary world zone data

*wztemporary* (*world zone temporary*) is used to identify a temporary world zone and can be used anywhere in the RAPID program for the MAIN task.

A world zone is supervised during robot movements both during program execution and jogging. If the robot's TCP reaches this world zone, the movement is stopped or a digital output signal is set or reset.

---

### Description

A *wztemporary* world zone is defined and activated by a *WZLimSup* or a *WZDOSet* instruction.

*WZLimSup* or *WZDOSet* gives the variable or persistent variable for *wztemporary* a numeric value, that identifies the world zone.

Once defined and activated, a temporary world zone can be deactivated by *WZDisable*, activated again by *WZEnable* and erased by *WZFree*.

All temporary world zones in the system are automatically erased (erased in the system and all data objects of type *wztemporary* in MAIN task are set to 0):

- when a new program is loaded in the MAIN task
- when starting program execution from the beginning in the MAIN task

---

### Example

```
VAR wztemporary roll;
...
PROC ...
  VAR shapedata volume;
  ...
  WZCylDef \Inside, volume, p_center, 400, 1000;
  WZLimSup \Temp, roll, volume;
ENDPROC
```

A *roll* (just being brought into the work area by the application) is defined as a cylinder. If the robot reaches this volume, the movement is stopped.

---

### Limitations

A *wztemporary* data can only be defined as global (not local within module or routine) variable (VAR) or as a persistent data (PERS).

Arguments of the type *wztemporary* should only be entire data (not array element or record component).

A temporary world zone (instructions *WZLimSup* or *WZDOSet*) should not be defined in tasks other than MAIN because such a definition is affected by the program execution in the MAIN task.

Init value for data of type *wztemporary* is not used by the system. When using a persistent variable in a multitasking system, set the init value to 0, e.g. PERS *wztemporary* share\_workarea := [0];

### Example

For a complete example see instruction *WZDOSet*.

### Structure

<dataobject of *wztemporary*>  
 <wz of *num*>

### Related information

	<u>Described in:</u>
Stationary world zone	Data Types - <i>wzstationary</i>
Activate world zone limit supervision	Instructions - <i>WZLimSup</i>
Activate world zone digital output set	Instructions - <i>WZDOSet</i>
Deactivate world zone	Instructions - <i>WZDisable</i>
Activate world zone	Instructions - <i>WZEnable</i>
Erase world zone	Instructions - <i>WZFree</i>

**zonedata****Zone data**

*Zonedata* is used to specify how a position is to be terminated, i.e. how close to the programmed position the axes must be before moving towards the next position.

**Description**

A position can be terminated either in the form of a stop point or a fly-by point.

A stop point means that the robot and external axes must reach the specified position (stand still) before program execution continues with the next instruction.

A fly-by point means that the programmed position is never attained. Instead, the direction of motion is changed before the position is reached.

Two different zones (ranges) can be defined for each position:

- The zone for the TCP path.
- The extended zone for reorientation of the tool and for external axes.

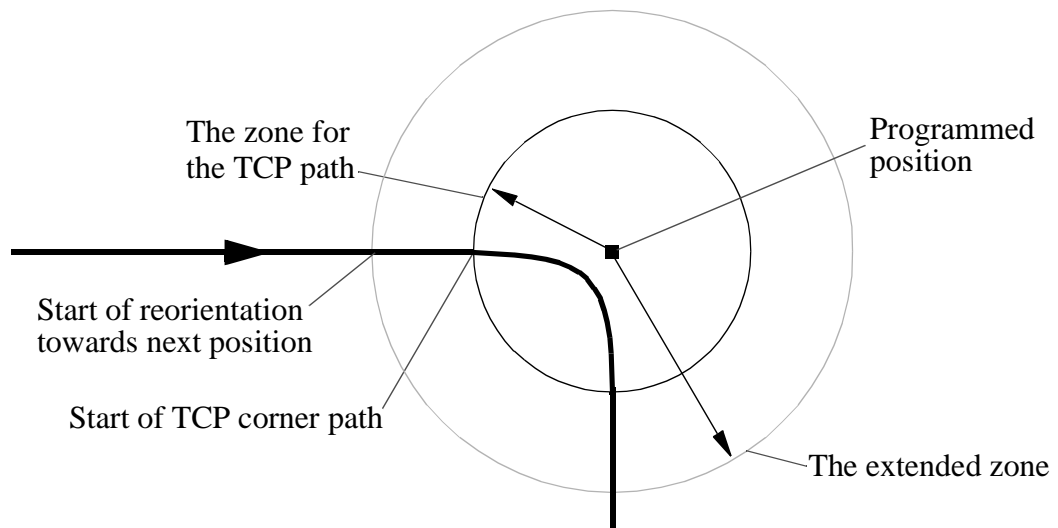


Figure 1 The zones for a fly-by point.

Zones function in the same way during joint movement, but the zone size may differ somewhat from the one programmed.

The zone size cannot be larger than half the distance to the closest position (forwards or backwards). If a larger zone is specified, the robot automatically reduces it.

***The zone for the TCP path***

A corner path (parabola) is generated as soon as the edge of the zone is reached (see Figure 1).

**The zone for reorientation of the tool**

Reorientation starts as soon as the TCP reaches the extended zone. The tool is reoriented in such a way that the orientation is the same leaving the zone as it would have been in the same position if stop points had been programmed. Reorientation will be smoother if the zone size is increased, and there is less of a risk of having to reduce the velocity to carry out the reorientation.

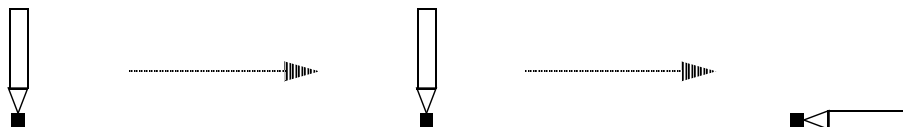


Figure 2a Three positions are programmed, the last with different tool orientation.

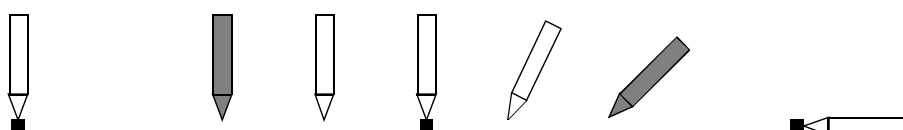


Figure 2b If all positions were stop points, program execution would look like this.

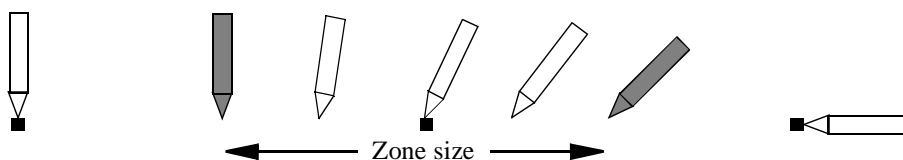


Figure 2c If the middle position was a fly-by point, program execution would look like this

**The zone for external axes**

External axes start to move towards the next position as soon as the TCP reaches the extended zone. In this way, a slow axis can start accelerating at an earlier stage and thus execute more evenly.

**Reduced zone**

With large reorientations of the tool or with large movements of the external axes, the extended zone and even the TCP zone can be reduced by the robot. The zone will be defined as the smallest relative size of the zone based upon the zone components (see next page) and the programmed motion.

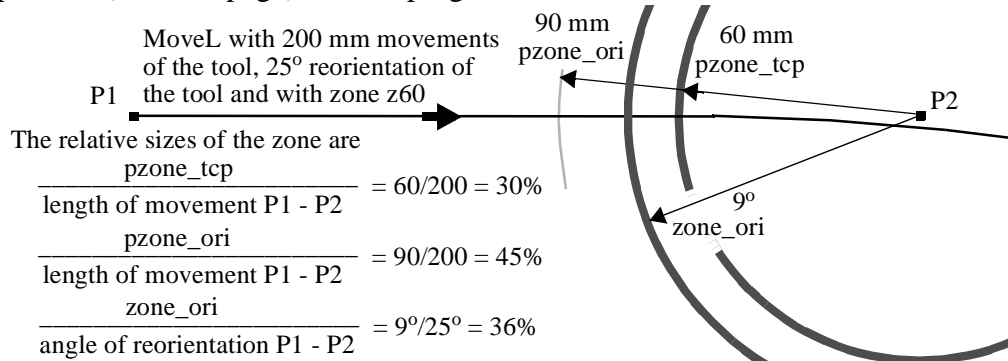


Figure 3 Example of reduced zone to 36% of the motion

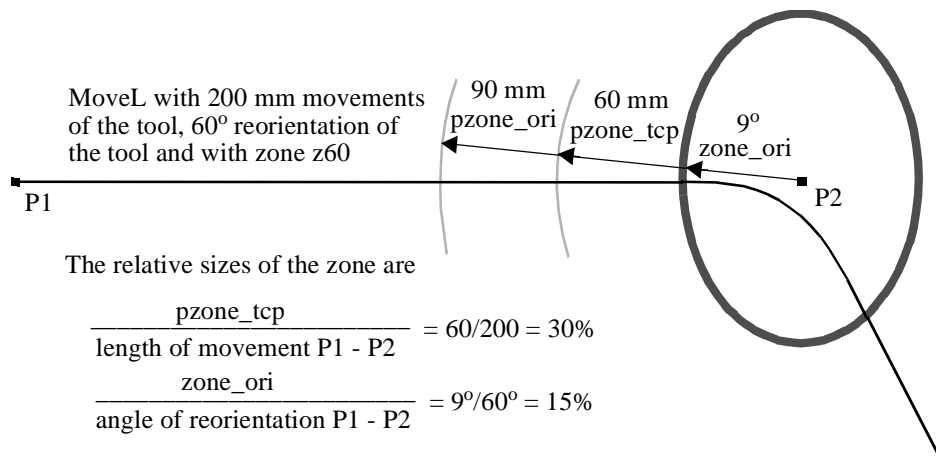


Figure 4 Example of reduced zone to 15% of the motion

## Components

**finep** (fine point) Data type: *bool*

Defines whether the movement is to terminate as a stop point (fine point) or as a fly-by point.

- *TRUE* -> The movement terminates as a stop point.  
The remaining components in the zone data are not used.
- *FALSE* -> The movement terminates as a fly-by point.

**pzone\_tcp** (path zone TCP) Data type: *num*

The size (the radius) of the TCP zone in mm.

**The extended zone will be defined as the smallest relative size of the zone based upon the following components and the programmed motion.**

**pzone\_ori** (path zone orientation) Data type: *num*

The zone size (the radius) for the tool reorientation. The size is defined as the distance of the TCP from the programmed point in mm.

The size must be larger than the corresponding value for *pzone\_tcp*.  
If a lower value is specified, the size is automatically increased to make it the same as *pzone\_tcp*.

**pzone\_eax** (path zone external axes) Data type: *num*

The zone size (the radius) for external axes. The size is defined as the distance of the TCP from the programmed point in mm.

The size must be larger than the corresponding value for *pzone\_tcp*.  
If a lower value is specified, the size is automatically increased to make it the same as *pzone\_tcp*.

<b>zone_ori</b>	( <i>zone orientation</i> )	Data type: <i>num</i>
The zone size for the tool reorientation in degrees. If the robot is holding the work object, this means an angle of rotation for the work object.		
<b>zone_leax</b>	( <i>zone linear external axes</i> )	Data type: <i>num</i>
The zone size for linear external axes in mm.		
<b>zone_reax</b>	( <i>zone rotational external axes</i> )	Data type: <i>num</i>
The zone size for rotating external axes in degrees.		

---

## Examples

```
VAR zonedata path := [ FALSE, 25, 40, 40, 10, 35, 5 ];
```

The zone data *path* is defined by means of the following characteristics:

- The zone size for the TCP path is 25 mm.
- The zone size for the tool reorientation is 40 mm (TCP movement).
- The zone size for external axes is 40 mm (TCP movement).

If the TCP is standing still, or there is a large reorientation, or there is a large external axis movement, with respect to the zone, the following apply instead:

- The zone size for the tool reorientation is 10 degrees.
- The zone size for linear external axes is 35 mm.
- The zone size for rotating external axes is 5 degrees.

```
path.pzone_tcp := 40;
```

The zone size for the TCP path is adjusted to 40 mm.

---

**Predefined data**

A number of zone data are already defined in the system module *BASE*.

**Stop points**Name

**fine**        0 mm

**Fly-by points**

<u>Name</u>	<u>TCP movement</u>			<u>Tool reorientation</u>		
	<u>TCP path</u>	<u>Orientation</u>	<u>Ext. axis</u>	<u>Orientation</u>	<u>Linear axis</u>	<u>Rotating axis</u>
<b>z1</b>	1 mm	1 mm	1 mm	0.1 °	1 mm	0.1 °
<b>z5</b>	5 mm	8 mm	8 mm	0.8 °	8 mm	0.8 °
<b>z10</b>	10 mm	15 mm	15 mm	1.5 °	15 mm	1.5 °
<b>z15</b>	15 mm	23 mm	23 mm	2.3 °	23 mm	2.3 °
<b>z20</b>	20 mm	30 mm	30 mm	3.0 °	30 mm	3.0 °
<b>z30</b>	30 mm	45 mm	45 mm	4.5 °	45 mm	4.5 °
<b>z40</b>	40 mm	60 mm	60 mm	6.0 °	60 mm	6.0 °
<b>z50</b>	50 mm	75 mm	75 mm	7.5 °	75 mm	7.5 °
<b>z60</b>	60 mm	90 mm	90 mm	9.0 °	90 mm	9.0 °
<b>z80</b>	80 mm	120 mm	120 mm	12 °	120 mm	12 °
<b>z100</b>	100 mm	150 mm	150 mm	15 °	150 mm	15 °
<b>z150</b>	150 mm	225 mm	225 mm	23 °	225 mm	23 °
<b>z200</b>	200 mm	300 mm	300 mm	30 °	300 mm	30 °

---

**Structure**

```

< data object of zonedata >
  < finep of bool >
  < pzone_tcp of num >
  < pzone_ori of num >
  < pzone_eax of num >
  < zone_ori of num >
  < zone_leax of num >
  < zone_reax of num >

```



---

**Related information**

Positioning instructions  
Movements/Paths in general  
Configuration of external axes

Described in:

RAPID Summary - *Motion*  
Motion and I/O Principles - *Positioning during Program Execution*  
User's Guide - *System Parameters*

---



---

## System Data

System data is the internal data of the robot that can be accessed and read by the program. It can be used to read the current status, e.g. the current maximum velocity.

The following table contains a list of all system data.

Name	Description	Data Type	Changed by	See also
C_MOTSET	Current motion settings, i.e.: - max. velocity and velocity override - max. acceleration - movement about singular points - monitoring the axis configuration - payload in gripper - path resolution	motsetdata	Instructions - VelSet - AccSet - SingArea - ConfL, ConfJ - GripLoad - PathResol	Data Types - <i>motsetdata</i> Instructions - <i>VelSet</i> Instructions - <i>AccSet</i> Instructions - <i>SingArea</i> Instructions - <i>ConfL, ConfJ</i> Instructions - <i>GripLoad</i> Instructions - <i>PathResol</i>
C_PROGDISP	Current program displacement for robot and external axes.	progdisp	Instructions - PDispSet - PDispOn - PDispOff - EOffsSet - EOffsOn - EOffsOff	Data Types - <i>progdisp</i> Instructions - <i>PDispSet</i> Instructions - <i>PDispOn</i> Instructions - <i>PDispOff</i> Instructions - <i>EOffsSet</i> Instructions - <i>EOffsOn</i> Instructions - <i>EOffsOff</i>
ERRNO	The latest error that occurred	errnum	The robot	Data Types - <i>errnum</i> RAPID Summary - <i>Error Recovery</i>
INTNO	The latest interrupt that occurred	intnum	The robot	Data Types - <i>intnum</i> RAPID Summary - <i>Interrupts</i>

*System Data*

“:=”	Assigns a value
AccSet	Reduces the acceleration
ActUnit	Activates a mechanical unit
Add	Adds a numeric value
Break	Break program execution
CallByVar	Call a procedure by a variable
Clear	Clears the value
ClkReset	Resets a clock used for timing
ClkStart	Starts a clock used for timing
ClkStop	Stops a clock used for timing
Close	Closes a file or serial channel
comment	Comment
ConfJ	Controls the configuration during joint movement
ConfL	Monitors the configuration during linear movement
CONNECT	Connects an interrupt to a trap routine
CorrClear	Removes all correction generators
CorrCon	Connects to a correction generator
CorrDiscon	Disconnects from a correction generator
CorrWrite	Writes to a correction generator
DeactUnit	Deactivates a mechanical unit
Decr	Decrements by 1
EOffsOff	Deactivates an offset for external axes
EOffsOn	Activates an offset for external axes
EOffsSet	Activates an offset for external axes using a value
ErrWrite	Write an Error Message
EXIT	Terminates program execution
ExitCycle	Break current cycle and start next
FOR	Repeats a given number of times
GOTO	Goes to a new instruction
GripLoad	Defines the payload of the robot
IDelete	Cancels an interrupt
IDisable	Disables interrupts
IEnable	Enables interrupts
Compact IF	If a condition is met, then... (one instruction)
IF	If a condition is met, then ...; otherwise ...

## ***Instructions***

Incr	Increments by 1
IndAMove	Independent Absolute position Movement
IndCMove	Independent Continuous Movement
IndDMove	Independent Delta position Movement
IndReset	Independent Reset
IndRMove	Independent Relative position Movement
InvertDO	Inverts the value of a digital output signal
IODisable	Disable I/O unit
IOEnable	Enable I/O unit
ISignalDI	Orders interrupts from a digital input signal
ISignalDO	Interrupts from a digital output signal
ISleep	Deactivates an interrupt
ITimer	Orders a timed interrupt
IVarValue	Orders a variable value interrupt
IWatch	Activates an interrupt
label	Line name
Load	Load a program module during execution
MoveAbsJ	Moves the robot to an absolute joint position
MoveC	Moves the robot circularly
MoveJ	Moves the robot by joint movement
MoveL	Moves the robot linearly
Open	Opens a file or serial channel
PathResol	Override path resolution
PDispOff	Deactivates program displacement
PDispOn	Activates program displacement
PDispSet	Activates program displacement using a value
ProcCall	Calls a new procedure
PulseDO	Generates a pulse on a digital output signal
RAISE	Calls an error handler
Reset	Resets a digital output signal
RestoPath	Restores the path after an interrupt
RETRY	Restarts following an error
RETURN	Finishes execution of a routine
Rewind	Rewind file position
SearchC	Searches circularly using the robot
SearchL	Searches linearly using the robot

Set	Sets a digital output signal
SetAO	Changes the value of an analog output signal
SetDO	Changes the value of a digital output signal
SetGO	Changes the value of a group of digital output signals
SingArea	Defines interpolation around singular points
SoftAct	Activating the soft servo
SoftDeact	Deactivating the soft servo
StartMove	Restarts robot motion
Stop	Stops program execution
StopMove	Stops robot motion
StorePath	Stores the path when an interrupt occurs
TEST	Depending on the value of an expression ...
TPerase	Erases text printed on the teach pendant
TPreadFK	Reads function keys
TPreadNum	Reads a number from the teach pendant
TPshow	Switch window on the teach pendant
TPwrite	Writes on the teach pendant
TriggC	Circular robot movement with events
TriggEquip	Defines a fixed position-time I/O event
TriggInt	Defines a position related interrupt
TriggIO	Defines a fixed position I/O event
TriggJ	Axis-wise robot movements with events
TriggL	Linear robot movements with events
TRYNEXT	Jumps over an instruction which has caused an error
TuneReset	Resetting servo tuning
TuneServo	Tuning servos
UnLoad	UnLoad a program module during execution
VelSet	Changes the programmed velocity
WaitDI	Waits until a digital input signal is set
WaitDO	Waits until a digital output signal is set
WaitTime	Waits a given amount of time
WaitUntil	Waits until a condition is met
WHILE	Repeats as long as ...
Write	Writes to a character-based file or serial channel
WriteBin	Writes to a binary serial channel

## ***Instructions***

WriteStrBin	Writes a string to a binary serial channel
WZBoxDef	Define a box-shaped world zone
WZCylDef	Define a cylinder-shaped world zone
WZDisable	Deactivate temporary world zone supervision
WZDOSet	Activate world zone to set digital output
WZEnable	Activate temporary world zone supervision
WZFree	Erase temporary world zone supervision
WZLimSup	Activate world zone limit supervision
WZSphDef	Define a sphere-shaped world zone

## “:=”

**Assigns a value**

The “:=” instruction is used to assign a new value to data. This value can be anything from a constant value to an arithmetic expression, e.g.  $reg1+5*reg3$ .

**Examples**

```
reg1 := 5;
```

*reg1* is assigned the value 5.

```
reg1 := reg2 - reg3;
```

*reg1* is assigned the value that the *reg2-reg3* calculation returns.

```
counter := counter + 1;
```

*counter* is incremented by one.

**Arguments****Data := Value****Data**

Data type: All

The data that is to be assigned a new value.

**Value**

Data type: Same as Data

The desired value.

**Examples**

```
tool1.tframe.trans.x := tool1.tframe.trans.x + 20;
```

The TCP for *tool1* is shifted 20 mm in the X-direction.

```
pallet{5,8} := Abs(value);
```

An element in the *pallet* matrix is assigned a value equal to the absolute value of the *value* variable.



---

## Limitations

The data (whose value is to be changed) must not be

- a constant
- a non-value data type.

The data and value must have similar (the same or alias) data types.

---

## Syntax

(EBNF)

<assignment target> ':=' <expression> ';' ;

<assignment target> ::=

<variable>	
<persistent>	
<parameter>	
<VAR>	

---

## Related information

Expressions

Non-value data types

Assigning an initial value to data

Manually assigning a value to data

Described in:

Basic Characteristics - *Expressions*

Basic Characteristics - *Data Types*

Basic Characteristics - *Data Programming and Testing*

Programming and Testing

---



---

## AccSet Reduces the acceleration

*AccSet* is used when handling fragile loads. It allows slower acceleration and deceleration, which results in smoother robot movements.

---

### Examples

AccSet 50, 100;

The acceleration is limited to 50% of the normal value.

AccSet 100, 50;

The acceleration ramp is limited to 50% of the normal value.

---

### Arguments

#### AccSet Acc Ramp

**Acc**

Data type: *num*

Acceleration and deceleration as a percentage of the normal values. 100% corresponds to maximum acceleration. Maximum value: 100%. Input value < 20% gives 20% of maximum acceleration.

**Ramp**

Data type: *num*

The rate at which acceleration and deceleration increases as a percentage of the normal values (see Figure 1). Jerking can be restricted by reducing this value. 100% corresponds to maximum rate. Maximum value: 100%. Input value < 10% gives 10% of maximum rate.

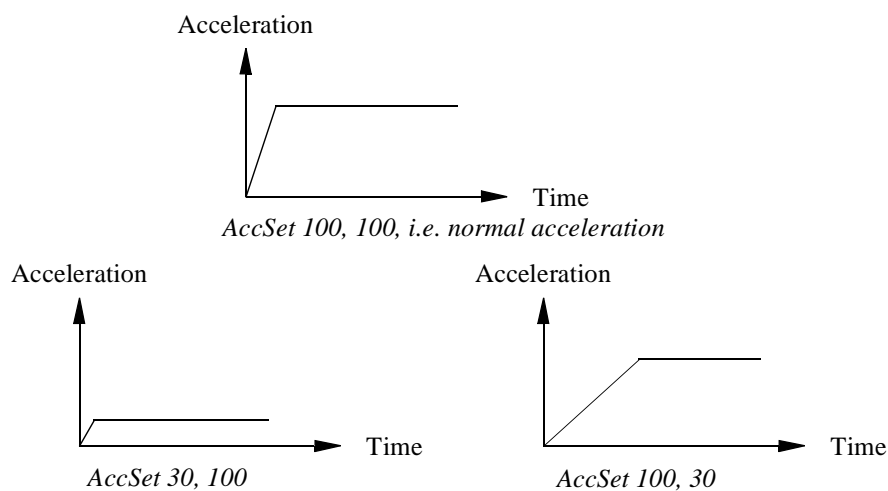


Figure 1 Reducing the acceleration results in smoother movements.

---

## Program execution

The acceleration applies to both the robot and external axes until a new *AccSet* instruction is executed.

The default values (100%) are automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Syntax

AccSet

[ Acc ':=' ] < expression (IN) of *num* > ','  
[ Ramp ':=' ] < expression (IN) of *num* > ','

---

## Related information

Positioning instructions

Described in:

RAPID Summary - *Motion*

**ActUnit****Activates a mechanical unit**

*ActUnit* is used to activate a mechanical unit.

It can be used to determine which unit is to be active when, for example, common drive units are used.

---

**Example**

```
ActUnit orbit_a;
```

Activation of the *orbit\_a* mechanical unit.

---

**Arguments**

**ActUnit** **MecUnit**

**MecUnit**

(*Mechanical Unit*)

Data type: *mecunit*

The name of the mechanical unit that is to be activated.

---

**Program execution**

When the robot and external axes have come to a standstill, the specified mechanical unit is activated. This means that it is controlled and monitored by the robot.

If several mechanical units share a common drive unit, activation of one of these mechanical units will also connect that unit to the common drive unit.

---

**Limitations**

Instruction *ActUnit* cannot be used in

- program sequence StorePath ... RestoPath
- event routine RESTART

The movement instruction previous to this instruction, should be terminated with a stop point in order to make a restart in this instruction possible following a power failure.

---

**Syntax**

ActUnit  
[MecUnit ':='] < variable (**VAR**) of *mecunit*> ';'

---

**Related information**

Deactivating mechanical units

Mechanical units

More examples

Described in:

Instructions - *DeactUnit*

Data Types - *mecunit*

Instructions - *DeactUnit*

---

---

**Add****Adds a numeric value**

*Add* is used to add or subtract a value to or from a numeric variable or persistent.

---

**Examples**

Add reg1, 3;

3 is added to *reg1*, i.e. *reg1:=reg1+3*.

Add reg1, -reg2;

The value of *reg2* is subtracted from *reg1*, i.e. *reg1:=reg1-reg2*.

---

**Arguments****Add Name AddValue****Name**Data type: *num*

The name of the variable or persistent to be changed.

**AddValue**Data type: *num*

The value to be added.

---

**Syntax**

Add

[ Name *':='* ] < var or pers (**INOUT**) of *num* > *','*

[ AddValue *':='* ] < expression (**IN**) of *num* > *','*

---

**Related information**

Incrementing a variable by 1

Decrementing a variable by 1

Changing data using an arbitrary expression, e.g. multiplication

Described in:Instructions - *Incr*Instructions - *Decr*Instructions - *:=*



---

---

## Break

## Break program execution

*Break* is used to make an immediate break in program execution for RAPID program code debugging purposes.

---

### Example

```
..  
Break;  
...
```

Program execution stops and it is possible to analyse variables, values etc. for debugging purposes.

---

### Program execution

The instruction stops program execution at once, without waiting for the robot and external axes to reach their programmed destination points for the movement being performed at the time. Program execution can then be restarted from the next instruction.

If there is a *Break* instruction in some event routine, the routine will be executed from the beginning of the next event.

---

### Syntax

```
Break';'
```

---

### Related information

	<u>Described in:</u>
Stopping for program actions	Instructions - <i>Stop</i>
Stopping after a fatal error	Instructions - <i>EXIT</i>
Terminating program execution	Instructions - <i>EXIT</i>
Only stopping robot movements	Instructions - <i>StopMove</i>





---



---

## CallByVar      Call a procedure by a variable

*CallByVar* (*Call By Variable*) can be used to call procedures with specific names, e.g. *proc\_name1*, *proc\_name2*, *proc\_name3* ... *proc\_name<sub>x</sub>* via a variable.

---

### Example

```
reg1 := 2;
CallByVar "proc", reg1;
```

The procedure *proc2* is called.

---

### Arguments

#### CallByVar Name Number

**Name** Data type: *string*

The first part of the procedure name, e.g. *proc\_name*.

**Number** Data type: *num*

The numeric value for the number of the procedure. This value will be converted to a string and gives the 2:nd part of the procedure name e.g. *1*. The value must be a positive integer.

---

### Example

#### Static selection of procedure call

```
TEST reg1
CASE 1:
  lf_door door_loc;
CASE 2:
  rf_door door_loc;
CASE 3:
  lr_door door_loc;
CASE 4:
  rr_door door_loc;
DEFAULT:
  EXIT;
ENDTEST
```

Depending on whether the value of register *reg1* is 1, 2, 3 or 4, different procedures are called that perform the appropriate type of work for the selected door.

The door location in argument *door\_loc*.

### Dynamic selection of procedure call with RAPID syntax

```
reg1 := 2;
%"proc"+NumToStr(reg1,0)% door_loc;
```

The procedure *proc2* is called with argument *door\_loc*.

Limitation: All procedures must have a specific name e.g. *proc1*, *proc2*, *proc3*.

### Dynamic selection of procedure call with CallByVar

```
reg1 := 2;
CallByVar "proc",reg1;
```

The procedure *proc2* is called.

Limitation: All procedures must have specific name, e.g. *proc1*, *proc2*, *proc3*, and no arguments can be used.

## Limitations

Can only be used to call procedures without parameters.

Execution of CallByVar takes a little more time than execution of a normal procedure call.

## Error handling

In the event of a reference to an unknown procedure, the system variable ERRNO is set to ERR\_REFUNKPRC.

In the event of the procedure call error (not procedure), the system variable ERRNO is set to ERR\_CALLPROC.

These errors can be handled in the error handler.

## Syntax

```
CallByVar
  [Name ':=' ] <expression (IN) of string>,'
  [Number ':=' ] <expression (IN) of num>';
```

---

**Related information**

Calling procedures

Described in:

Basic Characteristic - *Routines*  
User's Guide - *The programming language RAPID*



---

---

## Clear Clears the value

*Clear* is used to clear a numeric variable or persistent , i.e. it sets it to 0.

---

### Example

```
Clear reg1;
```

*Reg1* is cleared, i.e. reg1:=0.

---

### Arguments

**Clear**   **Name**

**Name**

Data type: *num*

The name of the variable or persistent to be cleared.

---

### Syntax

Clear

[ Name ':=' ] < var or pers (**INOUT**) of *num* > ';' ;

---

### Related information

Incrementing a variable by 1

Decrementing a variable by 1

Described in:

Instructions - *Incr*

Instructions - *Decr*

*Clear*

*Instructions*

## ClkReset      Resets a clock used for timing

*ClkReset* is used to reset a clock that functions as a stop-watch used for timing.

This instruction can be used before using a clock to make sure that it is set to 0.

---

### Example

```
ClkReset clock1;
```

The clock *clock1* is reset.

---

### Arguments

**ClkReset    Clock**

**Clock**

Data type: *clock*

The name of the clock to reset.

---

### Program execution

When a clock is reset, it is set to 0.

If a clock is running, it will be stopped and then reset.

---

### Syntax

```
ClkReset  
[ Clock ':=' ] < variable (VAR) of clock > ';' ;
```

---

### Related Information

Other clock instructions

Described in:

RAPID Summary - *System & Time*





---

---

## ClkStart      Starts a clock used for timing

*ClkStart* is used to start a clock that functions as a stop-watch used for timing.

---

### Example

```
ClkStart clock1;
```

The clock *clock1* is started.

---

### Arguments

**ClkStart    Clock**

**Clock**

Data type: *clock*

The name of the clock to start.

---

### Program execution

When a clock is started, it will run and continue counting seconds until it is stopped.

A clock continues to run when the program that started it is stopped. However, the event that you intended to time may no longer be valid. For example, if the program was measuring the waiting time for an input, the input may have been received while the program was stopped. In this case, the program will not be able to “see” the event that occurred while the program was stopped.

A clock continues to run when the robot is powered down as long as the battery back-up retains the program that contains the clock variable.

If a clock is running it can be read, stopped or reset.

---

### Example

```
VAR clock clock2;
```

```
ClkReset clock2;
```

```
ClkStart clock2;
```

```
WaitUntil DInput(di1) = 1;
```

```
ClkStop clock2;
```

```
time:=ClkRead(clock2);
```

The waiting time for *di1* to become 1 is measured.

---

**Syntax**

ClkStart  
[ Clock ':= ' ] < variable (**VAR**) of *clock* > ';' ;

---

**Related Information**

Other clock instructions

Described in:

RAPID Summary - *System & Time*

---

---

## ClkStop      Stops a clock used for timing

*ClkStop* is used to stop a clock that functions as a stop-watch used for timing.

---

### Example

```
ClkStop clock1;
```

The clock *clock1* is stopped.

---

### Arguments

**ClkStop    Clock**

**Clock**

Data type: *clock*

The name of the clock to stop.

---

### Program execution

When a clock is stopped, it will stop running.

If a clock is stopped, it can be read, started again or reset.

---

### Syntax

```
ClkStop  
[ Clock ':=' ] < variable (VAR) of clock > ';' ;
```

---

### Related Information

Other clock instructions

More examples

Described in:

RAPID Summary - *System & Time*

Instructions - *ClkStart*



---

---

## Close                      Closes a file or serial channel

*Close* is used to close a file or serial channel.

---

### Example

```
Close channel2;
```

The serial channel referred to by *channel2* is closed.

---

### Arguments

**Close**    **IODevice**

**IODevice**

Data type: *iodev*

The name (reference) of the file or serial channel to be closed.

---

### Program execution

The specified file or serial channel is closed and must be re-opened before reading or writing. If it is already closed, the instruction is ignored.

---

### Syntax

```
Close  
  [IODevice ':='] <variable (VAR) of iodev>;'
```

---

### Related information

Opening a file or serial channel

Described in:

RAPID Summary - *Communication*



---

---

**comment****Comment**

*Comment* is only used to make the program easier to understand. It has no effect on the execution of the program.

---

**Example**

```
! Goto the position above pallet
MoveL p100, v500, z20, tool1;
```

A comment is inserted into the program to make it easier to understand.

---

**Arguments****! Comment****Comment**

Text string

Any text.

---

**Program execution**

Nothing happens when you execute this instruction.

---

**Syntax**

(EBNF)

'!' {&lt;character&gt;} &lt;newline&gt;

---

**Related information**

Characters permitted in a comment

Comments within data and routine declarations

Described in:Basic Characteristics-  
*Basic Elements*Basic Characteristics-  
*Basic Elements*



*comment*

*Instructions*

---



---

## Compact IF    If a condition is met, then... (one instruction)

*Compact IF* is used when a single instruction is only to be executed if a given condition is met.

If different instructions are to be executed, depending on whether the specified condition is met or not, the *IF* instruction is used.

---

### Examples

IF reg1 > 5 GOTO next;

If *reg1* is greater than 5, program execution continues at the *next* label.

IF counter > 10 Set do1;

The *do1* signal is set if *counter* > 10.

---

### Arguments

**IF    Condition    ...**

**Condition** Data type: *bool*

The condition that must be satisfied for the instruction to be executed.

---

### Syntax

(EBNF)

**IF** <conditional expression> ( <instruction> | <SMT> ) ';' ;'

---

### Related information

Conditions (logical expressions)

IF with several instructions

Described in:

Basic Characteristics - *Expressions*

Instructions - *IF*



---



---

## ConfJ Controls the configuration during joint movement

*ConfJ (Configuration Joint)* is used to specify whether or not the robot's configuration is to be controlled during joint movement. If it is not controlled, the robot can sometimes use a different configuration than that which was programmed.

With `ConfJ\Off`, the robot cannot switch main axes configuration - it will search for a solution with the same main axes configuration as the current one. It moves to the closest wrist configuration for axes 4 and 6.

---

### Examples

```
ConfJ \Off;
MoveJ *, v1000, fine, tool1;
```

The robot moves to the programmed position and orientation. If this position can be reached in several different ways, with different axis configurations, the closest possible position is chosen.

```
ConfJ \On;
MoveJ *, v1000, fine, tool1;
```

The robot moves to the programmed position, orientation and axis configuration. If this is not possible, program execution stops.

---

### Arguments

**ConfJ** [**\On**] | [**\Off**]

**\On** Data type: *switch*

The robot always moves to the programmed axis configuration. If this is not possible using the programmed position and orientation, program execution stops.

The IRB5400 robot will move to the programmed axis configuration or to an axis configuration close to the programmed one. Program execution will not stop if it is impossible to reach the programmed axis configuration.

**\Off** Data type: *switch*

The robot always moves to the closest axis configuration.

---

### Program execution

If the argument `\On` (or no argument) is chosen, the robot always moves to the programmed axis configuration. If this is not possible using the programmed position and

orientation, program execution stops before the movement starts.

If the argument *\Off* is chosen, the robot always moves to the closest axis configuration. This may be different to the programmed one if the configuration has been incorrectly specified manually, or if a program displacement has been carried out.

The control is active by default. This is automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Syntax

ConfJ  
[ '\ On' | [ '\ Off' ] ';' ]

---

## Related information

	<u>Described in:</u>
Handling different configurations	Motion Principles - <i>Robot Configuration</i>
Robot configuration during linear movement	Instructions - <i>ConfL</i>

---

---

## ConfL Monitors the configuration during linear movement

*ConfL (Configuration Linear)* is used to specify whether or not the robot's configuration is to be monitored during linear or circular movement. If it is not monitored, the configuration at execution time may differ from that at programmed time. It may also result in unexpected sweeping robot movements when the mode is changed to joint movement.

**NOTE: For the IRB5400 robot the monitoring is always off independent of the switch.**

---

### Examples

```
ConfL \On;  
MoveL *, v1000, fine, tool1;
```

Program execution stops when the programmed configuration is not possible to reach from the current position.

```
SingArea \Wrist;  
ConfL \On;  
MoveL *, v1000, fine, tool1;
```

The robot moves to the programmed position, orientation and wrist axis configuration. If this is not possible, program execution stops.

```
ConfL \Off;  
MoveL *, v1000, fine, tool1;
```

No error message is displayed when the programmed configuration is not the same as the configuration achieved by program execution.

---

### Arguments

**ConfL**    **[\On] | [\Off]**

**\On**

Data type: *switch*

The robot configuration is monitored.

**\Off**

Data type: *switch*

The robot configuration is not monitored.

---

## Program execution

During linear or circular movement, the robot always moves to the programmed position and orientation that has the closest possible axis configuration. If the argument `\On` (or no argument) is chosen, then the program execution stops as soon as:

- the configuration of the programmed position will not be attained from the current position.
- the needed reorientation of any one of the wrist axes to get to the programmed position from the current position exceeds a limit (140-180 degrees).

However, it is possible to restart the program again, although the wrist axes may continue to the wrong configuration. At a stop point, the robot will check that the configurations of all axes are achieved, not only the wrist axes.

If `SingArea\Wrist` is also used, the robot always moves to the programmed wrist axes configuration and at a stop point the remaining axes configurations will be checked.

If the argument `\Off` is chosen, there is no monitoring.

Monitoring is active by default. This is automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Syntax

```
ConfL
  [ '\ On' | [ '\ Off' ] ] ;'
```

---

## Related information

	<u>Described in:</u>
Handling different configurations	Motion and I/O Principles- <i>Robot Configuration</i>
Robot configuration during joint movement	Instructions - <i>ConfJ</i>

---



---

## CONNECT      Connects an interrupt to a trap routine

*CONNECT* is used to find the identity of an interrupt and connect it to a trap routine.

The interrupt is defined by ordering an interrupt event and specifying its identity. Thus, when that event occurs, the trap routine is automatically executed.

---

### Example

```
VAR intnum feeder_low;
CONNECT feeder_low WITH feeder_empty;
ISignalDI di1, 1 , feeder_low;
```

An interrupt identity *feeder\_low* is created which is connected to the trap routine *feeder\_empty*. The interrupt is defined as *input di1 is getting high*. In other words, when this signal becomes high, the *feeder\_empty* trap routine is executed.

---

### Arguments

#### CONNECT    Interrupt    WITH    Trap routine

**Interrupt** Data type: *intnum*

The variable that is to be assigned the identity of the interrupt.  
This must not be declared within a routine (routine data).

**Trap routine** Identifier

The name of the trap routine.

---

### Program execution

The variable is assigned an interrupt identity which can then be used when ordering or disabling interrupts. This identity is also connected to the specified trap routine.

Note that before an event can be handled, an interrupt must also be ordered, i.e. the event specified.

---

### Limitations

An interrupt (interrupt identity) cannot be connected to more than one trap routine. Different interrupts, however, can be connected to the same trap routine.

When an interrupt has been connected to a trap routine, it cannot be reconnected or transferred to another routine; it must first be deleted using the instruction *IDelete*.



---

## Error handling

If the interrupt variable is already connected to a TRAP routine, the system variable ERRNO is set to ERR\_ALRDYCNT.

If the interrupt variable is not a variable reference, the system variable ERRNO is set to ERR\_CNTNOTVAR.

If no more interrupt numbers are available, the system variable ERRNO is set to ERR\_INOMAX.

These errors can be handled in the ERROR handler.

---

## Syntax

(EBNF)

**CONNECT** <connect target> **WITH** <trap>';

<connect target> ::= <variable>  
                  | <parameter>  
                  | <VAR>

<trap> ::= <identifier>

---

## Related information

Summary of interrupts

More information on interrupt management

Described in:

RAPID Summary - *Interrupts*

Basic Characteristics- *Interrupts*

---

---

## CorrClear      Removes all correction generators

*CorrClear* is used to remove all connected correction generators. The instruction can be used to remove all offsets provided earlier by all correction generators.

---

### Example

```
CorrClear;
```

The instruction removes all connected correction generators.

**Note!** An easy way to ensure that all correction generators (with corrections) are removed at program start, is to run *CorrClear* in a START event routine. See System Parameters - *Topic: Controller*.

---

### Syntax

```
CorrClear ‘;’
```

---

### Related information

Connects to a correction generator

Disconnects from a correction generator

Writes to a correction generator

Reads the current total offsets

Correction descriptor

Described in:

Instructions - *CorrCon*

Instructions - *CorrDiscon*

Instructions - *CorrWrite*

Functions - *CorrRead*

Data types - *corrdescr*



---



---

## CorrCon      Connects to a correction generator

*CorrCon* is used to connect to a correction generator.

---

### Example

```
VAR corrdescr id;
...
CorrCon id;
```

The correction generator reference corresponds to the variable *id* reservation.

---

### Arguments

#### CorrCon Descr

Descr

Data type: *corrdescr*

Descriptor of the correction generator.

---

### Example

#### Path coordinate system

All path corrections (offsets on the path) are added in the path coordinate system. The path coordinate system is defined as:

P = Path coordinate system  
T = Tool coordinate system

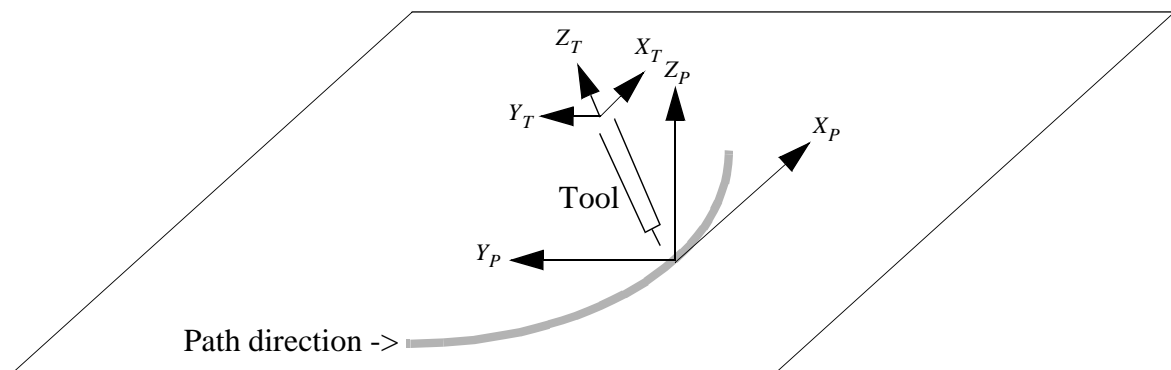


Figure 1 Path coordinate system.

- Path coordinate axis X is given as the tangent of the path.
- Path coordinate axis Y is derived as the cross product of tool coordinate axis Z and path coordinate axis X.
- Path coordinate axis Z is derived as the cross product of path coordinate axis X and path coordinate axis Y.

### Application example

An example of an application using path corrections is a robot holding a tool with two sensors mounted on it to detect the vertical and horizontal distances to a work object.

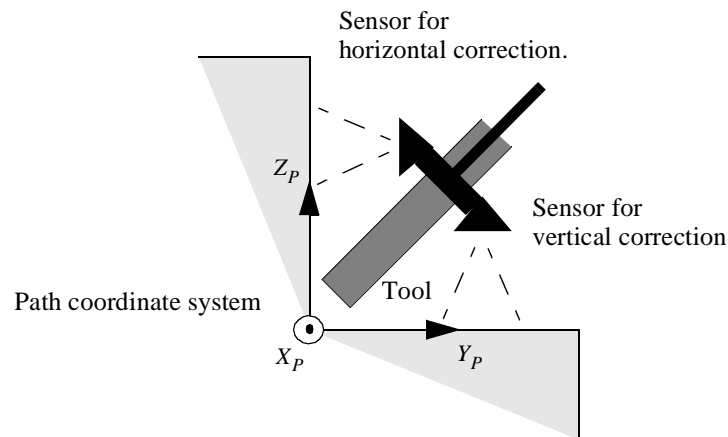


Figure 2 Path correction device.

### Program example

```

CONST num TARGET_DIST := 5;
CONST num SCALE_FACTOR := 0.5;
VAR intnum intno1;
VAR corrdesc hori_id;
VAR corrdesc vert_id;
VAR pos total_offset;
VAR signalai hori_sig;
VAR signalai vert_sig;
VAR pos write_offset;

```

```

PROC PathRoutine()

```

```

! Connect to the correction generators for horizontal and vertical correction.

```

```

CorrCon hori_id;

```

```

CorrCon vert_id;

```

```

! Setup a 5 Hz timer interrupt. The trap routine will read the sensor values and
! compute the path corrections.

```

```

CONNECT intno1 WITH ReadSensors;

```

```

ITimer\singel 0.2, intno1

```

```

! Position for start of contour tracking
MoveJ p10,v100,z10,tool1;

! Run MoveL with both vertical and horizontal correction.
MoveL p20,v100,z10,tool1\Corr;
! Read the total corrections added by all connected correction generators.
total_offset := CorrRead();
! Write the total vertical correction on the TeachPendant.
TPWrite "The total vertical correction is: "\Num:=total_offset.z;
! Disconnect the correction generator for vertical correction.
! Horizontal corrections will be unaffected.
CorrDiscon vert_id;
! Run MoveL with only horizontal correction.
MoveL p30,v100,z10,tool1\Corr;

! Remove all outstanding connected correction generators.
! In this case, the only connected correction generator is the one for horizontal
! correction.
CorrClear;

! Remove the timer interrupt.
IDelete intno1;

```

ENDPROC

TRAP ReadSensors

```

! Compute the horizontal correction values and execute the correction.
write_offset.x := 0;
write_offset.y := (hori_sig - TARGET_DIST)*SCALE_FACTOR;
write_offset.z := 0;
CorrWrite hori_id, write_offset;

! Compute the vertical correction values and execute the correction.
write_offset.x := 0;
write_offset.y := 0;
write_offset.z := (vert_sig - TARGET_DIST)*SCALE_FACTOR;
CorrWrite vert_id, write_offset;

!Setup interrupt again
IDelete intno1;
CONNECT intno1 WITH ReadSensors;
ITimer\singel 0.2, intno1;

```

ENDTRAP

### Program explanation

Two correction generators are connected with the instruction *CorrCon*. Each correction generator is referenced by a unique descriptor (*hori\_id* and *vert\_id*) of the type *corrdesc*. The two sensors will use one correction generator each.

A timer interrupt is set up to call the trap routine *ReadSensors* with a frequency of 5

Hz. The offsets, needed for path correction, are computed in the trap routine and written to the corresponding correction generator (referenced by the descriptors *hori\_id* and *vert\_id*) by the instruction *CorrWrite*. All the corrections will have immediate effect on the path.

The *MoveL* instruction must be programmed with the switch argument *Corr* when path corrections are used. Otherwise, no corrections will be executed.

When the first *MoveL* instruction is ready, the function *CorrRead* is used to read the sum of all the corrections (the total path correction) given by all the connected correction generators. The result of the total vertical path correction is written to the TeachPendant with the instruction *TPWrite*.

*CorrDiscon* will then disconnect the correction generator for vertical correction (referenced by the descriptor *vert\_id*). All corrections added by this correction generator will be removed from the total path correction. The corrections added by the correction generator for horizontal correction will still be preserved.

Finally, the function *CorrClear* will remove all outstanding connected correction generators and their previously added corrections. In this case, it is only the correction generator for horizontal correction that will be removed. The timer interrupt will also be removed by the instruction *IDelete*.

### The correction generators

x	y	z	Path coordinate axis.
0	0	3	Vertical correction generator, with the sum of all its own path corrections.
0	1	0	Horizontal correction generator, with the sum of all its own path corrections.
-	-	-	Not connected correction generator.
-	-	-	Not connected correction generator.
-	-	-	Not connected correction generator.
0	1	3	The sum of all corrections done by all connected correction generators.

Figure 3 Correction generators.

---

## Limitations

A maximum number of 5 correction generators can be connected simultaneously.

---

## Syntax

CorrCon

[ Descr ' := ' ] < variable (**VAR**) of *corrdescr* > ' ; '

---

**Related information**

	<u>Described in:</u>
Disconnects from a correction generator	Instructions - <i>CorrDiscon</i>
Writes to a correction generator	Instructions - <i>CorrWrite</i>
Reads the current total offsets	Functions - <i>CorrRead</i>
Removes all correction generators	Instructions - <i>CorrClear</i>
Correction generator descriptor	Data types - <i>corrdescr</i>





---

---

## CorrDiscon                      Disconnects from a correction generator

*CorrDiscon* is used to disconnect from a previously connected correction generator. The instruction can be used to remove corrections given earlier.

---

### Example

```
VAR corrdescr id;  
...  
CorrCon id;  
...  
CorrDiscon id;
```

*CorrDiscon* disconnects from the previously connected correction generator referenced by the descriptor *id*.

---

### Arguments

#### CorrDiscon Descr

**Descr**

Data type: *corrdescr*

Descriptor of the correction generator.

---

### Example

See Instructions - *CorrCon*

---

### Syntax

```
CorrDiscon  
[ Descr ' := ' ] < variable (VAR) of corrdescr > ';' ;
```

---

**Related information**

Connects to a correction generator  
Writes to a correction generator  
Reads the current total offsets  
Removes all correction generators  
Correction descriptor

Described in:

Instructions - *CorrCon*  
Instructions - *CorrWrite*  
Functions - *CorrRead*  
Instructions - *CorrClear*  
Data types - *corrdescr*

---

---

## CorrWrite      Writes to a correction generator

*CorrWrite* is used to write offsets in the path coordinate system to a correction generator.

---

### Example

```
VAR corrdescr id;  
VAR pos offset;  
...  
CorrWrite id, offset;
```

The current offsets, stored in the variable *offset*, are written to the correction generator referenced by the descriptor *id*.

---

### Arguments

#### CorrWrite Descr Data

**Descr**Data type: *corrdescr*

Descriptor of the correction generator.

**Data**Data type: *pos*

The offset to be written.

---

### Example

See Instructions - *CorrCon*

---

### Limitations

The best performance is achieved on straight paths. As the speed and angles between to consecutive linear paths increase, the deviation from the expected path will also increase. The same applies to circles with decreasing circle radius.

---

### Syntax

CorrWrite

[ Descr ' := ' ] < variable (**VAR**) of *corrdescr* > ','  
[ Data ' := ' ] < expression (**IN**) of *pos* > ','

---

**Related information**

	<u>Described in:</u>
Connects to a correction generator	Instructions - <i>CorrCon</i>
Disconnects from a correction generator	Instructions - <i>CorrDiscon</i>
Reads the current total offsets	Functions - <i>CorrRead</i>
Removes all correction generators	Instructions - <i>CorrClear</i>
Correction generator descriptor	Data types - <i>corrdescr</i>

---



---

## DeactUnit          Deactivates a mechanical unit

*DeactUnit* is used to deactivate a mechanical unit.

It can be used to determine which unit is to be active when, for example, common drive units are used.

---

### Examples

```
DeactUnit orbit_a;
```

Deactivation of the *orbit\_a* mechanical unit.

```
MoveL p10, v100, fine, tool1;
DeactUnit track_motion;
MoveL p20, v100, z10, tool1;
MoveL p30, v100, fine, tool1;
ActUnit track_motion;
MoveL p40, v100, z10, tool1;
```

The unit *track\_motion* will be stationary when the robot moves to *p20* and *p30*. After this, both the robot and *track\_motion* will move to *p40*.

```
MoveL p10, v100, fine, tool1;
DeactUnit orbit1;
ActUnit orbit2;
MoveL p20, v100, z10, tool1;
```

The unit *orbit1* is deactivated and *orbit2* activated.

---

### Arguments

**DeactUnit MecUnit**

**MecUnit**    (*Mechanical Unit*)    Data type: *mecunit*

The name of the mechanical unit that is to be deactivated.

---

### Program execution

When the robot and external axes have come to a standstill, the specified mechanical unit is deactivated. This means that it will neither be controlled nor monitored until it is re-activated.

If several mechanical units share a common drive unit, deactivation of one of the mechanical units will also disconnect that unit from the common drive unit.

---

**Limitations**

Instruction DeactUnit cannot be used

- in program sequence StorePath ... RestoPath
- in event routine RESTART
- when one of the axes in the mechanical unit is in independent mode.

The movement instruction previous to this instruction, should be terminated with a stop point in order to make a restart in this instruction possible following a power failure.

---

**Syntax**

DeactUnit  
[MecUnit ':=' ] < variable (**VAR**) of *mecunit*> ';' ;

---

**Related information**

Activating mechanical units  
Mechanical units

Described in:

Instructions - *ActUnit*  
Data Types - *mecunit*

---

---

**Decr****Decrements by 1**

*Decr* is used to subtract 1 from a numeric variable or persistent.

---

**Example**

```
Decr reg1;
```

*1* is subtracted from *reg1*, i.e. *reg1:=reg1-1*.

---

**Arguments**

**Decr**   **Name**

**Name**

Data type: *num*

The name of the variable or persistent to be decremented.

---

**Example**

```
TPReadNum no_of_parts, "How many parts should be produced? ";  
WHILE no_of_parts>0 DO  
  produce_part;  
  Decr no_of_parts;  
ENDWHILE
```

The operator is asked to input the number of parts to be produced. The variable *no\_of\_parts* is used to count the number that still have to be produced.

---

**Syntax**

```
Decr  
  [ Name ':' '=' ] < var or pers (INOUT) of num > ';' ;
```



---

**Related information**

Incrementing a variable by 1

Subtracting any value from a variable

Changing data using an arbitrary expression, e.g. multiplication

Described in:

Instructions - *Incr*

Instructions - *Add*

Instructions - *:=*

---

---

## EOffsOff      Deactivates an offset for external axes

*EOffsOff* (*External Offset Off*) is used to deactivate an offset for external axes.

The offset for external axes is activated by the instruction *EOffsSet* or *EOffsOn* and applies to all movements until some other offset for external axes is activated or until the offset for external axes is deactivated.

---

### Examples

```
EOffsOff;
```

Deactivation of the offset for external axes.

```
MoveL p10, v500, z10, tool1;  
EOffsOn \ExeP:=p10, p11;  
MoveL p20, v500, z10, tool1;  
MoveL p30, v500, z10, tool1;  
EOffsOff;  
MoveL p40, v500, z10, tool1;
```

An offset is defined as the difference between the position of each axis at *p10* and *p11*. This displacement affects the movement to *p20* and *p30*, but not to *p40*.

---

### Program execution

Active offsets for external axes are reset.

---

### Syntax

```
EOffsOff ‘;’
```

---

### Related information

	<u>Described in:</u>
Definition of offset using two positions	Instructions - <i>EOffsOn</i>
Definition of offset using values	Instructions - <i>EOffsSet</i>
Deactivation of the robot's motion displacement	Instructions - <i>PDispOff</i>



---

---

## **EOffsOn**                      **Activates an offset for external axes**

*EOffsOn* (*External Offset On*) is used to define and activate an offset for external axes using two positions.

---

### **Examples**

```
MoveL p10, v500, z10, tool1;  
EOffsOn \ExeP:=p10, p20;
```

Activation of an offset for external axes. This is calculated for each axis based on the difference between positions *p10* and *p20*.

```
MoveL p10, v500, fine, tool1;  
EOffsOn *;
```

Activation of an offset for external axes. Since a stop point has been used in the previous instruction, the argument *\ExeP* does not have to be used. The displacement is calculated on the basis of the difference between the actual position of each axis and the programmed point (\*) stored in the instruction.

---

### **Arguments**

#### **EOffsOn [ \ExeP ] ProgPoint**

<b>[ \ExeP ]</b>	<i>(Executed Point)</i>	Data type: <i>robtar</i>
------------------	-------------------------	--------------------------

The new position of the axes at the time of the program execution. If this argument is omitted, the current position of the axes at the time of the program execution is used.

<b>ProgPoint</b>	<i>(Programmed Point)</i>	Data type: <i>robtar</i>
------------------	---------------------------	--------------------------

The original position of the axes at the time of programming.

---

### **Program execution**

The offset is calculated as the difference between *ExeP* and *ProgPoint* for each separate external axis. If *ExeP* has not been specified, the current position of the axes at the time of the program execution is used instead. Since it is the actual position of the axes that is used, the axes should not move when *EOffsOn* is executed.

This offset is then used to displace the position of external axes in subsequent positioning instructions and remains active until some other offset is activated (the instruction

*EOffsSet* or *EOffsOn*) or until the offset for external axes is deactivated (the instruction *EOffsOff*).

Only one offset for each individual external axis can be activated at any one time. Several *EOffsOn*, on the other hand, can be programmed one after the other and, if they are, the different offsets will be added.

The external axes' offset is automatically reset

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Example

```
SearchL sen1, psearch, p10, v100, tool1;
PDispOn \ExeP:=psearch, *, tool1;
EOffsOn \ExeP:=psearch, *;
```

A search is carried out in which the searched position of both the robot and the external axes is stored in the position *psearch*. Any movement carried out after this starts from this position using a program displacement of both the robot and the external axes. This is calculated based on the difference between the searched position and the programmed point (\*) stored in the instruction.

---

## Syntax

```
EOffsOn
  [ '\ ExeP ':=' < expression (IN) of robtarget > ',' ]
  [ ProgPoint ':=' ] < expression (IN) of robtarget > ';' ;
```

---

## Related information

	<u>Described in:</u>
Deactivation of offset for external axes	Instructions - <i>EOffsOff</i>
Definition of offset using values	Instructions - <i>EOffsSet</i>
Displacement of the robot's movements	Instructions - <i>PDispOn</i>
Coordinate Systems	Motion Principles- <i>Coordinate Systems</i>

---



---

## EOffsSet Activates an offset for external axes using a value

*EOffsSet* (*External Offset Set*) is used to define and activate an offset for external axes using values.

---

### Example

```
VAR extjoint eax_a_p100 := [100, 0, 0, 0, 0, 0];
EOffsSet eax_a_p100;
```

Activation of an offset *eax\_a\_p100* for external axes, meaning (provided that the external axis “a” is linear) that:

- The ExtOffs coordinate system is displaced 100 mm for the logical axis “a” (see Figure 1).
- As long as this offset is active, all positions will be displaced 100 mm in the direction of the x-axis.

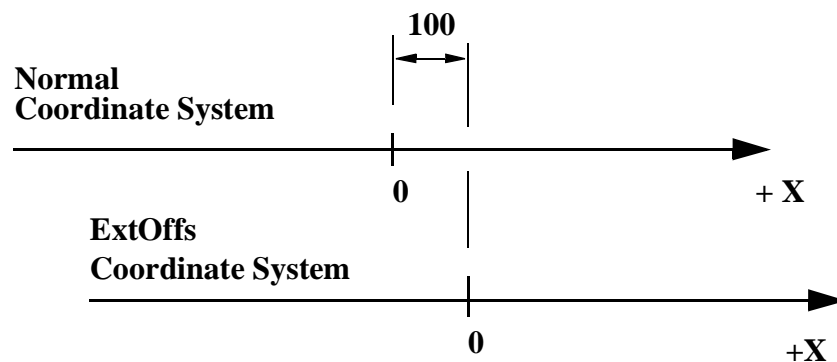


Figure 1 Displacement of an external axis.

---

### Arguments

#### EOffsSet EAxOffs

**EAxOffs**

(*External Axes Offset*)

Data type: *extjoint*

The offset for external axes is defined as data of the type *extjoint*, expressed in:

- mm for linear axes
- degrees for rotating axes

---

## Program execution

The offset for external axes is activated when the *EOffsSet* instruction is activated and remains active until some other offset is activated (the instruction *EOffsSet* or *EOffsOn*) or until the offset for external axes is deactivated (the *EOffsOff*).

Only one offset for external axes can be activated at any one time. Offsets cannot be added to one another using *EOffsSet*.

The external axes' offset is automatically reset

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Syntax

```
EOffsSet
  [ EAxOffs ':=' ] < expression (IN) of extjoint> ';'

```

---

## Related information

Deactivation of offset for external axes	<u>Described in:</u>
Definition of offset using two positions	Instructions - <i>EOffsOff</i>
Displacement of the robot's movements	Instructions - <i>EOffsSet</i>
Definition of data of the type <i>extjoint</i>	Instructions - <i>PDispOn</i>
Coordinate Systems	Data Types - <i>extjoint</i>
<i>tems</i>	Motion Principles- <i>Coordinate Sys-</i>





**Program execution**

An error message (max. 5 lines) is displayed on the teach pendant and written in the robot message log.

ErrWrite always generates the program error no. 80001 or in the event of a warning (argument \W) generates no. 80002.

---

**Limitations**

Total string length (Header+Reason+\RL2+\RL3+\RL4) is limited to 145 characters.

---

**Syntax**

```
ErrWrite
[ '\ W ' , ' ]
[ Header ' := ' ] < expression (IN) of string > ' , '
[ Reason ' := ' ] < expression (IN) of string >
[ '\ RL2 ' := ' < expression (IN) of string > ]
[ '\ RL3 ' := ' < expression (IN) of string > ]
[ '\ RL4 ' := ' < expression (IN) of string > ] ' , '
```

---

**Related information**

Display a message on the teach pendant only	<u>Described in:</u> Instructions - <i>TPWrite</i>
Message logs	Service

---

---

## EXIT Terminates program execution

*EXIT* is used to terminate program execution. Program restart will then be blocked, i.e. the program can only be restarted from the first instruction of the main routine (if the start point is not moved manually).

The *EXIT* instruction should be used when fatal errors occur or when program execution is to be stopped permanently. The *Stop* instruction is used to temporarily stop program execution.

---

### Example

```
ErrWrite "Fatal error","Illegal state";  
EXIT;
```

Program execution stops and cannot be restarted from that position in the program.

---

### Syntax

```
EXIT ';' ;
```

---

### Related information

Stopping program execution temporarily	<u>Described in:</u> Instructions - <i>Stop</i>
--	--



---



---

## ExitCycle      Break current cycle and start next

*ExitCycle* is used to break the current cycle and move the PP back to the first instruction in the main routine. If the execution mode CONT is set, the execution will start to execute the next cycle.

---

### Example

```

VAR num cyclecount:=0;
VAR intnum error_intno;

PROC main()
  IF cyclecount = 0 THEN
    CONNECT error_intno WITH error_trap;
    ISignalDI di_error,1,error_intno;
  ENDIF
  cyclecount:=cyclecount+1;
  ! start to do something intelligent
  ....

ENDPROC

TRAP error_trap
  TPWrite "ERROR, I will start on the next item";
  ExitCycle;
ENDTRAP

```

This will start the next cycle if the signal di\_error is set.

---

### Program Running

All variables, persistents, defined interrupts and motion settings are untouched.

---

### Syntax

```
ExitCycle';'
```

---

### Related information

	<u>Described in:</u>
Stopping after a fatal error	Instructions - <i>EXIT</i>
Terminating program execution	Instructions - <i>EXIT</i>
Stopping for program actions	Instructions - <i>Stop</i>
Finishing execution of a routine	Instructions - <i>RETURN</i>







---



---

## FOR Repeats a given number of times

*FOR* is used when one or several instructions are to be repeated a number of times.

If the instructions are to be repeated as long as a given condition is met, the *WHILE* instruction is used.

---

### Example

```
FOR i FROM 1 TO 10 DO
  routine1;
ENDFOR
```

Repeats the *routine1* procedure 10 times.

---

### Arguments

**FOR Loop counter FROM Start value TO End value  
[STEP Step value] DO ... ENDFOR**

**Loop counter**

Identifier

The name of the data that will contain the value of the current loop counter. The data is declared automatically and its name should therefore not be the same as the name of any data that exists already.

**Start value**Data type: *Num*

The desired start value of the loop counter.  
(usually integer values)

**End value**Data type: *Num*

The desired end value of the loop counter.  
(usually integer values)

**Step value**Data type: *Num*

The value by which the loop counter is to be incremented (or decremented) each loop.  
(usually integer values)

If this value is not specified, the step value will automatically be set to 1 (or -1 if the start value is greater than the end value).



---

**Example**

```
FOR i FROM 10 TO 2 STEP -1 DO
  a{i} := a{i-1};
ENDFOR
```

The values in an array are adjusted upwards so that  $a\{10\}:=a\{9\}$ ,  $a\{9\}:=a\{8\}$  etc.

---

**Program execution**

1. The expressions for the start, end and step values are calculated.
  2. The loop counter is assigned the start value.
  3. The value of the loop counter is checked to see whether its value lies between the start and end value, or whether it is equal to the start or end value. If the value of the loop counter is outside of this range, the FOR loop stops and program execution continues with the instruction following ENDFOR.
  4. The instructions in the FOR loop are executed.
  5. The loop counter is incremented (or decremented) in accordance with the step value.
  6. The FOR loop is repeated, starting from point 3.
- 

**Limitations**

The loop counter (of data type *num*) can only be accessed from within the FOR loop and consequently hides other data and routines that have the same name. It can only be read (not updated) by the instructions in the FOR loop.

Decimal values for start, end or stop values, in combination with exact termination conditions for the FOR loop, cannot be used (undefined whether or not the last loop is running).

---

**Syntax**

(EBNF)

```
FOR <loop variable> FROM <expression> TO <expression>
  [ STEP <expression> ] DO
  <instruction list>
ENDFOR
<loop variable> ::= <identifier>
```

---

**Related information**

Expressions

Identifiers

Described in:

Basic Characteristics - *Expressions*

Basic Characteristics -  
*Basic Elements*



---

---

## GOTO                      Goes to a new instruction

*GOTO* is used to transfer program execution to another line (a label) within the same routine.

---

### Examples

```
GOTO next;  
.  
next:
```

Program execution continues with the instruction following *next*.

```
reg1 := 1;  
next:  
.  
reg1 := reg1 + 1;  
IF reg1<=5 GOTO next;
```

The *next* program loop is executed five times.

```
IF reg1>100 GOTO highvalue;  
lowvalue:  
.  
GOTO ready;  
highvalue:  
.  
ready:
```

If *reg1* is greater than 100, the *highvalue* program loop is executed; otherwise the *lowvalue* loop is executed.

---

### Arguments

**GOTO    Label**

**Label**

Identifier

The label from where program execution is to continue.

---

### Limitations

It is only possible to transfer program execution to a label within the same routine.

It is only possible to transfer program execution to a label within an IF or TEST instruction if the GOTO instruction is also located within the same branch of that

instruction.

It is only possible to transfer program execution to a label within a FOR or WHILE instruction if the GOTO instruction is also located within that instruction.

---

**Syntax**

(EBNF)

**GOTO** <identifier>';'

---

**Related information**

Label

Other instructions that change the program flow

Described in:

Instructions - *label*

RAPID Summary -  
*Controlling the Program Flow*

---

---

## GripLoad      Defines the payload of the robot

*GripLoad* is used to define the payload which the robot holds in its gripper.

---

### Description



**It is important to always define the actual tool load and when used, the payload of the robot too. Incorrect definitions of load data can result in overloading of the robot mechanical structure.**

When incorrect load data is specified, it can often lead to the following consequences:

- If the value in the specified load data is greater than that of the value of the true load;
  - > The robot will not be used to its maximum capacity
  - > Impaired path accuracy including a risk of overshooting

If the value in the specified load data is less than the value of the true load;

- > Impaired path accuracy including a risk of overshooting
- > Risk of overloading the mechanical structure

---

### Examples

GripLoad piece1;

The robot gripper holds a load called *piece1*.

GripLoad load0;

The robot gripper releases all loads.

---

### Arguments

**GripLoad    Load**

**Load**

Data type: *loaddata*

The load data that describes the current payload.

---

### Program execution

The specified load affects the performance of the robot.

The default load, 0 kg, is automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Syntax

GripLoad  
[ Load ':=' ] < persistent (**PERS**) of *loaddata* > ':';

---

## Related information

Definition of load data

Definition of tool load

-

### Described in:

Data Types - *loaddata*

Data Types - *tooldata*

---

---

## IDelete                      Cancels an interrupt

*IDelete (Interrupt Delete)* is used to cancel (delete) an interrupt.

If the interrupt is to be only temporarily disabled, the instruction *ISleep* or *IDisable* should be used.

---

### Example

```
IDelete feeder_low;
```

The interrupt *feeder\_low* is cancelled.

---

### Arguments

**IDelete    Interrupt**

**Interrupt**

Data type: *intnum*

The interrupt identity.

---

### Program execution

The definition of the interrupt is completely erased. To define it again, it must first be re-connected to the trap routine.

The instruction should be preceded by a stop point. Otherwise the interrupt will be deactivated before the end point is reached.

Interrupts do not have to be erased; this is done automatically when

- a new program is loaded
- the program is restarted from the beginning
- the program pointer is moved to the start of a routine

---

### Syntax

```
IDelete  
  [ Interrupt ‘:=’ ] < variable (VAR) of intnum > ‘;’
```



---

**Related information**

Summary of interrupts  
Temporarily disabling an interrupt  
Temporarily disabling all interrupts

Described in:  
RAPID Summary - *Interrupts*  
Instructions - *ISleep*  
Instructions - *IDisable*

---

---

## IDisable                      Disables interrupts

*IDisable (Interrupt Disable)* is used to disable all interrupts temporarily. It may, for example, be used in a particularly sensitive part of the program where no interrupts may be permitted to take place in case they disturb normal program execution.

---

### Example

```
IDisable;  
FOR i FROM 1 TO 100 DO  
    character[i]:=ReadBin(sensor);  
ENDFOR  
IEnable;
```

No interrupts are permitted as long as the serial channel is reading.

---

### Program execution

Interrupts which occur during the time in which an *IDisable* instruction is in effect are placed in a queue. When interrupts are permitted once more, the interrupt(s) of the program then immediately start generating, executed in “first in - first out” order in the queue.

---

### Syntax

```
IDisable‘;’
```

---

### Related information

Summary of interrupts  
Permitting interrupts

Described in:  
RAPID Summary - *Interrupt*  
Instructions - *IEnable*



---

---

## **IEnable**                      **Enables interrupts**

*IEnable (Interrupt Enable)* is used to enable interrupts during program execution.

---

### **Example**

```
IDisable;  
FOR i FROM 1 TO 100 DO  
    character[i]:=ReadBin(sensor);  
ENDFOR  
IEnable;
```

No interrupts are permitted as long as the serial channel is reading. When it has finished reading, interrupts are once more permitted.

---

### **Program execution**

Interrupts which occur during the time in which an *IDisable* instruction is in effect, are placed in a queue. When interrupts are permitted once more (*IEnable*), the interrupt(s) of the program then immediately start generating, executed in “first in - first out” order in the queue. Program execution then continues in the ordinary program and interrupts which occur after this are dealt with as soon as they occur.

Interrupts are always permitted when a program is started from the beginning,. Interrupts disabled by the *ISleep* instruction are not affected by the *IEnable* instruction.

---

### **Syntax**

```
IEnable';'
```

---

### **Related information**

Summary of interrupts  
Permitting no interrupts

Described in:  
RAPID Summary - *Interrupts*  
Instructions - *IDisable*



---

---

## IF                    If a condition is met, then ...; otherwise ...

*IF* is used when different instructions are to be executed depending on whether a condition is met or not.

---

### Examples

```
IF reg1 > 5 THEN
  Set do1;
  Set do2;
ENDIF
```

The *do1* and *do2* signals are set only if *reg1* is greater than 5.

```
IF reg1 > 5 THEN
  Set do1;
  Set do2;
ELSE
  Reset do1;
  Reset do2;
ENDIF
```

The *do1* and *do2* signals are set or reset depending on whether *reg1* is greater than 5 or not.

---

### Arguments

```
IF Condition THEN ...
  {ELSEIF Condition THEN ...}
[ELSE ...]
ENDIF
```

**Condition**

Data type: *bool*

The condition that must be satisfied for the instructions between THEN and ELSE/ELSEIF to be executed.

---

### Example

```
IF counter > 100 THEN
  counter := 100;
ELSEIF counter < 0 THEN
  counter := 0;
ELSE
  counter := counter + 1;
```

ENDIF

*Counter* is incremented by 1. However, if the value of *counter* is outside the limit 0-100, *counter* is assigned the corresponding limit value.

---

## Program execution

The conditions are tested in sequential order, until one of them is satisfied. Program execution continues with the instructions associated with that condition. If none of the conditions are satisfied, program execution continues with the instructions following ELSE. If more than one condition is met, only the instructions associated with the first of those conditions are executed.

---

## Syntax

(EBNF)

**IF** <conditional expression> **THEN**

  <instruction list>

{ **ELSEIF** <conditional expression> **THEN** <instruction list> | <**EIF**> }

[**ELSE**

  <instruction list>]

**ENDIF**

---

## Related information

Conditions (logical expressions)

Described in:

Basic Characteristics - *Expressions*

---

---

**Incr****Increments by 1**

*Incr* is used to add 1 to a numeric variable or persistent.

---

**Example**

```
Incr reg1;
```

*I* is added to *reg1*, i.e. `reg1:=reg1+1`.

---

**Arguments**

**Incr** **Name**

**Name**

Data type: *num*

The name of the variable or persistent to be changed.

---

**Example**

```
WHILE stop_production=0 DO
  produce_part;
  Incr no_of_parts;
  TPWrite "No of produced parts= "\Num:=no_of_parts;
ENDWHILE
```

The number of parts produced is updated on the teach pendant each cycle. Production continues to run as long as the signal *stop\_production* is not set.

---

**Syntax**

```
Incr
  [ Name ':=' ] < var or pers (INOUT) of num > ';' ;
```

---

**Related information**

Decrementing a variable by 1

Adding any value to a variable

Changing data using an arbitrary expression, e.g. multiplication

Described in:

Instructions - *Decr*

Instructions - *Add*

Instructions - *:=*







Same function as `\ToAbsPos` but the position is defined as a numeric value to make it easy to manually change the position.

**Speed** Data type: *num*

Axis speed in degrees/s (mm/s for linear axis).

[ `\Ramp` ] Data type: *num*

Decrease acceleration and deceleration from maximum performance ( 1 - 100%, 100% = maximum performance).

## Program execution

When *IndAMove* is executed, the specified axis starts to move at the programmed speed to the specified axis position. If `\Ramp` is programmed, there will be a reduction of acceleration/deceleration.

To change the axis back to normal mode, the *IndReset* instruction is used. In connection with this, the logical position of the axis can be changed, so that a number of revolutions are erased from the position, for example, to avoid rotating back for the next movement.

The speed can be altered by executing another *IndAMove* instruction (or another *Ind\_Move* instruction). If a speed in the opposite direction is selected, the axis stops and then accelerates to the new speed and direction.

For stepwise execution of the instruction, the axis is set in independent mode only. The axis begins its movement when the next instruction is executed, and continues as long as program execution takes place. For more information see Chapter 6, Motion and I/O principles.

When the program pointer is moved to the start of the program, or to a new routine, all axes are automatically set to normal, without changing the measurement system (equivalent to executing the instruction *IndReset\Old*).

**Note** that an *IndAMove* instruction after an *IndCMove* operation can result in the axis spinning back the movement performed in the *IndCMove* instruction. To prevent this, use an *IndReset* instruction before the *IndAMove*, or use an *IndRMove* instruction.

## Limitations

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually, the axis will not move, and an error message will be displayed. Execute an *IndReset* instruction or move the program pointer to main, in order to leave independent mode.

If a loss of voltage occurs when an axis is in independent mode, the program cannot be restarted. An error message is displayed and the program must be started from the beginning.

---

## Example

```

ActUnit Station_A;
weld_stationA;
IndAMove Station_A,1\ToAbsNum:=90,20\Ramp:=50;
ActUnit Station_B;
weld_stationB_1;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
DeactUnit Station_A;
weld_stationB_2;

```

*Station\_A* is activated and the welding is started in station A.

*Station\_A* (axis 1) is then moved to the 90 degrees position while the robot is welding in station B. The speed of the axis is 20 degrees/s . The speed is changed with acceleration/deceleration reduced to 50% of max performance.

When station A reaches this position, it is deactivated and reloading can take place in the station at the same time as the robot continues to weld in station B.

---

## Error handling

If the axis is not activated, the system variable ERRNO is set to ERR\_AXIS\_ACT. This error can then be handled in the error handler.

---

## Syntax

```

IndAMove
[ MecUnit':=' ] < variable (VAR) of mecunit> ','
[ Axis':=' ] < expression (IN) of num>
[ '\ToAbsPos':=' < expression (IN) of robtarg> ]
| [ '\ ToAbsNum':=' < expression (IN) of num> ] ','
[ Speed ':=' ] < expression (IN) of num>
[ '\ Ramp':=' < expression (IN) of num> ] ';

```

---

**Related information**

	<u>Described in:</u>
Independent axes in general	Motion and I/O Principles - <i>Program execution</i>
Change back to normal mode	Instructions - <i>IndReset</i>
Reset the measurement system	Instructions - <i>IndReset</i>
Move an independent axis to a specific position within current revolution	Instructions - <i>IndRMove</i>
Move an independent axis a specific distance	Instructions - <i>IndDMove</i>
Check the speed status for independent axes	Functions - <i>IndSpeed</i>
Check the position status for independent axes	Functions - <i>IndInpos</i>



To change the axis back to normal mode, the *IndReset* instruction is used. The logical position of the axis can be changed in connection with this - an number of full revolutions can be erased, for example, to avoid rotating back for the next movement.

The speed can be changed by executing a further *IndCMove* instruction. If a speed in the opposite direction is ordered, the axis stops and then accelerates to the new speed and direction. To stop the axis, speed argument 0 can be used. It will then still be in independent mode.

During stepwise execution of the instruction, the axis is set in independent mode only. The axis starts its movement when the next instruction is executed, and continues as long as program execution continues. For more information see Chapter 6, Motion and I/O principles.

When the program pointer is moved to the beginning of the program, or to a new routine, all axes are set automatically to normal mode, without changing the measurement system (equivalent to executing the instruction *IndReset\Old*).

---

## Limitations

The resolution of the axis position worsens, the further it is moved from its logical zero position (usually the middle of the working area). To achieve high resolution again, the logical working area can be set to zero with the instruction *IndReset*. For more information see Chapter 6, Motion and I/O Principles.

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually, the axis will not move, and an error message will be displayed. Execute an *IndReset* instruction or move the program pointer to main, in order to leave independent mode.

If a loss of voltage occurs when the axis is in independent mode, the program cannot be restarted. An error message is displayed, and the program must be started from the beginning.

---

## Example

```
IndCMove Station_A,2,20;
WaitUntil IndSpeed(Station_A,2 \InSpeed) = TRUE;
WaitTime 0.2;
MoveL p10, v1000, fine, tool1;
IndCMove Station_A,2,-10\Ramp:=50;
MoveL p20, v1000, z50, tool1;
IndRMove Station_A,2 \ToRelPos:=p1 \Short,10;
MoveL p30, v1000, fine, tool1;
WaitUntil IndInpos(Station_A,2 ) = TRUE;
WaitTime 0.2;
IndReset Station_A,2 \RefPos:=p40\Short;
MoveL p40, v1000, fine, tool1;
```

Axis 2 of *Station\_A* starts to move in a positive direction at a speed of 20 degrees/s. When this axis has reached the selected speed the robot axes start to move.

When the robot reaches position *p10*, the external axis changes direction and rotates at a speed of 10 degrees/s. The change of speed is performed with acceleration/deceleration reduced to 50% of maximum performance. At the same time, the robot executes towards *p20*.

Axis 2 of *Station\_A* is then stopped as quickly as possible in position *p1* within the current revolution.

When axis 2 has reached this position, and the robot has stopped in position *p30*, axis 2 returns to normal mode again. The measurement system offset for this axis is changed a whole number of axis revolutions so that the actual position is as close as possible to *p40*.

When the robot is then moved to position *p40*, axis 2 of *Station\_A* will be moved via the shortest route to position *p40* (max  $\pm 180$  degrees).

## Error handling

If the axis is not activated, the system variable ERRNO is set to ERR\_AXIS\_ACT. This error can then be handled in the error handler.

## Syntax

```
IndCMove
[ MecUnit':=' ] < variable (VAR) of mecunit> ','
[ Axis':=' ] < expression (IN) of num> ','
[ Speed':=' ] < expression (IN) of num>
[ '\ Ramp':=' < expression (IN) of num > ]';'
```



---

**Related information**

	<u>Described in:</u>
Independent axes in general	Motion and I/O Principles - <i>Program execution</i>
Change back to normal mode	Instructions - <i>IndReset</i>
Reset the measurement system	Instructions - <i>IndReset</i>
Move an independent axis to a specific position	Instructions - <i>IndAMove, IndRMove</i>
Move an independent axis a specific distance	Instructions - <i>IndDMove</i>
Check the speed status for independent axes	Functions - <i>IndSpeed</i>
Check the position status for independent axes	Functions - <i>IndInpos</i>



---

## Program execution

When *IndAMove* is executed, the specified axis starts to move at the programmed speed for the specified distance. The direction of movement is specified as the sign of the *Delta* argument. If *\Ramp* is programmed there will be a reduction of acceleration/ deceleration.

If the axis is moving, the new position is calculated from the momentary position of the axis, when the instruction *IndDMove* is executed. If an *IndDMove* instruction with distance 0 is executed, the axis will stop and then move back to the position which the axis had when the instruction was executed.

To change the axis back to normal mode, the *IndReset* instruction is used. The logical position of the axis can be changed in connection with this - a number of full revolutions can be erased from the position, for example, to avoid rotating back for the next movement.

The speed can be changed by running a further *IndDMove* instruction (or another *Ind\_Move* instruction). If a speed in the opposite direction is selected, the axis stops and then accelerates to the new speed and direction.

During stepwise execution of the instruction, the axis is set in independent mode only. The axis starts its movement when the next instruction is executed, and continues as long as program execution continues. For more information see Chapter 6, Motion and I/O principles.

When the program pointer is moved to the beginning of the program, or to a new routine, all axes are automatically set to normal mode, without changing the measurement system (equivalent to running the instruction *IndReset \Old*).

---

## Limitations

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually, the axis will not move, and an error message will be displayed. Execute an *IndReset* instruction or move the program pointer to main, in order to leave independent mode.

If a loss of voltage occurs when the axis is in independent mode, the program cannot be restarted. An error message is displayed, and the program must be started from the beginning.

---

## Example

```

IndAMove Robot,6\ToAbsNum:=90,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndDMove Station_A,2,-30,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndDMove Station_A,2,400,20;

```

Axis 6 of the robot is moved to the following positions:

90 degrees

60 degrees

460 degrees (1 revolution + 100 degrees).

---

## Error handling

If the axis is not activated, the system variable ERRNO is set to ERR\_AXIS\_ACT. This error can then be handled in the error handler.

---

## Syntax

```

IndDMove
[ MecUnit':=' ] < variable (VAR) of mecunit> ','
[ Axis':=' ] < expression (IN) of num> ','
[ Delta':=' ] < expression (IN) of num> ','
[ Speed ':=' ] < expression (IN) of num>
[ '\ Ramp':=' < expression (IN) of num > ] ',';

```

---

## Related information

	<u>Described in:</u>
Independent axes in general	Motion and I/O Principles - <i>Program execution</i>
Change back to normal mode	Instructions - <i>IndReset</i>
Reset the measurement system	Instructions - <i>IndReset</i>
Move an independent axis to a specific position	Instructions - <i>IndAMove, IndRMove</i>
Check the speed status for independent axes	Functions - <i>IndSpeed</i>
Check the position status for independent axes	Functions - <i>IndInpos</i>



---

---

**IndReset****Independent Reset**

*IndReset* is used to change an independent axis back to normal mode. At the same time, the measurement system for rotational axes can be moved a number of axis revolutions.

---

**Example**

```
IndCMove Station_A,2,5;
MoveL *,v1000,fine,tool1;
IndCMove Station_A,2,0;
WaitUntil IndSpeed(Station_A,2\ZeroSpeed);
WaitTime 0.2
IndReset Station_A,2;
```

Axis 2 of *Station\_A* is first moved in independent mode and then changed back to normal mode. The axis will keep its position.

Note that the current independent axis, and the normal axes, should not move when the instruction *IndReset* is executed. This is because the previous position is a stop point, and an *IndCMove* instruction is executed at zero speed. Furthermore, a pause of 0.2 seconds is used to ensure that the correct status has been achieved.

---

**Arguments**

**IndReset MecUnit Axis [ \RefPos ] [ \RefNum ] [ \Short ] [ \Fwd ] [ \Bwd ] [ \Old ]**

**MecUnit** (Mechanical Unit) Data type: *mecunit*

The name of the mechanical unit.

**Axis** Data type: *num*

The number of the current axis for the mechanical unit (1-6).

**[ \RefPos ]** (Reference Position) Data type: *robtarget*

Axis position specified as a *robtarget*. Only the component for this specific axis is used. The position must be inside the normal working range.

For robot axes, the argument *\RefNum* is to be used instead.

The argument is only to be defined together with the argument *\Short*, *\Fwd* or *\Bwd*. It is not allowed together with the argument *\Old*.

[ **\RefNum** ]                              (*Reference Numeric value*)      Data type: *num*

Axis position defined in degrees (mm for linear axis). The position must be inside the normal working range.

The argument is only to be defined together with the argument *\Short*, *\Fwd* or *\Bwd*. It is not allowed together with the argument *\Old*.

Same function as *\RefPos* but the position is defined as a numeric value to make it easy to change the position manually.

[ **\Short** ]    Data type: *switch*

The measurement system will change a whole number of revolutions on the axis side so that the axis will be as close as possible to the specified *\RefPos* or *\RefNum* position. If a positioning instruction with the same position is executed after *IndReset*, the axis will travel the shortest route, less than  $\pm 180$  degrees, in order to reach the position.

[ **\Fwd** ]    (*Forward*)    Data type: *switch*

The measurement system will change a whole number of revolutions on the axis side so that the reference position will be on the positive side of the specified *\RefPos* or *\RefNum* position. If a positioning instruction with the same position is executed after *IndReset*, the axis will turn in a positive direction less than 360 degrees in order to reach the position.

[ **\Bwd** ]    (*Backward*)    Data type: *switch*

The measurement system will change a whole number of revolutions on the axis side so that the reference position will be on the negative side of the specified *\RefPos* or *\RefNum* position. If a positioning instruction with the same position is executed after *IndReset*, the axis will turn in a negative direction less than 360 degrees in order to reach the position.

[ **\Old** ]    Data type: *switch*

Keeps the old position. Note that resolution is decreased in positions far away from zero.

If no argument *\Short*, *\Fwd*, *\Bwd* or *\Old* is specified - *\Old* is used as default value.

---

## Program execution

When *IndReset* is executed, it changes the independent axis back to normal mode. At the same time, the measurement system for the axis can be moved by a whole number of axis revolutions.

The instruction may also be used in normal mode in order to change the measurement system.

Note that the position is used only to adjust the measurement system - the axis will not move to the position.

---

## Limitations

The instruction may only be executed when all active axes running in normal mode are standing still. The independent mode axis which is going to be changed to normal mode must also be stationary. For axes in normal mode this is achieved by executing a move instruction with the argument *fine*. The independent axis is stopped by an *IndCMove* with *Speed:=0* (followed by a wait period of 0.2 seconds), *IndRMove*, *IndAMove* or *IndDMove* instruction.

The resolution of positions is decreased when moving away from logical position 0. An axis which progressively rotates further and further from the position 0 should thus be set to zero using the instruction *IndReset* with an argument other than *\Old*.

The measurement system cannot be changed for linear axes.

To ensure a proper start after *IndReset* of an axis with a relative measured measurement system (synchronization switches), an extra time delay of 0.12 seconds must be added after the *IndReset* instruction.

Only robot axis 6 can be used as independent axis. The *IndReset* instruction can also be used for axis 4 on models IRB2400 and IRB 4400. If *IndReset* is used on robot axis 4, then axis 6 must not be in the independent mode.

---

## Example

```
IndAMove Station_A,1\ToAbsNum:=750,50;  
WaitUntil IndInpos(Station_A,1);  
WaitTime 0.2;  
IndReset Station_A,1 \RefNum:=0 \Short;  
.  
IndAMove Station_A,1\ToAbsNum:=750,50;  
WaitUntil IndInpos(Station_A,1);  
WaitTime 0.2;  
IndReset Station_A,1 \RefNum:=300 \Short;
```

Axis 1 in *Station\_A* is first moved independently to the 750 degrees position (2 revolutions and 30 degrees). At the same time as it changes to normal mode, the logical position is set to 30 degrees.

Axis 1 in *Station\_A* is subsequently moved to the 750 degrees position (2 revolutions and 30 degrees). At the same time as it changes to normal mode, the logical position is set to 390 degrees (1 revolution and 30 degrees).



---

## Error handling

If the axis is moving, the system variable ERRNO is set to ERR\_AXIS\_MOVING.

If the axis is not activated, the system variable ERRNO is set to ERR\_AXIS\_ACT. This error can then be handled in the error handler.

---

## Syntax

```
IndReset
  [ MecUnit':=' ] < variable (VAR) of mecunit> ', '
  [ Axis':=' ] < expression (IN) of num>
  [ '\ RefPos':=' < expression (IN) of robtarg> ]
  | [ '\ RefNum':=' < expression (IN) of num> ]
  [ '\ Short ] | [ '\ Fwd ] | [ '\ Bwd ] | [ '\ Old ]';
```

---

## Related information

	<u>Described in:</u>
Independent axes in general	Motion and I/O Principles - <i>Program execution</i>
Change an axis to independent mode	Instructions - <i>IndAMove, IndCMove,</i> <i>IndDMove, IndRMove</i>
Check the speed status for independent axes	Functions - <i>IndSpeed</i>
Check the position status for independent axes	Functions - <i>IndInpos</i>

---



---

## IndRMove Independent Relative position Movement

*IndRMove* is used to change a rotational axis to independent mode and move the axis to a specific position within one revolution.

An independent axis is an axis moving independently of other axes in the robot system. As program execution continues immediately, it is possible to execute other instructions (including positioning instructions) during the time the independent axis is moving.

If the axis is to be moved to an absolute position (several revolutions) or if the axis is linear, the instruction *IndAMove* is used instead. If the movement is to take place a certain distance from the current position, the instruction *IndDMove* must be used.

---

### Example

```
IndRMove Station_A,2\ToRelPos:=p5 \Short,20;
```

Axis 2 of *Station\_A* is moved the shortest route to position *p5* within one revolution (maximum rotation  $\pm 180$  degrees) at a speed of 20 degrees/s.

---

### Arguments

**IndRMove MecUnit Axis [ \ToRelPos ] [ \ToRelNum ] [ \Short ] [ \Fwd ] [ \Bwd ] Speed [ \Ramp ]**

**MecUnit** (Mechanical Unit) Data type: *mecunit*

The name of the mechanical unit.

**Axis** Data type: *num*

The number of the current axis for the mechanical unit (1-6).

**[ \ToRelPos ]** (To Relative Position) Data type: *robtarg*

Axis position specified as a *robtarg*. Only the component for this specific axis is used. The value is used as a position value in degrees within one axis revolution. This means that the axis moves less than one revolution.

The axis position will be affected if the axis is displaced using the instruction *EOffsSet* or *EOffsOn*.

For robot axes, the argument *\ToRelNum* is to be used instead.



During stepwise execution of the instruction, the axis is set in independent mode only. The axis starts its movement when the next instruction is executed, and continues as long as program execution continues. For more information see Chapter 6, Motion and I/O principles.

When the program pointer is moved to the beginning of the program, or to a new routine, all axes are automatically set to normal mode, without changing the measurement system (equivalent to running the instruction *IndReset \Old*).

## Limitations

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually, the axis will not move, and an error message will be displayed. Execute an *IndReset* instruction or move the program pointer to main, in order to leave independent mode.

If a loss of voltage occurs when the axis is in independent mode, the program cannot be restarted. An error message is displayed, and the program must be started from the beginning.

## Examples

```
IndRMove Station_A,1\ToRelPos:=p5 \Fwd,20\Ramp:=50;
```

Axis 1 of *Station\_A* starts to move in a positive direction to the position *p5* within one revolution (maximum rotation 360 degrees) at a speed of 20 degrees/s. The speed is changed with acceleration/deceleration reduced to 50% of maximum performance.

```
IndAMove Station_A,1\ToAbsNum:=90,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
IndRMove Station_A,1\ToRelNum:=80 \Fwd,20;
WaitTime 0.2;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndRMove Station_A,1\ToRelNum:=50 \Bwd,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndRMove Station_A,1\ToRelNum:=150 \Short,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndAMove Station_A,1\ToAbsNum:=10,20;
```

Axis 1 of *Station\_A* is moved to the following positions:

- 90 degrees
- 440 degrees (1 revolution + 80 degrees)
- 410 degrees (1 revolution + 50 degrees)
- 510 degrees (1 revolution + 150 degrees)
- 10 degrees

---

## Error handling

If the axis is not activated, the system variable ERRNO is set to ERR\_AXIS\_ACT. This error can then be handled in the error handler.

---

## Syntax

```
IndRMove
  [ MecUnit':=' ] < variable (VAR) of mecunit> ','
  [ Axis':=' ] < expression (IN) of num>
  [ '\ToRelPos':=' < expression (IN) of robtargets> ]
  | [ '\ToRelNum':=' < expression (IN) of num> ]
  [ '\Short ] | [ '\ Fwd ] | [ '\ Bwd ] ','
  [ Speed ':=' ] < expression (IN) of num>
  [ '\Ramp':=' < expression (IN) of num > ] ';'

```

---

## Related information

	<u>Described in:</u>
Independent axes in general	Motion and I/O Principles - <i>Program execution</i>
Change back to normal mode	Instructions - <i>IndReset</i>
Reset the measurement system	Instructions - <i>IndReset</i>
Move an independent axis to an absolute position	Instructions - <i>IndAMove</i>
Move an independent axis a specific distance	Instructions - <i>IndDMove</i>
More examples	Instructions - <i>IndCMove</i>
Check the speed status for independent axes	Functions - <i>IndSpeed</i>
Check the position status for independent axes	Functions - <i>IndInpos</i>

---



---

## InvertDO      Inverts the value of a digital output signal

*InvertDO* (*Invert Digital Output*) inverts the value of a digital output signal (0 -> 1 and 1 -> 0).

---

### Example

```
InvertDO do15;
```

The current value of the signal *do15* is inverted.

---

### Arguments

**InvertDO    Signal**

**Signal**

Data type: *signaldo*

The name of the signal to be inverted.

---

### Program execution

The current value of the signal is inverted (see Figure 1).

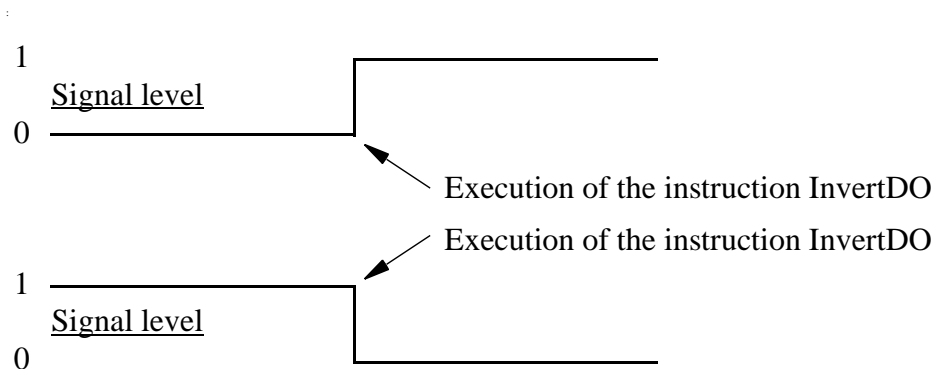


Figure 1 Inversion of a digital output signal.

---

### Syntax

```
InvertDO
  [ Signal ':=' ] < variable (VAR) of signaldo > ',';
```

---

**Related information**

	<u>Described in:</u>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	System Parameters

---

---

## IODisable

## Disable I/O unit

*IODisable* is used to disable an I/O unit during program execution (only in the S4C system).

I/O units are automatically enabled after start-up if they are defined in the system parameters. When required for some reason, I/O units can be disabled or enabled during program execution.

---

### Examples

```
IODisable "cell1", 5;
```

Disable I/O unit with name *cell1*. Wait max. 5 s.

---

### Arguments

#### IODisable UnitName MaxTime

##### UnitName

Data type: *string*

The name of the I/O unit to be disabled (with same name as configured).

##### MaxTime

Data type: *num*

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the I/O unit has finished the disable steps, the error handler will be called, if there is one, with the error code `ERR_IODISABLE`. If there is no error handler, the execution will be stopped.

To disable an I/O unit takes about 2-5 s.

---

### Program execution

The specified I/O unit starts the disable steps. The instruction is ready when the disable steps are finished. If the *MaxTime* runs out before the I/O unit has finished the disable steps, a recoverable error will be generated.

After disabling an I/O unit, any setting of outputs in this unit will result in an error.



---

**Example**

```

PROC go_home()
  VAR num recover_flag :=0;
  ...
  ! Start to disable I/O unit cell1
  recover_flag := 1;
  IODisable "cell1", 0;
  ! Move to home position
  MoveJ home, v1000,fine,tool1;
  ! Wait until disable of I/O unit cell1 is ready
  recover_flag := 2;
  IODisable "cell1", 5;
  ...
  ERROR
  IF ERRNO = ERR_IODISABLE THEN
    IF recover_flag = 1 THEN
      TRYNEXT;
    ELSEIF recover_flag = 2 THEN
      RETRY;
    ENDIF
  ELSEIF ERRNO = ERR_EXCRTYMAX THEN
    ErrWrite "IODisable error", "Not possible to disable I/O unit cell1";
    Stop;
  ENDIF
ENDPROC

```

To save cycle time, the I/O unit *cell1* is disabled during robot movement to the *home* position. With the robot at the *home* position, a test is done to establish whether or not the I/O unit *cell1* is fully disabled. After the max. number of retries (5 with a waiting time of 5 s), the robot execution will stop with an error message.

The same principle can be used with *IOEnable* (this will save more cycle time compared with *IODisable*).

---

**Syntax**

```

IODisable
  [ UnitName ':= ' ] < expression (IN) of string > ','
  [ MaxTime ':= ' ] < expression (IN) of num > ','

```

---

**Related information**

	<u>Described in:</u>
Enabling an I/O unit	Instructions - <i>IOEnable</i>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	User's Guide - <i>System Parameters</i>



## IOEnable

## Enable I/O unit

*IOEnable* is used to enable an I/O unit during program execution (only in the S4C system).

I/O units are automatically enabled after start-up if they are defined in the system parameters. When required for some reason, I/O units can be disabled or enabled during program execution.

---

### Examples

```
IOEnable "cell1", 5;
```

Enable I/O unit with name *cell1*. Wait max. 5 s.

---

### Arguments

#### IOEnable UnitName MaxTime

##### UnitName

Data type: *string*

The name of the I/O unit to be enabled (with same name as configured).

##### MaxTime

Data type: *num*

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the I/O unit has finished the enable steps, the error handler will be called, if there is one, with the error code `ERR_IOENABLE`. If there is no error handler, the execution will be stopped.

To enable an I/O unit takes about 2-5 s.

---

### Program execution

The specified I/O unit starts the enable steps. The instruction is ready when the enable steps are finished. If the *MaxTime* runs out before the I/O unit has finished the enable steps, a recoverable error will be generated.

After a sequence of *IODisable* - *IOEnable*, all outputs for the current I/O unit will be set to the old values (before *IODisable*).

---

## Example

*IOEnable* can also be used to check whether some I/O unit is disconnected for some reason.

```
VAR num max_retry:=0;
...
IOEnable "cell1", 0;
SetDO cell1_sig3, 1;
...
ERROR
  IF ERRNO = ERR_IOENABLE THEN
    IF max_retry < 5 THEN
      WaitTime 1;
      max_retry := max_retry + 1;
      RETRY;
    ELSE
      RAISE;
    ENDIF
  ENDIF
```

Before using signals on the I/O unit *cell1*, a test is done by trying to enable the I/O unit with timeout after 0 sec. If the test fails, a jump is made to the error handler. In the error handler, the program execution waits for 1 sec. and a new retry is made. After 5 retry attempts the error ERR\_IOENABLE is propagated to the caller of this routine.

---

## Syntax

```
IOEnable
  [ UnitName ':=' ] < expression (IN) of string > ','
  [ MaxTime ':=' ] < expression (IN) of num > ','
```

---

## Related information

	<u>Described in:</u>
More examples	Instructions - <i>IODisable</i>
Disabling an I/O unit	Instructions - <i>IODisable</i>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	User's Guide - <i>System Parameters</i>

---



---

## ISignalDI Orders interrupts from a digital input signal

*ISignalDI (Interrupt Signal Digital In)* is used to order and enable interrupts from a digital input signal.

System signals can also generate interrupts.

---

### Examples

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalDI di1,1,sig1int;
```

Orders an interrupt which is to occur each time the digital input signal *di1* is set to *1*. A call is then made to the *iroutine1* trap routine.

```
ISignalDI di1,0,sig1int;
```

Orders an interrupt which is to occur each time the digital input signal *di1* is set to *0*.

```
ISignalDI \Single, di1,1,sig1int;
```

Orders an interrupt which is to occur only the first time the digital input signal *di1* is set to *1*.

---

### Arguments

#### **ISignalDI [ \Single ] Signal TriggValue Interrupt**

**[ \Single ]** Data type: *switch*

Specifies whether the interrupt is to occur once or cyclically.

If the argument *Single* is set, the interrupt occurs once at the most. If the argument is omitted, an interrupt will occur each time its condition is satisfied.

**Signal** Data type: *signalDI*

The name of the signal that is to generate interrupts.

**TriggValue** Data type: *dionum*

The value to which the signal must change for an interrupt to occur.

The value is specified as 0 or 1 or as a symbolic value (e.g. *open/close*). The signal is edge-triggered upon changeover to 0 or 1.

**Interrupt**Data type: *intnum*

The interrupt identity. This should have previously been connected to a trap routine by means of the instruction *CONNECT*.

**Program execution**

When the signal assumes the specified value, a call is made to the corresponding trap routine. When this has been executed, program execution continues from where the interrupt occurred.

If the signal changes to the specified value before the interrupt is ordered, no interrupt occurs (see Figure 1).

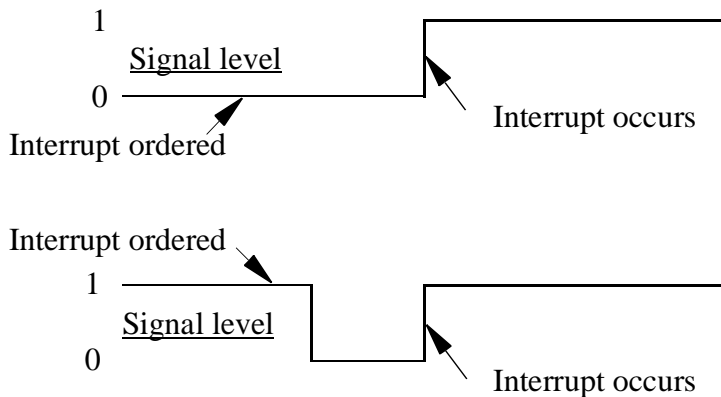


Figure 1 Interrupts from a digital input signal at signal level 1.

**Limitations**

The same variable for interrupt identity cannot be used more than once, without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ( )
  VAR intnum sig lint;
  CONNECT sig lint WITH iroutine1;
  ISignalDI di1, 1, sig lint;
  WHILE TRUE DO
  :
  :
  ENDWHILE
ENDPROC
```

All activation of interrupts is done at the beginning of the program. These instructions are then kept outside the main flow of the program.

```

PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalDI di1, 1, sig1int;
  :
  :
  IDelete sig1int;
ENDPROC

```

The interrupt is deleted at the end of the program, and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

---

## Syntax

```

ISignalDI
[ '\ Single', ]
[ Signal ':=' ] < variable (VAR) of signal > ', '
[ TriggValue ':=' ] < expression (IN) of dionum > ', '
[ Interrupt ':=' ] < variable (VAR) of intnum > ', '

```

---

## Related information

	<u>Described in:</u>
Summary of interrupts	RAPID Summary - <i>Interrupts</i>
Interrupt from an output signal	Instructions - <i>ISignalDO</i>
More information on interrupt management	Basic Characteristics - <i>Interrupts</i>
More examples	Data Types - <i>intnum</i>





---



---

## ISignalDO Interrupts from a digital output signal

*ISignalDO* (*Interrupt Signal Digital Out*) is used to order and enable interrupts from a digital output signal.

System signals can also generate interrupts.

---

### Examples

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalDO do1,1,sig1int;
```

Orders an interrupt which is to occur each time the digital output signal *do1* is set to *1*. A call is then made to the *iroutine1* trap routine.

```
ISignalDO do1,0,sig1int;
```

Orders an interrupt which is to occur each time the digital output signal *do1* is set to *0*.

```
ISignalDO\Single, do1,1,sig1int;
```

Orders an interrupt which is to occur only the first time the digital output signal *do1* is set to *1*.

---

### Arguments

#### **ISignalDO** [ \Single ] **Signal TriggValue Interrupt**

[ \Single ] Data type: *switch*

Specifies whether the interrupt is to occur once or cyclically.

If the argument *Single* is set, the interrupt occurs once at the most. If the argument is omitted, an interrupt will occur each time its condition is satisfied.

**Signal** Data type: *signaldo*

The name of the signal that is to generate interrupts.

**TriggValue** Data type: *dionum*

The value to which the signal must change for an interrupt to occur.

The value is specified as 0 or 1 or as a symbolic value (e.g. *open/close*). The signal is edge-triggered upon changeover to 0 or 1.

**Interrupt**Data type: *intnum*

The interrupt identity. This should have previously been connected to a trap routine by means of the instruction *CONNECT*.

**Program execution**

When the signal assumes the specified value, a call is made to the corresponding trap routine. When this has been executed, program execution continues from where the interrupt occurred.

If the signal changes to the specified value before the interrupt is ordered, no interrupt occurs (see Figure 1).

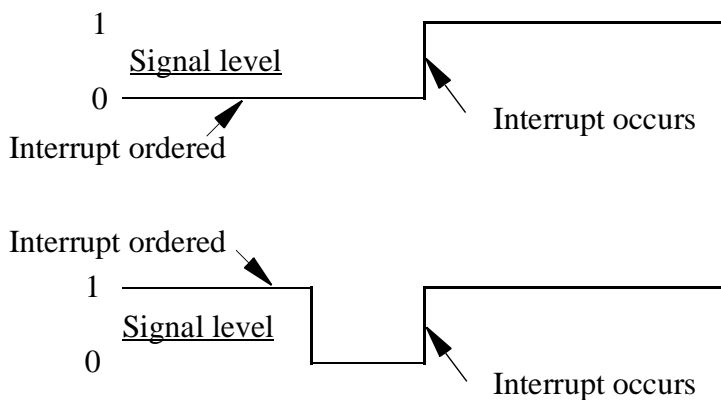


Figure 1 Interrupts from a digital output signal at signal level 1.

**Limitations**

The same variable for interrupt identity cannot be used more than once, without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalDO do1, 1, sig1int;
  WHILE TRUE DO
    :
    :
  ENDWHILE
ENDPROC
```

All activation of interrupts is done at the beginning of the program. These instructions are then kept outside the main flow of the program.

```

PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalDO do1, 1, sig1int;
  :
  :
  IDelete sig1int;
ENDPROC

```

The interrupt is deleted at the end of the program, and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

---

## Syntax

```

ISignalDO
  [ '\ Single' ]
  [ Signal ':=' ] < variable (VAR) of signaldo > ','
  [ TriggValue ':=' ] < expression (IN) of dionum > ','
  [ Interrupt ':=' ] < variable (VAR) of intnum > ','

```

---

## Related information

	<u>Described in:</u>
Summary of interrupts	RAPID Summary - <i>Interrupts</i>
Interrupt from an input signal	Instructions - <i>ISignalDI</i>
More information on interrupt management	Basic Characteristics- <i>Interrupts</i>
More examples	Data Types - <i>intnum</i>



---



---

## ISleep Deactivates an interrupt

*ISleep (Interrupt Sleep)* is used to deactivate an individual interrupt temporarily.

---

### Example

```
ISleep siglint;
```

The interrupt *siglint* is deactivated.

---

### Arguments

**ISleep Interrupt**

**Interrupt**

Data type: *intnum*

The variable (interrupt identity) of the interrupt.

---

### Program execution

The event connected to this interrupt does not generate any interrupts until the interrupt has been re-activated by means of the instruction *IWatch*. Interrupts which are generated whilst *ISleep* is in effect are ignored.

---

### Example

```
VAR intnum timeint;
CONNECT timeint WITH check_serialch;
ITimer 60, timeint;
.
ISleep timeint;
WriteBin ch1, buffer, 30;
IWatch timeint;
.
TRAP check_serialch
  WriteBin ch1, buffer, 1;
  IF ReadBin(ch1\Time:=5) < 0 THEN
    TPWrite "The serial communication is broken";
    EXIT;
  ENDIF
ENDTRAP
```

Communication across the ch1 serial channel is monitored by means of interrupts which are generated every 60 seconds. The trap routine checks whether the

communication is working. When, however, communication is in progress, these interrupts are not permitted.

---

## **Error handling**

Interrupts which have neither been ordered nor enabled are not permitted. If the interrupt number is unknown, the system variable ERRNO will be set to ERR\_UNKINO (see “Data types - errnum”). The error can be handled in the error handler.

---

## **Syntax**

```
ISleep  
  [ Interrupt ‘:=’ ] < variable (VAR) of intnum > ‘;’
```

---

## **Related information**

Summary of interrupts

Enabling an interrupt

Disabling all interrupts

Cancelling an interrupt

### Described in:

RAPID Summary - *Interrupts*

Instructions - *IWatch*

Instructions - *IDisable*

Instructions - *IDelete*

---



---

## ITimer Orders a timed interrupt

*ITimer* (*Interrupt Timer*) is used to order and enable a timed interrupt.

This instruction can be used, for example, to check the status of peripheral equipment once every minute.

---

### Examples

```
VAR intnum timeint;
CONNECT timeint WITH iroutine1;
ITimer 60, timeint;
```

Orders an interrupt that is to occur cyclically every *60* seconds. A call is then made to the trap routine *iroutine1*.

```
ITimer \Single, 60, timeint;
```

Orders an interrupt that is to occur once, after *60* seconds.

---

### Arguments

#### ITimer [ \Single ] Time Interrupt

[ \Single ] Data type: *switch*

Specifies whether the interrupt is to occur once or cyclically.

If the argument *Single* is set, the interrupt occurs only once. If the argument is omitted, an interrupt will occur each time at the specified time.

**Time** Data type: *num*

The amount of time that must lapse before the interrupt occurs.

The value is specified in second if *Single* is set, this time may not be less than 0.05 seconds. The corresponding time for cyclical interrupts is 0.25 seconds.

**Interrupt** Data type: *intnum*

The variable (interrupt identity) of the interrupt. This should have previously been connected to a trap routine by means of the instruction *CONNECT*.

---

### Program execution

The corresponding trap routine is automatically called at a given time following the interrupt order. When this has been executed, program execution continues from where the interrupt occurred.



If the interrupt occurs cyclically, a new computation of time is started from when the interrupt occurs.

---

## Example

```

VAR intnum timeint;
CONNECT timeint WITH check_serialch;
ITimer 60, timeint;

.
TRAP check_serialch
  WriteBin ch1, buffer, 1;
  IF ReadBin(ch1\Time:=5) < 0 THEN
    TPWrite "The serial communication is broken";
    EXIT;
  ENDIF
ENDTRAP

```

Communication across the ch1 serial channel is monitored by means of interrupts which are generated every 60 seconds. The trap routine checks whether the communication is working. If it is not, program execution is interrupted and an error message appears.

---

## Limitations

The same variable for interrupt identity cannot be used more than once, without being first deleted. See Instructions - *ISignalDI*.

---

## Syntax

```

ITimer
  [ '\Single ',' ]
  [ Time ':=' ] < expression (IN) of num > ','
  [ Interrupt ':=' ] < variable (VAR) of intnum > ','

```

---

## Related information

	<u>Described in:</u>
Summary of interrupts	RAPID Summary - <i>Interrupts</i>
More information on interrupt management	Basic Characteristics- <i>Interrupts</i>

---



---

## IVarValue Orders a variable value interrupt

*IVarVal(Interrupt Variable Value)* is used to order and enable an interrupt when the value of a variable accessed via the serial sensor interface has been changed.

This instruction can be used, for example, to get seam volume or gap values from a seam tracker.

---

### Examples

```

LOCAL PERS num adtVlt{25}:=[1,1.2,1.4,1.6,1.8,2,2.16667,2.33333,2.5,...];
LOCAL PERS num adptWfd{25}:=[2,2.2,2.4,2.6,2.8,3,3.16667,3.33333,3.5,...];
LOCAL PERS num adptSpd{25}:=[10,12,14,16,18,20,21.6667,23.3333,25,...];
LOCAL CONST num GAP_VARIABLE_NO:=11;
PERS num gap_value;
VAR intnum IntAdap;

PROC main()
! Setup the interrupt. The trap routine AdapTrp will be called
! when the gap variable with number 'GAP_VARIABLE_NO' in
! the sensor interface has been changed. The new value will be available
! in the PERS gp_value variable.
  CONNECT IntAdap WITH AdapTrp;
  IVarValue GAP_VARIABLE_NO, gap_value, IntAdap;

  ! Start welding
  ArcL\On,*,v100,adaptSm,adaptWd,adaptWv,z10,tool\j\Track:=track;
  ArcL\On,*,v100,adaptSm,adaptWd,adaptWv,z10,tool\j\Track:=track;
ENDPROC

TRAP AdapTrap
  VAR num ArrInd;

  !Scale the raw gap value received
  ArrInd:=ArrIdx(gap_value);

  ! Update active welddata PERS variable 'adaptWd' with
  ! new data from the arrays of predefined parameter arrays.
  ! The scaled gap value is used as index in the voltage, wirefeed and speed arrays.
  adaptWd.weld_voltage:=adptVlt{ ArrInd};
  adaptWd.weld_wirefeed:=adptWfd{ ArrInd};
  adaptWd.weld_speed:=adptSpd{ ArrInd};

  !Request a refresh of AW parameters using the new data i adaptWd
  ArcRefresh;
ENDTRAP

```

---

## Arguments

### IVarValue    VarNo Value, Interrupt

#### VarNo

Data type: *num*

The number of the variable to be supervised.

#### Value

Data type: *num*

A PERS variable which will hold the new value of VarNo.

#### Interrupt

Data type: *intnum*The variable (interrupt identity) of the interrupt. This should have previously been connected to a trap routine by means of the instruction *CONNECT*.

---

## Program execution

The corresponding trap routine is automatically called at a given time following the interrupt order. When this has been executed, program execution continues from where the interrupt occurred.

---

## Limitations

The same variable for interrupt identity cannot be used more than five times, without first being deleted.

---

## Syntax

IVarValue

[ VarNo ':= ' ] < expression (**IN**) of *num* > ';[ Value ':= ' ] < persistent(**PERS**) of *num* > ';[ Interrupt ':= ' ] < variable (**VAR**) of *intnum* > ';

---

## Related information

Summary of interrupts

More information on interrupt management

Described in:RAPID Summary - *Interrupts*Basic Characteristics- *Interrupts*



---

**Syntax**

IWatch  
[ Interrupt ':=' ] < variable (**VAR**) of *intnum* > ';'

---

**Related information**

Summary of interrupts  
Deactivating an interrupt

Described in:  
RAPID Summary - *Interrupts*  
Instructions - *ISleep*

---

---

**label****Line name**

*Label* is used to name a line in the program. Using the *GOTO* instruction, this name can then be used to move program execution.

---

**Example**

```
GOTO next;  
.  
next:
```

Program execution continues with the instruction following *next*.

---

**Arguments****Label:****Label**

Identifier

The name you wish to give the line.

---

**Program execution**

Nothing happens when you execute this instruction.

---

**Limitations**

The label must not be the same as

- any other label within the same routine,
- any data name within the same routine.

A label hides global data and routines with the same name within the routine it is located in.

---

**Syntax**

(EBNF)  
<identifier>'.'

---

**Related information**

	<u>Described in:</u>
Identifiers	Basic Characteristics- <i>Basic Elements</i>
Moving program execution to a label	Instructions - <i>GOTO</i>

---

---

## Load            Load a program module during execution

*Load* is used to load a program module into the program memory during execution.

The loaded program module will be added to the already existing modules in the program memory.

---

### Example

```
Load ram1disk \File:="PART_A.MOD";
```

*Load* the program module *PART\_A.MOD* from the *ram1disk* into the program memory. (*ram1disk* is a predefined string constant "ram1disk:").

---

### Arguments

#### Load FilePath [\File]

##### FilePath

Data type: *string*

The file path and the file name to the file that will be loaded into the program memory. The file name shall be excluded when the argument *\File* is used.

##### [\File]

Data type: *string*

When the file name is excluded in the argument *FilePath* then it must be defined with this argument.

---

### Program execution

Program execution waits for the program module to finish loading before proceeding with the next instruction.

To obtain a good program structure, that is easy to understand and maintain, all loading and unloading of program modules should be done from the main module which is always present in the program memory during execution.

After the program module is loaded it will be linked and initialised. The initialisation of the loaded module sets all variables at module level to their init values. Unresolved references will be accepted if the system parameter for *Load* is set (*BindRef* = NO). However, when the program is started, the teach pendant function Program/File/Check program will not check for unresolved references if the parameter *BindRef* = NO. There will be a run time error on execution of an unresolved reference.



## Examples

Load "ram1disk:DOORDIR/DOOR1.MOD";

Load the program module *DOOR1.MOD* from the *ram1disk* at the directory *DOORDIR* into the program memory.

Load "ram1disk:DOORDIR" \File:="DOOR1.MOD";

Same as above but another syntax.

---

## Limitations

It is not allowed to load a program module that contains a main routine.

TRAP routines, system I/O events and other program tasks cannot execute during the loading.

Avoid ongoing robot movements during the loading.

Avoid using the floppy disk for loading since reading from the floppy drive is very time consuming.

A program stop during execution of the *Load* instruction results in a guard stop with motors off and the error message "20025 Stop order timeout" will be displayed on the Teach Pendant.

---

## Error handling

If the file in the *Load* instructions cannot be found, then the system variable ERRNO is set to ERR\_FILNOTFND. If the module already is loaded into the program memory then the system variable ERRNO is set to ERR\_LOADED (see "Data types - errnum"). The errors above can be handled in an error handler.

---

## Syntax

Load  
[FilePath':='<expression (IN) of *string*>  
['\File':=' <expression (IN) of *string*>'];'

---

**Related information**

Unload a program module  
Accept unresolved references

Described in:

Instructions - *UnLoad*  
System Parameters - *Controller*  
System Parameters - *Tasks*  
System Parameters - *BindRef*

*Load*

*Instructions*

---



---

## MoveAbsJ Moves the robot to an absolute joint position

*MoveAbsJ* (*Move Absolute Joint*) is used to move the robot to an absolute position, defined in axes positions.

This instruction need only be used when:

- the end point is a singular point
- for ambiguous positions on the IRB 6400C, e.g. for movements with the tool over the robot.

The final position of the robot, during a movement with *MoveAbsJ*, is neither affected by the given tool and work object, nor by active program displacement. However, the robot uses these data to calculating the load, TCP velocity, and the corner path. The same tools can be used as in adjacent movement instructions.

The robot and external axes move to the destination position along a non-linear path. All axes reach the destination position at the same time.

---

### Examples

```
MoveAbsJ p50, v1000, z50, tool2;
```

The robot with the tool *tool2* is moved along a non-linear path to the absolute axis position, *p50*, with velocity data *v1000* and zone data *z50*.

```
MoveAbsJ *, v1000\T:=5, fine, grip3;
```

The robot with the tool *grip3*, is moved along a non-linear path to a stop point which is stored as an absolute axis position in the instruction (marked with an \*). The entire movement takes 5 s.

---

### Arguments

**MoveAbsJ** [ \Conc ] ToJointPos Speed [ \V ] [ \T ] Zone [ \Z ]  
Tool [ \WObj ]

[ \Conc ]

(Concurrent)

Data type: *switch*

Subsequent logical instructions are executed at once. The argument is used to shorten the cycle time when, for example, communicating with external equipment, if synchronisation is not required.

Using the argument \Conc, the number of movement instructions in succession is limited to 5. In a program section that includes StorePath-RestoPath, movement instructions with the argument \Conc are not permitted.

If this argument is omitted and the ToPoint is not a stop point, the subsequent instruction is executed some time before the robot has reached the programmed zone.

<b>ToJointPos</b>	<i>(To Joint Position)</i>	Data type: <i>jointtarget</i>
The destination absolute joint position of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).		
<b>Speed</b>		Data type: <i>speeddata</i>
The speed data that applies to movements. Speed data defines the velocity of the tool centre point, the tool reorientation and external axes.		
<b>[ \V ]</b>	<i>(Velocity)</i>	Data type: <i>num</i>
This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.		
<b>[ \T ]</b>	<i>(Time)</i>	Data type: <i>num</i>
This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.		
<b>Zone</b>		Data type: <i>zonedata</i>
Zone data for the movement. Zone data describes the size of the generated corner path.		
<b>[ \Z ]</b>	<i>(Zone)</i>	Data type: <i>num</i>
This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone specified in the zone data.		
<b>Tool</b>		Data type: <i>tooldata</i>
The tool in use during the movement.		
The position of the TCP and the load on the tool are defined in the tool data. The TCP position is used to decide the velocity and the corner path for the movement.		
<b>[ \WObj ]</b>	<i>(Work Object)</i>	Data type: <i>wobjdata</i>
The work object used during the movement.		
This argument can be omitted if the tool is held by the robot. However, if the robot holds the work object, i.e. the tool is stationary, or with coordinated external axes, then the argument must be specified.		
In the case of a stationary tool or coordinated external axes, the data used by the system to decide the velocity and the corner path for the movement, is defined in the work object.		

## Program execution

The tool is moved to the destination absolute joint position with interpolation of the axis angles. This means that each axis is moved with constant axis velocity and that all axes reach the destination joint position at the same time, which results in a non-linear path.

Generally speaking, the TCP is moved at approximate programmed velocity. The tool is reoriented and the external axes are moved at the same time as the TCP moves. If the programmed velocity for reorientation, or for the external axes, cannot be attained, the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of the path. If a stop point is specified in the zone data, program execution only continues when the robot and external axes have reached the appropriate joint position.

---

## Examples

```
MoveAbsJ *, v2000\V:=2200, z40 \Z:=45, grip3;
```

The tool, *grip3*, is moved along a non-linear path to a absolute joint position stored in the instruction. The movement is carried out with data set to *v2000* and *z40*, the velocity and zone size of the TCP are *2200* mm/s and *45* mm respectively.

```
MoveAbsJ \Conc, *, v2000, z40, grip3;
```

The tool, *grip3*, is moved along a non-linear path to a absolute joint position stored in the instruction. Subsequent logical instructions are executed while the robot moves.

```
GripLoad obj_mass;  
MoveAbsJ start, v2000, z40, grip3 \WObj:= obj;
```

The robot moves the work object *obj* in relation to the fixed tool *grip3* along a non-linear path to an absolute axis position *start*.

---

## Error handling

When running the program, a check is made that the arguments Tool and \WObj do not contain contradictory data with regard to a movable or a stationary tool respectively.

---

## Limitations

A movement with *MoveAbsJ* is not affected by active program displacement, but is affected by active offset for external axes.

In order to be able to run backwards with the instruction *MoveAbsJ* involved, and

avoiding problems with singular points or ambiguous areas, it is essential that the subsequent instructions fulfil certain requirements, as follows (see Figure 1).

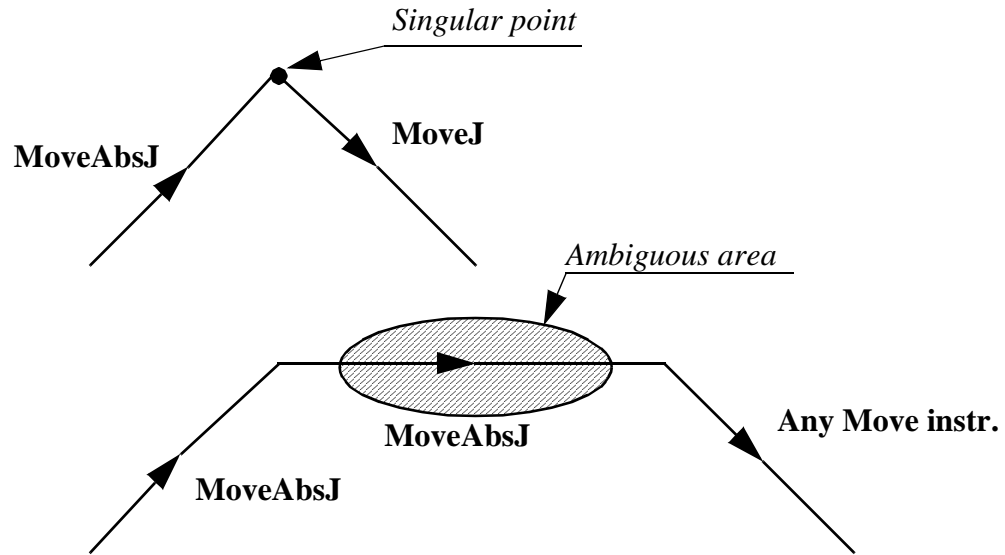


Figure 1 Limitation for backward execution with MoveAbsJ.

---

## Syntax

### MoveAbsJ

```
[ '\ Conc ' , ' ]
[ ToJointPos ' := ' ] < expression (IN) of jointtarget > ' , '
[ Speed ' := ' ] < expression (IN) of speeddata >
  [ '\ V ' := ' < expression (IN) of num > ]
  | [ '\ T ' := ' < expression (IN) of num > ] ' , '
[ Zone ' := ' ] < expression (IN) of zonedata >
  [ '\ Z ' := ' < expression (IN) of num > ] ' , '
[ Tool ' := ' ] < persistent (PERS) of tooldata >
[ '\ WObj ' := ' < persistent (PERS) of wobjdata > ] ' , '

```

---

**Related information**

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of jointtarget	Data Types - <i>jointtarget</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of zone data	Data Types - <i>zonedata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Motion in general	Motion and I/O Principles
Concurrent program execution	Motion and I/O Principles - <i>Synchronisation Using Logical Instructions</i>





---



---

## MoveC Moves the robot circularly

*MoveC* is used to move the tool centre point (TCP) circularly to a given destination. During the movement, the orientation normally remains unchanged relative to the circle.

---

### Examples

```
MoveC p1, p2, v500, z30, tool2;
```

The TCP of the tool, *tool2*, is moved circularly to the position *p2*, with speed data *v500* and zone data *z30*. The circle is defined from the start position, the circle point *p1* and the destination point *p2*.

```
MoveC *, *, v500 \T:=5, fine, grip3;
```

The TCP of the tool, *grip3*, is moved circularly to a fine point stored in the instruction (marked by the second \*). The circle point is also stored in the instruction (marked by the first \*). The complete movement takes 5 seconds.

```
MoveL p1, v500, fine, tool1;
MoveC p2, p3, v500, z20, tool1;
MoveC p4, p1, v500, fine, tool1;
```

A complete circle is performed if the positions are the same as those shown in Figure 1.

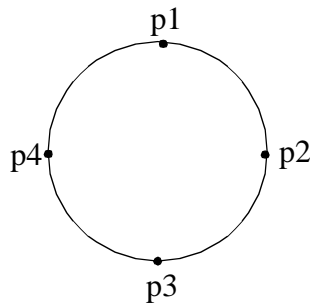


Figure 1 A complete circle is performed by two *MoveC* instructions.

---

### Arguments

```
MoveC [ \Conc ] CirPoint ToPoint Speed [ \V ] [ \T ] Zone [ \Z ]
Tool [ \WObj ] [ \Corr ]
```

[ \Conc ]

(Concurrent)

Data type: *switch*

Subsequent logical instructions are executed at once. This argument is used to shorten the cycle time when, for example, communicating with external equipment, if synchronisation is not required.

Using the argument \Conc, the number of movement instructions in succession is limited to 5. In a program section that includes StorePath-RestoPath, movement instructions with the argument \Conc are not permitted.

If this argument is omitted, and the ToPoint is not a Stop point the subsequent instruction is executed some time before the robot has reached the programmed zone.

**CirPoint** Data type: *robtarget*

The circle point of the robot. The circle point is a position on the circle between the start point and the destination point. To obtain the best accuracy, it should be placed about halfway between the start and destination points. If it is placed too close to the start or destination point, the robot may give a warning. The circle point is defined as a named position or stored directly in the instruction (marked with an \* in the instruction). The position of the external axes are not used.

**ToPoint** Data type: *robtarget*

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**Speed** Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity of the TCP, the tool reorientation and external axes.

[ \V ] (Velocity) Data type: *num*

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

[ \T ] (Time) Data type: *num*

This argument is used to specify the total time in seconds during which the robot and external axes move. It is then substituted for the corresponding speed data.

**Zone** Data type: *zonedata*

Zone data for the movement. Zone data describes the size of the generated corner path.

[ \Z ] (Zone) Data type: *num*

This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone specified in the zone data.

**Tool** Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point that is moved to the specified destination point.

[ \WObj] (Work Object) Data type: *wobjdata*

The work object (object coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified in order for a circle relative to the work object to be executed.

[ \Corr] (Correction) Data type: *switch*

Correction data written to a corrections entry by the instruction *CorrWrite* will be added to the path and destination position, if this argument is present.

## Program execution

The robot and external units are moved to the destination point as follows:

- The TCP of the tool is moved circularly at constant programmed velocity.
- The tool is reorientated at a constant velocity, from the orientation at the start position to the orientation at the destination point.
- The reorientation is performed relative to the circular path. Thus, if the orientation relative to the path is the same at the start and the destination points, the relative orientation remains unchanged during the movement (see Figure 2).

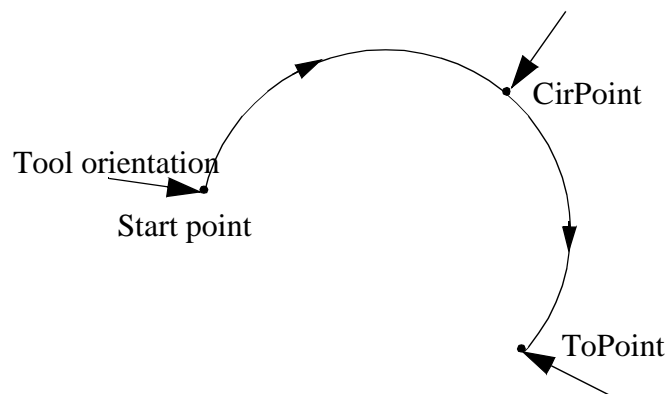


Figure 2 Tool orientation during circular movement.

- The orientation at the circle point is not critical; it is only used to distinguish between two possible directions of reorientation. The accuracy of the reorientation along the path depends only on the orientation at the start and destination points.
- Uncoordinated external axes are executed at constant velocity in order for them to arrive at the destination point at the same time as the robot axes. The position in the circle position is not used.

If it is not possible to attain the programmed velocity for the reorientation or for the external axes, the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of a path. If a stop point is specified in the zone data, program execution only continues when the robot and external axes have reached the appropriate position.

---

## Examples

```
MoveC *, *, v500 \V:=550, z40 \Z:=45, grip3;
```

The TCP of the tool, *grip3*, is moved circularly to a position stored in the instruction. The movement is carried out with data set to *v500* and *z40*; the velocity and zone size of the TCP are *550* mm/s and *45* mm respectively.

```
MoveC \Conc, *, *, v500, z40, grip3;
```

The TCP of the tool, *grip3*, is moved circularly to a position stored in the instruction. The circle point is also stored in the instruction. Subsequent logical instructions are executed while the robot moves.

```
MoveC cir1, p15, v500, z40, grip3 \WObj:=fixture;
```

The TCP of the tool, *grip3*, is moved circularly to a position, *p15*, via the circle point *cir1*. These positions are specified in the object coordinate system for *fixture*.

---

## Limitations

A change of execution mode from forward to backward or vice versa, while the robot is stopped on a circular path, is not permitted and will result in an error message.

The instruction *MoveC* (or any other instruction including circular movement) should never be started from the beginning, with TCP between the circle point and the end point. Otherwise the robot will not take the programmed path (positioning around the circular path in another direction compared with that programmed).

Make sure that the robot can reach the circle point during program execution and divide the circle segment if necessary.

---

**Syntax**

```

MoveC
  [ '\ Conc ',' ]
  [ CirPoint ':=' ] < expression (IN) of robtargt > ','
  [ ToPoint ':=' ] < expression (IN) of robtargt > ','
  [ Speed ':=' ] < expression (IN) of speeddata >
    [ '\ V ':=' < expression (IN) of num > ]
    | [ '\ T ':=' < expression (IN) of num > ] ','
  [ Zone ':=' ] < expression (IN) of zonedata >
    [ '\ Z ':=' < expression (IN) of num > ] ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\ WObj ':=' < persistent (PERS) of wobjdata > ]
  [ '\ Corr ]';

```

---

**Related information**

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of zone data	Data Types - <i>zonedata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Writes to a corrections entry	Instructions - <i>CorrWrite</i>
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
Concurrent program execution	Motion and I/O Principles - <i>Synchronisation Using Logical Instructions</i>



---



---

## MoveJ Moves the robot by joint movement

*MoveJ* is used to move the robot quickly from one point to another when that movement does not have to be in a straight line.

The robot and external axes move to the destination position along a non-linear path. All axes reach the destination position at the same time.

---

### Examples

```
MoveJ p1, vmax, z30, tool2;
```

The tool centre point (TCP) of the tool, *tool2*, is moved along a non-linear path to the position, *p1*, with speed data *vmax* and zone data *z30*.

```
MoveJ *, vmax \T:=5, fine, grip3;
```

The TCP of the tool, *grip3*, is moved along a non-linear path to a stop point stored in the instruction (marked with an \*). The entire movement takes 5 seconds.

---

### Arguments

**MoveJ** [ \Conc ] ToPoint Speed [ \V ] [ [ \T ] Zone [ \Z ] Tool [ \WObj ]

[ \Conc ] (Concurrent) Data type: *switch*

Subsequent logical instructions are executed at once. The argument is used to shorten the cycle time when, for example, communicating with external equipment, if synchronisation is not required.

Using the argument \Conc, the number of movement instructions in succession is limited to 5. In a program section that includes StorePath-RestoPath, movement instructions with the argument \Conc are not permitted.

If this argument is omitted the subsequent instruction is executed some time before the robot has reached the programmed zone.

**ToPoint** Data type: *robtaraget*

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**Speed** Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity of the tool centre point, the tool reorientation and external axes.



<b>[ \V ]</b>	<i>(Velocity)</i>	Data type: <i>num</i>
This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.		
<b>[ \T ]</b>	<i>(Time)</i>	Data type: <i>num</i>
This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.		
<b>Zone</b>		Data type: <i>zonedata</i>
Zone data for the movement. Zone data describes the size of the generated corner path.		
<b>[ \Z ]</b>	<i>(Zone)</i>	Data type: <i>num</i>
This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone specified in the zone data.		
<b>Tool</b>		Data type: <i>tooldata</i>
The tool in use when the robot moves. The tool centre point is the point moved to the specified destination point.		
<b>[ \WObj ]</b>	<i>(Work Object)</i>	Data type: <i>wobjdata</i>
The work object (coordinate system) to which the robot position in the instruction is related.		
This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified.		

---

## Program execution

The tool centre point is moved to the destination point with interpolation of the axis angles. This means that each axis is moved with constant axis velocity and that all axes reach the destination point at the same time, which results in a non-linear path.

Generally speaking, the TCP is moved at the approximate programmed velocity (regardless of whether or not the external axes are coordinated). The tool is reoriented and the external axes are moved at the same time as the TCP moves. If the programmed velocity for reorientation, or for the external axes, cannot be attained, the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of the path. If a stop point is specified in the zone data, program execution only continues when the robot and external axes have reached the appropriate position.

---

**Examples**

```
MoveJ *, v2000\V:=2200, z40 \Z:=45, grip3;
```

The TCP of the tool, *grip3*, is moved along a non-linear path to a position stored in the instruction. The movement is carried out with data set to *v2000* and *z40*; the velocity and zone size of the TCP are *2200* mm/s and *45* mm respectively.

```
MoveJ \Conc, *, v2000, z40, grip3;
```

The TCP of the tool, *grip3*, is moved along a non-linear path to a position stored in the instruction. Subsequent logical instructions are executed while the robot moves.

```
MoveJ start, v2000, z40, grip3 \WObj:=fixture;
```

The TCP of the tool, *grip3*, is moved along a non-linear path to a position, *start*. This position is specified in the object coordinate system for *fixture*.

---

**Syntax**

```
MoveJ
  [ '\ Conc ' , ' ]
  [ ToPoint ':=' ] < expression (IN) of robtarg > ' , '
  [ Speed ':=' ] < expression (IN) of speeddata >
    [ '\ V ':=' < expression (IN) of num > ]
    | [ '\ T ':=' < expression (IN) of num > ] ' , '
  [ Zone ':=' ] < expression (IN) of zonedata >
    [ '\ Z ':=' < expression (IN) of num > ] ' , '
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\ WObj ':=' < persistent (PERS) of wobjdata > ] ' , '
  ' ; ' ;
```

---

**Related information**

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of zone data	Data Types - <i>zonedata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
Concurrent program execution	Motion and I/O Principles - <i>Synchronisation Using Logical Instructions</i>



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---

## Open                      Opens a file or serial channel

*Open* is used to open a file or serial channel for reading or writing.

---

### Example

```
VAR iodev logfile;
```

```
Open "flp1:LOGDIR" \File:= "LOGFILE1.DOC",logfile;
```

The file *LOGFILE1.DOC* in unit *flp1*: (diskette), directory *LOGDIR*, is opened for writing. The reference name *logfile* is used later in the program when writing to the file.

---

### Arguments

**Open**    **Object** [**File**] **IODevice** [**Read**] | [**Write**] | [**Append**] | [**Bin**]

**Object**Data type: *string*

The I/O object that is to be opened, e.g. "flp1:", "ram1disk:".

**[File]**Data type: *string*

The name of the file. This name can also be specified in the argument *Object*, e.g. "flp1:LOGDIR/LOGFILE.DOC".

**IODevice**Data type: *iodev*

A reference to the file or serial channel to open. This reference is then used for reading from and writing to the file/channel.

The arguments *\Read*, *\Write*, *\Append* and *\Bin* are mutually exclusive. If none of these are specified, the instruction acts in the same way as the *\Write* argument.

**[Read]**Data type: *switch*

Opens a character-based file or serial channel for reading. When reading from a file, the reading is started from the beginning of the file.

**[Write]**Data type: *switch*

Opens a character-based file or serial channel for writing. If the selected file already exists, its contents are deleted. Anything subsequently written is written at the start of the file.

**[Append]**Data type: *switch*

Opens a character-based file or serial channel for writing. If the selected file already exists, anything subsequently written is written at the end of the file.

**[Bin]**Data type: *switch*

Opens a binary serial channel for reading and writing.  
Works as append, i.e. file pointer at end of file.

**Example**

```
VAR iodev printer;
.
Open "sio1:", printer \Bin;
Write printer, "This is a message to the printer";
Close printer;
```

The serial channel *sio1:* is opened for binary reading and writing. The reference name *printer* is used later when writing to and closing the serial channel.

**Program execution**

The specified serial channel/file is activated so that it can be read from or written to. Several files can be open on the same unit at the same time.

**Error handling**

If a file cannot be opened, the system variable `ERRNO` is set to `ERR_FILEOPEN`. This error can then be handled in the error handler.

**Syntax**

```
Open
[Object :=] <expression (IN) of string>
['\File' :=] <expression (IN) of string>' ' ','
[IIODevice :=] <variable (VAR) of iodev>
['\Read' | ['\Write' | ['\Append' | ['\Bin' ]];'
```

**Related information**

Writing to and reading from  
serial channels and files

Described in:

RAPID Summary - *Communication*



<b>[ \V ]</b>	<i>(Velocity)</i>	Data type: <i>num</i>
<p>This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.</p>		
<b>[ \T ]</b>	<i>(Time)</i>	Data type: <i>num</i>
<p>This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.</p>		
<b>Zone</b>		Data type: <i>zonedata</i>
<p>Zone data for the movement. Zone data describes the size of the generated corner path.</p>		
<b>[ \Z ]</b>	<i>(Zone)</i>	Data type: <i>num</i>
<p>This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone specified in the zone data.</p>		
<b>Tool</b>		Data type: <i>tooldata</i>
<p>The tool in use when the robot moves. The tool centre point is the point moved to the specified destination position.</p>		
<b>[ \WObj ]</b>	<i>(Work Object)</i>	Data type: <i>wobjdata</i>
<p>The work object (coordinate system) to which the robot position in the instruction is related.</p> <p>This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary tool or coordinated external axes are used, this argument must be specified in order to perform a linear movement relative to the work object.</p>		
<b>[ \Corr ]</b>	<i>(Correction)</i>	Data type: <i>switch</i>
<p>Correction data written to a corrections entry by the instruction <i>CorrWrite</i> will be added to the path and destination position, if this argument is present.</p>		

---

## Program execution

The robot and external units are moved to the destination position as follows:

- The TCP of the tool is moved linearly at constant programmed velocity.
- The tool is reorientated at equal intervals along the path.
- Uncoordinated external axes are executed at a constant velocity in order for them to arrive at the destination point at the same time as the robot axes.

If it is not possible to attain the programmed velocity for the reorientation or for the external axes, the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of a path. If a stop point is specified in the zone data, program execution only continues when the robot and external axes have reached the appropriate position.

## Examples

```
MoveL *, v2000 \V:=2200, z40 \Z:=45, grip3;
```

The TCP of the tool, *grip3*, is moved linearly to a position stored in the instruction. The movement is carried out with data set to *v2000* and *z40*; the velocity and zone size of the TCP are *2200* mm/s and *45* mm respectively.

```
MoveL \Conc, *, v2000, z40, grip3;
```

The TCP of the tool, *grip3*, is moved linearly to a position stored in the instruction. Subsequent logical instructions are executed while the robot moves.

```
MoveL start, v2000, z40, grip3 \WObj:=fixture;
```

The TCP of the tool, *grip3*, is moved linearly to a position, *start*. This position is specified in the object coordinate system for *fixture*.

## Syntax

```
MoveL
  [ '\ Conc ', ]
  [ ToPoint ':=' ] < expression (IN) of robtarg > ', '
  [ Speed ':=' ] < expression (IN) of speeddata >
    [ '\ V ':=' < expression (IN) of num > ]
    | [ '\ T ':=' < expression (IN) of num > ] ', '
  [ Zone ':=' ] < expression (IN) of zonedata >
    [ '\ Z ':=' < expression (IN) of num > ] ', '
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\ WObj ':=' < persistent (PERS) of wobjdata > ]
  [ '\ Corr ]';'
```



---

**Related information**

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of zone data	Data Types - <i>zonedata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Writes to a corrections entry	Instructions - <i>CorrWrite</i>
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
Concurrent program execution	Motion and I/O Principles - <i>Synchronisation Using Logical Instructions</i>

---

---

## PathResol

## Override path resolution

*PathResol* (*Path Resolution*) is used to override the configured geometric path resolution (geometric sample time) defined in the system parameters for the manipulator.

---

### Description

The path resolution affects the accuracy of the interpolated path and the program cycle time. The path accuracy is improved and the cycle time is often reduced when the argument of *PathResol* is decreased. Too low a value for *PathResol* argument may however cause CPU load problems in some demanding applications. However, use of the standard configured path resolution (*PathResol* 100%) will avoid CPU load problems and provide sufficient path accuracy in most situations.

Example of *PathResol* usage:

Dynamically critical movements (max payload, high speed, combined joint motions close to the border of the work area) may cause CPU load problems. Increase the argument of *PathResol*.

Low performance external axes may cause CPU load problems during coordination. Increase the argument of *PathResol*.

Arc-welding with high frequency weaving may require high resolution of the interpolated path. Decrease the argument of *PathResol*.

Small circles or combined small movements with direction changes can decrease the path performance quality and increase the cycle time. Decrease the argument of *PathResol*.

Gluing with large reorientations and small corner zones can cause speed variations. Decrease the argument of *PathResol*.

---

### Example

```
MoveJ p1,v1000,fine,tool1;  
PathResol 150;
```

With the robot at a stop point, the path resolution is decreased to 150% of that configured.

---

### Arguments

#### PathResol Value

**Value**

Data type: *num*

Override as a percent of the configured path resolution

(a higher value decreases the path resolution).  
100% corresponds to the configured path resolution.  
Within the range 25-400%.

---

## Program execution

The path resolutions of all subsequent positioning instructions are affected until a new *PathResol* instruction is executed. This will affect the path resolution during all program execution of movements (default path level and path level after *StorePath*) and also during jogging.

The default value for override of path resolution is 100%. This value is automatically set

- at a cold start-up
- when a new program is loaded
- when starting program execution from the beginning.

The current override of path resolution can be read from the variable *C\_MOTSET* (data type *motsetdata*) in component *pathresol*.

---

## Limitations

The robot must be standing still at a stop point before overriding the path resolution. When there is a corner path in the program, the system will instead create a stop point (warning 50146) and it is not possible to restart in this instruction following a power failure.

---

## Syntax

```
PathResol  
[Value ':=' ] < expression (IN) of num> ';' ;
```

---

## Related information

Positioning instructions  
Motion settings  
Current override of path resolution

Described in:

Motion and I/O Principles- *Movements*  
RAPID Summary - *Motion Settings*  
Data Types - *System Data*

---

---

## **PDispOff**      **Deactivates program displacement**

*PDispOff* (*Program Displacement Off*) is used to deactivate a program displacement.

Program displacement is activated by the instruction *PDispSet* or *PDispOn* and applies to all movements until some other program displacement is activated or until program displacement is deactivated.

---

### **Examples**

```
PDispOff;
```

Deactivation of a program displacement.

```
MoveL p10, v500, z10, tool1;  
PDispOn \ExeP:=p10, p11, tool1;  
MoveL p20, v500, z10, tool1;  
MoveL p30, v500, z10, tool1;  
PDispOff;  
MoveL p40, v500, z10, tool1;
```

A program displacement is defined as the difference between the positions *p10* and *p11*. This displacement affects the movement to *p20* and *p30*, but not to *p40*.

---

### **Program execution**

Active program displacement is reset. This means that the program displacement coordinate system is the same as the object coordinate system, and thus all programmed positions will be related to the latter.

---

### **Syntax**

```
PDispOff ‘;’
```

---

### **Related information**

	<u>Described in:</u>
Definition of program displacement using two positions	Instructions - <i>PDispOn</i>
Definition of program displacement using values	Instructions - <i>PDispSet</i>



---



---

## **PDispOn**                      **Activates program displacement**

*PDispOn (Program Displacement On)* is used to define and activate a program displacement using two robot positions.

Program displacement is used, for example, after a search has been carried out, or when similar motion patterns are repeated at several different places in the program.

---

### **Examples**

```
MoveL p10, v500, z10, tool1;
PDispOn \ExeP:=p10, p20, tool1;
```

Activation of a program displacement (parallel movement). This is calculated based on the difference between positions *p10* and *p20*.

```
MoveL p10, v500, fine, tool1;
PDispOn *, tool1;
```

Activation of a program displacement (parallel movement). Since a stop point has been used in the previous instruction, the argument `\ExeP` does not have to be used. The displacement is calculated on the basis of the difference between the robot's actual position and the programmed point (\*) stored in the instruction.

```
PDispOn \Rot \ExeP:=p10, p20, tool1;
```

Activation of a program displacement including a rotation. This is calculated based on the difference between positions *p10* and *p20*.

---

### **Arguments**

**PDispOn** [ \Rot ] [ \ExeP ] ProgPoint Tool [ \WObj ]

**[ \Rot ]**    (*Rotation*)    Data type: *switch*

The difference in the tool orientation is taken into consideration and this involves a rotation of the program.

**[ \ExeP ]**    (*Executed Point*)    Data type: *robtarget*

The robot's new position at the time of the program execution.  
If this argument is omitted, the robot's current position at the time of the program execution is used.

**ProgPoint**    (*Programmed Point*)    Data type: *robtarget*

The robot's original position at the time of programming.

**Tool**

Data type: *tooldata*

The tool used during programming, i.e. the TCP to which the *ProgPoint* position is related.

**[\WObj]**

(*Work Object*)

Data type: *wobjdata*

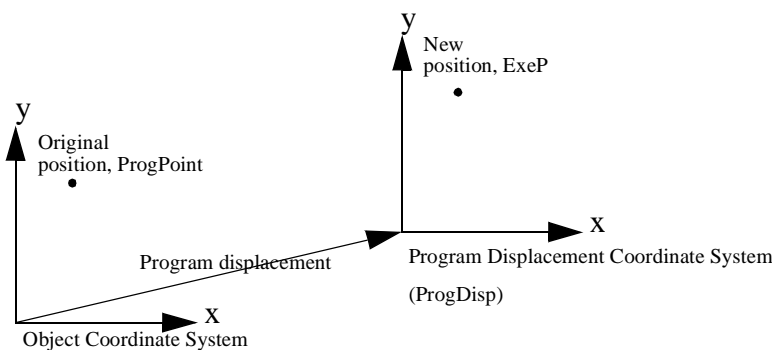
The work object (coordinate system) to which the *ProgPoint* position is related.

This argument can be omitted and, if it is, the position is related to the world coordinate system. However, if a stationary TCP or coordinated external axes are used, this argument must be specified.

The arguments *Tool* and *\WObj* are used both to calculate the *ProgPoint* during programming and to calculate the current position during program execution if no *ExeP* argument is programmed.

**Program execution**

Program displacement means that the *ProgDisp* coordinate system is translated in relation to the object coordinate system. Since all positions are related to the *ProgDisp* coordinate system, all programmed positions will also be displaced. See Figure 1.



*Figure 1 Displacement of a programmed position using program displacement.*

Program displacement is activated when the instruction *PDispOn* is executed and remains active until some other program displacement is activated (the instruction *PDispSet* or *PDispOn*) or until program displacement is deactivated (the instruction *PDispOff*).

Only one program displacement can be active at any one time. Several *PDispOn* instructions, on the other hand, can be programmed one after the other and, in this case, the different program displacements will be added.

Program displacement is calculated as the difference between *ExeP* and *ProgPoint*. If *ExeP* has not been specified, the current position of the robot at the time of the program execution is used instead. Since it is the actual position of the robot that is used, the robot should not move when *PDispOn* is executed.

If the argument *\Rot* is used, the rotation is also calculated based on the tool orientation

at the two positions. The displacement will be calculated in such a way that the new position (*ExeP*) will have the same position and orientation in relation to the displaced coordinate system, *ProgDisp*, as the old position (*ProgPoint*) had in relation to the original coordinate system (see Figure 2).

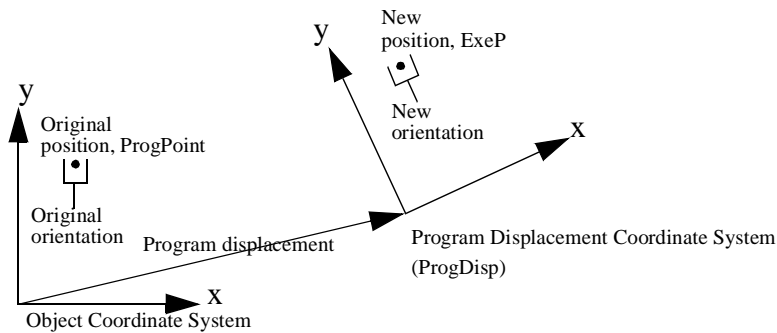


Figure 2 Translation and rotation of a programmed position.

The program displacement is automatically reset

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Example

```
PROC draw_square()
  PDispOn *, tool1;
  MoveL *, v500, z10, tool1;
  MoveL *, v500, z10, tool1;
  MoveL *, v500, z10, tool1;
  MoveL *, v500, z10, tool1;
  PDispOff;
ENDPROC
.
MoveL p10, v500, fine, tool1;
draw_square;
MoveL p20, v500, fine, tool1;
draw_square;
MoveL p30, v500, fine, tool1;
draw_square;
```

The routine *draw\_square* is used to execute the same motion pattern at three different positions, based on the positions *p10*, *p20* and *p30*. See Figure 3.



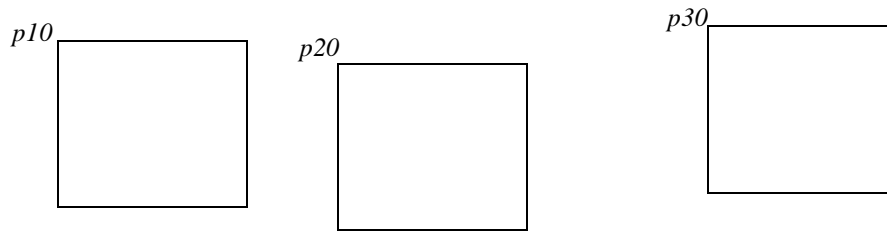


Figure 3 Using program displacement, motion patterns can be reused.

```
SearchL sen1, psearch, p10, v100, tool1\WObj:=fixture1;
PDispOn \ExeP:=psearch, *, tool1 \WObj:=fixture1;
```

A search is carried out in which the robot's searched position is stored in the position *psearch*. Any movement carried out after this starts from this position using a program displacement (parallel movement). The latter is calculated based on the difference between the searched position and the programmed point (\*) stored in the instruction. All positions are based on the *fixture1* object coordinate system.

## Syntax

```
PDispOn
[ [ '\ Rot ]
  [ '\ ExeP := < expression (IN) of robtargt > ' , ' ]
[ ProgPoint := ] < expression (IN) of robtargt > ' , '
[ Tool := ] < persistent (PERS) of tooldata >
[ '\ WObj := < persistent (PERS) of wobjdata > ] ' ;'
```

## Related information

	<u>Described in:</u>
Deactivation of program displacement	Instructions - <i>PDispOff</i>
Definition of program displacement using values	Instructions - <i>PDispSet</i>
Coordinate systems	Motion Principles - <i>Coordinate Systems</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
More examples	Instructions - <i>PDispOff</i>

---



---

## PDispSet      Activates program displacement using a value

*PDispSet* (*Program Displacement Set*) is used to define and activate a program displacement using values.

Program displacement is used, for example, when similar motion patterns are repeated at several different places in the program.

---

### Example

```
VAR pose xp100 := [ [100, 0, 0], [1, 0, 0, 0] ];
.
PDispSet xp100;
```

Activation of the *xp100* program displacement, meaning that:

- The ProgDisp coordinate system is displaced 100 mm from the object coordinate system, in the direction of the positive x-axis (see Figure 1).
- As long as this program displacement is active, all positions will be displaced 100 mm in the direction of the x-axis.

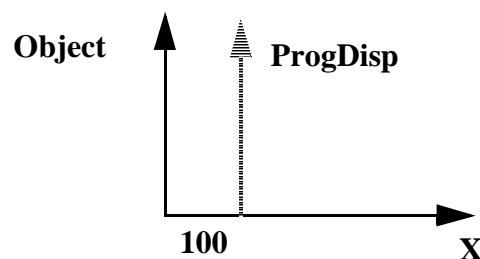


Figure 1 A 100 mm-program displacement along the x-axis.

---

### Arguments

**PDispSet**    **DispFrame**

**DispFrame**                      (*Displacement Frame*)                      Datatyp: *pose*

The program displacement is defined as data of the type *pose*.

---

### Program execution

Program displacement involves translating and/or rotating the ProgDisp coordinate system relative to the object coordinate system. Since all positions are related to the ProgDisp coordinate system, all programmed positions will also be displaced. See Figure 2.

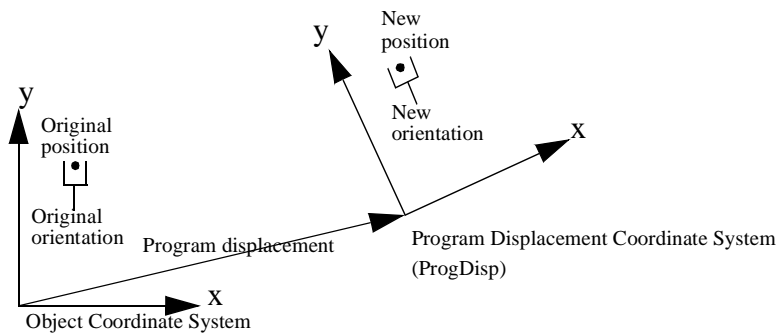


Figure 2 Translation and rotation of a programmed position.

Program displacement is activated when the instruction *PDispSet* is executed and remains active until some other program displacement is activated (the instruction *PDispSet* or *PDispOn*) or until program displacement is deactivated (the instruction *PDispOff*).

Only one program displacement can be active at any one time. Program displacements cannot be added to one another using *PDispSet*.

The program displacement is automatically reset

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

## Syntax

```
PDispSet
  [ DispFrame ':=' ] < expression (IN) of pose> ',';
```

## Related information

	<u>Described in:</u>
Deactivation of program displacement	Instructions - <i>PDispOff</i>
Definition of program displacement using two positions	Instructions - <i>PDispOn</i>
Definition of data of the type <i>pose</i>	Data Types - <i>pose</i>
Coordinate systems	Motion Principles- <i>Coordinate Systems</i>
Examples of how program displacement can be used	Instructions - <i>PDispOn</i>

---



---

## ProcCall                      Calls a new procedure

A procedure call is used to transfer program execution to another procedure. When the procedure has been fully executed, program execution continues with the instruction following the procedure call.

It is usually possible to send a number of arguments to the new procedure. These control the behaviour of the procedure and make it possible for the same procedure to be used for different things.

---

### Examples

```
weldpipe1;
```

          Calls the *weldpipe1* procedure.

```
errormessage;
Set dol;
```

```
.
```

```
PROC errormessage()
  TPWrite "ERROR";
ENDPROC
```

          The *errormessage* procedure is called. When this procedure is ready, program execution returns to the instruction following the procedure call, *Set dol*.

---

### Arguments

**Procedure**    { **Argument** }

**Procedure**

Identifier

          The name of the procedure to be called.

**Argument**

Data type: In accordance with the procedure declaration

          The procedure arguments (in accordance with the parameters of the procedure).

---

### Example

```
weldpipe2 10, lowspeed;
```

          Calls the *weldpipe2* procedure, including two arguments.

```
weldpipe3 10 \speed:=20;
```

Calls the *weldpipe3* procedure, including one mandatory and one optional argument.

---

**Limitations**

The procedure's arguments must agree with its parameters:

- All mandatory arguments must be included.
- They must be placed in the same order.
- They must be of the same data type.
- They must be of the correct type with respect to the access-mode (input, variable or persistent).

A routine can call a routine which, in turn, calls another routine, etc. A routine can also call itself, i.e. a recursive call. The number of routine levels permitted depends on the number of parameters, but more than 10 levels are usually permitted.

---

**Syntax**

(EBNF)

<procedure> [ <argument list> ] ';' ;

<procedure> ::= <identifier>

---

**Related information**

Arguments, parameters

More examples

Described in:

Basic Characteristics - *Routines*

Program Examples

---



---

## PulseDO Generates a pulse on a digital output signal

*PulseDO* is used to generate a pulse on a digital output signal.

---

### Examples

PulseDO do15;

A pulse with a pulse length of 0.2 s is generated on the output signal *do15*.

PulseDO \PLength:=1.0, ignition;

A pulse of length 1.0 s is generated on the signal *ignition*.

---

### Arguments

**PulseDO** [ \PLength ] Signal

[ \PLength ] (Pulse Length) Data type: *num*

The length of the pulse in seconds (0.1 - 32s).  
If the argument is omitted, a 0.2 second pulse is generated.

**Signal** Data type: *signaldo*

The name of the signal on which a pulse is to be generated.

---

### Program execution

A pulse is generated with a specified pulse length (see Figure 1).

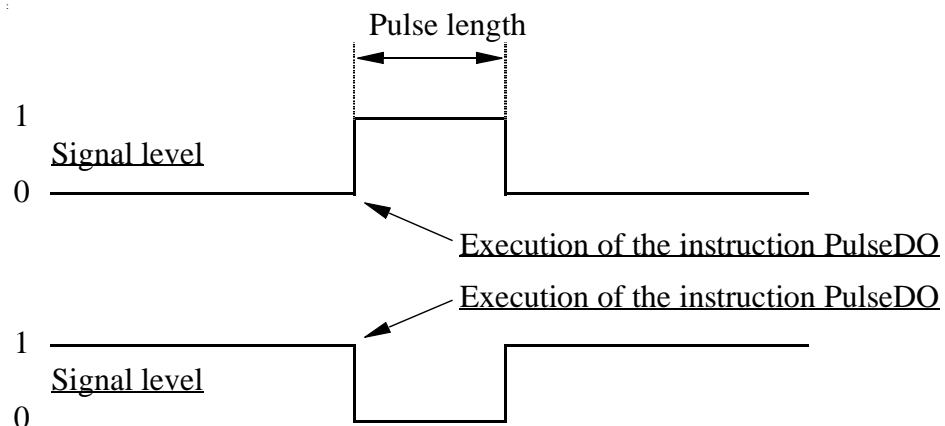


Figure 1 Generation of a pulse on a digital output signal.

The next instruction is executed directly after the pulse starts. The pulse can then be set/reset without affecting the rest of the program execution.

---

### **Limitations**

The length of the pulse has a resolution of 0.01 seconds. Programmed values that differ from this are rounded off.

---

### **Syntax**

PulseDO  
[ '\ PLength ':= < expression (**IN**) of *num* > ',' ]  
[ Signal ':=' ] < variable (**VAR**) of *signaldo* > ','

---

### **Related information**

	<u>Described in:</u>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	User's Guide - <i>System Parameters</i>

---



---

**RAISE**                      **Calls an error handler**

*RAISE* is used to create an error in the program and then to call the error handler of the routine. *RAISE* can also be used in the error handler to propagate the current error to the error handler of the calling routine.

This instruction can, for example, be used to jump back to a higher level in the structure of the program, e.g. to the error handler in the main routine, if an error occurs at a lower level.

---

**Example**

```
IF ...
  IF ...
    IF ...
      RAISE escape1;
    .
  ERROR
  IF ERRNO=escape1 RAISE;
```

The routine is interrupted to enable it to remove itself from a low level in the program. A jump occurs to the error handler of the called routine.

---

**Arguments**

**RAISE**    [ **Error no.** ]

**Error no.**

Data type: *errnum*

Error number: Any number between 1 and 90 which the error handler can use to locate the error that has occurred (the *ERRNO* system variable).

It is also possible to book an error number outside the range 1-90 with the instruction *BookErrNo*.

The error number must be specified outside the error handler in a *RAISE* instruction in order to be able to transfer execution to the error handler of that routine.

If the instruction is present in a routine's error handler, the error number may not be specified. In this case, the error is propagated to the error handler of the calling routine.

---

**Program execution**

Program execution continues in the routine's error handler. After the error handler has



been executed, program execution can continue with:

- the routine that called the routine in question (RETURN),
- the error handler of the routine that called the routine in question (RAISE).

If the RAISE instruction is present in a routine's error handler, program execution continues in the error handler of the routine that called the routine in question. The same error number remains active.

If the RAISE instruction is present in a trap routine, the error is dealt with by the system's error handler.

---

## **Error handling**

If the error number is out of range, the system variable ERRNO is set to ERR\_ILLRAISE (see "Data types - errnum"). This error can be handled in the error handler.

---

## **Syntax**

(EBNF)

**RAISE** [<error number>] ';' ;

<error number> ::= <expression>

---

## **Related information**

	<u>Described in:</u>
Error handling	Basic Characteristics - <i>Error Recovery</i>
Booking error numbers	Instructions - <i>BookErrNo</i>

---

---

## Reset                      Resets a digital output signal

*Reset* is used to reset the value of a digital output signal to zero.

---

### Examples

Reset do15;

The signal *do15* is set to 0.

Reset weld;

The signal *weld* is set to 0.

---

### Arguments

**Reset    Signal**

**Signal**

Data type: *signaldo*

The name of the signal to be reset to zero.

---

### Program execution

The true value depends on the configuration of the signal. If the signal is inverted in the system parameters, this instruction causes the physical channel to be set to 1.

---

### Syntax

Reset  
[ Signal ':=' ] < variable (**VAR**) of *signaldo* > ';' ;

---

**Related information**

	<u>Described in:</u>
Setting a digital output signal	Instructions - <i>Set</i>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	System Parameters

---



---

## RestoPath Restores the path after an interrupt

*RestoPath* is used to restore a path that was stored at a previous stage using the instruction *StorePath*.

---

### Example

```
RestoPath;
```

Restores the path that was stored earlier using *StorePath*.

---

### Program execution

The current movement path of the robot and the external axes is deleted and the path stored earlier using *StorePath* is restored. Nothing moves, however, until the instruction *StartMove* is executed or a return is made using *RETRY* from an error handler.

---

### Example

```
ArcL p100, v100, seam1, weld5, weave1, z10, gun1;
...
ERROR
  IF ERRNO=AW_WELD_ERR THEN
    gun_cleaning;
    RETRY;
  ENDIF
...
PROC gun_cleaning()
  VAR robtarg p1;
  StorePath;
  p1 := CRobT();
  MoveL pclean, v100, fine, gun1;
  ...
  MoveL p1, v100, fine, gun1;
  RestoPath;
ENDPROC
```

In the event of a welding error, program execution continues in the error handler of the routine, which, in turn, calls *gun\_cleaning*. The movement path being executed at the time is then stored and the robot moves to the position *pclean* where the error is rectified. When this has been done, the robot returns to the position where the error occurred, *p1*, and stores the original movement once again. The weld then automatically restarts, meaning that the robot is first reversed along the path before welding starts and ordinary program execution can continue.

**Limitations**

The movement being executed at the time must first be stopped, using a stop point for example, before the instruction *RestoPath* is executed.

The movement instruction which precedes this instruction should be terminated with a stop point, in order to be able to restart in this instruction following a power failure.

---

**Syntax**

RestoPath‘;’

---

**Related information**

Storing paths

More examples

**Described in:**

Instructions - *StorePath*

Instructions - *StorePath*

---

---

## **RETRY**            **Restarts following an error**

*RETRY* is used to restart program execution after an error has occurred.

---

### **Example**

```
reg2 := reg3/reg4;  
.  
ERROR  
  IF ERRNO = ERR_DIVZERO THEN  
    reg4 := 1;  
    RETRY;  
  ENDIF
```

An attempt is made to divide *reg3* by *reg4*. If *reg4* is equal to 0 (division by zero), a jump is made to the error handler, which initialises *reg4*. The *RETRY* instruction is then used to jump from the error handler and another attempt is made to complete the division.

---

### **Program execution**

Program execution continues with (re-executes) the instruction that caused the error.

---

### **Error handling**

If the maximum number of retries (4 retries) is exceeded, the program execution stops with an error message and the system variable `ERRNO` is set to `ERR_EXCRTYMAX` (see "Data types - errnum").

---

### **Limitations**

The instruction can only exist in a routine's error handler. If the error was created using a *RAISE* instruction, program execution cannot be restarted with a *RETRY* instruction, then the instruction *TRYNEXT* should be used.

---

### **Syntax**

```
RETRY ',';
```

---

**Related information**

	<u>Described in:</u>
Error handlers	Basic Characteristics- <i>Error Recovery</i>
Continue with the next instruction	Instructions - <i>TRYNEXT</i>

---

---

**RETURN**      **Finishes execution of a routine**

*RETURN* is used to finish the execution of a routine. If the routine is a function, the function value is also returned.

---

**Examples**

```
errormessage;
Set dol;
.

PROC errormessage()
  TPWrite "ERROR";
  RETURN;
ENDPROC
```

The *errormessage* procedure is called. When the procedure arrives at the RETURN instruction, program execution returns to the instruction following the procedure call, *Set dol*.

```
FUNC num abs_value(num value)
  IF value<0 THEN
    RETURN -value;
  ELSE
    RETURN value;
  ENDIF
ENDFUNC
```

The function returns the absolute value of a number.

---

**Arguments**

**RETURN**    [ **Return value** ]

**Return value**  
ration

Data type: According to the function declaration

The return value of a function.

The return value must be specified in a RETURN instruction present in a function.

If the instruction is present in a procedure or trap routine, a return value may not be specified.



---

**Program execution**

The result of the *RETURN* instruction may vary, depending on the type of routine it is used in:

- Main routine: If a program stop has been ordered at the end of the cycle, the program stops. Otherwise, program execution continues with the first instruction of the main routine.
- Procedure: Program execution continues with the instruction following the procedure call.
- Function: Returns the value of the function.
- Trap routine: Program execution continues from where the interrupt occurred.
- Error handler: In a procedure:  
Program execution continues with the routine that called the routine with the error handler (with the instruction following the procedure call).  
In a function:  
The function value is returned.

---

**Syntax**

(EBNF)  
**RETURN** [ <expression> ]';'

---

**Related information**

	<u>Described in:</u>
Functions and Procedures	Basic Characteristics - <i>Routines</i>
Trap routines	Basic Characteristics - <i>Interrupts</i>
Error handlers	Basic Characteristics - <i>Error Recovery</i>

---

---

## **Rewind                      Rewind file position**

*Rewind* sets the file position to the beginning of the file.

---

### **Example**

Rewind iodev1;

The file referred to by *iodev1* will have the file position set to the beginning of the file.

---

### **Arguments**

**Rewind    IODevice**

**IODevice**

Data type: *iodev*

Name (reference) of the file to be rewound.

---

### **Program execution**

The specified file is rewound to the beginning.

**Example**

```
! IO device and numeric variable for use together with a binary file
VAR iodev dev;
VAR num bindata;

! Open the binary file with \Write switch to erase old contents
Open "flp1:"\File := "bin_file",dev \Write;
Close dev;

! Open the binary file with \Bin switch for binary read and write access
Open "flp1:"\File := "bin_file",dev \Bin;
WriteStrBin dev,"Hello world";

! Rewind the file pointer to the beginning of the binary file
! Read contents of the file and write the binary result on TP
! (gives 72 101 108 108 111 32 119 111 114 108 100 )
Rewind dev;
bindata := ReadBin(dev);
WHILE bindata <> EOF_BIN DO
    TPWrite " " \Num:=bindata;
    bindata := ReadBin(dev);
ENDWHILE

! Close the binary file
Close dev;
```

The instruction *Rewind* is used to rewind a binary file to the beginning so that the contents of the file can be read back with *ReadBin*.

---

**Syntax**

```
Rewind
  [IODevice ':='] <variable (VAR) of iodev>;'
```

---

**Related information**

Opening (etc.) of files

Described in:

RAPID Summary - *Communication*

---



---

## SearchC      Searches circularly using the robot

*SearchC* (*Search Circular*) is used to search for a position when moving the tool centre point (TCP) circularly.

During the movement, the robot supervises a digital input signal. When the value of the signal changes to the requested one, the robot immediately reads the current position.

This instruction can typically be used when the tool held by the robot is a probe for surface detection. Using the *SearchC* instruction, the outline coordinates of a work object can be obtained.

---

### Examples

```
SearchC sen1, sp, cirpoint, p10, v100, probe;
```

The TCP of the *probe* is moved circularly towards the position *p10* at a speed of *v100*. When the value of the signal *sen1* changes to active, the position is stored in *sp*.

```
SearchC \Stop, sen1, sp, cirpoint, p10, v100, probe;
```

The TCP of the *probe* is moved circularly towards the position *p10*. When the value of the signal *sen1* changes to active, the position is stored in *sp* and the robot stops immediately.

---

### Arguments

**SearchC** [ **\Stop** ] | [ **\PStop** ] | [ **\Sup** ] **Signal** [ **\Flanks** ] **SearcPoint**  
**CirPoint ToPoint Speed** [ **\V** ] | [ **\T** ] **Tool** [ **\WObj** ] [ **\Corr** ]

[ **\Stop** ]

Data type: *switch*

The robot movement is stopped, as quickly as possible, without keeping the TCP on the path (hard stop), when the value of the search signal changes to active. However, the robot is moved a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

[ **\PStop** ]

(*Path Stop*)

Data type: *switch*

The robot movement is stopped as quickly as possible, while keeping the TCP on the path (soft stop), when the value of the search signal changes to active. However, the robot is moved a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

- [ \Sup ]** *(Supervision)* Data type: *switch*
- The search instruction is sensitive to signal activation during the complete movement (flying search), i.e. even after the first signal change has been reported. If more than one match occurs during a search, program execution stops.
- If the argument *\Stop*, *\PStop* or *\Sup* is omitted, the movement continues (flying search) to the position specified in the *ToPoint* argument (same as with argument *\Sup*),
- Signal** Data type: *signal di*
- The name of the signal to supervise.
- [ \Flanks ]** Data type: *switch*
- The positive and the negative edge of the signal is valid for a search hit.
- If the argument *\Flanks* is omitted, only the positive edge of the signal is valid for a search hit and a signal supervision will be activated at the beginning of a search process. This means that if the signal has a positive value already at the beginning of a search process, the robot movement is stopped as quickly as possible, while keeping the TCP on the path (soft stop). However, the robot is moved a small distance before it stops and is not moved back to the start position. A user recovery error (ERR\_SIGSUPSEARCH) will be generated and can be dealt with by the error handler.
- SearchPoint** Data type: *robtarg*
- The position of the TCP and external axes when the search signal has been triggered. The position is specified in the outermost coordinate system, taking the specified tool, work object and active ProgDisp/ExtOffs coordinate system into consideration.
- CirPoint** Data type: *robtarg*
- The circle point of the robot. See the instruction MoveC for a more detailed description of circular movement. The circle point is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).
- ToPoint** Data type: *robtarg*
- The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction). *SearchC* always uses a stop point as zone data for the destination.
- Speed** Data type: *speeddata*
- The speed data that applies to movements. Speed data defines the velocity of the tool centre point, the external axes and of the tool reorientation.

[ \V ] (Velocity) Data type: *num*

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

[ \T ] (Time) Data type: *num*

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

**Tool** Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point that is moved to the specified destination position.

[ \WObj ] (Work Object) Data type: *wobjdata*

The work object (coordinate system) to which the robot positions in the instruction are related.

This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified for a linear movement relative to the work object to be performed.

[ \Corr ] (Correction) Data type: *switch*

Correction data written to a corrections entry by the instruction *CorrWrite* will be added to the path and destination position, when this argument is present.

---

## Program execution

See the instruction *MoveC* for information about circular movement.

The movement is always ended with a stop point, i.e. the robot is stopped at the destination point.

When a flying search is used, i.e. the *\Sup* argument is specified, the robot movement always continues to the programmed destination point. When a search is made using the switch *\Stop* or *\PStop*, the robot movement stops when the first signal is detected.

The *SearchC* instruction returns the position of the TCP when the value of the digital signal changes to the requested one, as illustrated in Figure 1.

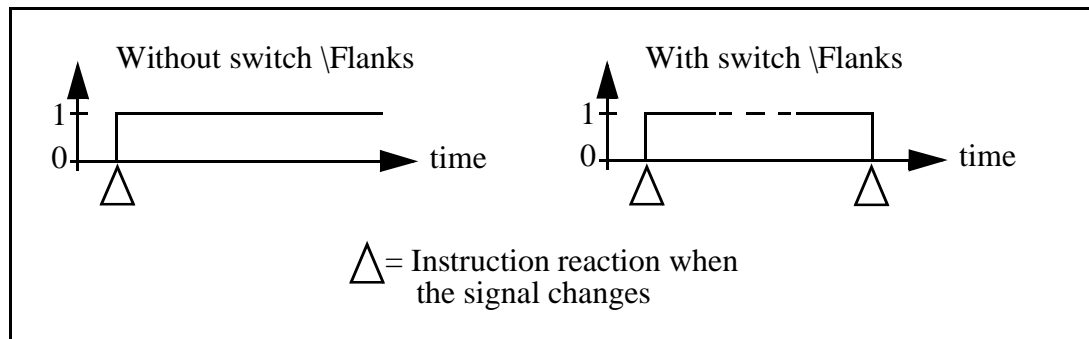


Figure 1 Flank-triggered signal detection (the position is stored when the signal is changed the first time only).

## Example

```
SearchC \Sup, sen1\Flanks, sp, cirpoint, p10, v100, probe;
```

The TCP of the *probe* is moved circularly towards the position *p10*. When the value of the signal *sen1* changes to active or passive, the position is stored in *sp*. If the value of the signal changes twice, program execution stops.

## Limitations

Zone data for the positioning instruction that precedes *SearchC* must be used carefully. The start of the search, i.e. when the I/O signal is ready to react, is not, in this case, the programmed destination point of the previous positioning instruction, but a point along the real robot path. Figure 2 illustrates an example of something that may go wrong when zone data other than *fine* is used.

The instruction *SearchC* should never be restarted after the circle point has been passed. Otherwise the robot will not take the programmed path (positioning around the circular path in another direction compared with that programmed).

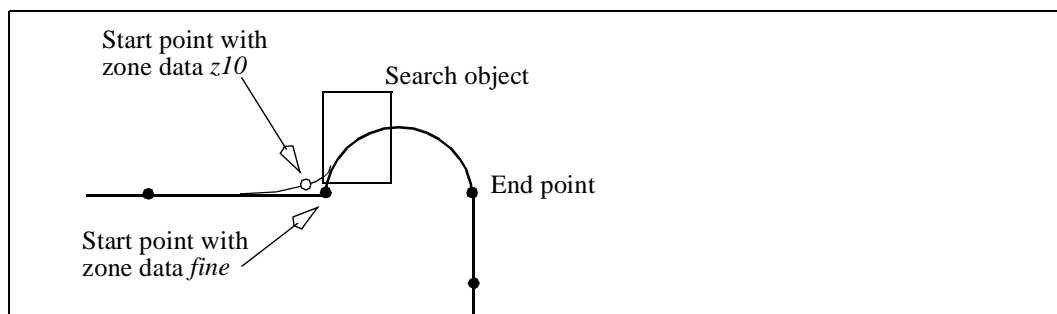


Figure 2 A match is made on the wrong side of the object because the wrong zone data was used.

Typical stop distance using a search velocity of 50 mm/s:

- without TCP on path (switch `\Stop`) 1-3 mm
- with TCP on path (switch `\PStop`) 12-16 mm

---

## Error handling

An error is reported during a search when:

- no signal detection occurred - this generates the error ERR\_WHLSEARCH.
- more than one signal detection occurred – this generates the error ERR\_WHLSEARCH only if the `\Sup` argument is used.
- the signal has already a positive value at the beginning of the search process - this generates the error ERR\_SIGSUPSEARCH only if the `\Flanks` argument is omitted.

Errors can be handled in different ways depending on the selected running mode:

### **Continuous forward** / ERR\_WHLSEARCH

No position is returned and the movement always continues to the programmed destination point. The system variable ERRNO is set to ERR\_WHLSEARCH and the error can be handled in the error handler of the routine.

### **Continuous forward** / **Instruction forward** / ERR\_SIGSUPSEARCH

No position is returned and the movement always stops as quickly as possible at the beginning of the search path. The system variable ERRNO is set to ERR\_SIGSUPSEARCH and the error can be handled in the error handler of the routine.

### **Instruction forward** / ERR\_WHLSEARCH

No position is returned and the movement always continues to the programmed destination point. Program execution stops with an error message.

### **Instruction backward**

During backward execution, the instruction just carries out the movement without any signal supervision.



---

**Syntax**

## SearchC

```
[ '\ Stop', ' ] | [ '\ PStop ', ' ] | [ '\ Sup ', ' ]
[ Signal ':=' ] < variable (VAR) of signaldi >
    [ '\ Flanks', ' ]
[ SearchPoint ':=' ] < var or pers (INOUT) of robttarget > ', '
[ CirPoint ':=' ] < expression (IN) of robttarget > ', '
[ ToPoint ':=' ] < expression (IN) of robttarget > ', '
[ Speed ':=' ] < expression (IN) of speeddata >
    [ '\ V ':=' < expression (IN) of num > ]
    | [ '\ T ':=' < expression (IN) of num > ] ', '
[ Tool ':=' ] < persistent (PERS) of tooldata >
[ '\ WObj ':=' < persistent (PERS) of wobjdata > ]
[ '\ Corr ]';
```

---

**Related information**

	<u>Described in:</u>
Linear searches	Instructions - <i>SearchL</i>
Writes to a corrections entry	Instructions - <i>CorrWrite</i>
Circular movement	Motion and I/O Principles - <i>Positioning during Program Execution</i>
Definition of velocity	Data Types - <i>speed</i> data
Definition of tools	Data Types - <i>tool</i> data
Definition of work objects	Data Types - <i>wobj</i> data
Using error handlers	RAPID Summary - <i>Error Recovery</i>
Motion in general	Motion and I/O Principles
More searching examples	Instructions - <i>SearchL</i>

---



---

## SearchL      Searches linearly using the robot

*SearchL* (*Search Linear*) is used to search for a position when moving the tool centre point (TCP) linearly.

During the movement, the robot supervises a digital input signal. When the value of the signal changes to the requested one, the robot immediately reads the current position.

This instruction can typically be used when the tool held by the robot is a probe for surface detection. Using the *SearchL* instruction, the outline coordinates of a work object can be obtained.

---

### Examples

```
SearchL sen1, sp, p10, v100, probe;
```

The TCP of the *probe* is moved linearly towards the position *p10* at a speed of *v100*. When the value of the signal *sen1* changes to active, the position is stored in *sp*.

```
SearchL \Stop, sen1, sp, p10, v100, probe;
```

The TCP of the *probe* is moved linearly towards the position *p10*. When the value of the signal *sen1* changes to active, the position is stored in *sp* and the robot stops immediately.

---

### Arguments

**SearchL** [ \Stop ] | [ \PStop ] | [ \Sup ] **Signal** [ \Flanks ] **SearchPoint**  
**ToPoint** **Speed** [ \V ] | [ \T ] **Tool** [ \WObj ] [ \Corr ]

[ \Stop ]

Data type: *switch*

The robot movement is stopped as quickly as possible, without keeping the TCP on the path (hard stop), when the value of the search signal changes to active. However, the robot is moved a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

[ \PStop ]

(*Path Stop*)

Data type: *switch*

The robot movement is stopped as quickly as possible, while keeping the TCP on the path (soft stop), when the value of the search signal changes to active. However, the robot is moved a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

- [Sup ]** (Supervision) Data type: *switch*
- The search instruction is sensitive to signal activation during the complete movement (flying search), i.e. even after the first signal change has been reported. If more than one match occurs during a search, program execution stops.
- If the argument *\Stop*, *\PStop* or *\Sup* is omitted, the movement continues (flying search) to the position specified in the *ToPoint* argument (same as with argument *\Sup*).
- Signal** Data type: *signaldi*
- The name of the signal to supervise.
- [Flanks ]** Data type: *switch*
- The positive and the negative edge of the signal is valid for a search hit.
- If the argument *\Flanks* is omitted, only the positive edge of the signal is valid for a search hit and a signal supervision will be activated at the beginning of a search process. This means that if the signal has the positive value already at the beginning of a search process, the robot movement is stopped as quickly as possible, while keeping the TCP on the path (soft stop). A user recovery error (ERR\_SIGSUPSEARCH) will be generated and can be handled in the error handler.
- SearchPoint** Data type: *robtaraget*
- The position of the TCP and external axes when the search signal has been triggered. The position is specified in the outermost coordinate system, taking the specified tool, work object and active ProgDisp/ExtOffs coordinate system into consideration.
- ToPoint** Data type: *robtaraget*
- The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction). *SearchL* always uses a stop point as zone data for the destination.
- Speed** Data type: *speeddata*
- The speed data that applies to movements. Speed data defines the velocity of the tool centre point, the external axes and of the tool reorientation.
- [V ]** (Velocity) Data type: *num*
- This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.
- [T ]** (Time) Data type: *num*
- This argument is used to specify the total time in seconds during which the robot

moves. It is then substituted for the corresponding speed data.

**Tool**Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point that is moved to the specified destination position.

**[ \WObj]***(Work Object)*Data type: *wobjdata*

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified for a linear movement relative to the work object to be performed.

**[ \Corr]***(Correction)*Data type: *switch*

Correction data written to a corrections entry by the instruction *CorrWrite* will be added to the path and destination position, if this argument is present.

**Program execution**

See the instruction *MoveL* for information about linear movement.

The movement always ends with a stop point, i.e. the robot stops at the destination point.

If a flying search is used, i.e. the *\Sup* argument is specified, the robot movement always continues to the programmed destination point. If a search is made using the switch *\Stop* or *\PStop*, the robot movement stops when the first signal is detected.

The *SearchL* instruction stores the position of the TCP when the value of the digital signal changes to the requested one, as illustrated in Figure 1.

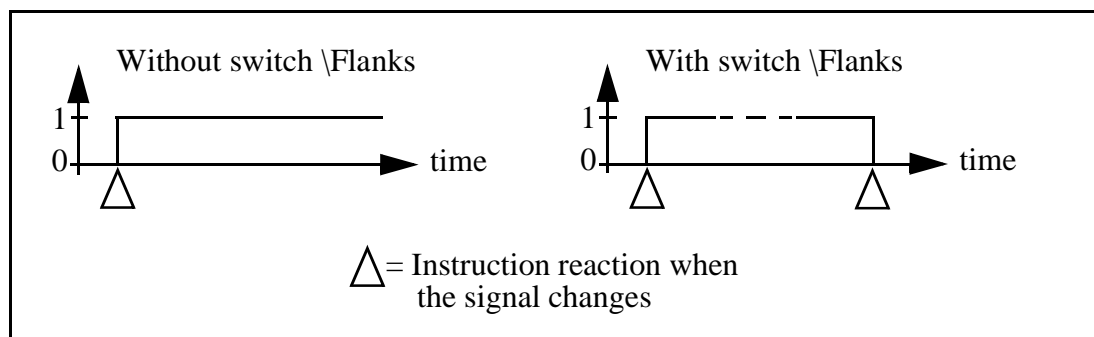


Figure 1 Flank-triggered signal detection (the position is stored when the signal is changed the first time only).

In order to get a fast response, use the interrupt-driven sensor signals *sen1*, *sen2* or *sen3* on the system board.

---

## Examples

```
SearchL \Sup, sen1\Flanks, sp, p10, v100, probe;
```

The TCP of the *probe* is moved linearly towards the position *p10*. When the value of the signal *sen1* changes to active or passive, the position is stored in *sp*. If the value of the signal changes twice, program execution stops after the search process is finished.

```
SearchL \Stop, sen1, sp, p10, v100, tool1;
MoveL sp, v100, fine, tool1;
PDispOn *, tool1;
MoveL p100, v100, z10, tool1;
MoveL p110, v100, z10, tool1;
MoveL p120, v100, z10, tool1;
PDispOff;
```

At the beginning of the search process, a check on the signal *sen1* will be done and if the signal already has a positive value, the program execution stops. Otherwise the TCP of *tool1* is moved linearly towards the position *p10*. When the value of the signal *sen1* changes to active, the position is stored in *sp* and the robot is moved back to this point. Using program displacement, the robot then moves relative to the searched position, *sp*.

---

## Limitations

Zone data for the positioning instruction that precedes *SearchL* must be used carefully. The start of the search, i.e. when the I/O signal is ready to react, is not, in this case, the programmed destination point of the previous positioning instruction, but a point along the real robot path. Figure 2 to Figure 4 illustrate examples of things that may go wrong when zone data other than *fine* is used.

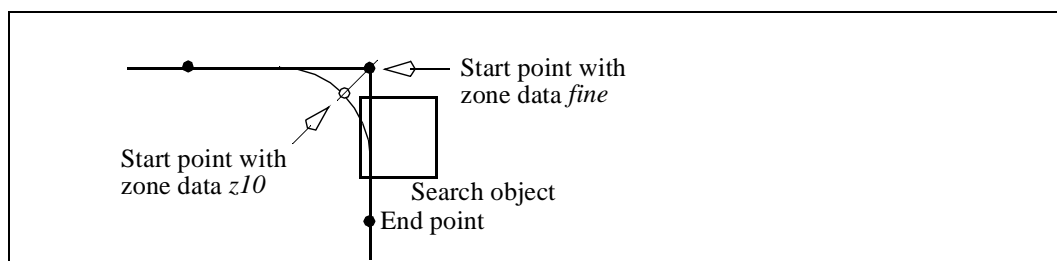


Figure 2 A match is made on the wrong side of the object because the wrong zone data was used.

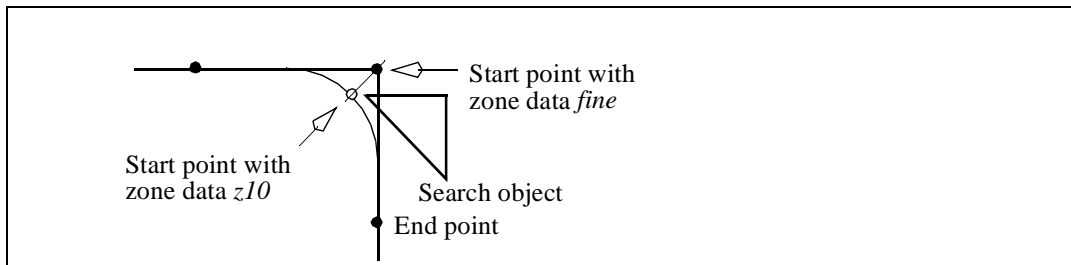


Figure 3 No match detected because the wrong zone data was used.

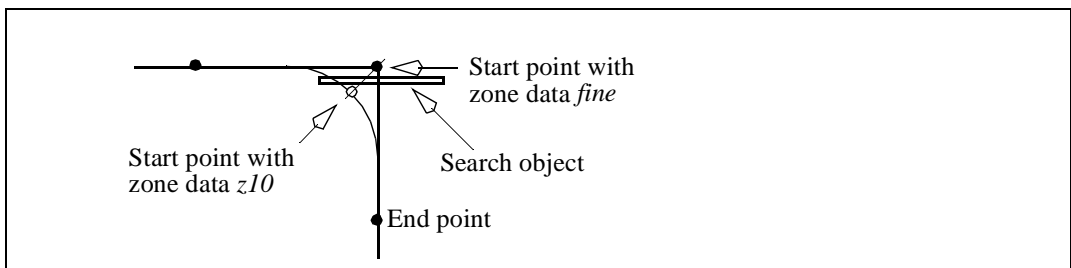


Figure 4 No match detected because the wrong zone data was used.

Typical stop distance using a search velocity of 50 mm/s:

- without TCP on path (switch `\Stop`) 1-3 mm
- with TCP on path (switch `\PStop`) 12-16 mm

---

## Error handling

An error is reported during a search when:

- no signal detection occurred - this generates the error `ERR_WHLSEARCH`.
- more than one signal detection occurred – this generates the error `ERR_WHLSEARCH` only if the `\Sup` argument is used.
- the signal already has a positive value at the beginning of the search process - this generates the error `ERR_SIGSUPSEARCH` only if the `\Flanks` argument is omitted.

Errors can be handled in different ways depending on the selected running mode:

### **Continuous forward / `ERR_WHLSEARCH`**

No position is returned and the movement always continues to the programmed destination point. The system variable `ERRNO` is set to `ERR_WHLSEARCH` and the error can be handled in the error handler of the routine.

### **Continuous forward / Instruction forward / `ERR_SIGSUPSEARCH`**

No position is returned and the movement always stops as quickly as possible at the beginning of the search path. The system variable `ERRNO` is set to `ERR_SIGSUPSEARCH` and the error can be handled in the error handler of the routine.

**Instruction forward / ERR\_WHLSEARCH**

No position is returned and the movement continues to the programmed destination point. Program execution stops with an error message.

**Instruction backward**

During backward execution, the instruction just carries out the movement without any signal supervision.

---

**Example**

```

VAR num fk;
.
MoveL p10, v100, fine, tool1;
SearchL \Stop, sen1, sp, p20, v100, tool1;
.
ERROR
  IF ERRNO=ERR_WHLSEARCH THEN
    MoveL p10, v100, fine, tool1;
    RETRY;
  ELSEIF ERRNO=ERR_SIGSUPSEARCH THEN
    TPWrite "The signal of the SearchL instruction is already high!";
    TPReadFK fk,"Try again after manual reset of signal ?","YES","","","","NO";
    IF fk = 1 THEN
      MoveL p10, v100, fine, tool1;
      RETRY;
    ELSE
      Stop;
    ENDIF
  ENDIF
ENDIF

```

If the signal is already active at the beginning of the search process, a user dialog will be activated (TPReadFK ...). Reset the signal and push YES on the user dialog and the robot moves back to p10 and tries once more. Otherwise program execution will stop.

If the signal is passive at the beginning of the search process, the robot searches from position *p10* to *p20*. If no signal detection occurs, the robot moves back to *p10* and tries once more.

---

**Syntax**

## SearchL

```
[ '\ Stop ',' ] | [ '\ PStop ',' ] | [ '\ Sup ',' ]
[ Signal ':=' ] < variable (VAR) of signaldi >
    [ '\ Flanks ] ','
[ SearchPoint ':=' ] < var or pers (INOUT) of robtarg > ','
[ ToPoint ':=' ] < expression (IN) of robtarg > ','
[ Speed ':=' ] < expression (IN) of speeddata >
    [ '\ V ':=' < expression (IN) of num > ]
    | [ '\ T ':=' < expression (IN) of num > ] ','
[ Tool ':=' ] < persistent (PERS) of tooldata >
[ '\ WObj ':=' < persistent (PERS) of wobjdata > ]
[ '\ Corr ] ;'
```

---

**Related information**

	<u>Described in:</u>
Circular searches	Instructions - <i>SearchC</i>
Writes to a corrections entry	Instructions - <i>CorrWrite</i>
Linear movement	Motion and I/O Principles - <i>Positioning during Program Execution</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Using error handlers	RAPID Summary - <i>Error Recovery</i>
Motion in general	Motion and I/O Principles





---

---

## Set                      Sets a digital output signal

*Set* is used to set the value of a digital output signal to one.

---

### Examples

Set do15;

The signal *do15* is set to 1.

Set weldon;

The signal *weldon* is set to 1.

---

### Arguments

**Set**    **Signal**

**Signal**

Data type: *signaldo*

The name of the signal to be set to one.

---

### Program execution

The true value depends on the configuration of the signal. If the signal is inverted in the system parameters, this instruction causes the physical channel to be set to zero.

---

### Syntax

Set  
[ Signal ':=' ] < variable (**VAR**) of *signaldo* > ';' ;

---

**Related information**

	<u>Described in:</u>
Setting a digital output signal to zero	Instructions - <i>Reset</i>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	System Parameters

---



---

## SetAO Changes the value of an analog output signal

*SetAO* is used to change the value of an analog output signal.

---

### Example

```
SetAO ao2, 5.5;
```

The signal *ao2* is set to 5.5.

---

### Arguments

**SetAO Signal Value**

**Signal** Data type: *signalao*

The name of the analog output signal to be changed.

**Value** Data type: *num*

The desired value of the signal.

---

### Program execution

The programmed value is scaled (in accordance with the system parameters) before it is sent on the physical channel. See Figure 1.

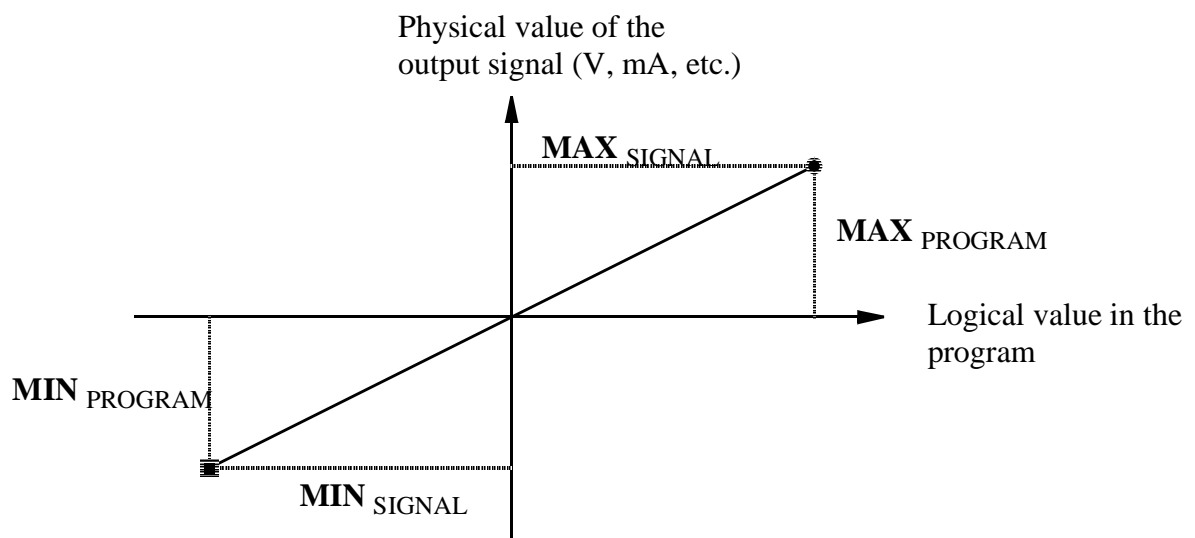


Figure 1 Diagram of how analog signal values are scaled.

---

**Example**

```
SetAO weldcurr, curr_outp;
```

The signal *weldcurr* is set to the same value as the current value of the variable *curr\_outp*.

---

**Syntax**

```
SetAO  
[ Signal ':=' ] < variable (VAR) of signalao > ','  
[ Value ':=' ] < expression (IN) of num > ',';
```

---

**Related information**

	<u>Described in:</u>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	System Parameters

---

---

## SetDO Changes the value of a digital output signal

*SetDO* is used to change the value of a digital output signal, with or without a time-delay.

---

### Examples

```
SetDO do15, 1;
```

The signal *do15* is set to *1*.

```
SetDO weld, off;
```

The signal *weld* is set to *off*.

```
SetDO \SDelay := 0.2, weld, high;
```

The signal *weld* is set to *high* with a delay of *0.2* s. Program execution, however, continues with the next instruction.

---

### Arguments

#### SetDO [ \SDelay ] Signal Value

[ \SDelay ] (Signal Delay) Data type: *num*

Delays the change for the amount of time given in seconds (0.1 - 32s). Program execution continues directly with the next instruction. After the given time-delay, the signal is changed without the rest of the program execution being affected.

If the argument is omitted, the value of the signal is changed directly.

**Signal** Data type: *signaldo*

The name of the signal to be changed.

**Value** Data type: *dionum*

The desired value of the signal.

The value is specified as 0 or 1.

---

## Program execution

The true value depends on the configuration of the signal. If the signal is inverted in the system parameters, the value of the physical channel is the opposite.

---

## Syntax

```
SetDO  
[ '\ SDelay :=' < expression (IN) of num > ',' ]  
[ Signal :=' ] < variable (VAR) of signaldo > ','  
[ Value :=' ] < expression (IN) of dionum > ';' 
```

---

## Related information

	<u>Described in:</u>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	User's Guide - <i>System Parameters</i>

---



---

## SetGO Changes the value of a group of digital output signals

*SetGO* is used to change the value of a group of digital output signals, with or without a time delay.

---

### Example

```
SetGO go2, 12;
```

The signal *go2* is set to *12*. If *go2* comprises 4 signals, e.g. outputs 6-9, outputs 6 and 7 are set to zero, while outputs 8 and 9 are set to one.

```
SetGO \SDelay := 0.4, go2, 10;
```

The signal *go2* is set to *10*. If *go2* comprises 4 signals, e.g. outputs 6-9, outputs 6 and 8 are set to zero, while outputs 7 and 9 are set to one, with a delay of *0.4* s. Program execution, however, continues with the next instruction.

---

### Arguments

**SetGO** [ \SDelay ] **Signal Value**

[ \SDelay ] (Signal Delay) Data type: *num*

Delays the change for the period of time stated in seconds (0.1 - 32s). Program execution continues directly with the next instruction. After the specified time delay, the value of the signals is changed without the rest of the program execution being affected.

If the argument is omitted, the value is changed directly.

**Signal** Data type: *signalgo*

The name of the signal group to be changed.

**Value** Data type: *num*

The desired value of the signal group (a positive integer).

The permitted value is dependent on the number of signals in the group:



<u>No. of signals</u>	<u>Permitted value</u>	<u>No. of signals</u>	<u>Permitted value</u>
1	0 - 1	9	0 - 511
2	0 - 3	10	0 - 1023
3	0 - 7	11	0 - 2047
4	0 - 15	12	0 - 4095
5	0 - 31	13	0 - 8191
6	0 - 63	14	0 - 16383
7	0 - 127	15	0 - 32767
8	0 - 255	16	0 - 65535

---

## Program execution

The programmed value is converted to an unsigned binary number. This binary number is sent on the signal group, with the result that individual signals in the group are set to 0 or 1. Due to internal delays, the value of the signal may be undefined for a short period of time.

---

## Syntax

SetDO

```
[ '\ SDelay ':=' < expression (IN) of num > ',' ]
[ Signal ':=' ] < variable (VAR) of signalgo > ','
[ Value ':=' ] < expression (IN) of num > ','
```

---

## Related information

	<u>Described in:</u>
Other input/output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O (system parameters)	System Parameters

---

---

## SingArea Defines interpolation around singular points

*SingArea* is used to define how the robot is to move in the proximity of singular points.

---

### Examples

```
SingArea \Wrist;
```

The orientation of the tool may be changed slightly in order to pass a singular point (axes 4 and 6 in line).

```
SingArea \Off;
```

The tool orientation is not allowed to differ from the programmed orientation. If a singular point is passed, one or more axes may perform a sweeping movement, resulting in a reduction in velocity.

---

### Arguments

```
SingArea [ \Wrist ] | [ \Off ]
```

```
[ \Wrist ]
```

Data type: *switch*

The tool orientation is allowed to differ somewhat in order to avoid wrist singularity. Used when axes 4 and 6 are parallel (axis 5 at 0 degrees).

```
[ \Off ]
```

Data type: *switch*

The tool orientation is not allowed to differ. Used when no singular points are passed, or when the orientation is not permitted to be changed in singular points.

---

### Program execution

If the arguments *\Wrist* is specified, the orientation is joint-interpolated to avoid singular points. In this way, the TCP follows the correct path, but the orientation of the tool deviates somewhat. This will also happen when a singular point is not passed.

The specified interpolation applies to all subsequent movements until a new *SingArea* instruction is executed.

The movement is only affected on execution of linear or circular interpolation.

By default, or if none of the arguments are specified, program execution automatically uses the */Off* argument. This is automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

**Limitations**

Only one of the arguments can be specified.

---

**Syntax**

```
SingArea  
[ '\ Wrist ] | [ '\ Off ] ;'
```

---

**Related information**

Singularity

Interpolation

-

Described in:

Motion Principles- *Singularity*

Motion Principles - *Positioning during Program Execution*

---



---

## SoftAct                      Activating the soft servo

*SoftAct (Soft Servo Activate)* is used to activate the so called "soft" servo on any of the robot axes.

---

### Example

SoftAct 3, 20;

Activation of soft servo on axis 3, with softness value 20%.

SoftAct 1, 90 \Ramp:=150;

Activation of the soft servo on axis 1, with softness value 90% and ramp factor 150%.

---

### Arguments

**SoftAct Axis Softness [\Ramp ]**

**Axis**

Data type: *num*

Number of current axis on the robot (1 - 6).

**Softness**

Data type: *num*

Softness value in percent (0 - 100%). 0% denotes min. softness (max. stiffness), and 100% denotes max. softness.

**Ramp**

Data type: *num*

Ramp factor in percent ( $\geq 100\%$ ). The ramp factor is used to control the engagement of the soft servo. A factor 100% denotes the normal value; with greater values the soft servo is engaged more slowly (longer ramp). The default value for ramp factor is 100 %.

---

### Program execution

Softness is activated at the value specified for the current axis. The softness value is valid for all movements, until a new softness value is programmed for the current axis, or until the soft servo is deactivated by an instruction.

---

## Limitations

The same axis must not be activated twice, unless there is a moving instruction in between. Thus, the following program sequence should be avoided, otherwise there will be a jerk in the robot movement:

```
SoftAct    n , x ;  
SoftAct    n , y ;  
(n = robot axis n, x and y softness values)
```

---

## Syntax

```
SoftAct  
[Axis ':=' ] < expression (IN) of num> ','  
[Softness ':=' ] < expression (IN) of num>  
[ '\Ramp ':=' < expression (IN) of num> ]';'
```

---

## Related information

Behaviour with the soft servo engaged

Described in:

Motion and I/O Principles- *Positioning during program execution*

---

---

## SoftDeact      Deactivating the soft servo

*SoftDeact (Soft Servo Deactivate)* is used to deactivate the so called "soft" servo on all robot axes.

---

### Example

SoftDeact;

Deactivating the soft servo on all axes.

SoftDeact \Ramp:=150;

Deactivating the soft servo on all axes, with ramp factor 150%.

---

### Arguments

**SoftDeact** [**\Ramp** ]

**Ramp**

Data type: *num*

Ramp factor in percent ( $\geq 100\%$ ). The ramp factor is used to control the deactivating of the soft servo. A factor 100% denotes the normal value; with greater values the soft servo is deactivated more slowly (longer ramp). The default value for rampfactor is 100 %.

---

### Program execution

The soft servo is deactivated on all axes.

---

### Syntax

SoftDeact  
[ '\Ramp' := ' < expression (IN) of *num*> ]';

---

### Related information

Activating the soft servo

Described in:

Instructions - *SoftAct*



## StartMove

## Restarts robot motion

*StartMove* is used to resume robot and external axes motion when this has been stopped by the instruction *StopMove*.

---

### Example

```
StopMove;  
WaitDI ready_input, 1;  
StartMove;
```

The robot starts to move again when the input *ready\_input* is set.

---

### Program execution

Any processes associated with the stopped movement are restarted at the same time as motion resumes.

---

### Error handling

If the robot is too far from the path (more than 10 mm or 20 degrees) to perform a start of the interrupted movement, the system variable *ERRNO* is set to *ERR\_PATHDIST*. This error can then be handled in the error handler.

---

### Syntax

```
StartMove';'
```

---

### Related information

Stopping movements

More examples

-

Described in:

Instructions - *StopMove*

Instructions - *StorePath*





---

---

## Stop                      Stops program execution

*Stop* is used to temporarily stop program execution.

Program execution can also be stopped using the instruction *EXIT*. This, however, should only be done if a task is complete, or if a fatal error occurs, since program execution cannot be restarted with *EXIT*.

---

### Example

```
TPWrite "The line to the host computer is broken";  
Stop;
```

Program execution stops after a message has been written on the teach pendant.

---

### Arguments

**Stop** [ \NoRegain ]

[ \NoRegain ]

Data type: *switch*

Specifies for the next program start in manual mode, whether or not the robot and external axes should regain to the stop position. In automatic mode the robot and external axes always regain to the stop position.

If the argument *NoRegain* is set, the robot and external axes will not regain to the stop position (if they have been jogged away from it).

If the argument is omitted and if the robot or external axes have been jogged away from the stop position, the robot displays a question on the teach pendant. The user can then answer, whether or not the robot should regain to the stop position.

---

### Program execution

The instruction stops program execution as soon as the robot and external axes reach the programmed destination point for the movement it is performing at the time. Program execution can then be restarted from the next instruction.

If there is a *Stop* instruction in some event routine, the routine will be executed from the beginning in the next event.

**Example**

```
MoveL p1, v500, fine, tool1;  
TPWrite "Jog the robot to the position for pallet corner 1";  
Stop \NoRegain;  
p1_read := CRobT();  
MoveL p2, v500, z50, tool1;
```

Program execution stops with the robot at *p1*. The operator jogs the robot to *p1\_read*. For the next program start, the robot does not regain to *p1*, so the position *p1\_read* can be stored in the program.

---

**Limitations**

The movement instruction which precedes this instruction should be terminated with a stop point, in order to be able to restart in this instruction following a power failure.

---

**Syntax**

```
Stop  
[ '\ NoRegain ]';
```

---

**Related information**

	<u>Described in:</u>
Stopping after a fatal error	Instructions - <i>EXIT</i>
Terminating program execution	Instructions - <i>EXIT</i>
Only stopping robot movements	Instructions - <i>StopMove</i>

---



---

## StopMove                      Stops robot motion

*StopMove* is used to stop robot and external axes movements temporarily. If the instruction *StartMove* is given, movement resumes.

This instruction can, for example, be used in a trap routine to stop the robot temporarily when an interrupt occurs.

---

### Example

```
StopMove;
WaitDI ready_input, 1;
StartMove;
```

The robot movement is stopped until the input, *ready\_input*, is set.

---

### Program execution

The movements of the robot and external axes stop without the brakes being engaged. Any processes associated with the movement in progress are stopped at the same time as the movement is stopped.

Program execution continues without waiting for the robot and external axes to stop (standing still).

---

### Examples

```
VAR intnum intno1;
...
CONNECT intno1 WITH go_to_home_pos;
ISignalDI di1,1,intno1;

TRAP go_to_home_pos
  VAR robtarg p10;

  StopMove;
  StorePath;
  p10:=CRobT();
  MoveL home,v500,fine,tool1;
  WaitDI di1,0;
  Move L p10,v500,fine,tool1;
  RestoPath;
  StartMove;
ENDTRAP
```

When the input *di1* is set to 1, an interrupt is activated which in turn activates the

interrupt routine *go\_to\_home\_pos*. The current movement is stopped immediately and the robot moves instead to the *home* position. When *di1* is set to 0, the robot returns to the position at which the interrupt occurred and continues to move along the programmed path.

```
VAR intnum intno1;
...
CONNECT intno1 WITH go_to_home_pos;
ISignalDI di1,1,intno1;

TRAP go_to_home_pos ()
  VAR robtarg p10;

  StorePath;
  p10:=CRobT();
  MoveL home,v500,fine,tool1;
  WaitDI di1,0;
  Move L p10,v500,fine,tool1;
  RestoPath;
  StartMove;
ENDTRAP
```

Similar to the previous example, but the robot does not move to the *home* position until the current movement instruction is finished.

---

## Syntax

StopMove';'

---

## Related information

Continuing a movement  
Interrupts

Described in:

Instructions - *StartMove*  
RAPID Summary - *Interrupts*  
Basic Characteristics- *Interrupts*

---

---

## StorePath      Stores the path when an interrupt occurs

*StorePath* is used to store the movement path being executed when an error or interrupt occurs. The error handler or trap routine can then start a new movement and, following this, restart the movement that was stored earlier.

This instruction can be used to go to a service position or to clean the gun, for example, when an error occurs.

---

### Example

```
StorePath;
```

The current movement path is stored for later use.

---

### Program execution

The current movement path of the robot and external axes is saved. After this, another movement can be started in a trap routine or an error handler. When the reason for the error or interrupt has been rectified, the saved movement path can be restarted.

---

### Example

```
TRAP machine_ready  
  VAR robtarg p1;  
  StorePath;  
  p1 := CRobT();  
  MoveL p100, v100, fine, tool1;  
  ...  
  MoveL p1, v100, fine, tool1;  
  RestoPath;  
  StartMove;  
ENDTRAP
```

When an interrupt occurs that activates the trap routine *machine\_ready*, the movement path which the robot is executing at the time is stopped at the end of the instruction (ToPoint) and stored. After this, the robot remedies the interrupt by, for example, replacing a part in the machine and the normal movement is restarted.

---

### Limitations

Only one movement path can be stored at a time.

---

**Syntax**

StorePath';'

---

**Related information**

Restoring a path

More examples

Described in:

Instructions - *RestoPath*

Instructions - *RestoPath*

## TEST            Depending on the value of an expression ...

*TEST* is used when different instructions are to be executed depending on the value of an expression or data.

If there are not too many alternatives, the *IF..ELSE* instruction can also be used.

---

### Example

```
TEST reg1
CASE 1,2,3 :
  routine1;
CASE 4 :
  routine2;
DEFAULT :
  TPWrite "Illegal choice";
  Stop;
ENDTEST
```

Different instructions are executed depending on the value of *reg1*. If the value is 1-3 *routine1* is executed. If the value is 4, *routine2* is executed. Otherwise, an error message is printed and execution stops.

---

### Arguments

```
TEST    Test data {CASE Test value {, Test value} : ...}
[ DEFAULT: ...] ENDTEST
```

#### Test data

Data type: All

The data or expression with which the test value will be compared.

#### Test value

Data type: Same as test data

The value which the test data must have for the associated instructions to be executed.

---

### Program execution

The test data is compared with the test values in the first *CASE* condition. If the comparison is true, the associated instructions are executed. After that, program execution continues with the instruction following *ENDTEST*.

If the first *CASE* condition is not satisfied, other *CASE* conditions are tested, and so on. If none of the conditions are satisfied, the instructions associated with *DEFAULT* are executed (if this is present).



---

**Syntax**

(EBNF)  
**TEST** <expression>  
{ ( **CASE** <test value> { ',' <test value> } ':'  
    <instruction list> ) | **CSE** }  
[ **DEFAULT** ':' <instruction list> ]  
**ENDTEST**

<test value> ::= <expression>

---

**Related information**

Expressions

Described in:

Basic Characteristics - *Expressions*

## TPErase Erases text printed on the teach pendant

*TPErase (Teach Pendant Erase)* is used to clear the display of the teach pendant.

---

### Example

```
TPErase;  
TPWrite "Execution started";
```

The teach pendant display is cleared before *Execution started* is written.

---

### Program execution

The teach pendant display is completely cleared of all text. The next time text is written, it will be entered on the uppermost line of the display.

---

### Syntax

```
TPErase;
```

---

### Related information

Writing on the teach pendant

Described in:

RAPID Summary - *Communication*



---



---

## TPReadFK      Reads function keys

*TPReadFK (Teach Pendant Read Function Key)* is used to write text above the functions keys and to find out which key is depressed.

---

### Example

```
TPReadFK reg1, "More ?", "", "", "", "Yes", "No";
```

The text *More ?* is written on the teach pendant display and the function keys 4 and 5 are activated by means of the text strings *Yes* and *No* respectively (see Figure 1). Program execution waits until one of the function keys 4 or 5 is pressed. In other words, *reg1* will be assigned 4 or 5 depending on which of the keys is depressed.

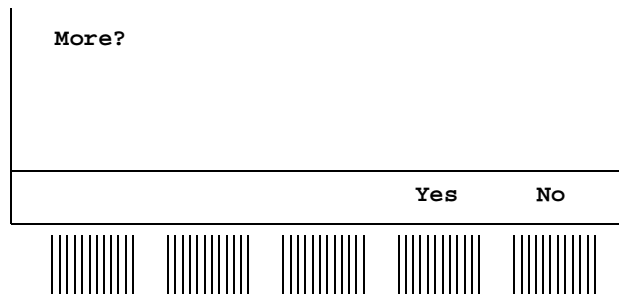


Figure 1 The operator can input information via the function keys.

---

### Arguments

**TPReadFK Answer Text FK1 FK2 FK3 FK4 FK5 [\MaxTime] [\DIBreak] [\BreakFlag]**

**Answer** Data type: *num*

The variable for which, depending on which key is pressed, the numeric value 1..5 is returned. If the function key 1 is pressed, 1 is returned, and so on.

**Text** Data type: *string*

The information text to be written on the display (a maximum of 80 characters).

**FKx** Data type: *string*  
(Function key text)

The text to be written as a prompt for the appropriate function key (a maximum of 7 characters). FK1 is the left-most key.

Function keys without prompts are specified by an empty string "".

**[MaxTime]**

Data type: *num*

The maximum amount of time [s] that program execution waits. If no function key is depressed within this time, the program continues to execute in the error handler unless the BreakFlag is used (see below). The constant ERR\_TP\_MAXTIME can be used to test whether or not the maximum time has elapsed.

**[DIBreak]**

(*Digital Input Break*)

Data type: *signaldi*

The digital signal that may interrupt the operator dialog. If no function key is depressed when the signal is set to 1 (or is already 1), the program continues to execute in the error handler, unless the BreakFlag is used (see below). The constant ERR\_TP\_DIBREAK can be used to test whether or not this has occurred.

**[BreakFlag]**

Data type: *errnum*

A variable that will hold the error code if maxtime or dibreak is used. If this optional variable is omitted, the error handler will be executed. The constants ERR\_TP\_MAXTIME and ERR\_TP\_DIBREAK can be used to select the reason.

**Program execution**

The information text is always written on a new line. If the display is full of text, this body of text is moved up one line first. Strings longer than the width of the teach pendant (40 characters) are split into two lines.

Prompts are written above the appropriate function keys. Keys without prompts are deactivated.

Program execution waits until one of the activated function keys is depressed.

Description of concurrent *TPReadFK* or *TPReadNum* request on Teach Pendant (TP request) from same or other program tasks:

- New TP request from other program task will not take focus (new put in queue)
- New TP request from TRAP in the same program task will take focus (old put in queue)
- Program stop take focus (old put in queue)
- New TP request in program stop state takes focus (old put in queue)

**Example**

```

VAR errnum errvar;
...
TPReadFK reg1, "Go to service position?", "", "", "", "Yes", "No" \MaxTime:= 600
  \DIBreak:= di5\BreakFlag:= errvar;
IF reg1 = 4 or OR errvar = ERR_TP_DIBREAK THEN
  MoveL service, v500, fine, tool1;
  Stop;

```

```
END IF
IF errvar = ERR_TP_MAXTIME EXIT;
```

The robot is moved to the service position if the forth function key ("Yes") is pressed, or if the input 5 is activated. If no answer is given within 10 minutes, the execution is terminated.

---

## Syntax

```
TPReadFK
[Answer':=' <var or pers (INOUT) of num>',
[Text':=' <expression (IN) of string>',
[FK1 ':=' <expression (IN) of string>',
[FK2 ':=' <expression (IN) of string>',
[FK3 ':=' <expression (IN) of string>',
[FK4 ':=' <expression (IN) of string>',
[FK5 ':=' <expression (IN) of string>
['\MaxTime ':=' <expression (IN) of num>]
['\DIBreak ':=' <variable (VAR) of signaldi>]
['\BreakFlag ':=' <var or pers (INOUT) of errnum>];'
```

---

## Related information

	<u>Described in:</u>
Writing to and reading from the teach pendant	RAPID Summary - <i>Communication</i>
Replying via the teach pendant	Running Production



---



---

## TPReadNum Reads a number from the teach pendant

*TPReadNum* (*Teach Pendant Read Numerical*) is used to read a number from the teach pendant.

---

### Example

TPReadNum reg1, “How many units should be produced?”;

The text *How many units should be produced?* is written on the teach pendant display. Program execution waits until a number has been input from the numeric keyboard on the teach pendant. That number is stored in *reg1*.

---

### Arguments

**TPReadNum Answer String** [**MaxTime**] [**\DIBreak**]  
[**BreakFlag**]

**Answer**Data type: *num*

The variable for which the number input via the teach pendant is returned.

**String**Data type: *string*

The information text to be written on the teach pendant (a maximum of 80 characters).

**[\MaxTime]**Data type: *num*

The maximum amount of time that program execution waits. If no number is input within this time, the program continues to execute in the error handler unless the BreakFlag is used (see below). The constant ERR\_TP\_MAXTIME can be used to test whether or not the maximum time has elapsed.

**[\DIBreak]***(Digital Input Break)*Data type: *signal*

The digital signal that may interrupt the operator dialog. If no number is input when the signal is set to 1 (or is already 1), the program continues to execute in the error handler unless the BreakFlag is used (see below). The constant ERR\_TP\_DIBREAK can be used to test whether or not this has occurred.

**[\BreakFlag]**Data type: *errnum*

A variable that will hold the error code if maxtime or dibreak is used. If this optional variable is omitted, the error handler will be executed. The constants ERR\_TP\_MAXTIME and ERR\_TP\_DIBREAK can be used to select the reason.



---

## Program execution

The information text is always written on a new line. If the display is full of text, this body of text is moved up one line first. Strings longer than the width of the teach pendant (40 characters) are split into two lines.

Program execution waits until a number is typed on the numeric keyboard (followed by Enter or *OK*).

Reference to *TPReadFK* about description of concurrent *TPReadFK* or *TPReadNum* request on Teach Pendant from same or other program tasks.

---

## Example

```
TPReadNum reg1, "How many units should be produced?";
FOR i FROM 1 TO reg1 DO
  produce_part;
ENDFOR
```

The text *How many units should be produced?* is written on the teach pendant display. The routine *produce\_part* is then repeated the number of times that is input via the teach pendant.

---

## Syntax

```
TPReadNum
  [Answer':=' ] <var or pers (INOUT) of num>' ;
  [String':=' ] <expression (IN) of string>
  [ '\MaxTime ':=' <expression (IN) of num> ]
  [ '\DIBreak ':=' <variable (VAR) of signal> ]
  [ '\BreakFlag ':=' <var or pers (INOUT) of errnum> ] ';' ;
```

---

## Related information

	<u>Described in:</u>
Writing to and reading from the teach pendant	RAPID Summary - <i>Communication</i>
Entering a number on the teach pendant	Production Running
Examples of how to use the arguments MaxTime, DIBreak and BreakFlag	Instructions - <i>TPReadFK</i>

## TPShow Switch window on the teach pendant

*TPShow (Teach Pendant Show)* is used to select Teach Pendant Window from RAPID.

---

### Examples

TPShow TP\_PROGRAM;

The *Production Window* will be active if the system is in *AUTO* mode and the *Program Window* will be active if the system is in *MAN* mode after execution of this instruction.

TPShow TP\_LATEST;

The latest used Teach Pendant Window used before the *Operator Input&Output Window* will be active after execution of this instruction.

---

### Arguments

#### TPShow Window

##### Window

Data type: *tpnum*

The window to show:

TP\_PROGRAM = *Production Window* if in *AUTO* mode. *Program Window* if in *MAN* mode.

TP\_LATEST = Latest used Teach Pendant Window before *Operator Input&Output Window*

---

### Predefined data

```
CONST tpnum TP_PROGRAM := 1;  
CONST tpnum TP_LATEST := 2;
```

---

### Program execution

The selected Teach Pendant Window will be activated.

---

**Syntax**

TPShow  
[Window':=' ] <expression (IN) of *tpnum*> ';' ;

---

**Related information**

Communicating using  
the teach pendant

Teach Pendant Window number

-

Described in:

RAPID Summary - *Communication*

Data Types - *tpnum*



to a text string before it is added to the first string. The conversion from value to text string takes place as follows:

<u>Argument</u>	<u>Value</u>	<u>Text string</u>
\Num	23	"23"
\Num	1.141367	"1.14137"
\Bool	TRUE	"TRUE"
\Pos	[1817.3,905.17,879.11]	"[1817.3,905.17,879.11]"
\Orient	[0.96593,0,0.25882,0]	"[0.96593,0,0.25882,0]"

The value is converted to a string with standard RAPID format. This means in principle 6 significant digits. If the decimal part is less than 0.000005 or greater than 0.999995, the number is rounded to an integer.

---

## Limitations

The arguments *\Num*, *\Bool*, *\Pos* and *\Orient* are mutually exclusive and thus cannot be used simultaneously in the same instruction.

---

## Syntax

```
TPWrite
[String :='] <expression (IN) of string>
['\Num :=' <expression (IN) of num> ]
| ['\Bool :=' <expression (IN) of bool> ]
| ['\Pos :=' <expression (IN) of pos> ]
| ['\Orient :=' <expression (IN) of orient> ]';'
```

---

## Related information

Clearing and reading  
the teach pendant

Described in:

RAPID Summary - *Communication*

-

---



---

## TriggC Circular robot movement with events

*TriggC* (*Trigg Circular*) is used to set output signals and/or run interrupt routines at fixed positions, at the same time as the robot is moving on a circular path.

One or more (max. 4) events can be defined using the instructions *TriggIO*, *TriggEquip* or *TriggInt* and afterwards these definitions are referred to in the instruction *TriggC*.

---

### Examples

```
VAR triggdata gunon;

TriggIO gunon, 0 \Start \DOp:=gun, on;

MoveL p1, v500, z50, gun1;
TriggC p2, p3, v500, gunon, fine, gun1;
```

The digital output signal *gun* is set when the robot's TCP passes the midpoint of the corner path of the point *p1*.

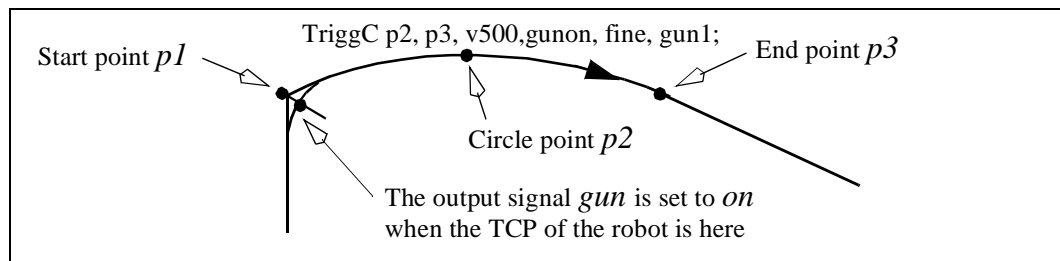


Figure 1 Example of fixed-position IO event.

---

### Arguments

**TriggC** [**\Conc**] **CirPoint ToPoint Speed** [**\T**]  
**Trigg\_1** [**\T2**] [**\T3**] [**\T4**] **Zone Tool** [**\WObj**] [**\Corr**]

[**\Conc**]

(*Concurrent*)

Data type: *switch*

Subsequent logical instructions are executed at once. This argument is used to shorten the cycle time when, for example, communicating with external equipment, and synchronisation is not required. It can also be used to tune the execution of the robot path, to avoid warning 50024 Corner path failure, or error 40082 Deceleration limit.

When using the argument **\Conc**, the number of movement instructions in succession is limited to 5. In a program section that includes *StorePath-RestoPath*, movement instructions with the argument **\Conc** are not permitted.

If this argument is omitted and the ToPoint is not a stop point, the subsequent instruction is executed some time before the robot has reached the programmed stop point or 100 ms before the specified zone.

**CirPoint** Data type: *robtarget*

The circle point of the robot. See the instruction *MoveC* for a more detailed description of circular movement. The circle point is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**ToPoint** Data type: *robtarget*

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**Speed** Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity of the tool centre point, the external axes and of the tool reorientation.

[ \T ] (Time) Data type: *num*

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

**Trigg\_1** Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T2 ] (Trigg 2) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T3 ] (Trigg 3) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T4 ] (Trigg 4) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

**Zone** Data type: *zonedata*

Zone data for the movement. Zone data describes the size of the generated corner path.

**Tool** Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point that is moved to the specified destination position.

[ \WObj] (Work Object) Data type: *wobjdata*

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified for a linear movement relative to the work object to be performed.

[ \Corr] (Correction) Data type: *switch*

Correction data written to a corrections entry by the instruction *CorrWrite* will be added to the path and destination position, if this argument is present.

## Program execution

See the instruction *MoveC* for information about circular movement.

As the trigger conditions are fulfilled when the robot is positioned closer and closer to the end point, the defined trigger activities are carried out. The trigger conditions are fulfilled either at a certain distance before the end point of the instruction, or at a certain distance after the start point of the instruction, or at a certain point in time (limited to a short time) before the end point of the instruction.

During stepping execution forwards, the I/O activities are carried out but the interrupt routines are not run. During stepping execution backwards, no trigger activities at all are carried out.

## Examples

```
VAR intnum intno1;
VAR triggdata trigg1;
...
CONNECT intno1 WITH trap1;
TriggInt trigg1, 0.1 \Time, intno1;
...
TriggC p1, p2, v500, trigg1, fine, gun1;
TriggC p3, p4, v500, trigg1, fine, gun1;
...
IDelete intno1;
```

The interrupt routine *trap1* is run when the work point is at a position *0.1* s before the point *p2* or *p4* respectively.

## Limitations

If the current start point deviates from the usual, so that the total positioning length of



the instruction *TriggC* is shorter than usual, it may happen that several or all of the trigger conditions are fulfilled immediately and at the same position. In such cases, the sequence in which the trigger activities are carried out will be undefined. The program logic in the user program may not be based on a normal sequence of trigger activities for an “incomplete movement”.

The instruction *TriggC* should never be started from the beginning with the robot in position after the circle point. Otherwise the robot will not take the programmed path (positioning around the circular path in another direction compared with that programmed).

---

## Syntax

```
TriggC
  [ '\ Conc ' ; ]
  [ CirPoint := ] < expression (IN) of robtarg > ;
  [ ToPoint := ] < expression (IN) of robtarg > ;
  [ Speed := ] < expression (IN) of speeddata >
  [ '\ T := ] < expression (IN) of num > ] ;
  [ Trigg_1 := ] < variable (VAR) of triggdata >
  [ '\ T2 := ] < variable (VAR) of triggdata > ]
  [ '\ T3 := ] < variable (VAR) of triggdata > ]
  [ '\ T4 := ] < variable (VAR) of triggdata > ] ;
  [ Zone := ] < expression (IN) of zonedata > ;
  [ Tool := ] < persistent (PERS) of tooldata >
  [ '\ WObj := ] < persistent (PERS) of wobjdata > ]
  [ '\ Corr ] ;
```

---

## Related information

	<u>Described in:</u>
Linear movement with triggers	Instructions - <i>TriggL</i>
Joint movement with triggers	Instructions - <i>TriggJ</i>
Definition of triggers	Instructions - <i>TriggIO</i> , <i>TriggEquip</i> <i>TriggInt</i>
Writes to a corrections entry	Instructions - <i>CorrWrite</i>
Circular movement	Motion Principles - <i>Positioning during Program Execution</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Motion in general	Motion Principles

---



---

## TriggEquip Defines a fixed position-time I/O event

*TriggEquip* (*Trigg Equipment*) is used to define conditions and actions for setting a digital, a group of digital, or an analog output signal at a fixed position along the robot's movement path with possibility to do time compensation for the lag in the external equipment.

The data defined is used for implementation in one or more subsequent *TriggL*, *TriggC* or *TriggJ* instructions.

---

### Examples

```
VAR triggdata gunon;
```

```
TriggEquip gunon, 10, 0.1 \DOp:=gun, 1;
```

```
TriggL p1, v500, gunon, z50, gun1;
```

The tool *gun1* opens in point *p2*, when the TCP is *10* mm before the point *p1*. To reach this, the digital output signal *gun* is set to the value *1*, when TCP is *0.1* s before the point *p2*. The gun is full open when TCP reach point *p2*.

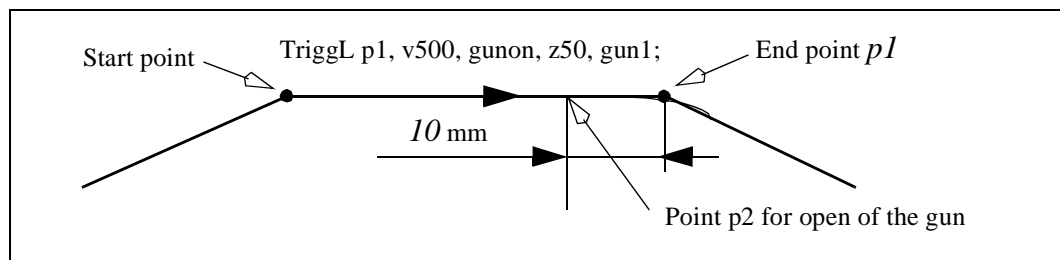


Figure 1 Example of fixed position-time I/O event.

---

### Arguments

**TriggEquip** **TriggData** **Distance** [ **\Start** ] **EquipLag**  
 [ **\DOp** ] [ **\GOp** ] [ **\AOp** ] [ **\ProcID** ] **SetValue** [ **\Inhib** ]

**TriggData**

Data type: *triggdata*

Variable for storing the *triggdata* returned from this instruction. These *triggdata* are then used in the subsequent *TriggL*, *TriggC* or *TriggJ* instructions.

**Distance**

Data type: *num*

Defines the position on the path where the I/O equipment event shall occur.

Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument *\Start* is not set).

See the section entitled Program execution for further details.

[ \Start ] Data type: *switch*

Used when the distance for the argument *Distance* starts at the movement start point instead of the end point.

**EquipLag** (*Equipment Lag*) Data type: *num*

Specify the lag for the external equipment in s.

For compensation of external equipment lag, use positive argument value. Positive argument value means that the I/O signal is set by the robot system at specified time before the TCP physical reach the specified distance in relation to the movement start or end point.

Negative argument value means that the I/O signal is set by the robot system at specified time after that the TCP physical has passed the specified distance in relation to the movement start or end point.

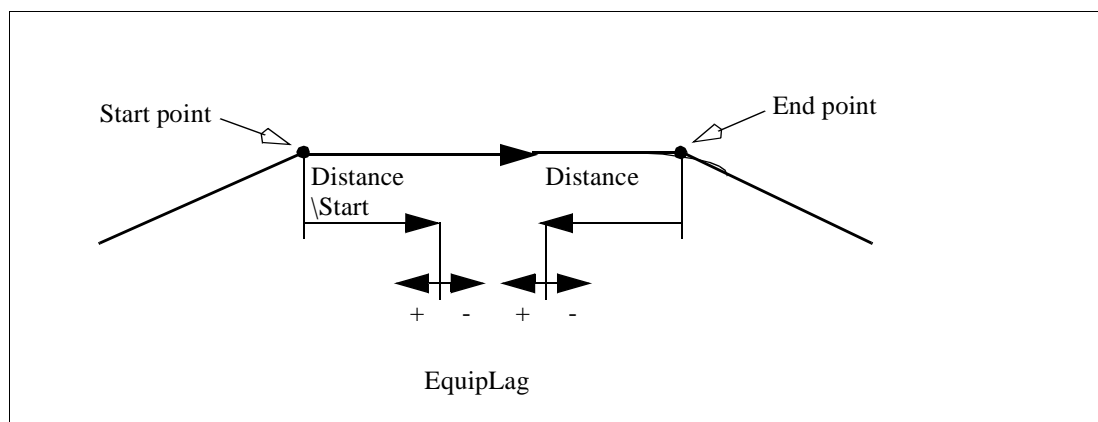


Figure 2 Use of argument EquipLag.

[ \DOp ] (*Digital OutPut*) Data type: *signaldo*

The name of the signal, when a digital output signal shall be changed.

[ \GOp ] (*Group OutPut*) Data type: *signalgo*

The name of the signal, when a group of digital output signals shall be changed.

[ \AOp ] (*Analog Output*) Data type: *signalao*

The name of the signal, when a analog output signal shall be changed.

[ \ProcID ] (*Process Identity*) Data type: *num*

Not implemented for customer use.

(The identity of the IPM process to receive the event. The selector is specified in the argument *SetValue*.)

**SetValue**Data type: *num*

Desired value of output signal (within the allowed range for the current signal).

**[ \Inhib ]***(Inhibit)*Data type: *bool*

The name of a persistent variable flag for inhibit the setting of the signal at runtime.

If this optional argument is used and the actual value of the specified flag is TRUE at the position-time for setting of the signal then the specified signal (*DOP*, *GOp* or *AOp*) will be set to 0 in stead of specified value.

**Program execution**

When running the instruction *TriggEquip*, the trigger condition is stored in the specified variable for the argument *TriggData*.

Afterwards, when one of the instructions *TriggL*, *TriggC* or *TriggJ* is executed, the following are applicable, with regard to the definitions in *TriggEquip*:

The distance specified in the argument *Distance*:

Linear movement

The straight line distance

Circular movement

The circle arc length

Non-linear movement

The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

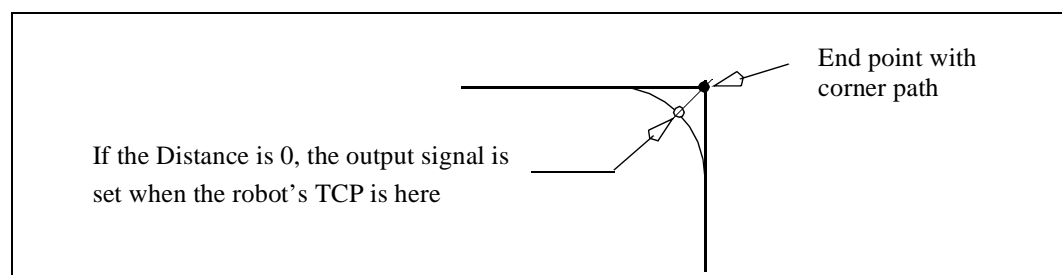


Figure 3 Fixed position-time I/O on a corner path.

The position-time related event will be generated when the start point (end point) is passed, if the specified distance from the end point (start point) is not within the length of movement of the current instruction (*Trigg...*). With use of argument *EquipLag* with negative time (delay), the I/O signal can be set after the end point.

**Examples**

```
VAR triggdata glueflow;
```

TriggEquip glueflow, 1 \Start, 0.05 \AOp:=glue, 5.3;

MoveJ p1, v1000, z50, tool1;

TriggL p2, v500, glueflow, z50, tool1;

The analog output signal *glue* is set to the value 5.3 when the TCP passes a point located 1 mm after the start point *p1* with compensation for equipment lag 0.05 s.

...

TriggL p3, v500, glueflow, z50, tool1;

The analog output signal *glue* is set once more to the value 5.3 when the TCP passes a point located 1 mm after the start point *p2*.

## Limitations

I/O events with distance (without the argument *\Time*) is intended for flying points (corner path). I/O events with distance, using stop points, results in worse accuracy than specified below.

Regarding the accuracy for I/O events with distance and using flying points, the following is applicable when setting a digital output at a specified distance from the start point or end point in the instruction *TriggL* or *TriggC*:

- Accuracy specified below is valid for positive *EquipLag* parameter < 60 ms, equivalent to the lag in the robot servo (without changing the system parameter *Event Preset Time*).
- Accuracy specified below is valid for positive *EquipLag* parameter < configured *Event Preset Time* (system parameter).
- Accuracy specified below is not valid for positive *EquipLag* parameter > configured *Event Preset Time* (system parameter). In this case, an approximate method is used in which the dynamic limitations of the robot are not taken into consideration. *SingArea \Wrist* must be used in order to achieve an acceptable accuracy.
- Accuracy specified below is valid for negative *EquipLag*.

I/O events with time (with the argument *\Time*) is intended for stop points. I/O events with time, using flying points, results in worse accuracy than specified below.

I/O events with time can only be specified from the end point of the movement. This time cannot exceed the current braking time of the robot, which is max. approx. 0.5 s (typical values at speed 500 mm/s for IRB2400 150 ms and for IRB6400 250 ms). If the specified time is greater than the current braking time, the event will be generated anyhow, but not until braking is started (later than specified). However, the whole of the movement time for the current movement can be utilised during small and fast movements.

Typical absolute accuracy values for set of digital outputs +/- 5 ms.

Typical repeat accuracy values for set of digital outputs +/- 2 ms.

Used digital output signals (*DOP* or *GOP*) cannot be cross connected to other signals.

---

**Syntax**

```

TriggEquip
[ TriggData := ] < variable (VAR) of triggdata> ‘,
[ Distance := ] < expression (IN) of num>
[ '\ Start ] ‘,
[ EquipLag := ] < expression (IN) of num>
[ '\ DOp := ] < variable (VAR) of signaldo> ]
| [ '\ GOP := ] < variable (VAR) of signalgo> ]
| [ '\ AOp := ] < variable (VAR) of signalao> ]
| [ '\ ProcID := ] < expression (IN) of num> ] ‘,
[ SetValue := ] < expression (IN) of num>
[ '\ Inhibit := ] < persistent (PERS) of bool> ] ‘,

```

---

**Related information**

	<u>Described in:</u>
Use of triggers	Instructions - <i>TriggL, TriggC, TriggJ</i>
Definition of other triggs	Instruction - <i>TriggIO, TriggInt</i>
More examples	Data Types - <i>triggdata</i>
Set of I/O	Instructions - <i>SetDO, SetGO, SetAO</i>
Configuration of Event preset time	User's guide System Parameters - <i>Manipulator</i>



---



---

## TriggInt Defines a position related interrupt

*TriggInt* is used to define conditions and actions for running an interrupt routine at a position on the robot's movement path.

The data defined is used for implementation in one or more subsequent *TriggL*, *TriggC* or *TriggJ* instructions.

---

### Examples

```
VAR intnum intno1;
VAR triggdata trigg1;
...
CONNECT intno1 WITH trap1;
TriggInt trigg1, 5, intno1;
...
TriggL p1, v500, trigg1, z50, gun1;
TriggL p2, v500, trigg1, z50, gun1;
...
IDelete intno1;
```

The interrupt routine *trap1* is run when the TCP is at a position 5 mm before the point *p1* or *p2* respectively.

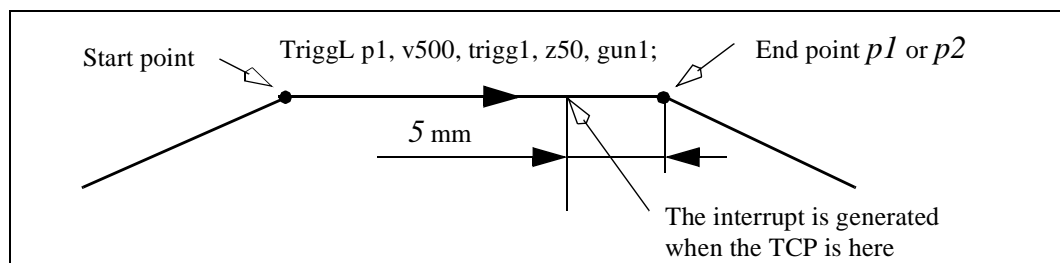


Figure 1 Example position related interrupt.

---

### Arguments

**TriggInt TriggData Distance [ \Start ] | [ \Time ]  
Interrupt**

**TriggData** Data type: *triggdata*

Variable for storing the *triggdata* returned from this instruction. These *triggdata* are then used in the subsequent *TriggL*, *TriggC* or *TriggJ* instructions.

**Distance** Data type: *num*

Defines the position on the path where the interrupt shall be generated.



Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument `\Start` or `\Time` is not set).

See the section entitled Program execution for further details.

[ `\Start` ] Data type: *switch*

Used when the distance for the argument *Distance* starts at the movement start point instead of the end point.

[ `\Time` ] Data type: *switch*

Used when the value specified for the argument *Distance* is in fact a time in seconds (positive value) instead of a distance.

Position related interrupts in time can only be used for short times (< 0.5 s) before the robot reaches the end point of the instruction. See the section entitled Limitations for more details.

**Interrupt** Data type: *intnum*

Variable used to identify an interrupt.

## Program execution

When running the instruction *TriggInt*, data is stored in a specified variable for the argument *TriggData* and the interrupt that is specified in the variable for the argument *Interrupt* is activated.

Afterwards, when one of the instructions *TriggL*, *TriggC* or *TriggJ* is executed, the following are applicable, with regard to the definitions in *TriggInt*:

### The distance specified in the argument *Distance*:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

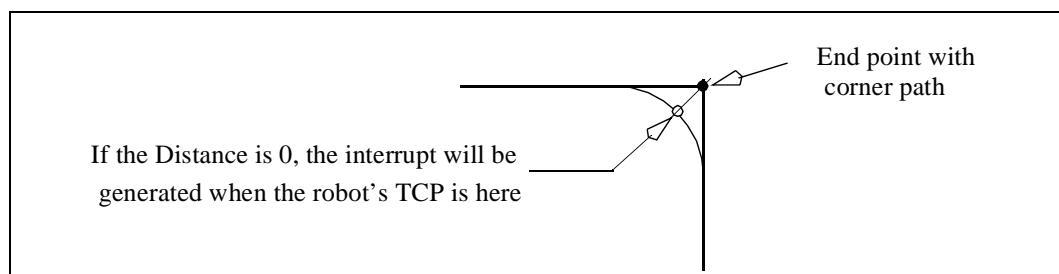


Figure 2 Position related interrupt on a corner path.

The position related interrupt will be generated when the start point (end point) is passed, if the specified distance from the end point (start point) is not within the length of movement of the current instruction (*Trigg...*).

---

## Examples

This example describes programming of the instructions that interact to generate position related interrupts:

```
VAR intnum intno2;
VAR triggdata trigg2;
```

- Declaration of the variables *intno2* and *trigg2* (shall not be initiated).

```
CONNECT intno2 WITH trap2;
```

- Allocation of interrupt numbers that are stored in the variable *intno2*
- The interrupt number is coupled to the interrupt routine *trap2*

```
TriggInt trigg2, 0, intno2;
```

- The interrupt number in the variable *intno2* is flagged as used
- The interrupt is activated
- Defined trigger conditions and interrupt number are stored in the variable *trigg2*

```
TriggL p1, v500, trigg2, z50, gun1;
```

- The robot is moved to the point *p1*.
- When the TCP reaches the point *p1*, an interrupt is generated and the interrupt routine *trap2* is run.

```
TriggL p2, v500, trigg2, z50, gun1;
```

- The robot is moved to the point *p2*
- When the TCP reaches the point *p2*, an interrupt is generated and the interrupt routine *trap2* is run once more.

```
IDelete intno2;
```

- The interrupt number in the variable *intno2* is de-allocated.

---

## Limitations

Interrupt events with distance (without the argument *\Time*) is intended for flying points (corner path). Interrupt events with distance, using stop points, results in worse accuracy than specified below.

Interrupt events with time (with the argument  $\backslash$ Time) is intended for stop points. Interrupt events with time, using flying points, results in worse accuracy than specified below.

I/O events with time can only be specified from the end point of the movement. This time cannot exceed the current braking time of the robot, which is max. approx. 0.5 s (typical values at speed 500 mm/s for IRB2400 150 ms and for IRB6400 250 ms). If the specified time is greater than the current braking time, the event will be generated anyhow, but not until braking is started (later than specified). However, the whole of the movement time for the current movement can be utilised during small and fast movements.

Typical absolute accuracy values for generation of interrupts +/- 5 ms.

Typical repeat accuracy values for generation of interrupts +/- 2 ms.

Normally there is a delay of 5 to 120 ms between interrupt generation and response, depending on the type of movement being performed at the time of the interrupt. (Ref. to Basic Characteristics RAPID - *Interrupts*).

To obtain the best accuracy when setting an output at a fixed position along the robot's path, use the instructions *TriggIO* or *TriggEquip* in preference to the instructions *TriggInt* with *SetDO/SetGO/SetAO* in an interrupt routine.

## Syntax

```
TriggInt
  [ TriggData ':=' ] < variable (VAR) of triggdata> ','
  [ Distance ':=' ] < expression (IN) of num>
  [ '\ Start ] | [ '\ Time ] ','
  [ Interrupt ':=' ] < variable (VAR) of intnum> ',';
```

## Related information

Use of triggers

Definition of position fix I/O

More examples

Interrupts

### Described in:

Instructions - *TriggL, TriggC, TriggJ*

Instruction - *TriggIO, TriggEquip*

Data Types - *triggdata*

Basic Characteristics - *Interrupts*

---



---

## TriggIO Defines a fixed position I/O event

*TriggIO* is used to define conditions and actions for setting a digital, a group of digital, or an analog output signal at a fixed position along the robot's movement path.

To obtain a fixed position I/O event, *TriggIO* compensates for the lag in the control system (lag between robot and servo) but not for any lag in the external equipment. For compensation of both lags use *TriggEquip*.

The data defined is used for implementation in one or more subsequent *TriggL*, *TriggC* or *TriggJ* instructions.

---

### Examples

```
VAR triggdata gunon;
```

```
TriggIO gunon, 10 \DOp:=gun, 1;
```

```
TriggL p1, v500, gunon, z50, gun1;
```

The digital output signal *gun* is set to the value *1* when the TCP is *10* mm before the point *p1*.

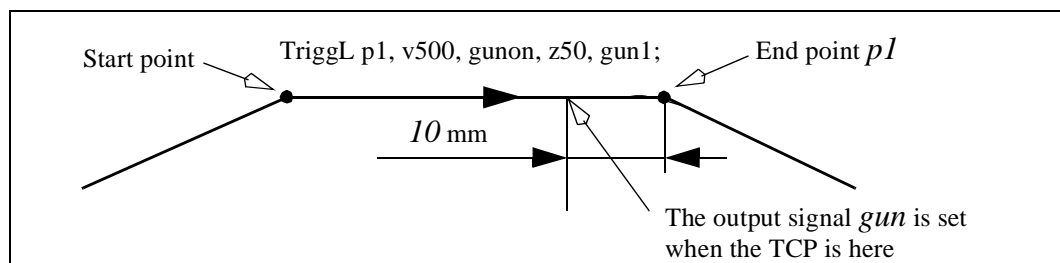


Figure 1 Example of fixed-position IO event.

---

### Arguments

```
TriggIO TriggData Distance [ \Start ] | [ \Time ]
[ \DOp ] | [ \GOp ] | [ \AOp ] | [ \ProcID ] SetValue
[ \DODelay ]
```

**TriggData** Data type: *triggdata*

Variable for storing the *triggdata* returned from this instruction. These *triggdata* are then used in the subsequent *TriggL*, *TriggC* or *TriggJ* instructions.

**Distance** Data type: *num*

Defines the position on the path where the I/O event shall occur.

Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument `\Start` or `\Time` is not set).

See the section entitled Program execution for further details.

[ `\Start` ] Data type: *switch*

Used when the distance for the argument *Distance* starts at the movement start point instead of the end point.

[ `\Time` ] Data type: *switch*

Used when the value specified for the argument *Distance* is in fact a time in seconds (positive value) instead of a distance.

Fixed position I/O in time can only be used for short times (< 0.5 s) before the robot reaches the end point of the instruction. See the section entitled Limitations for more details.

[ `\DOp` ] (*Digital OutPut*) Data type: *signaldo*

The name of the signal, when a digital output signal shall be changed.

[ `\GOp` ] (*Group OutPut*) Data type: *signalgo*

The name of the signal, when a group of digital output signals shall be changed.

[ `\AOp` ] (*Analog Output*) Data type: *signalao*

The name of the signal, when a analog output signal shall be changed.

[ `\ProcID` ] (*Process Identity*) Data type: *num*

Not implemented for customer use.

(The identity of the IPM process to receive the event. The selector is specified in the argument *SetValue*.)

**SetValue** Data type: *num*

Desired value of output signal (within the allowed range for the current signal).

[ `\DODelay` ] (*Digital Output Delay*) Data type: *num*

Time delay in seconds (positive value) for a digital output signal or group of digital output signals.

Only used to delay setting digital output signals, after the robot has reached the specified position. There will be no delay if the argument is omitted.

The delay is not synchronised with the movement.

---

## Program execution

When running the instruction *TriggIO*, the trigger condition is stored in a specified variable for the argument *TriggData*.

Afterwards, when one of the instructions *TriggL*, *TriggC* or *TriggJ* is executed, the following are applicable, with regard to the definitions in *TriggIO*:

The distance specified in the argument *Distance*:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

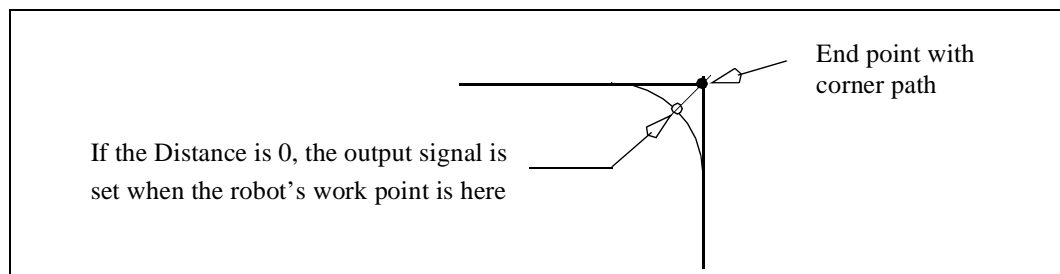


Figure 2 Fixed position I/O on a corner path.

The fixed position I/O will be generated when the start point (end point) is passed, if the specified distance from the end point (start point) is not within the length of movement of the current instruction (*Trigg...*).

---

## Examples

```
VAR triggdata glueflow;
TriggIO glueflow, 1 \Start \AOp:=glue, 5.3;
MoveJ p1, v1000, z50, tool1;
TriggL p2, v500, glueflow, z50, tool1;
```

The analog output signal *glue* is set to the value 5.3 when the work point passes a point located 1 mm after the start point *p1*.

```
...
TriggL p3, v500, glueflow, z50, tool1;
```

The analog output signal *glue* is set once more to the value 5.3 when the work point passes a point located 1 mm after the start point *p2*.

---

## Limitations

I/O events with distance (without the argument *\Time*) is intended for flying points (corner path). I/O events with distance, using stop points, results in worse accuracy than specified below.

I/O events with time (with the argument *\Time*) is intended for stop points. I/O events with time, using flying points, results in worse accuracy than specified below.

I/O events with time can only be specified from the end point of the movement. This time cannot exceed the current braking time of the robot, which is max. approx. 0.5 s (typical values at speed 500 mm/s for IRB2400 150 ms and for IRB6400 250 ms). If the specified time is greater than the current braking time, the event will be generated anyhow, but not until braking is started (later than specified). However, the whole of the movement time for the current movement can be utilised during small and fast movements.

Typical absolute accuracy values for set of digital outputs +/- 5 ms.

Typical repeat accuracy values for set of digital outputs +/- 2 ms.

Used digital output signals (*DOP* or *GOP*) cannot be cross connected to other signals.

---

## Syntax

```
TriggIO
[ TriggData ':=' ] < variable (VAR) of triggdata> ','
[ Distance ':=' ] < expression (IN) of num>
[ '\ Start ] | [ '\ Time ]
[ '\ DOP ':=' < variable (VAR) of signaldo> ]
| [ '\ GOP ':=' < variable (VAR) of signalgo> ]
| [ '\ AOP ':=' < variable (VAR) of signalao> ]
| [ '\ ProcID ':=' < expression (IN) of num> ] ','
[ SetValue ':=' ] < expression (IN) of num>
[ '\ DODelay ':=' < expression (IN) of num> ] ','
```

---

## Related information

	<u>Described in:</u>
Use of triggers	Instructions - <i>TriggL</i> , <i>TriggC</i> , <i>TriggJ</i>
Definition of position-time I/O event	Instruction - <i>TriggEquip</i>
Definition of position related interrupts	Instruction - <i>TriggInt</i>
More examples	Data Types - <i>triggdata</i>
Set of I/O	Instructions - <i>SetDO</i> , <i>SetGO</i> , <i>SetAO</i>

---



---

## TriggJ Axis-wise robot movements with events

*TriggJ* (*Trigg Joint*) is used to set output signals and/or run interrupt routines at fixed positions, at the same time as the robot is moving on a circular path.

One or more (max. 4) events can be defined using the instructions *TriggIO*, *TriggEquip* or *TriggInt* and afterwards these definitions are referred to in the instruction *TriggJ*.

---

### Examples

```
VAR triggdata gunon;

TriggIO gunon, 0 \Start \DOp:=gun, on;

MoveL p1, v500, z50, gun1;
TriggJ p2, v500, gunon, fine, gun1;
```

The digital output signal *gun* is set when the robot's TCP passes the midpoint of the corner path of the point *p1*.

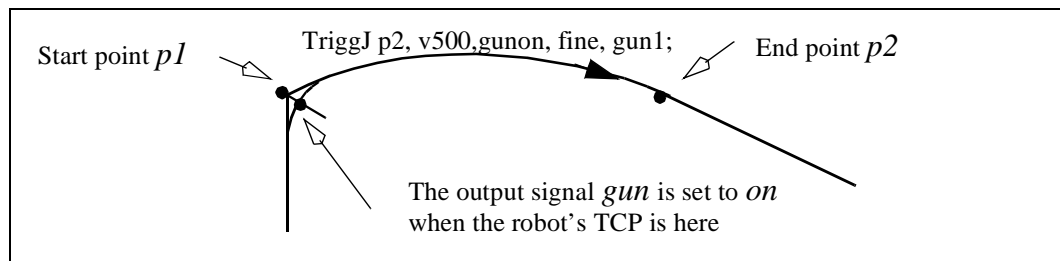


Figure 1 Example of fixed-position IO event.

---

### Arguments

**TriggJ** [**\Conc**] **ToPoint** **Speed** [**\T**] **Trigg\_1** [**\T2**] [**\T3**] [**\T4**]  
**Zone** **Tool** [**\WObj**]

[**\Conc**]

(*Concurrent*)

Data type: *switch*

Subsequent logical instructions are executed at once. This argument is used to shorten the cycle time when, for example, communicating with external equipment, if synchronisation is not required. It can also be used to tune the execution of the robot path, to avoid warning 50024 Corner path failure or error 40082 Deceleration limit.

Using the argument **\Conc**, the number of movement instructions in succession is limited to 5. In a program section that includes **StorePath-RestoPath**, movement instructions with the argument **\Conc** are not permitted.



If this argument is omitted and the ToPoint is not a stop point, the subsequent instruction is executed some time before the robot has reached the programmed zone .

**ToPoint** Data type: *robtarget*

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**Speed** Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity of the tool centre point, the external axes and of the tool reorientation.

[ \T ] (Time) Data type: *num*

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

**Trigg\_1** Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T2 ] (Trigg 2) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T3 ] (Trigg 3) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T4 ] (Trigg 4) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

**Zone** Data type: *zonedata*

Zone data for the movement. Zone data describes the size of the generated corner path.

**Tool** Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point that is moved to the specified destination position.

[ \WObj ] (Work Object) Data type: *wobjdata*

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world

coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified for a linear movement relative to the work object to be performed.

---

## Program execution

See the instruction *MoveJ* for information about joint movement.

As the trigger conditions are fulfilled when the robot is positioned closer and closer to the end point, the defined trigger activities are carried out. The trigger conditions are fulfilled either at a certain distance before the end point of the instruction, or at a certain distance after the start point of the instruction, or at a certain point in time (limited to a short time) before the end point of the instruction.

During stepping execution forwards, the I/O activities are carried out but the interrupt routines are not run. During stepping execution backwards, no trigger activities at all are carried out.

---

## Examples

```
VAR intnum intno1;
VAR triggdata trigg1;
...
CONNECT intno1 WITH trap1;
TriggInt trigg1, 0.1 \Time , intno1;
...
TriggJ p1, v500, trigg1, fine, gun1;
TriggJ p2, v500, trigg1, fine, gun1;
...
IDelete intno1;
```

The interrupt routine *trap1* is run when the work point is at a position *0.1* s before the point *p1* or *p2* respectively.

---

## Limitations

If the current start point deviates from the usual, so that the total positioning length of the instruction *TriggJ* is shorter than usual (e.g. at the start of *TriggJ* with the robot position at the end point), it may happen that several or all of the trigger conditions are fulfilled immediately and at the same position. In such cases, the sequence in which the trigger activities are carried will be undefined. The program logic in the user program may not be based on a normal sequences of trigger activities for an "incomplete movement".

---

**Syntax**

```

TriggJ
  [ '\ Conc ' , ]
  [ ToPoint ':=' ] < expression (IN) of robtarget > ' , '
  [ Speed ':=' ] < expression (IN) of speeddata >
    [ '\ T ':=' < expression (IN) of num > ] ' , '
  [ Trigg_1 ':=' ] < variable (VAR) of triggdata >
  [ '\ T2 ':=' < variable (VAR) of triggdata > ]
  [ '\ T3 ':=' < variable (VAR) of triggdata > ]
  [ '\ T4 ':=' < variable (VAR) of triggdata > ] ' , '
  [ Zone ':=' ] < expression (IN) of zonedata > ' , '
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\ WObj ':=' < persistent (PERS) of wobjdata > ] ' , '

```

---

**Related information**

	<u>Described in:</u>
Linear movement with triggs	Instructions - <i>TriggL</i>
Circular movement with triggers	Instructions - <i>TriggC</i>
Definition of triggers	Instructions - <i>TriggIO</i> , <i>TriggEquip</i> or <i>TriggInt</i>
Joint movement	Motion Principles - <i>Positioning during Program Execution</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Motion in general	Motion Principles

---



---

## TriggL Linear robot movements with events

*TriggL* (*Trigg Linear*) is used to set output signals and/or run interrupt routines at fixed positions, at the same time as the robot is making a linear movement.

One or more (max. 4) events can be defined using the instructions *TriggIO*, *TriggEquip* or *TriggInt* and afterwards these definitions are referred to in the instruction *TriggL*.

---

### Examples

```
VAR triggdata gunon;

TriggIO gunon, 0 \Start \DOp:=gun, on;

MoveJ p1, v500, z50, gun1;
TriggL p2, v500, gunon, fine, gun1;
```

The digital output signal *gun* is set when the robot's TCP passes the midpoint of the corner path of the point *p1*.

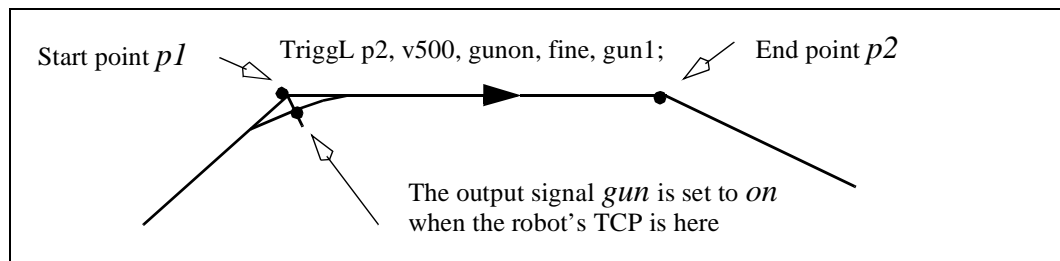


Figure 1 Example of fixed-position IO event.

---

### Arguments

**TriggL** [**\Conc**] **ToPoint** **Speed** [**\T**] **Trigg\_1** [**\T2**] [**\T3**] [**\T4**]  
**Zone** **Tool** [**\WObj**] [**\Corr**]

[**\Conc**]

(*Concurrent*)

Data type: *switch*

Subsequent logical instructions are executed at once. This argument is used to shorten the cycle time when, for example, communicating with external equipment, if synchronisation is not required. It can also be used to tune the execution of the robot path, to avoid warning 50024 Corner path failure or error 40082 Deceleration limit.

Using the argument **\Conc**, the number of movement instructions in succession is limited to 5. In a program section that includes **StorePath-RestoPath**, movement instructions with the argument **\Conc** are not permitted.

If this argument is omitted and the ToPoint is not a stop point, the subsequent instruction is executed some time before the robot has reached the programmed stop point or 100 ms before the specified zone.

**ToPoint** Data type: *robtarget*

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**Speed** Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity of the tool centre point, the external axes and of the tool reorientation.

[ \T ] (Time) Data type: *num*

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

**Trigg\_1** Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T2 ] (*Trigg 2*) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T3 ] (*Trigg 3*) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

[ \T4 ] (*Trigg 4*) Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO*, *TriggEquip* or *TriggInt*.

**Zone** Data type: *zonedata*

Zone data for the movement. Zone data describes the size of the generated corner path.

**Tool** Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point that is moved to the specified destination position.

[ \WObj ] (*Work Object*) Data type: *wobjdata*

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world



---

**Syntax**

```

TriggL
  [ '\ Conc ', ]
  [ ToPoint := ] < expression (IN) of robtarg > ', '
  [ Speed := ] < expression (IN) of speeddata >
  [ '\ T := ] < expression (IN) of num > ', '
  [ Trigg_1 := ] < variable (VAR) of triggdata >
  [ '\ T2 := ] < variable (VAR) of triggdata > ]
  [ '\ T3 := ] < variable (VAR) of triggdata > ]
  [ '\ T4 := ] < variable (VAR) of triggdata > ', '
  [ Zone := ] < expression (IN) of zonedata > ', '
  [ Tool := ] < persistent (PERS) of tooldata >
  [ '\ WObj := ] < persistent (PERS) of wobjdata > ]
  [ '\ Corr ]; '

```

---

**Related information**

	<u>Described in:</u>
Circular movement with triggers	Instructions - <i>TriggC</i>
Joint movement with triggers	Instructions - <i>TriggJ</i>
Definition of triggers	Instructions - <i>TriggIO</i> , <i>TriggEquip</i> or <i>TriggInt</i>
Writes to a corrections entry	Instructions - <i>CorrWrite</i>
Linear movement	Motion Principles - <i>Positioning during Program Execution</i>
Definition of velocity	Data Types - <i>speeddata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Motion in general	Motion Principles

**TRYNEXT****Jumps over an instruction  
which has caused an error**

*TRYNEXT* is used to jump over an instruction which has caused an error. Instead, the next instruction is run.

---

**Example**

```
reg2 := reg3/reg4;  
.  
ERROR  
  IF ERRNO = ERR_DIVZERO THEN  
    reg2:=0;  
    TRYNEXT;  
  ENDIF
```

An attempt is made to divide *reg3* by *reg4*. If *reg4* is equal to 0 (division by zero), a jump is made to the error handler, where *reg2* is set to 0. The *TRYNEXT* instruction is then used to continue with the next instruction.

---

**Program execution**

Program execution continues with the instruction subsequent to the instruction that caused the error.

---

**Limitations**

The instruction can only exist in a routine's error handler.

---

**Syntax**

```
TRYNEXT ;'
```

---

**Related information**

Error handlers

Described in:

Basic Characteristics-  
*Error Recovery*





## TuneReset      Resetting servo tuning

*TuneReset* is used to reset the dynamic behaviour of all robot axes and external mechanical units to their normal values.

---

### Example

```
TuneReset;
```

Resetting tuning values for all axes to 100%.

---

### Program execution

The tuning values for all axes are reset to 100%.

The default servo tuning values for all axes are automatically set by executing instruction *TuneReset*

- at a cold start-up
  - when a new program is loaded
  - when starting program execution from the beginning.
- 

### Syntax

```
TuneReset ';' ;
```

---

### Related information

Tuning servos

Described in:

Instructions - *TuneServo*



---

---

## TuneServo

## Tuning servos

*TuneServo* is used to tune the dynamic behaviour of separate axes on the robot. It is not necessary to use *TuneServo* under normal circumstances, but sometimes tuning can be optimised depending on the robot configuration and the load characteristics. For external axes *TuneServo* can be used for load adaptation.



**Incorrect use of the *TuneServo* can cause oscillating movements or torques that can damage the robot. You must bear this in mind and be careful when using the *TuneServo*.**

**Note. To obtain optimal tuning it is essential that the correct load data is used.** Check on this before using *TuneServo*.

---

### Description

#### Tune\_df

Tune\_df is used for reducing overshoots or oscillations along the path.

There is always an optimum tuning value that can vary depending on position and movement length. This optimum value can be found by changing the tuning in small steps (1 - 2%) on the axes that are involved in this unwanted behaviour. Normally the optimal tuning will be found in the range 70% - 130%. Too low or too high tuning values have a negative effect and will impair movements considerably.

When the tuning value at the start point of a long movement differs considerably from the tuning value at the end point, it can be advantageous in some cases to use an intermediate point with a corner zone to define where the tuning value will change.

Some examples of the use of *TuneServo* to optimise tuning follow below:

IRB 6400, in a press service application (extended and flexible load), axes 4 - 6: Reduce the tuning value for the current wrist axis until the movement is acceptable. A change in the movement will not be noticeable until the optimum value is approached. A low value will impair the movement considerably. Typical tuning value 25%.

IRB 6400, upper parts of working area. Axis 1 can often be optimised with a tuning value of 85% - 95%.

IRB 6400, short movement (< 80 mm). Axis 1 can often be optimised with a tuning value of 94% - 98%.

IRB 2400, with track motion. In some cases axes 2 - 3 can be optimised with a tuning value of 110% - 130%. The movement along the track can require a different tuning value compared with movement at right angles to the track.

Overshoots and oscillations can be reduced by decreasing the acceleration or the acceleration ramp (*AccSet*), which will however increase the cycle time. This is an

alternative method to the use of *TuneServo*.

### **Tune\_kp, tune\_kv, tune\_ti external axes**

These tune types affect position control gain (kp), speed control gain (kv) and speed control integration time (ti) for external axes. These are used for adapting external axes to different load inertias. Basic tuning of external axes can also be simplified by using these tune types.

### **Tune\_kp, tune\_kv, tune\_ti robot axes**

For robot axes, these tune types have another significance and can be used for reducing path errors at low speed (< 500 mm/s).

Recommended values: tune\_kv 100 - 180%, tune\_ti 50 - 100%. Tune\_kp should not be used for robot axes. Too high or low values of tune\_kv/tune\_ti cause vibrations or oscillations.

Never use these tune types at high speed or when the required path accuracy is fulfilled.

## **Example**

```
TuneServo IRB, 2, 90;
```

Activating of tuning type *TUNE\_DF* with the tuning value 90% on axis 2 in the mechanical unit *IRB*.

## **Arguments**

**TuneServo MecUnit Axis TuneValue [\Type]**

**MecUnit** (Mechanical Unit) Data type: *mecunit*

The name of the mechanical unit.

**Axis** Data type: *num*

The number of the current axis for the mechanical unit (1 - 6).

**TuneValue** Data type: *num*

Tuning value in percent (1 - 500). 100% is the normal value.

**[\Type]** Data type: *tunetype*

Type of servo tuning. Available types are *TUNE\_DF*, *TUNE\_KP*, *TUNE\_KV* and *TUNE\_TI*. These types are predefined in the system with constants.

This argument can be omitted when using tuning type *TUNE\_DF*.

---

## Example

```
TuneServo MHA160R1, 1, 110 \Type:= TUNE_KP;
```

Activating of tuning type *TUNE\_KP* with the tuning value *110%* on axis *1* in the mechanical unit *MHA160R1*.

---

## Program execution

The specified tuning type and tuning value are activated for the specified axis. This value is applicable for all movements until a new value is programmed for the current axis, or until the tuning types and values for all axes are reset using the instruction *TuneReset*.

The default servo tuning values for all axes are automatically set by executing instruction *TuneReset*

- at a cold start-up
- when a new program is loaded
- when starting program execution from the beginning.

---

## Syntax

```
TuneServo
[MecUnit ':=' ] < variable (VAR) of mecunit> ','
[Axis ':=' ] < expression (IN) of num> ','
[TuneValue ':=' ] < expression (IN) of num>
['\ Type ':=' <expression (IN) of tunetype>'];'
```

---

## Related information

Other motion settings  
Types of servo tuning  
Reset of all servo tunings  
Tuning of external axes  
-

### Described in:

Summary Rapid - *Motion Settings*  
Data Types - *tunetype*  
Instructions - *TuneReset*  
System parameters - *Manipulator*



---



---

## UnLoad UnLoad a program module during execution

*UnLoad* is used to unload a program module from the program memory during execution.

The program module must previously have been loaded into the program memory using the instruction *Load*.

---

### Example

```
UnLoad ram1disk \File:="PART_A.MOD";
```

*UnLoad* the program module *PART\_A.MOD* from the program memory, that previously was loaded into the program memory with *Load*. (See instructions *Load*). (*ram1disk* is a predefined string constant "ram1disk:").

---

### Arguments

#### UnLoad FilePath [\File]

##### FilePath

Data type: *string*

The file path and the file name to the file that will be unloaded from the program memory. The file path and the file name must be the same as in the previously executed *Load* instruction. The file name shall be excluded when the argument *\File* is used.

##### [\File]

Data type: *string*

When the file name is excluded in the argument *FilePath*, then it must be defined with this argument. The file name must be the same as in the previously executed *Load* instruction.

---

### Program execution

To be able to execute a *UnLoad* instruction in the program, a *Load* instruction with the same file path and name must have been executed earlier in the program.

The program execution waits for the program module to be finish unloading before the execution proceeds with the next instruction.

After that the program module is unloaded, the rest of the program modules will be linked.

For more information see the instruction called *Load*.



---

## Examples

```
UnLoad "ram1disk:DOORDIR/DOOR1.MOD";
```

*UnLoad* the program module *DOOR1.MOD* from the program memory, that previously was loaded into the program memory with *Load*. (See instructions *Load*).

```
UnLoad "ram1disk:DOORDIR" \File:="DOOR1.MOD";
```

Same as above but another syntax.

---

## Limitations

It is not allowed to unload a program module that is executing.

TRAP routines, system I/O events and other program tasks cannot execute during the unloading.

Avoid ongoing robot movements during the unloading.

Program stop during execution of *UnLoad* instruction results in guard stop with motors off and error message "20025 Stop order timeout" on the Teach Pendant.

---

## Error handling

If the file in the *UnLoad* instruction cannot be unloaded, because of ongoing execution within the module or wrong path (module not loaded with *Load*), then the system variable ERRNO is set to ERR\_UNLOAD (see "Data types - errnum"). This error can then be handled in the error handler.

---

## Syntax

```
UnLoad  
  [FilePath':=']<expression (IN) of string>  
  ['\File':=' <expression (IN) of string>'];
```

---

**Related information**

Load a program module  
Accept unresolved references

Described in:

Instructions - *Load*  
System Parameters - *Controller*  
System Parameters - *Tasks*  
System Parameters - *BindRef*



---



---

## VelSet      Changes the programmed velocity

*VelSet* is used to increase or decrease the programmed velocity of all subsequent positioning instructions. This instruction is also used to maximize the velocity.

---

### Example

VelSet 50, 800;

All the programmed velocities are decreased to 50% of the value in the instruction. The TCP velocity is not, however, permitted to exceed 800 mm/s.

---

### Arguments

#### VelSet    Override    Max

##### Override

Data type: *num*

Desired velocity as a percentage of programmed velocity. 100% corresponds to the programmed velocity.

##### Max

Data type: *num*

Maximum TCP velocity in mm/s.

---

### Program execution

The programmed velocity of all subsequent positioning instructions is affected until a new *VelSet* instruction is executed.

The argument *Override* affects:

- All velocity components (TCP, orientation, rotating and linear external axes) in *speeddata*.
- The programmed velocity override in the positioning instruction (the argument *\V*).
- Timed movements.

The argument *Override* does not affect:

- The welding speed in *welddata*.
- The heating and filling speed in *seamdata*.

The argument *Max* only affects the velocity of the TCP.

The default values for *Override* and *Max* are 100% and 5000 mm/s respectively. These values are automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

---

## Example

```
VelSet 50, 800;
MoveL p1, v1000, z10, tool1;
MoveL p2, v2000, z10, tool1;
MoveL p3, v1000\T:=5, z10, tool1;
```

The speed is 500 mm/s to point *p1* and 800 mm/s to *p2*. It takes 10 seconds to move from *p2* to *p3*.

---

## Limitations

The maximum speed is not taken into consideration when the time is specified in the positioning instruction.

---

## Syntax

```
VelSet
  [ Override ':=' ] < expression (IN) of num > ','
  [ Max ':=' ] < expression (IN) of num > ';' ;
```

---

## Related information

Definition of velocity  
Positioning instructions

Described in:  
Data Types - *speeddata*  
RAPID Summary - *Motion*

---



---

## WaitDI      Waits until a digital input signal is set

*WaitDI* (*Wait Digital Input*) is used to wait until a digital input is set.

---

### Example

```
WaitDI di4, 1;
```

Program execution continues only after the *di4* input has been set.

```
WaitDI grip_status, 0;
```

Program execution continues only after the *grip\_status* input has been reset.

---

### Arguments

**WaitDI    Signal Value** [**\MaxTime**] [**\TimeFlag**]

**Signal**

Data type: *signal**di*

The name of the signal.

**Value**

Data type: *dionum*

The desired value of the signal.

[**\MaxTime**]

(*Maximum Time*)

Data type: *num*

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met, the error handler will be called, if there is one, with the error code ERR\_WAIT\_MAXTIME. If there is no error handler, the execution will be stopped.

[**\TimeFlag**]

(*Timeout Flag*)

Data type: *bool*

The output parameter that contains the value TRUE if the maximum permitted waiting time runs out before the condition is met. If this parameter is included in the instruction, it is not considered to be an error if the max. time runs out. This argument is ignored if the *MaxTime* argument is not included in the instruction.

---

### Program Running

If the value of the signal is correct, when the instruction is executed, the program simply continues with the following instruction.

If the signal value is not correct, the robot enters a waiting state and when the signal changes to the correct value, the program continues. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised, and if it exceeds the max time value, the program will continue if a Time Flag is specified, or raise an error if it's not. If a Time Flag is specified, this will be set to true if the time is exceeded, otherwise it will be set to false.

---

## Syntax

WaitDI

```
[ Signal ':=' ] < variable (VAR) of signaldi > ','  
[ Value ':=' ] < expression (IN) of dionum >  
[ '\MaxTime ':=' <expression (IN) of num> ]  
[ '\TimeFlag ':=' <variable (VAR) of bool> ] ','
```

---

## Related information

	<u>Described in:</u>
Waiting until a condition is satisfied	Instructions - <i>WaitUntil</i>
Waiting for a specified period of time	Instructions - <i>WaitTime</i>

---



---

## WaitDO    Waits until a digital output signal is set

*WaitDO (Wait Digital Output)* is used to wait until a digital output is set.

---

### Example

```
WaitDO do4, 1;
```

Program execution continues only after the *do4* output has been set.

```
WaitDO grip_status, 0;
```

Program execution continues only after the *grip\_status* output has been reset.

---

### Arguments

**WaitDO    Signal Value** [**\MaxTime**] [**\TimeFlag**]

**Signal**

Data type: *signaldo*

The name of the signal.

**Value**

Data type: *dionum*

The desired value of the signal.

[**\MaxTime**]

(*Maximum Time*)

Data type: *num*

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met, the error handler will be called, if there is one, with the error code ERR\_WAIT\_MAXTIME. If there is no error handler, the execution will be stopped.

[**\TimeFlag**]

(*Timeout Flag*)

Data type: *bool*

The output parameter that contains the value TRUE if the maximum permitted waiting time runs out before the condition is met. If this parameter is included in the instruction, it is not considered to be an error if the max. time runs out. This argument is ignored if the *MaxTime* argument is not included in the instruction.

---

### Program Running

If the value of the signal is correct, when the instruction is executed, the program simply continues with the following instruction.



If the signal value is not correct, the robot enters a waiting state and when the signal changes to the correct value, the program continues. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised, and if it exceeds the max time value, the program will continue if a Time Flag is specified, or raise an error if its not. If a Time Flag is specified, this will be set to true if the time is exceeded, otherwise it will be set to false.

---

## Syntax

WaitDO

```
[ Signal ':=' ] < variable (VAR) of signaldo > ','  
[ Value ':=' ] < expression (IN) of dionum >  
[ '\MaxTime ':=' <expression (IN) of num> ]  
[ '\TimeFlag ':=' <variable (VAR) of bool> ] ','
```

---

## Related information

	<u>Described in:</u>
Waiting until a condition is satisfied	Instructions - <i>WaitUntil</i>
Waiting for a specified period of time	Instructions - <i>WaitTime</i>

---



---

## WaitTime      Waits a given amount of time

*WaitTime* is used to wait a given amount of time. This instruction can also be used to wait until the robot and external axes have come to a standstill.

---

### Example

```
WaitTime 0.5;
```

Program execution waits 0.5 seconds.

---

### Arguments

**WaitTime**    [**\InPos**] **Time**

**[\InPos]**

Data type: *switch*

If this argument is used, the robot and external axes must have come to a standstill before the waiting time starts to be counted.

**Time**

Data type: *num*

The time, expressed in seconds, that program execution is to wait.

---

### Program execution

Program execution temporarily stops for the given amount of time. Interrupt handling and other similar functions, nevertheless, are still active.

---

### Example

```
WaitTime \InPos,0;
```

Program execution waits until the robot and the external axes have come to a standstill.

---

### Limitations

If the argument *\Inpos* is used, the movement instruction which precedes this instruction should be terminated with a stop point, in order to be able to restart in this instruction following a power failure.

Argument *\Inpos* cannot be used together with *SoftServo*.

---

**Syntax**

```
WaitTime  
  ['\InPos',']  
  [Time ':='] <expression (IN) of num>';
```

---

**Related information**

Waiting until a condition is met  
Waiting until an I/O is set/reset

Described in:

Instructions - *WaitUntil*  
Instruction - *WaitDI*



---

## Examples

```

VAR bool timeout;
WaitUntil start_input = 1 AND grip_status = 1 \MaxTime := 60
        \TimeFlag := timeout;
IF timeout THEN
    TPWrite "No start order received within expected time";
ELSE
    start_next_cycle;
ENDIF

```

If the two input conditions are not met within 60 seconds, an error message will be written on the display of the teach pendant.

```

WaitUntil \Inpos, di4 = 1;

```

Program execution waits until the robot has come to a standstill and the *di4* input has been set.

---

## Limitation

If the argument *\Inpos* is used, the movement instruction which precedes this instruction should be terminated with a stop point, in order to be able to restart in this instruction following a power failure.

---

## Syntax

```

WaitUntil
    ['\InPos',']
    [Cond ':='] <expression (IN) of bool>
    ['\MaxTime ':='<expression (IN) of num>]
    ['\TimeFlag':='<variable (VAR) of bool>'];

```

---

## Related information

Waiting until an input is set/reset	<u>Described in:</u> Instructions - <i>WaitDI</i>
Waiting a given amount of time	Instructions - <i>WaitTime</i>
Expressions	Basic Characteristics - <i>Expressions</i>

---

---

## **WHILE**                      **Repeats as long as ...**

*WHILE* is used when a number of instructions are to be repeated as long as a given condition is met.

If it is possible to determine the number of repetitions in advance, the *FOR* instruction can be used.

---

### **Example**

```
WHILE reg1 < reg2 DO
  ...
  reg1 := reg1 + 1;
ENDWHILE
```

Repeats the instructions in the *WHILE* loop as long as *reg1 < reg2*.

---

### **Arguments**

**WHILE**    **Condition**    **DO ...**    **ENDWHILE**

**Condition**

Data type: *bool*

The condition that must be met for the instructions in the *WHILE* loop to be executed.

---

### **Program execution**

1. The condition is calculated. If the condition is not met, the *WHILE* loop terminates and program execution continues with the instruction following *ENDWHILE*.
2. The instructions in the *WHILE* loop are executed.
3. The *WHILE* loop is repeated, starting from point 1.

---

### **Syntax**

(EBNF)

```
WHILE <conditional expression> DO
  <instruction list>
ENDWHILE
```

---

**Related information**

Expressions

Described in:

Basic Characteristics - *Expressions*

---



---

## Write Writes to a character-based file or serial channel

*Write* is used to write to a character-based file or serial channel. The value of certain data can be written as well as text.

---

### Examples

Write logfile, "Execution started";

The text *Execution started* is written to the file with reference name *logfile*.

Write logfile, "No of produced parts="\Num:=reg1;

The text *No of produced parts=5*, for example, is written to the file with the reference name *logfile* (assuming that the contents of *reg1* is 5).

---

### Arguments

**Write IODevice String [\Num] | [\Bool] | [\Pos] | [\Orient]  
[\NoNewLine]**

**IODevice** Data type: *iodev*

The name (reference) of the current file or serial channel.

**String** Data type: *string*

The text to be written.

**[\Num]** (*Numeric*) Data type: *num*

The data whose numeric values are to be written after the text string.

**[\Bool]** (*Boolean*) Data type: *bool*

The data whose logical values are to be written after the text string.

**[\Pos]** (*Position*) Data type: *pos*

The data whose position is to be written after the text string.

**[\Orient]** (*Orientation*) Data type: *orient*

The data whose orientation is to be written after the text string.

**[\NoNewLine]** Data type: *switch*

Omits the line-feed character that normally indicates the end of the text.



---

## Program execution

The text string is written to a specified file or serial channel. If the argument `\NoNewLine` is not used, a line-feed character (LF) is also written.

If one of the arguments `\Num`, `\Bool`, `\Pos` or `\Orient` is used, its value is first converted to a text string before being added to the first string. The conversion from value to text string takes place as follows:

<u>Argument</u>	<u>Value</u>	<u>Text string</u>
<code>\Num</code>	23	"23"
<code>\Num</code>	1.141367	"1.14137"
<code>\Bool</code>	TRUE	"TRUE"
<code>\Pos</code>	[1817.3,905.17,879.11]	"[1817.3,905.17,879.11]"
<code>\Orient</code>	[0.96593,0,0.25882,0]	"[0.96593,0,0.25882,0]"

The value is converted to a string with standard RAPID format. This means in principle 6 significant digits. If the decimal part is less than 0.000005 or greater than 0.999995, the number is rounded to an integer.

---

## Example

```
VAR iodev printer;
.
Open "sio1:", printer\Write;
WHILE DInput(stopprod)=0 DO
  produce_part;
  Write printer, "Produced part="\Num:=reg1\NoNewLine;
  Write printer, "          "\NoNewLine;
  Write printer, CTime();
ENDWHILE
Close printer;
```

A line, including the number of the produced part and the time, is output to a printer each cycle. The printer is connected to serial channel `sio1:`. The printed message could look like this:

```
Produced part=473      09:47:15
```

---

## Limitations

The arguments `\Num`, `\Bool`, `\Pos` and `\Orient` are mutually exclusive and thus cannot be used simultaneously in the same instruction.

This instruction can only be used for files or serial channels that have been opened for writing.

---

## Error handling

If an error occurs during writing, the system variable ERRNO is set to ERR\_FILEACC. This error can then be handled in the error handler.

---

## Syntax

Write

```
[IODevice':='] <variable (VAR) of iodev>','  
[String':='] <expression (IN) of string>  
['\Num':=' <expression (IN) of num> ]  
| ['\Bool':=' <expression (IN) of bool> ]  
| ['\Pos':=' <expression (IN) of pos> ]  
| ['\Orient':=' <expression (IN) of orient> ]  
['\NoNewLine]';'
```

---

## Related information

Opening a file or serial channel

Described in:

RAPID Summary - *Communication*



---

---

## WriteBin      Writes to a binary serial channel

*WriteBin* is used to write a number of bytes to a binary serial channel.

---

### Example

```
WriteBin channel2, text_buffer, 10;
```

*10* characters from the *text\_buffer* list are written to the channel referred to by *channel2*.

---

### Arguments

**WriteBin    IODevice    Buffer    NChar**

**IODevice** Data type: *iodev*

Name (reference) of the current serial channel.

**Buffer** Data type: *array of num*

The list (array) containing the numbers (characters) to be written.

**NChar** *(Number of Characters)* Data type: *num*

The number of characters to be written from the *Buffer*.

---

### Program execution

The specified number of numbers (characters) in the list is written to the serial channel.

---

### Limitations

This instruction can only be used for serial channels that have been opened for binary reading and writing.

---

### Error handling

If an error occurs during writing, the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

---

**Example**

```

VAR iodev channel;
VAR num out_buffer{20};
VAR num input;
VAR num nchar;
Open "sio1:", channel\Bin;

out_buffer{1} := 5;                ( enq )
WriteBin channel, out_buffer, 1;
input := ReadBin (channel \Time:= 0.1);

IF input = 6 THEN                  ( ack )
  out_buffer{1} := 2;              ( stx )
  out_buffer{2} := 72;             ( 'H' )
  out_buffer{3} := 101;           ( 'e' )
  out_buffer{4} := 108;           ( 'l' )
  out_buffer{5} := 108;           ( 'l' )
  out_buffer{6} := 111;           ( 'o' )
  out_buffer{7} := 32;            ( ' ' )
  out_buffer{8} := StrToByte("w"\Char); ( 'w' )
  out_buffer{9} := StrToByte("o"\Char); ( 'o' )
  out_buffer{10} := StrToByte("r"\Char); ( 'r' )
  out_buffer{11} := StrToByte("l"\Char); ( 'l' )
  out_buffer{12} := StrToByte("d"\Char); ( 'd' )
  out_buffer{13} := 3;            ( etx )
  WriteBin channel, out_buffer, 13;
ENDIF

```

The text string *Hello world* (with associated control characters) is written to a serial channel. The function *StrToByte* is used in the same cases to convert a string into a *byte (num)* data.

---

**Syntax**

```

WriteBin
  [IODevice':=' ] <variable (VAR) of iodev>',
  [Buffer':=' ] <array {*} (IN) of num>',
  [NChar':=' ] <expression (IN) of num>;

```

---

**Related information**

Opening (etc.) of serial channels  
Convert a string to a byte data  
Byte data

Described in:

RAPID Summary - *Communication*  
Functions - *StrToByte*  
Data Types - *byte*



## WriteStrBin Writes a string to a binary serial channel

*WriteStrBin* (*Write String Binary*) is used to write a string to a binary serial channel or binary file.

---

### Example

```
WriteStrBin channel2, "Hello World\0A";
```

The string "*Hello World\0A*" is written to the channel referred to by *channel2*. The string is in this case ended with new line \0A. All characters and hexadecimal values written with *WriteStrBin* will be unchanged by the system.

---

### Arguments

**WriteStrBin**    **IODevice**    **Str**

**IODevice**

Data type: *iodev*

Name (reference) of the current serial channel.

**Str**

(*String*)

Data type: *string*

The text to be written.

---

### Program execution

The text string is written to the specified serial channel or file.

---

### Limitations

This instruction can only be used for serial channels or files that have been opened for binary reading and writing.

---

### Error handling

If an error occurs during writing, the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

---



---

**Example**

```
VAR iodev channel;
VAR num input;
Open "sio1:", channel\Bin;

! Send the control character enq
WriteStrBin channel, "\05";
! Wait for the control character ack
input := ReadBin (channel \Time:= 0.1);
IF input = 6 THEN
    ! Send a text starting with control character stx and ending with etx
    WriteStrBin channel, "\02Hello world\03";
ENDIF

Close channel;
```

The text string *Hello world* (with associated control characters in hexadecimal) is written to a binary serial channel.

---

**Syntax**

```
WriteStrBin
  [IODevice':=' ] <variable (VAR) of iodev>',
  [Str':=' ] <expression (IN) of string>';
```

---

**Related information**

Opening (etc.) of serial channels

Described in:

RAPID Summary - *Communication*

---



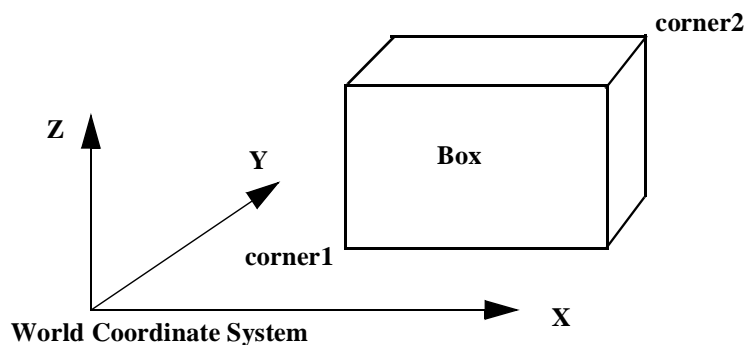
---

## WZBoxDef Define a box-shaped world zone

*WZBoxDef* (*World Zone Box Definition*) is used to define a world zone that has the shape of a straight box with all its sides parallel to the axes of the World Coordinate System.

---

### Example



```
VAR shapedata volume;
CONST pos corner1:=[200,100,100];
CONST pos corner2:=[600,400,400];
...
WZBoxDef \Inside, volume, corner1, corner2;
```

Define a straight box with coordinates parallel to the axes of the world coordinate system and defined by the opposite corners *corner1* and *corner2*.

---

### Arguments

**WZBoxDef** [**\Inside**] | [**\Outside**] **Shape** **LowPoint** **HighPoint**

**\Inside** Data type: *switch*

Define the volume inside the box.

**\Outside** Data type: *switch*

Define the volume outside the box (inverse volume).

One of the arguments *\Inside* or *\Outside* must be specified.

**Shape** Data type: *shapedata*

Variable for storage of the defined volume (private data for the system).

**LowPoint**Data type: *pos*

Position (x,y,x) in mm defining one lower corner of the box.

**HighPoint**Data type: *pos*

Position (x,y,z) in mm defining the corner diagonally opposite to the previous one.

**Program execution**

The definition of the box is stored in the variable of type *shapedata* (argument *Shape*), for future use in *WZLimSup* or *WZDOSet* instructions.

**Limitations**

The *LowPoint* and *HighPoint* positions must be valid opposite corners (with different x,y and z coordinate values).

If the robot is used to point out the *LowPoint* or *HighPoint*, work object *wobj0* must be active (use of component *trans* in *robtarget* e.g. *p1.trans* as argument).

**Syntax**

```
WZBoxDef
  ['\Inside' | ['\Outside' ] ,
  [Shape':='<variable (VAR) of shapedata>',
  [LowPoint':='<expression (IN) of pos>',
  [HighPoint':='<expression (IN) of pos>'];
```

**Related information**

	<u>Described in:</u>
World zone shape	Data Types - <i>shapedata</i>
Define sphere-shaped world zone	Instructions - <i>WZSphDef</i>
Define cylinder-shaped world zone	Instructions - <i>WZCylDef</i>
Activate world zone limit supervision	Instructions - <i>WZLimSup</i>
Activate world zone digital output set	Instructions - <i>WZDOSet</i>





---



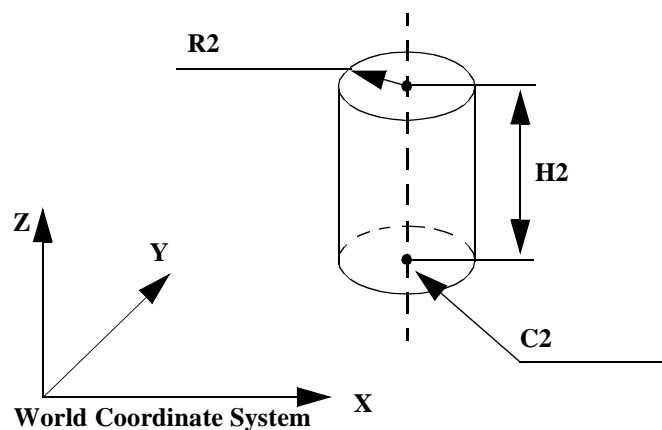
---

## WZCylDef Define a cylinder-shaped world zone

*WZCylDef* (*World Zone Cylinder Definition*) is used to define a world zone that has the shape of a cylinder with the cylinder axis parallel to the z-axis of the World Coordinate System.

---

### Example



```
VAR shapedata volume;
CONST pos C2:=[300,200,200];
CONST num R2:=100;
CONST num H2:=200;
...
WZCylDef \Inside, volume, C2, R2, H2;
```

Define a cylinder with the centre of the bottom circle in *C2*, radius *R2* and height *H2*.

---

### Arguments

**WZCylDef** [**\Inside**] | [**\Outside**] **Shape** **CentrePoint** **Radius** **Height**

**\Inside** Data type: *switch*

Define the volume inside the cylinder.

**\Outside** Data type: *switch*

Define the volume outside the cylinder (inverse volume).

One of the arguments *\Inside* or *\Outside* must be specified.

**Shape**Data type: *shapedata*

Variable for storage of the defined volume (private data for the system).

**CentrePoint**Data type: *pos*

Position (x,y,z) in mm defining the centre of one circular end of the cylinder.

**Radius**Data type: *num*

The radius of the cylinder in mm.

**Height**Data type: *num*

The height of the cylinder in mm.

If it is positive (+z direction), the *CentrePoint* argument is the centre of the lower end of the cylinder (as in the above example).

If it is negative (-z direction), the *CentrePoint* argument is the centre of the upper end of the cylinder.

**Program execution**

The definition of the cylinder is stored in the variable of type *shapedata* (argument *Shape*), for future use in *WZLimSup* or *WZDOSet* instructions.

**Limitations**

If the robot is used to point out the *CentrePoint*, work object *wobj0* must be active (use of component *trans* in *robtarg* e.g. *p1.trans* as argument).

**Syntax**

```
WZCylDef
  ['\Inside' | ['\Outside'],
  [Shape':='<variable (VAR) of shapedata>',
  [CentrePoint':='<expression (IN) of pos>',
  [Radius':='<expression (IN) of num>',
  [Height':='<expression (IN) of num>'];
```

---

**Related information**

	<u>Described in:</u>
Define box-shaped world zone	Instructions - <i>WZBoxDef</i>
Define sphere-shaped world zone	Instructions - <i>WZSphDef</i>
Activate world zone limit supervision	Instructions - <i>WZLimSup</i>
Activate world zone digital output set	Instructions - <i>WZDOSet</i>





---

---

## WZDisable Deactivate temporary world zone supervision

*WZDisable (World Zone Disable)* is used to deactivate the supervision of a temporary world zone, previously defined either to stop the movement or to set an output.

---

### Example

```
VAR wztemporary wzzone;  
...  
PROC ...  
  WZLimSup \Temp, wzzone, volume;  
  MoveL p_pick, v500, z40, tool1;  
  WZDisable wzzone;  
  MoveL p_place, v200, z30, tool1;  
ENDPROC
```

When moving to *p\_pick*, the position of the robot's TCP is checked so that it will not go inside the specified volume *wzone*. This supervision is not performed when going to *p\_place*.

---

### Arguments

#### WZDisable WorldZone

#### WorldZone

Data type: *wztemporary*

Variable or persistent variable of type *wztemporary*, which contains the identity of the world zone to be deactivated.

---

### Program execution

The temporary world zone is deactivated. This means that the supervision of the robot's TCP, relative to the corresponding volume, is temporarily stopped. It can be re-activated via the *WZEnable* instruction.

---

### Limitations

Only a temporary world zone can be deactivated. A stationary world zone is always active.

---

**Syntax**

WZDisable  
[WorldZone':=' ]<variable or persistent (**INOUT**) of *wztemporary*>';'

---

**Related information**

Temporary world zone data

Activate world zone limit supervision

Activate world zone set digital output

Activate world zone

Erase world zone

**Described in:**

Data Types - *wztemporary*

Instructions - *WZLimSup*

Instructions - *WZDOSet*

Instructions - *WZEnable*

Instructions - *WZFree*

---

---

## WZDOSet Activate world zone to set digital output

*WZDOSet (World Zone Digital Output Set)* is used to define the action and to activate a world zone for supervision of the robot movements.

After this instruction is executed, when the robot's TCP is inside the defined world zone or is approaching close to it, a digital output signal is set to the specified value.

---

### Example

```
VAR wztemporary service;

PROC zone_output()
  VAR shapedata volume;
  CONST pos p_service:=[500,500,700];
  ...
  WZSphDef \Inside, volume, p_service, 50;
  WZDOSet \Temp, service \Inside, volume, do_service, 1;
ENDPROC
```

Definition of temporary world zone *service* in the application program, that sets the signal *do\_service*, when the robot's TCP is inside the defined sphere during program execution or when jogging.

---

### Arguments

**WZDOSet** [**\Temp**] | [**\Stat**] **WorldZone** [**\Inside**] | [**\Before**] **Shape**  
**Signal SetValue**

**\Temp** (*Temporary*) Data type: *switch*

The world zone to define is a temporary world zone.

**\Stat** (*Stationary*) Data type: *switch*

The world zone to define is a stationary world zone.

One of the arguments *\Temp* or *\Stat* must be specified.

**WorldZone** Data type: *wztemporary*

Variable or persistent variable, that will be updated with the identity (numeric value) of the world zone.

If use of switch *\Temp*, the data type must be *wztemporary*.

If use of switch *\Stat*, the data type must be *wzstationary*.

**\Inside**Data type: *switch*

The digital output signal will be set when the robot's TCP is inside the defined volume.

**\Before**Data type: *switch*

The digital output signal will be set before the robot's TCP reaches the defined volume (as soon as possible before the volume).

One of the arguments *\Inside* or *\Outside* must be specified.

**Shape**Data type: *shapedata*

The variable that defines the volume of the world zone.

**Signal**Data type: *signaldo*

The name of the digital output signal that will be changed.

**SetValue**Data type: *dionum*

Desired value of the signal (0 or 1) when the robot's TCP is inside the volume or just before it enters the volume.

When outside or just outside the volume, the signal is set to the opposite value.

**Program execution**

The defined world zone is activated. From this moment, the robot's TCP position is supervised and the output will be set, when the robot's TCP position is inside the volume (*\Inside*) or comes close to the border of the volume (*\Before*).

**Example**

```

VAR wztemporary home;
VAR wztemporary service;
PERS wztemporary equip1:=0;

PROC main()
...
! Definition of all temporary world zones
zone_output;
...
! equip1 in robot work area
WZEnable equip1;
...
! equip1 out of robot work area
WZDisable equip1;
...

```

```

! No use for equip1 any more
WZFree equip1;
...
ENDPROC

PROC zone_output()
  VAR shapedata volume;
  CONST pos p_home:=[800,0,800];
  CONST pos p_service:=[800,800,800];
  CONST pos p_equip1:=[-800,-800,0];
  ...
  WZSphDef \Inside, volume, p_home, 50;
  WZDOSet \Temp, home \Inside, volume, do_home, 1;
  WZSphDef \Inside, volume, p_service, 50;
  WZDOSet \Temp, service \Inside, volume, do_service, 1;
  WZCylDef \Inside, volume, p_equip1, 300, 1000;
  WZLimSup \Temp, equip1, volume;
  ! equip1 not in robot work area
  WZDisable equip1;
ENDPROC

```

Definition of temporary world zones *home* and *service* in the application program, that sets the signals *do\_home* and *do\_service*, when the robot is inside the sphere *home* or *service* respectively during program execution or when jogging.

Also, definition of a temporary world zone *equip1*, which is active only in the part of the robot program when *equip1* is inside the working area for the robot. At that time the robot stops before entering the *equip1* volume, both during program execution and manual jogging. *equip1* can be disabled or enabled from other program tasks by using the persistent variable *equip1* value.

---

## Limitations

A world zone cannot be redefined by using the same variable in the argument *WorldZone*.

A stationary world zone cannot be deactivated, activated again or erased in the RAPID program.

A temporary world zone can be deactivated (*WZDisable*), activated again (*WZEnable*) or erased (*WZFree*) in the RAPID program.

---

**Syntax**

```

WZDOSet
  ('\Temp) | ('\Stat) ',
  [WorldZone':=']<variable or persistent (INOUT) of wztemporary>
  ('\Inside) | ('\Before) ',
  [Shape':=']<variable (VAR) of shapedata>',
  [Signal':=']<variable (VAR) of signaldo>',
  [SetValue':=']<expression (IN) of dionum>;

```

---

**Related information**

	<u>Described in:</u>
Temporary world zone	Data Types - <i>wztemporary</i>
Stationary world zone	Data Types - <i>wzstationary</i>
World zone shape	Data Types - <i>shapedata</i>
Define straight box-shaped world zone	Instructions - <i>WZBoxDef</i>
Define sphere-shaped world zone	Instructions - <i>WZSphDef</i>
Define cylinder-shaped world zone	Instructions - <i>WZCylDef</i>
Activate world zone limit supervision	Instructions - <i>WZLimSup</i>

## WZEnable Activate temporary world zone supervision

*WZEnable* (*World Zone Enable*) is used to re-activate the supervision of a temporary world zone, previously defined either to stop the movement or to set an output.

---

### Example

```
VAR wztemporary wzzone;  
...  
PROC ...  
  WZLimSup \Temp, wzzone, volume;  
  MoveL p_pick, v500, z40, tool1;  
  WZDisable wzzone;  
  MoveL p_place, v200, z30, tool1;  
  WZEnable wzzone;  
  MoveL p_home, v200, z30, tool1;  
ENDPROC
```

When moving to *p\_pick*, the position of the robot's TCP is checked so that it will not go inside the specified volume *wzone*. This supervision is not performed when going to *p\_place*, but is reactivated before going to *p\_home*

---

### Arguments

#### WZEnable WorldZone

#### WorldZone

Data type: *wztemporary*

Variable or persistent variable of the type *wztemporary*, which contains the identity of the world zone to be activated.

---

### Program execution

The temporary world zone is re-activated.

Please note that a world zone is automatically activated when it is created. It need only be re-activated when it has previously been deactivated by *WZDisable*.

---

### Limitations

Only a temporary world zone can be deactivated and reactivated. A stationary world zone is always active.



---

**Syntax**

WZEnable  
[WorldZone':=' ]<variable or persistent (**INOUT**) of *wztemporary*>';'

---

**Related information**

Temporary world zone data  
Activate world zone limit supervision  
Activate world zone set digital output  
Deactivate world zone  
Erase world zone

Described in:

Data Types - *wztemporary*  
Instructions - *WZLimSup*  
Instructions - *WZDOSet*  
Instructions - *WZDisable*  
Instructions - *WZFree*

---

---

## WZFree      Erase temporary world zone supervision

*WZFree (World Zone Free)* is used to erase the definition of a temporary world zone, previously defined either to stop the movement or to set an output.

---

### Example

```
VAR wztemporary wzzone;  
...  
PROC ...  
  WZLimSup \Temp, wzzone, volume;  
  MoveL p_pick, v500, z40, tool1;  
  WZDisable wzzone;  
  MoveL p_place, v200, z30, tool1;  
  WZEnable wzzone;  
  MoveL p_home, v200, z30, tool1;  
  WZFree wzzone;  
ENDPROC
```

When moving to *p\_pick*, the position of the robot's TCP is checked so that it will not go inside a specified volume *wzone*. This supervision is not performed when going to *p\_place*, but is reactivated before going to *p\_home*. When this position is reached, the world zone definition is erased.

---

### Arguments

#### WZFree WorldZone

#### WorldZone

Data type: *wztemporary*

Variable or persistent variable of the type *wztemporary*, which contains the identity of the world zone to be erased.

---

### Program execution

The temporary world zone is first deactivated and then its definition is erased.

Once erased, a temporary world zone cannot be either re-activated nor deactivated.

---

### Limitations

Only a temporary world zone can be deactivated, reactivated or erased. A stationary world zone is always active.

---

**Syntax**

WZFree  
[WorldZone':=' ]<variable or persistent (**INOUT**) of *wztemporary*>';'

---

**Related information**

Temporary world zone data  
Activate world zone limit supervision  
Activate world zone set digital output  
Deactivate world zone  
Activate world zone

Described in:

Data Types - *wztemporary*  
Instructions - *WZLimSup*  
Instructions - *WZDOSet*  
Instructions - *WZDisable*  
Instructions - *WZEnable*



**Shape**Data type: *shapedata*

The variable that defines the volume of the world zone.

**Program execution**

The defined world zone is activated. From this moment the robot's TCP position is supervised. If it reaches the defined area the movement is stopped.

**Example**

```

VAR wzstationary box1_invers;
VAR wzstationary box2;

PROC wzzone_power_on()
  VAR shapedata volume;
  CONST pos box1_c1:=[500,-500,0];
  CONST pos box1_c2:=[-500,500,500];
  CONST pos box2_c1:=[500,-500,0];
  CONST pos box2_c2:=[200,-200,300];
  ...
  WZBoxDef \Outside, volume, box1_c1, box1_c2;
  WZLimSup \Stat, box1_invers, volume;
  WZBoxDef \Inside, volume, box2_c1, box2_c2;
  WZLimSup \Stat, box2, volume;
ENDPROC

```

Limitation of work area for the robot with the following stationary world zones:

- Outside working area when outside box1\_invers
- Outside working area when inside box2

If this routine is connected to the system event POWER ON, these world zones will always be active in the system, both for program movements and manual jogging.

**Limitations**

A world zone cannot be redefined using the same variable in argument *WorldZone*.

A stationary world zone cannot be deactivated, activated again or erased in the RAPID program.

A temporary world zone can be deactivated (*WZDisable*), activated again (*WZEnable*) or erased (*WZFree*) in the RAPID program.

---

**Syntax**

```
WZLimSup
  ['\Temp'] | ['\Stat'],'
  [WorldZone':=']<variable or persistent (INOUT) of wztemporary>',
  [Shape':='] <variable (VAR) of shapedata>';
```

---

**Related information**

	<u>Described in:</u>
Temporary world zone	Data Types - <i>wztemporary</i>
Stationary world zone	Data Types - <i>wzstationary</i>
World zone shape	Data Types - <i>shapedata</i>
Define straight box-shaped world zone	Instructions - <i>WZBoxDef</i>
Define sphere-shaped world zone	Instructions - <i>WZSphDef</i>
Define cylinder-shaped world zone	Instructions - <i>WZCylDef</i>
Activate world zone digital output set	Instructions - <i>WZDOSet</i>



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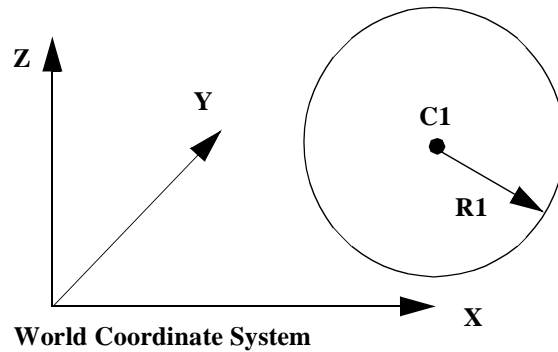
---

## WZSphDef    Define a sphere-shaped world zone

*WZSphDef* (*World Zone Sphere Definition*) is used to define a world zone that has the shape of a sphere.

---

### Example



```
VAR shapedata volume;
CONST pos C1:=[300,300,200];
CONST num R1:=200;
...
WZSphDef \Inside, volume, C1, R1;
```

Define a sphere named *volume* by its centre *C1* and its radius *R1*.

---

### Arguments

**WZSphDef**    [**\Inside**] | [**\Outside**] **Shape** **CentrePoint** **Radius**

**\Inside**    Data type: *switch*

Define the volume inside the sphere.

**\Outside**    Data type: *switch*

Define the volume outside the sphere (inverse volume).

One of the arguments *\Inside* or *\Outside* must be specified.

**Shape**    Data type: *shapedata*

Variable for storage of the defined volume (private data for the system).



**CentrePoint**Data type: *pos*

Position (x,y,z) in mm defining the centre of the sphere.

**Radius**Data type: *num*

The radius of the sphere in mm.

**Program execution**

The definition of the sphere is stored in the variable of type *shapedata* (argument *Shape*), for future use in *WZLimSup* or *WZDOSet* instructions.

**Limitations**

If the robot is used to point out the *CentrePoint*, work object *wobj0* must be active (use of component *trans* in *robtarget* e.g. *p1.trans* as argument).

**Syntax**

```
WZSphDef
  ['\Inside' | ['\Outside'],'
  [Shape':='<variable (VAR) of shapedata>','
  [CentrePoint':='<expression (IN) of pos>','
  [Radius':='<expression (IN) of num>'];
```

**Related information**

	<u>Described in:</u>
World zone shape	Data Types - <i>shapedata</i>
Define box-shaped world zone	Instructions - <i>WZBoxDef</i>
Define cylinder-shaped world zone	Instructions - <i>WZCylDef</i>
Activate world zone limit supervision	Instructions - <i>WZLimSup</i>
Activate world zone digital output set	Instructions - <i>WZDOSet</i>

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---

Abs	Gets the absolute value
ACos	Calculates the arc cosine value
AOutput	Reads the value of an analog output signal
ArgName	Gets argument name
ASin	Calculates the arc sine value
ATan	Calculates the arc tangent value
ATan2	Calculates the arc tangent2 value
ByteToStr	Converts a byte to a string data
CDate	Reads the current date as a string
CJointT	Reads the current joint angles
ClkRead	Reads a clock used for timing
CorrRead	Reads the current total offsets
Cos	Calculates the cosine value
CPos	Reads the current position (pos) data
CRobT	Reads the current position (robtargt) data
CTime	Reads the current time as a string
CTool	Reads the current tool data
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DefDFrame	Define a displacement frame
DefFrame	Define a frame
Dim	Obtains the size of an array
DOutput	Reads the value of a digital output signal
EulerZYX	Gets Euler angles from orient
Exp	Calculates the exponential value
GOutput	Reads the value of a group of digital output signals
GetTime	Reads the current time as a numeric value
IndInpos	Independent In position status
IndSpeed	Independent Speed status
IsPers	Is Persistent
IsVar	Is Variable
MirPos	Mirroring of a position
NumToStr	Converts numeric value to string
Offs	Displaces a robot position
OpMode	Read the operating mode
OrientZYX	Builds an orient from Euler angles
ORobT	Removes a program displacement from a position

## ***Functions***

PoseInv	Inverts the pose
PoseMult	Multiplies pose data
PoseVect	Applies a transformation to a vector
Pow	Calculates the power of a value
Present	Tests if an optional parameter is used
ReadBin	Reads from a binary serial channel or file
ReadMotor	Reads the current motor angles
ReadNum	Reads a number from a file or the serial channel
ReadStr	Reads a string from a file or serial channel
RelTool	Make a displacement relative to the tool
Round	Round is a numeric value
RunMode	Read the running mode
Sin	Calculates the sine value
Sqrt	Calculates the square root value
StrFind	Searches for a character in a string
StrLen	Gets the string length
StrMap	Maps a string
StrMatch	Search for pattern in string
StrMemb	Checks if a character belongs to a set
StrOrder	Checks if strings are ordered
StrPart	Finds a part of a string
StrToByte	Converts a string to a byte data
StrToVal	Converts a string to a value
Tan	Calculates the tangent value
TestDI	Tests if a digital input is set
Trunc	Truncates a numeric value
ValToStr	Converts a value to a string

---



---

## Abs Gets the absolute value

*Abs* is used to get the absolute value, i.e. a positive value of numeric data.

---

### Example

```
reg1 := Abs(reg2);
```

*Reg1* is assigned the absolute value of *reg2*.

---

### Return value

Data type: *num*

The absolute value, i.e. a positive numeric value.

e.g.	<u>Input value</u>	<u>Returned value</u>
	3	3
	-3	3
	-2.53	2.53

---

### Arguments

#### **Abs (Input)**

##### **Input**

Data type: *num*

The input value.

---

### Example

```
TPReadNum no_of_parts, "How many parts should be produced? ";
no_of_parts := Abs(no_of_parts);
```

The operator is asked to input the number of parts to be produced. To ensure that the value is greater than zero, the value given by the operator is made positive.

---

### Syntax

```
Abs '('
  [ Input ':=' ] < expression (IN) of num > ')'
```

A function with a return value of the data type *num*.

---

**Related information**

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*

## ACos                      Calculates the arc cosine value

*ACos* (*Arc Cosine*) is used to calculate the arc cosine value.

---

### Example

```
VAR num angle;  
VAR num value;  
. .  
angle := ACos(value);
```

---

### Return value

Data type: *num*

The arc cosine value, expressed in degrees, range [0, 180].

---

### Arguments

**ACos** (**Value**)

**Value**

Data type: *num*

The argument value, range [-1, 1].

---

### Syntax

```
Acos('  
  [Value ':=' ] <expression (IN) of num>  
')
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*



---



---

## AOutput Reads the value of an analog output signal

*AOutput* is used to read the current value of an analog output signal.

---

### Example

IF AOutput(ao4) > 5 THEN ...

If the current value of the signal *ao4* is greater than 5, then ...

---

### Return value

Data type: *num*

The current value of the signal.

The current value is scaled (in accordance with the system parameters) before it is read by the RAPID program. See Figure 1.

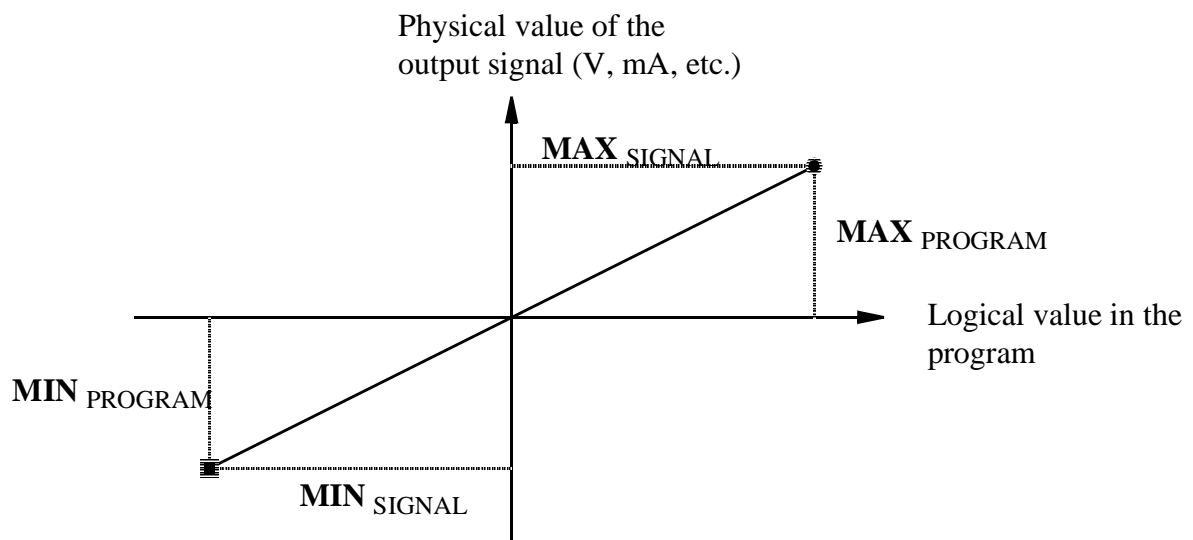


Figure 1 Diagram of how analog signal values are scaled.

---

### Arguments

**AOutput (Signal)**

**Signal**

Data type: *signalao*

The name of the analog output to be read.



---

**Syntax**

AOutput '('  
[ Signal ':=' ] < variable (**VAR**) of *signalao* > ')'

A function with a return value of data type *num*.

---

**Related information**

	<u>Described in:</u>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	User's Guide - <i>System Parameters</i>

---



---

## ArgName Gets argument name

*ArgName* (*Argument Name*) is used to get the name of the original data object for the current argument or the current data.

---

### Example

```
VAR num abc123 :=5;
...
proc1 abc123;

PROC proc1 (num par1)
  VAR string parstring;
  ...
  parstring:=ArgName(par1);
  TPWrite "Argument name "+parstring+" with value "\Num:=par1;
ENDPROC
```

The variable *parstring* is assigned the string value "abc123". On TP the following string is written: "Argument name abc123 with value 5".

---

### Return value

Data type: *string*

The original data object name.

---

### Arguments

#### ArgName (Parameter)

##### Parameter

Data type: *anytype*

The formal parameter identifier (for the routine in which *ArgName* is located) or the data identity.

---

### Program execution

The function returns the original data object name for an entire object of the type constant, variable or persistent. The original data object can be global, local in the program module or local in a routine (normal RAPID scope rules).

If it is a part of a data object, the name of the whole data object is returned.

---

**Example**
**Convert from identifier to string**

This function can also be used to convert from identifier to string, by stating the identifier in the argument *Parameter* for any data object with global, local in module or local in routine scope:

```
VAR num chales :=5;
...
proc1;

PROC proc1 ()
  VAR string name;
  ...
  name:=ArgName(chales);
  TPWrite "Global data object "+name+" has value "\Num:=chales;
ENDPROC
```

The variable *name* is assigned the string value "*chales*" and on TP the following string is written: "Global data object chales has value 5".

**Routine call in several steps**

Note that the function returns the **original** data object name:

```
VAR num chales :=5;
...
proc1 chales;
...
PROC proc1 (num parameter1)
  ...
  proc2 parameter1;
  ...
ENDPROC

PROC proc2 (num par1)
  VAR string name;
  ...
  name:=ArgName(par1);
  TPWrite "Original data object name "+name+" with value "\Num:=par1;
ENDPROC
```

The variable *name* is assigned the string value "*chales*" and on TP the following string is written: "Original data object name charles with value 5".

**Error handling**

If one of the following errors occurs, the system variable ERRNO is set to ERR\_ARGNAME:

- Argument is expression value
- Argument is not present
- Argument is of type switch

This error can then be handled in the error handler.

---

**Syntax**

ArgName '('  
[ Parameter':=' ] < reference (**REF**) of any type> ')'

A function with a return value of the data type *string*.

---

**Related information**

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

*ArgName*

*Functions*

---

---

## ASin Calculates the arc sine value

*ASin* (*Arc Sine*) is used to calculate the arc sine value.

---

### Example

```
VAR num angle;  
VAR num value;  
. .  
angle := ASin(value);
```

---

### Return value

Data type: *num*

The arc sine value, expressed in degrees, range [-90, 90].

---

### Arguments

#### ASin (Value)

##### Value

Data type: *num*

The argument value, range [-1, 1].

---

### Syntax

```
ASin('  
  [Value ']:='] <expression (IN) of num>  
'')
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*



---

---

## ATan                      Calculates the arc tangent value

*ATan* (*Arc Tangent*) is used to calculate the arc tangent value.

---

### Example

```
VAR num angle;  
VAR num value;  
. .  
angle := ATan(value);
```

---

### Return value

Data type: *num*

The arc tangent value, expressed in degrees, range [-90, 90].

---

### Arguments

#### **ATan** (Value)

##### **Value**

Data type: *num*

The argument value.

---

### Syntax

```
ATan(''  
  [Value ':=' ] <expression (IN) of num>  
  ''
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions

Arc tangent with a return value in the range [-180, 180]

Described in:

RAPID Summary - *Mathematics*

Functions - *ATan2*





---



---

## ATan2      Calculates the arc tangent2 value

*ATan2* (*Arc Tangent2*) is used to calculate the arc tangent2 value.

---

### Example

```
VAR num angle;
VAR num x_value;
VAR num y_value;
.
.
angle := ATan2(y_value, x_value);
```

---

### Return value

Data type: *num*

The arc tangent value, expressed in degrees, range [-180, 180].

The value will be equal to  $\text{ATan}(y/x)$ , but in the range [-180, 180], since the function uses the sign of both arguments to determine the quadrant of the return value.

---

### Arguments

**ATan2** (Y X)

**Y** Data type: *num*

The numerator argument value.

**X** Data type: *num*

The denominator argument value.

---

### Syntax

```
ATan2('
  [Y ':=' ] <expression (IN) of num> ',
  [X ':=' ] <expression (IN) of num>
')
```

A function with a return value of the data type *num*.

---

**Related information**

Mathematical instructions and functions  
Arc tangent with only one argument

Described in:

RAPID Summary - *Mathematics*  
Functions - *ATan*

---



---

## ByteToStr      Converts a byte to a string data

*ByteToStr* (*Byte To String*) is used to convert a *byte* into a *string* data with a defined byte data format.

---

### Example

```
VAR string con_data_buffer{5};
VAR byte data1 := 122;
```

```
con_data_buffer{1} := ByteToStr(data1);
```

The content of the array component *con\_data\_buffer{1}* will be "122" after the *ByteToStr ...* function.

```
con_data_buffer{2} := ByteToStr(data1\Hex);
```

The content of the array component *con\_data\_buffer{2}* will be "7A" after the *ByteToStr ...* function.

```
con_data_buffer{3} := ByteToStr(data1\Okt);
```

The content of the array component *con\_data\_buffer{3}* will be "172" after the *ByteToStr ...* function.

```
con_data_buffer{4} := ByteToStr(data1\Bin);
```

The content of the array component *con\_data\_buffer{4}* will be "01111010" after the *ByteToStr ...* function.

```
con_data_buffer{5} := ByteToStr(data1\Char);
```

The content of the array component *con\_data\_buffer{5}* will be "z" after the *ByteToStr ...* function.

---

### Return value

Data type: *string*

The result of the conversion operation with the following format:

Format:	Characters:	String length:	Range:
Dec .....	'0' - '9'	1-3	"0" - "255"
Hex .....	'0' - '9', 'A' - 'F'	2	"00" - "FF"
Okt .....	'0' - '7'	3	"000" - "377"
Bin .....	'0' - '1'	8	"00000000" - "11111111"
Char .....	Writable ASCII char	1	ASCII table (*)

(\*) If non-writable ASCII char, the return format will be RAPID character code format (e.g. "\07" for BEL control character).

---

## Arguments

**ByteToStr** (**ByteData** [**\Hex**] | [**\Okt**] | [**\Bin**] | [**\Char**])

**ByteData**

Data type: *byte*

The byte data to be converted.

If the optional switch argument is omitted, the data will be converted in *decimal* (Dec) format.

**[Hex]**

(*Hexadecimal*)

Data type: *switch*

The data will be converted in *hexadecimal* format.

**[Okt]**

(*Octal*)

Data type: *switch*

The data will be converted in *octal* format.

**[Bin]**

(*Binary*)

Data type: *switch*

The data will be converted in *binary* format.

**[Char]**

(*Character*)

Data type: *switch*

The data will be converted in *ASCII character* format.

---

## Limitations

The range for a data type *byte* is 0 to 255 decimal.

---

## Syntax

```
ByteToStr('
  [ByteData ':=' ] <expression (IN) of byte>
  ['\ Hex ] | ['\ Okt] | ['\ Bin] | ['\ Char]
  ')';
```

A function with a return value of the data type *string*.

---

**Related information**

Convert a string to a byte data

Other bit (byte) functions

Other string functions

Described in:

Instructions - *StrToByte*

RAPID Summary - Bit Functions

RAPID Summary - String Functions



## CDate                      Reads the current date as a string

*CDate* (*Current Date*) is used to read the current system date.

This function can be used to present the current date to the operator on the teach pendant display or to paste the current date into a text file that the program writes to.

---

### Example

```
VAR string date;  
date := CDate();
```

The current date is stored in the variable *date*.

---

### Return value

Data type: *string*

The current date in a string.

The standard date format is "year-month-day", e.g. "93-05-16".

---

### Example

```
date := CDate();  
TPWrite "The current date is: "+date;  
Write logfile, date;
```

The current date is written to the teach pendant display and into a text file.

---

### Syntax

```
CDate '(' ')'
```

A function with a return value of the type *string*.

---

### Related Information

Time instructions  
Setting the system clock

#### Described in:

RAPID Summary - *System & Time*  
User's Guide - *System Parameters*





---

---

## CJointT Reads the current joint angles

*CJointT* (*Current Joint Target*) is used to read the current angles of the robot axes and external axes.

---

### Example

```
VAR jointtarget joints;
```

```
joints := CJointT();
```

The current angles of the axes for the robot and external axes are stored in *joints*.

---

### Return value

Data type: *jointtarget*

The current angles in degrees for the axes of the robot on the arm side.

The current values for the external axes, in mm for linear axes, in degrees for rotational axes.

The returned values are related to the calibration position.

---

### Syntax

```
CJointT('')
```

A function with a return value of the data type *jointtarget*.

---

### Related information

Definition of joint

Reading the current motor angle

Described in:

Data Types - *jointtarget*

Functions - *ReadMotor*



## ClkRead      Reads a clock used for timing

*ClkRead* is used to read a clock that functions as a stop-watch used for timing.

---

### Example

```
reg1:=ClkRead(clock1);
```

The clock *clock1* is read and the time in seconds is stored in the variable *reg1*.

---

### Return value

Data type: *num*

The time in seconds stored in the clock.

---

### Argument

**ClkRead (Clock)**

**Clock**

Data type: *clock*

The name of the clock to read.

---

### Program execution

A clock can be read when it is stopped or running.

Once a clock is read it can be read again, started again, stopped or reset.

If the clock has overflowed, program execution is stopped with an error message.

---

### Syntax

```
ClkRead '('  
  [ Clock ':=' ] < variable (VAR) of clock > ')'
```

A function with a return value of the type *num*.

---

---

**Related Information**

Clock instructions

Clock overflow

More examples

Described in:

RAPID Summary - *System & Time*

Data Types - *clock*

Instructions - *ClkStart*

## CorrRead      Reads the current total offsets

*CorrRead* is used to read the total corrections delivered by all connected correction generators.

*CorrRead* can be used to:

- find out how much the current path differs from the original path.
- take actions to reduce the difference.

---

### Example

```
VAR pos offset;  
...  
offset := CorrRead();
```

The current offsets delivered by all connected correction generators are available in the variable *offset*.

---

### Return value

Data type: *pos*

The total absolute offsets delivered from all connected correction generators so far.

---

### Example

See Instructions - *CorrCon*

---

### Syntax

```
CorrRead '( ' )'
```

A function with a return value of the data type *pos*.

---

**Related information**

	<u>Described in:</u>
Connects to a correction generator	Instructions - <i>CorrCon</i>
Disconnects from a correction generator	Instructions - <i>CorrDiscon</i>
Writes to a correction generator	Instructions - <i>CorrWrite</i>
Removes all correction generators	Instructions - <i>CorrClear</i>
Correction descriptor	Data types - <i>corrdescr</i>

---

---

## Cos Calculates the cosine value

*Cos* (*Cosine*) is used to calculate the cosine value from an angle value.

---

### Example

```
VAR num angle;  
VAR num value;  
.  
.  
value := Cos(angle);
```

---

### Return value

Data type: *num*

The cosine value, range = [-1, 1] .

---

### Arguments

**Cos** (**Angle**)

**Angle**

Data type: *num*

The angle value, expressed in degrees.

---

### Syntax

```
Cos('  
  [Angle ':=' ] <expression (IN) of num>  
  ')
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*





---



---

## CPos Reads the current position (pos) data

*CPos* (*Current Position*) is used to read the current position of the robot.

This function returns the x, y, and z values of the robot TCP as data of type *pos*. If the complete robot position (*robtarget*) is to be read, use the function *CRobT* instead.

---

### Example

```
VAR pos pos1;

pos1 := CPos(\Tool:=tool1 \WObj:=wobj0);
```

The current position of the robot TCP is stored in variable *pos1*. The tool *tool1* and work object *wobj0* are used for calculating the position.

---

### Return value

Data type: *pos*

The current position (pos) of the robot with x, y, and z in the outermost coordinate system, taking the specified tool, work object and active ProgDisp coordinate system into consideration.

---

### Arguments

**CPos** ([\Tool] [\WObj])

**[\Tool]**

Data type: *tooldata*

The tool used for calculation of the current robot position.

If this argument is omitted the current active tool is used.

**[\WObj]**

(*Work Object*)

Data type: *wobjdata*

The work object (coordinate system) to which the current robot position returned by the function is related.

If this argument is omitted the current active work object is used.

When programming, it is very sensible to always specify arguments `\Tool` and `\WObj`. The function will always then return the wanted position, although some other tool or work object has been activated manually.

---

## Program execution

The coordinates returned represent the TCP position in the ProgDisp coordinate system.

---

## Example

```
VAR pos pos2;
VAR pos pos3;
VAR pos pos4;

pos2 := CPos(\Tool:=grip3 \WObj:=fixture);
.
.
pos3 := CPos(\Tool:=grip3 \WObj:=fixture);
pos4 := pos3-pos2;
```

The x, y, and z position of the robot is captured at two places within the program using the *CPos* function. The tool *grip3* and work object *fixture* are used for calculating the position. The x, y and z distances travelled between these positions are then calculated and stored in the *pos* variable *pos4*.

---

## Syntax

```
CPos '('
  ['\Tool ':=' <persistent (PERS) of tooldata>]
  ['\WObj ':=' <persistent (PERS) of wobjdata>] ')'
```

A function with a return value of the data type *pos*.

---

## Related information

	<u>Described in:</u>
Definition of position	Data Types - <i>pos</i>
Definition of tools	Data Types- <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
Reading the current <i>robtargt</i>	Functions - <i>CRobT</i>

---



---

## CRobT Reads the current position (robtarget) data

*CRobT* (*Current Robot Target*) is used to read the current position of the robot and external axes.

This function returns a *robtarget* value with position (x, y, z), orientation (q1 ... q4), robot axes configuration and external axes position. If only the x, y, and z values of the robot TCP (*pos*) are to be read, use the function *CPos* instead.

---

### Example

```
VAR robtarget p1;

p1 := CRobT(\Tool:=tool1 \WObj:=wobj0);
```

The current position of the robot and external axes is stored in *p1*. The tool *tool1* and work object *wobj0* are used for calculating the position.

---

### Return value

Data type: *robtarget*

The current position of the robot and external axes in the outermost coordinate system, taking the specified tool, work object and active ProgDisp/ExtOffs coordinate system into consideration.

---

### Arguments

**CRobT** ([\Tool] [\WObj])

**[\Tool]**

Data type: *tooldata*

The tool used for calculation of the current robot position.

If this argument is omitted the current active tool is used.

**[\WObj]**

(*Work Object*)

Data type: *wobjdata*

The work object (coordinate system) to which the current robot position returned by the function is related.

If this argument is omitted the current active work object is used.

When programming, it is very sensible to always specify arguments `\Tool` and `\WObj`. The function will always then return the wanted position, although some other tool or work object has been activated manually.

---

## Program execution

The coordinates returned represent the TCP position in the ProgDisp coordinate system. External axes are represented in the ExtOffs coordinate system.

---

## Example

```
VAR robtarg p2;
```

```
p2 := ORobT( RobT(\Tool:=grip3 \WObj:=fixture) );
```

The current position in the object coordinate system (without any ProgDisp or ExtOffs) of the robot and external axes is stored in *p2*. The tool *grip3* and work object *fixture* are used for calculating the position.

---

## Syntax

```
CRobT'(
  ['\Tool ':=' <persistent (PERS) of tooldata>]
  ['\WObj ':=' <persistent (PERS) of wobjdata>] )'
```

A function with a return value of the data type *robtarg*.

---

## Related information

	<u>Described in:</u>
Definition of position	Data Types - <i>robtarg</i>
Definition of tools	Data Types- <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>
ExtOffs coordinate system	Instructions - <i>EOffsOn</i>
Reading the current <i>pos</i> (x, y, z only)	Functions - <i>CPos</i>

## CTime      Reads the current time as a string

*CTime* is used to read the current system time.

This function can be used to present the current time to the operator on the teach pendant display or to paste the current time into a text file that the program writes to.

---

### Example

```
VAR string time;  
  
time := CTime();
```

The current time is stored in the variable *time*.

---

### Return value

Data type: *string*

The current time in a string.

The standard time format is "hours:minutes:seconds", e.g. "18:20:46".

---

### Example

```
time := CTime();  
TPWrite "The current time is: "+time;  
Write logfile, time;
```

The current time is written to the teach pendant display and written into a text file.

---

### Syntax

```
CTime '(' ')'
```

A function with a return value of the type *string*.

---

**Related Information**

Time and date instructions  
Setting the system clock

Described in:

RAPID Summary - *System & Time*  
User's Guide - *System Parameters*

---

---

## CTool Reads the current tool data

*CTool* (*Current Tool*) is used to read the data of the current tool.

---

### Example

```
PERS tooldata temp_tool;  
  
temp_tool := CTool();
```

The value of the current tool is stored in the variable *temp\_tool*.

---

### Return value

Data type: *tooldata*

This function returns a *tooldata* value holding the value of the current tool, i.e. the tool last used in a movement instruction.

The value returned represents the TCP position and orientation in the wrist centre coordinate system, see *tooldata*.

---

### Syntax

```
CTool('')
```

A function with a return value of the data type *tooldata*.

---

### Related information

Definition of tools  
Coordinate systems

Described in:

Data Types- *tooldata*  
Motion and I/O Principles - *Coordinate Systems*





---

---

## CWOBJ Reads the current work object data

*CWOBJ* (*Current Work Object*) is used to read the data of the current work object.

---

### Example

```
PERS wobjdata temp_wobj;  
temp_wobj := CWOBJ();
```

The value of the current work object is stored in the variable *temp\_wobj*.

---

### Return value

Data type: *wobjdata*

This function returns a *wobjdata* value holding the value of the current work object, i.e. the work object last used in a movement instruction.

The value returned represents the work object position and orientation in the world coordinate system, see *wobjdata*.

---

### Syntax

```
CWOBJ('')
```

A function with a return value of the data type *wobjdata*.

---

### Related information

Definition of work objects

Coordinate systems

Described in:

Data Types- *wobjdata*

Motion and I/O Principles - *Coordinate Systems*



---



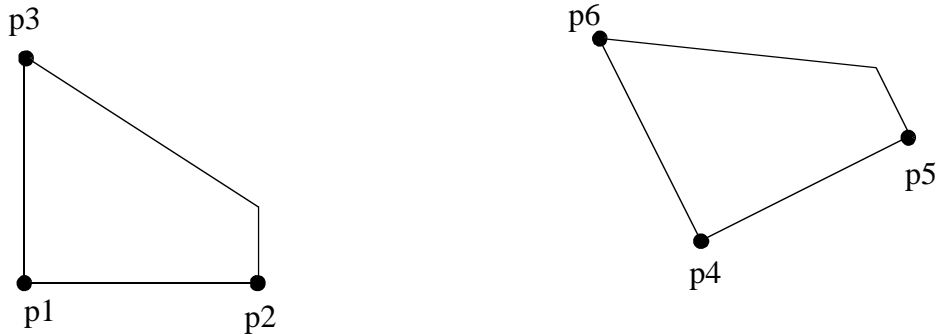
---

## DefDFrame      Define a displacement frame

*DefDFrame* (*Define Displacement Frame*) is used to calculate a displacement frame from three original positions and three displaced positions.

---

### Example



Three positions, *p1*-*p3*, related to an object in an original position, have been stored. After a displacement of the object the same positions are searched for and stored as *p4*-*p6*. From these six positions the displacement frame is calculated. Then the calculated frame is used to displace all the stored positions in the program.

```

CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];
VAR robtarget p4;
VAR robtarget p5;
VAR robtarget p6;
VAR pose frame1;
.
!Search for the new positions
SearchL sen1, p4, *, v50, tool1;
.
SearchL sen1, p5, *, v50, tool1;
.
SearchL sen1, p6, *, v50, tool1;
frame1 := DefDframe (p1, p2, p3, p4, p5, p6);
.
!activation of the displacement defined by frame1
PDispSet frame1;

```

---

### Return value

Data type: *pose*

The displacement frame.

---

**Arguments**

**DefDFrame (OldP1 OldP2 OldP3 NewP1 NewP2 NewP3)**

**OldP1** Data type: *robtarget*

The first original position.

**OldP2** Data type: *robtarget*

The second original position.

**OldP3** Data type: *robtarget*

The third original position.

**NewP1** Data type: *robtarget*

The first displaced position. This position must be measured and determined with great accuracy.

**NewP2** Data type: *robtarget*

The second displaced position. It should be noted that this position can be measured and determined with less accuracy in one direction, e.g. this position must be placed on a line describing the new direction of *p1* to *p2*.

**NewP3** Data type: *robtarget*

The third displaced position. This position can be measured and determined with less accuracy in two directions, e.g. it has to be placed in a plane describing the new plane of *p1*, *p2* and *p3*.

---

**Syntax**

```
DefDFrame('
  [OldP1 ':='] <expression (IN) of robtarget> ','
  [OldP2 ':='] <expression (IN) of robtarget> ','
  [OldP3 ':='] <expression (IN) of robtarget> ','
  [NewP1 ':='] <expression (IN) of robtarget> ','
  [NewP2 ':='] <expression (IN) of robtarget> ','
  [NewP3 ':='] <expression (IN) of robtarget> ')'
```

A function with a return value of the data type *pose*.

---

**Related information**

Activation of displacement frame

Manual definition of displacement frame

Described in:

Instructions - *PDispSet*

User's Guide - *Calibration*

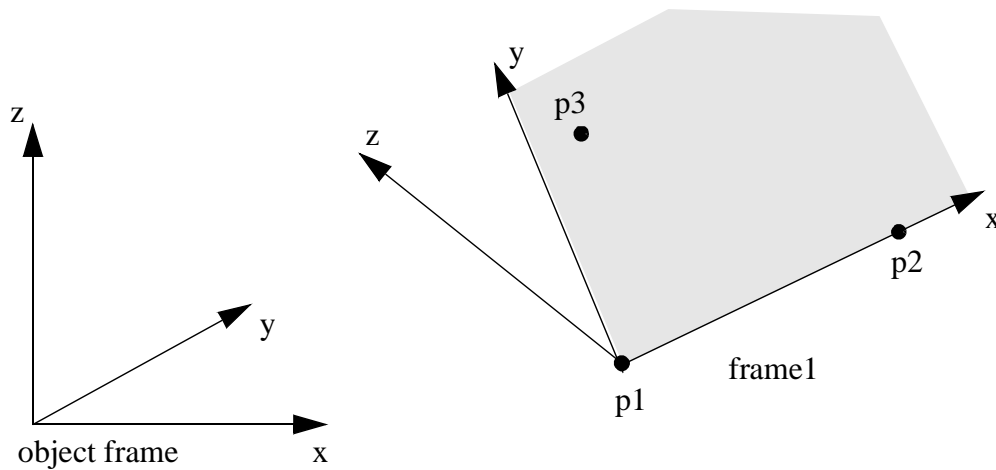
---

---

**DefFrame****Define a frame**

*DefFrame* (*Define Frame*) is used to calculate a frame, from three positions defining the frame.

---

**Example**

Three positions,  $p1$ -  $p3$ , related to the object coordinate system, are used to define the new coordinate system, *frame1*. The first position,  $p1$ , is defining the origin of *frame1*, the second position,  $p2$ , is defining the direction of the x-axis and the third position,  $p3$ , is defining the location of the xy-plane. The defined *frame1* may be used as a displacement frame, as shown in the example below:

```

CONST robtarg p1 := [...];
CONST robtarg p2 := [...];
CONST robtarg p3 := [...];
VAR pose frame1;
.
.
frame1 := DefFrame (p1, p2, p3);
.
.
!activation of the displacement defined by frame1
PDispSet frame1;

```

---

**Return value**Data type: *pose*

The calculated frame.

The calculation is related to the active object coordinate system.

---

**Arguments**

**DefFrame** (NewP1 NewP2 NewP3 [\Origin])

**NewP1** Data type: *robtarget*

The first position, which will define the origin of the new frame.

**NewP2** Data type: *robtarget*

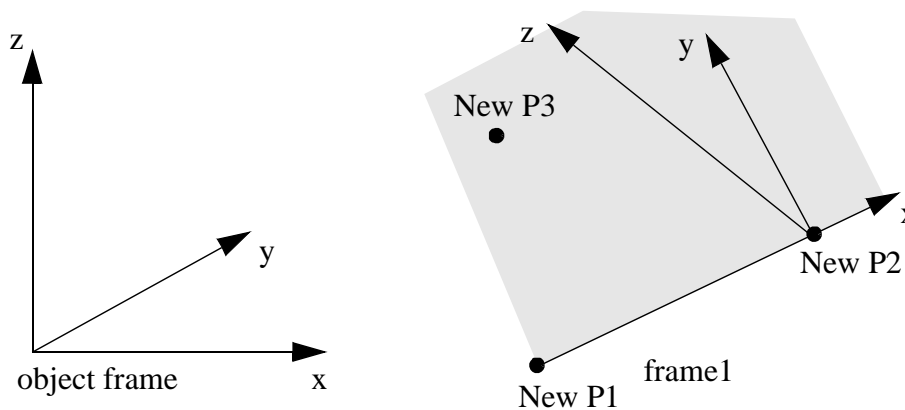
The second position, which will define the direction of the x-axis of the new frame.

**NewP3** Data type: *robtarget*

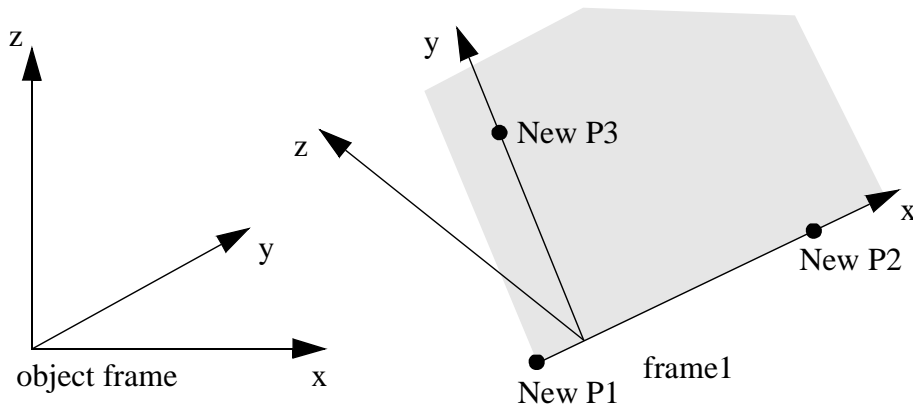
The third position, which will define the xy-plane of the new frame. The position of point 3 will be on the positive y side, see the figure above.

**[\Origin]** Data type: *num*

Optional argument, which will define how the origin of the frame will be placed. Origin = 1, means that the origin is placed in NewP1, i.e. the same as if this argument is omitted. Origin = 2 means that the origin is placed in NewP2, see the figure below.



Origin = 3 means that the origin is placed on the line going through NewP1 and NewP2 and so that NewP3 will be placed on the y axis, see the figure below.



Other values, or if Origin is omitted, will place the origin in NewP1.

### Syntax

```
DefFrame('
  [NewP1 ':='] <expression (IN) of robtarget> ','
  [NewP2 ':='] <expression (IN) of robtarget> ','
  [NewP3 ':='] <expression (IN) of robtarget>
  ['\''Origin ':=' <expression (IN) of num> ']')
```

A function with a return value of the data type *pose*.

### Related information

Mathematical instructions and functions  
 Activation of displacement frame

Described in:

RAPID Summary - *Mathematics*  
 Instructions - *PDispSet*





---



---

## Dim Obtains the size of an array

*Dim (Dimension)* is used to obtain the number of elements in an array.

---

### Example

```
PROC arrmul(VAR num array{*}, num factor)
  FOR index FROM 1 TO Dim(array, 1) DO
    array{index} := array{index} * factor;
  ENDFOR
ENDPROC
```

All elements of a num array are multiplied by a factor.  
This procedure can take any one-dimensional array of data type *num* as an input.

---

### Return value

Data type: *num*

The number of array elements of the specified dimension.

---

### Arguments

#### **Dim (ArrPar DimNo)**

**ArrPar** *(Array Parameter)* Data type: Any type

The name of the array.

**DimNo** *(Dimension Number)* Data type: *num*

The desired array dimension:    1 = first dimension  
     2 = second dimension  
     3 = third dimension

---

**Example**

```

PROC add_matrix(VAR num array1{*,*,*}, num array2{*,*,*})

  IF Dim(array1,1) <> Dim(array2,1) OR Dim(array1,2) <> Dim(array2,2) OR
     Dim(array1,3) <> Dim(array2,3) THEN
    TPWrite "The size of the matrices are not the same";
    Stop;
  ELSE
    FOR i1 FROM 1 TO Dim(array1, 1) DO
      FOR i2 FROM 1 TO Dim(array1, 2) DO
        FOR i3 FROM 1 TO Dim(array1, 3) DO
          array1{i1,i2,i3} := array1{i1,i2,i3} + array2{i1,i2,i3};
        ENDFOR
      ENDFOR
    ENDFOR
  ENDIF
  RETURN;

ENDPROC

```

Two matrices are added. If the size of the matrices differs, the program stops and an error message appears.

This procedure can take any three-dimensional arrays of data type *num* as an input.

---

**Syntax**

```

Dim '('
  [ArrPar':='] <reference (REF) of any type> ','
  [DimNo':='] <expression (IN) of num> ')'

```

A REF parameter requires that the corresponding argument be either a constant, a variable or an entire persistent. The argument could also be an IN parameter, a VAR parameter or an entire PERS parameter.

A function with a return value of the data type *num*.

---

**Related information**

Array parameters

Array declaration

Described in:

Basic Characteristics - *Routines*

Basic Characteristics - *Data*

---

---

## DOutput      Reads the value of a digital output signal

*DOutput* is used to read the current value of a digital output signal.

---

### Example

IF DOutput(do2) = 1 THEN . . .

If the current value of the signal *do2* is equal to 1, then . . .

---

### Return value

Data type: *dionum*

The current value of the signal (0 or 1).

---

### Arguments

**DOutput (Signal)**

**Signal**

Data type: *signaldo*

The name of the signal to be read.

---

### Program execution

The value read depends on the configuration of the signal. If the signal is inverted in the system parameters, the value returned by this function is the opposite of the true value of the physical channel.

---

### Example

IF DOutput(auto\_on) <> active THEN . . .

If the current value of the system signal *auto\_on* is *not active*, then ..., i.e. if the robot is in the manual operating mode, then ... Note that the signal must first be defined as a system output in the system parameters.

---

### Syntax

```
DOutput '('  
  [ Signal ':=' ] < variable (VAR) of signaldo > ')'
```

A function with a return value of the data type *dionum*.

---

**Related information**

	<u>Described in:</u>
Input/Output instructions	RAPID Summary - <i>Input and Output Signals</i>
Input/Output functionality in general	Motion and I/O Principles - <i>I/O Principles</i>
Configuration of I/O	User's Guide - <i>System Parameters</i>

---



---

## EulerZYX      Gets Euler angles from orient

*EulerZYX (Euler ZYX rotations)* is used to get an Euler angle component from an orient type variable.

---

### Example

```
VAR num anglex;
VAR num angley;
VAR num anglez;
VAR pose object;
.
.
anglex := GetEuler(\X, object.rot);
angley := GetEuler(\Y, object.rot);
anglez := GetEuler(\Z, object.rot);
```

---

### Return value

Data type: *num*

The corresponding Euler angle, expressed in degrees, range [-180, 180].

---

### Arguments

#### **EulerZYX** ([\X] | [\Y] | [\Z] **Rotation**)

The arguments \X, \Y and \Z are mutually exclusive. If none of these are specified, a run-time error is generated.

**[\X]** Data type: *switch*

Gets the rotation around the X axis.

**[\Y]** Data type: *switch*

Gets the rotation around the Y axis.

**[\Z]** Data type: *switch*

Gets the rotation around the Z axis.

**Rotation** Data type: *orient*

The rotation in its quaternion representation.

---

**Syntax**

```
EulerZYX'(
  ['\X ',''] | ['\Y ',''] | ['\Z ','']
  [Rotation ':='] <expression (IN) of orient>
  )'
```

A function with a return value of the data type *num*.

---

**Related information**

	<b>Described in:</b>
Mathematical instructions and functions	RAPID Summary - <i>Mathematics</i>

---



---

## Exp Calculates the exponential value

*Exp (Exponential)* is used to calculate the exponential value,  $e^x$ .

---

### Example

```
VAR num x;
VAR num value;
.
.
value:= Exp( x);
```

---

### Return value

Data type: *num*

The exponential value  $e^x$ .

---

### Arguments

#### Exp (Exponent)

Exponent

Data type: *num*

The exponent argument value.

---

### Syntax

```
Exp'(
  [Exponent ':=' ] <expression (IN) of num>
')
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*





---



---

## GetTime      Reads the current time as a numeric value

*GetTime* is used to read a specified component of the current system time as a numeric value.

*GetTime* can be used to :

- have the program perform an action at a certain time,
- perform certain activities on a weekday,
- abstain from performing certain activities on the weekend,
- respond to errors differently depending on the time of day.

---

### Example

```
hour := GetTime(\Hour);
```

The current hour is stored in the variable *hour*.

---

### Return value

Data type: *num*

One of the four time components specified below.

---

### Argument

**GetTime** ( [\WDay] | [\Hour] | [\Min] | [\Sec] )

**[\WDay]**

Data type: *switch*

Return the current weekday.  
Range: 1 to 7 (Monday to Sunday).

**[\Hour]**

Data type: *switch*

Return the current hour.  
Range: 0 to 23.

**[\Min]**

Data type: *switch*

Return the current minute.  
Range: 0 to 59.

**[\Sec]**

Data type: *switch*

Return the current second.  
Range: 0 to 59.

One of the arguments must be specified, otherwise program execution stops with an error message.

---

### Example

```
weekday := GetTime(\WDay);
hour := GetTime(\Hour);
IF weekday < 6 AND hour >6 AND hour < 16 THEN
    production;
ELSE
    maintenance;
ENDIF
```

If it is a weekday and the time is between 7:00 and 15:59 the robot performs production. At all other times, the robot is in the maintenance mode.

---

### Syntax

```
GetTime '('
    ['\ WDay ]
    | ['\ Hour ]
    | ['\ Min ]
    | ['\ Sec ] ')'

```

A function with a return value of the type *num*.

---

### Related Information

Time and date instructions  
Setting the system clock

Described in:

RAPID Summary - *System & Time*  
User's Guide - *System Parameters*

## **GOutput Reads the value of a group of digital output signals**

*GOutput* is used to read the current value of a group of digital output signals.

### **Example**

IF GOutput(go2) = 5 THEN ...

If the current value of the signal *go2* is equal to 5, then ...

### **Return value**

Data type: *num*

The current value of the signal (a positive integer).

The values of each signal in the group are read and interpreted as an unsigned binary number. This binary number is then converted to an integer.

The value returned lies within a range that is dependent on the number of signals in the group.

<u>No. of signals</u>	<u>Return value</u>	<u>No. of signals</u>	<u>Return value</u>
1	0 - 1	9	0 - 511
2	0 - 3	10	0 - 1023
3	0 - 7	11	0 - 2047
4	0 - 15	12	0 - 4095
5	0 - 31	13	0 - 8191
6	0 - 63	14	0 - 16383
7	0 - 127	15	0 - 32767
8	0 - 255	16	0 - 65535

### **Arguments**

#### **GOutput (Signal)**

##### **Signal**

Data type: *signalgo*

The name of the signal group to be read.

---

**Syntax**

GOutput '('  
[ Signal ':=' ] < variable (**VAR**) of *signalgo* > ')'

A function with a return value of data type *num*.

---

**Related information**

Input/Output instructions

Input/Output functionality in general

Configuration of I/O

Described in:

RAPID Summary -  
*Input and Output Signals*

Motion and I/O Principles -  
*I/O Principles*

User's Guide - *System Parameters*



---

**Error handling**

If the axis is not in independent mode, the system variable ERRNO will be set to ERR\_AXIS\_IND.

---

**Syntax**

```
IndInpos '('  
  [ MecUnit':=' ] < variable (VAR) of mecunit> ','  
  [ Axis':=' ] < expression (IN) of num>'
```

A function with a return value of the data type *bool*.

---

**Related information**

	<u>Described in:</u>
Independent axes in general	Motion and I/O Principles - <i>Program execution</i>
Check the speed status for independent axes	Functions - <i>IndSpeed</i>





[ \ZeroSpeed ]

Data type: *switch*

*IndSpeed* returns value TRUE if the axis has zero speed otherwise FALSE.

If both the arguments *InSpeed* and *ZeroSpeed* are omitted, an error message will be displayed.

## Limitation

The function *IndSpeed*\InSpeed will always return the value FALSE in the following situations:

- The robot is in manual mode with reduced speed.
- The speed is reduced using the *VelSet* instruction.
- The speed is reduced from the production window.

A wait period of 0.2 seconds should be added after the instruction, to ensure that the correct status is obtained. This time period should be longer for external axes with poor performance.

## Error handling

If the axis is not in independent mode, the system variable ERRNO will be set to ERR\_AXIS\_IND.

## Syntax

```
IndSpeed '('
  [ MecUnit':=' ] < variable (VAR) of mecunit> ','
  [ Axis':=' ] < expression (IN) of num>
  [ '\ InSpeed ] | [ '\ ZeroSpeed ] ')'
```

A function with a return value of the data type *bool*.

## Related information

Independent axes in general	<u>Described in:</u> Motion and I/O Principles - <i>Program execution</i>
More examples	Instructions - <i>IndCMove</i>
Check the position status for independent axes	Functions - <i>IndInpos</i>

---

---

**IsPers****Is Persistent**

*IsPers* is used to test if a data object is a persistent variable or not.

---

**Example**

```
PROC procedure1 (INOUT num parameter1)
  IF IsVar(parameter1) THEN
    ! For this call reference to a variable
    ...
  ELSEIF IsPers(parameter1) THEN
    ! For this call reference to a persistent variable
    ...
  ELSE
    ! Should not happen
    EXIT;
  ENDIF
ENDPROC
```

The procedure *procedure1* will take different actions depending on whether the actual parameter *parameter1* is a variable or a persistent variable.

---

**Return value**

Data type: *bool*

TRUE if the tested actual INOUT parameter is a persistent variable.  
FALSE if the tested actual INOUT parameter is not a persistent variable.

---

**Arguments**

**IsPers** (**DatObj**)

**DatObj**

(*Data Object*)

Data type: any type

The name of the formal INOUT parameter.

---

**Syntax**

```
IsPers(' [ DatObj ' := ' ] < var or pers (INOUT) of any type > ')
```

A function with a return value of the data type *bool*.

---

---

**Related information**

Test if variable

Types of parameters (access modes)

Described in:

Function - *IsVar*

RAPID Characteristics - *Routines*

---

---

**IsVar****Is Variable**

*IsVar* is used to test whether a data object is a variable or not.

---

**Example**

```
PROC procedure1 (INOUT num parameter1)
  IF IsVAR(parameter1) THEN
    ! For this call reference to a variable
    ...
  ELSEIF IsPers(parameter1) THEN
    ! For this call reference to a persistent variable
    ...
  ELSE
    ! Should not happen
    EXIT;
  ENDIF
ENDPROC
```

The procedure *procedure1* will take different actions, depending on whether the actual parameter *parameter1* is a variable or a persistent variable.

---

**Return value**Data type: *bool*

TRUE if the tested actual INOUT parameter is a variable.  
FALSE if the tested actual INOUT parameter is not a variable.

---

**Arguments****IsVar** (**DatObj**)**DatObj***(Data Object)*

Data type: any type

The name of the formal INOUT parameter.

---

**Syntax**

```
IsVar'( '  
  [ DatObj ':=' ] < var or pers (INOUT) of any type > ' )'
```

A function with a return value of the data type *bool*.

---

---

**Related information**

Test if persistent

Types of parameters (access modes)

Described in:

Function - *IsPers*

RAPID Characteristics - *Routines*

---

---

**MirPos****Mirroring of a position**

*MirPos* (*Mirror Position*) is used to mirror the translation and rotation parts of a position.

---

**Example**

```
CONST robtarg p1;
VAR robtarg p2;
PERS wobjdata mirror;
.
.
p2 := MirPos(p1, mirror);
```

*p1* is a robtarg storing a position of the robot and an orientation of the tool. This position is mirrored in the xy-plane of the frame defined by *mirror*, relative to the world coordinate system. The result is new robtarg data, which is stored in *p2*.

---

**Return value**Data type: *robtarg*

The new position which is the mirrored position of the input position.

---

**Arguments**

**MirPos** (**Point** **MirPlane** [**\WObj**] [**\MirY**])

**Point**Data type: *robtarg*

The input robot position. The orientation part of this position defines the current orientation of the tool coordinate system.

**MirPlane**(*Mirror Plane*)Data type: *wobjdata*

The work object data defining the mirror plane. The mirror plane is the xy-plane of the object frame defined in *MirPlane*. The location of the object frame is defined relative to the user frame, also defined in *MirPlane*, which in turn is defined relative to the world frame.

## [\WObj]

(*Work Object*)Data type: *wobjdata*

The work object data defining the object frame, and user frame, relative to which the input position, *Point*, is defined. If this argument is left out, the position is defined relative to the World coordinate system.

**Note.** If the position is created with a work object active, this work object must be referred to in the argument.

[\bMirY]

*(Mirror Y)*Data type: *switch*

If this switch is left out, which is the default rule, the tool frame will be mirrored as regards the x-axis and the z-axis. If the switch is specified, the tool frame will be mirrored as regards the y-axis and the z-axis.

---

**Limitations**

No recalculation is done of the robot configuration part of the input *robtarg* data.

---

**Syntax**

```
MirPos'(
  [ Point ':=' ] <expression (IN) of robtarg> ','
  [ MirPlane ':=' ] <expression (IN) of wobjdata> ','
  [ '\WObj ':=' <expression (IN) of wobjdata> ]
  [ '\MirY ]')
```

A function with a return value of the data type *robtarg*.

---

**Related information**

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*

---



---

## NumToStr      Converts numeric value to string

*NumToStr (Numeric To String)* is used to convert a numeric value to a string.

---

### Example

```
VAR string str;
```

```
str := NumToStr(0.38521,3);
```

The variable *str* is given the value "0.385".

```
reg1 := 0.38521
```

```
str := NumToStr(reg1, 2\Exp);
```

The variable *str* is given the value "3.85E-01".

---

### Return value

Data type: *string*

The numeric value converted to a string with the specified number of decimals, with exponent if so requested. The numeric value is rounded if necessary. The decimal point is suppressed if no decimals are included.

---

### Arguments

**NumToStr (Val Dec [\Exp])**

**Val**                                      (*Value*)                                      Data type: *num*

The numeric value to be converted.

**Dec**                                      (*Decimals*)                                      Data type: *num*

Number of decimals. The number of decimals must not be negative or greater than the available precision for numeric values.

**[\Exp]**                                      (*Exponent*)                                      Data type: *switch*

To use exponent.



---

**Syntax**

```
NumToStr('
  [ Val ':= ' ] <expression (IN) of num> ',
  [ Dec ':= ' ] <expression (IN) of num>
  [ \Exp ]
  ')'
```

A function with a return value of the data type *string*.

---

**Related information**

String functions

Definition of string

String values

**Described in:**

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

---

---

## Offs Displaces a robot position

*Offs* is used to add an offset to a robot position.

---

### Examples

```
MoveL Offs(p2, 0, 0, 10), v1000, z50, tool1;
```

The robot is moved to a point *10* mm from the position *p2* (in the z-direction).

```
p1 := Offs (p1, 5, 10, 15);
```

The robot position *p1* is displaced 5 mm in the x-direction, 10 mm in the y-direction and 15 mm in the z-direction.

---

### Return value

Data type: *robtarget*

The displaced position data.

---

### Arguments

**Offs** (Point XOffset YOffset ZOffset)

**Point**

Data type: *robtarget*

The position data to be displaced.

**XOffset**

Data type: *num*

The displacement in the x-direction.

**YOffset**

Data type: *num*

The displacement in the y-direction.

**ZOffset**

Data type: *num*

The displacement in the z-direction.

---

**Example**

```

PROC pallet (num row, num column, num distance, PERS tooldata tool,
            PERS wobjdata wobj)

VAR robtargt palletpos:=[[0, 0, 0], [1, 0, 0, 0], [0, 0, 0, 0],
                        [9E9, 9E9, 9E9, 9E9, 9E9, 9E9]];

palettpos := Offs (palettpos, (row-1)*distance, (column-1)*distance, 0);
MoveL palettpos, v100, fine, tool\WObj:=wobj;

ENDPROC

```

A routine for picking parts from a pallet is made. Each pallet is defined as a work object (see Figure 1). The part to be picked (row and column) and the distance between the parts are given as input parameters. Incrementing the row and column index is performed outside the routine.

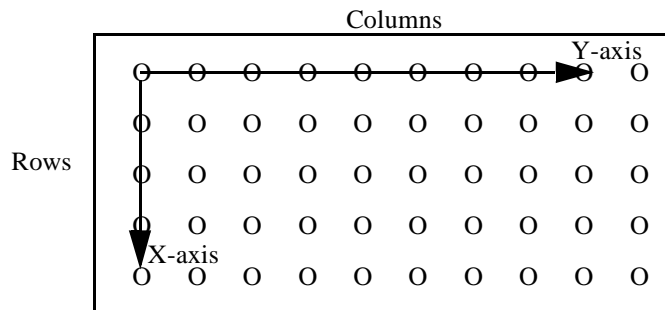


Figure 1 The position and orientation of the pallet is specified by defining a work object.

---

**Syntax**

```

Offs '('
    [Point ':='] <expression (IN) of robtargt> ','
    [XOffset ':='] <expression (IN) of num> ','
    [YOffset ':='] <expression (IN) of num> ','
    [ZOffset ':='] <expression (IN) of num> ')'

```

A function with a return value of the data type *robtargt*.

---

**Related information**

Position data

Described in:

Data Types - *robtargt*

---



---

## OpMode                      Read the operating mode

*OpMode (Operating Mode)* is used to read the current operating mode of the system.

---

### Example

```

TEST OpMode()
CASE OP_AUTO:
    ...
CASE OP_MAN_PROG:
    ...
CASE OP_MAN_TEST:
    ...
DEFAULT:
    ...
ENDTEST

```

Different program sections are executed depending on the current operating mode.

---

### Return value

Data type: *symnum*

The current operating mode as defined in the table below.

Return value	Symbolic constant	Comment
0	OP_UNDEF	Undefined operating mode
1	OP_AUTO	Automatic operating mode
2	OP_MAN_PROG	Manual operating mode max. 250 mm/s
3	OP_MAN_TEST	Manual operating mode full speed, 100 %

---

### Syntax

`OpMode(' ')`

A function with a return value of the data type *symnum*.

---

### Related information

Different operating modes  
Reading running mode

#### Described in:

User's Guide - *Starting up*  
Functions - *RunMode*



---



---

## OrientZYX Builds an orient from Euler angles

*OrientZYX (Orient from Euler ZYX angles)* is used to build an orient type variable out of Euler angles.

---

### Example

```
VAR num anglex;
VAR num angley;
VAR num anglez;
VAR pose object;
.
object.rot := OrientZYX(anglez, angley, anglex)
```

---

### Return value

Data type: *orient*

The orientation made from the Euler angles.

The rotations will be performed in the following order:

- rotation around the z axis,
- rotation around the new y axis
- rotation around the new x axis.

---

### Arguments

#### **OrientZYX (ZAngle YAngle XAngle)**

##### **ZAngle**

Data type: *num*

The rotation, in degrees, around the Z axis.

##### **YAngle**

Data type: *num*

The rotation, in degrees, around the Y axis.

##### **XAngle**

Data type: *num*

The rotation, in degrees, around the X axis.

The rotations will be performed in the following order:

- rotation around the z axis,
- rotation around the new y axis
- rotation around the new x axis.

---

**Syntax**

```
OrientZYX '('  
  [ZAngle ':='] <expression (IN) of num> ','  
  [YAngle ':='] <expression (IN) of num> ','  
  [XAngle ':='] <expression (IN) of num>  
)'
```

A function with a return value of the data type *orient*.

---

**Related information**

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*

---



---

## ORobT Removes a program displacement from a position

*ORobT (Object Robot Target)* is used to transform a robot position from the program displacement coordinate system to the object coordinate system and/or to remove an offset for the external axes.

---

### Example

```
VAR robtargt p10;
VAR robtargt p11;

p10 := CRobT();
p11 := ORobT(p10);
```

The current positions of the robot and the external axes are stored in *p10* and *p11*. The values stored in *p10* are related to the ProgDisp/ExtOffs coordinate system. The values stored in *p11* are related to the object coordinate system without any offset on the external axes.

---

### Return value

Data type: *robtargt*

The transformed position data.

---

### Arguments

**ORobT** (**OrgPoint** [**\InPDisp**] | [**\InEOffs**])

**OrgPoint** (*Original Point*) Data type: *robtargt*

The original point to be transformed.

**\InPDisp** (*In Program Displacement*) Data type: *switch*

Returns the TCP position in the ProgDisp coordinate system, i.e. removes external axes offset only.

**\InEOffs** (*In External Offset*) Data type: *switch*

Returns the external axes in the offset coordinate system, i.e. removes program displacement for the robot only.



---

**Examples**

```
p10 := ORobT(p10 \InEOffs );
```

The ORobT function will remove any program displacement that is active, leaving the TCP position relative to the object coordinate system. The external axes will remain in the offset coordinate system.

```
p10 := ORobT(p10 \InPDisp );
```

The ORobT function will remove any offset of the external axes. The TCP position will remain in the ProgDisp coordinate system.

---

**Syntax**

```
ORobT '(  
  [ OrgPoint ':=' ] < expression (IN) of robtargt>  
  ['\InPDisp] | ['\InEOffs'] )'
```

A function with a return value of the data type *robtargt*.

---

**Related information**

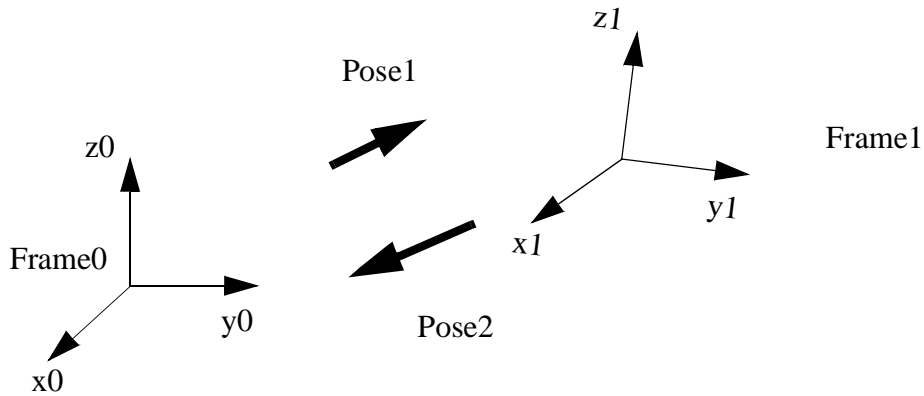
Definition of program displacement for the robot	<u>Described in:</u> Instructions - <i>PDispOn</i> , <i>PDispSet</i>
Definition of offset for external axes	Instructions - <i>EOffsOn</i> , <i>EOffsSet</i>
Coordinate systems	Motion and I/O Principles - <i>Coordinate Systems</i>

## PoseInv

## Inverts the pose

*PoseInv* (*Pose Invert*) calculates the reverse transformation of a pose.

### Example



Pose1 represents the coordinates of Frame1 related to Frame0.

The transformation giving the coordinates of Frame0 related to Frame1 is obtained by the reverse transformation:

```

VAR pose pose1;
VAR pose pose2;
.
.
pose2 := PoseInv(pose1);
    
```

### Return value

Data type: *pose*

The value of the reverse pose.

### Arguments

**PoseInv** (**Pose**)

**Pose**

Data type: *pose*

The pose to invert.

---

**Syntax**

```
PoseInv '('  
  [Pose ':='] <expression (IN) of pose>  
  ')'
```

A function with a return value of the data type *pose*.

---

**Related information**

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*

---



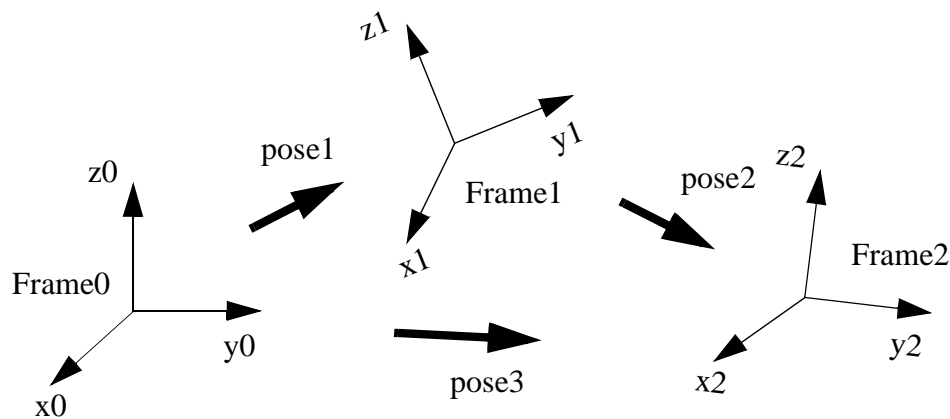
---

## PoseMult Multiplies pose data

*PoseMult (Pose Multiply)* is used to calculate the product of two frame transformations. A typical use is to calculate a new frame as the result of a displacement acting on an original frame.

---

### Example



pose1 represents the coordinates of Frame1 related to Frame0.

pose2 represents the coordinates of Frame2 related to Frame1.

The transformation giving pose3, the coordinates of Frame2 related to Frame0, is obtained by the product of the two transformations:

```

VAR pose pose1;
VAR pose pose2;
VAR pose pose3;
.
.
pose3 := PoseMult(pose1, pose2);

```

---

### Return value

Data type: *pose*

The value of the product of the two poses.

---

**Arguments****PoseMult (Pose1 Pose2)****Pose1**Data type: *pose*

The first pose.

**Pose2**Data type: *pose*

The second pose.

---

**Syntax**

```
PoseMult '('  
  [Pose1 ':=' ] <expression (IN) of pose> ','  
  [Pose2 ':=' ] <expression (IN) of pose>  
' )'
```

A function with a return value of the data type *pose*.

---

**Related information**

Mathematical instructions and functions

Described in:RAPID Summary - *Mathematics*

---



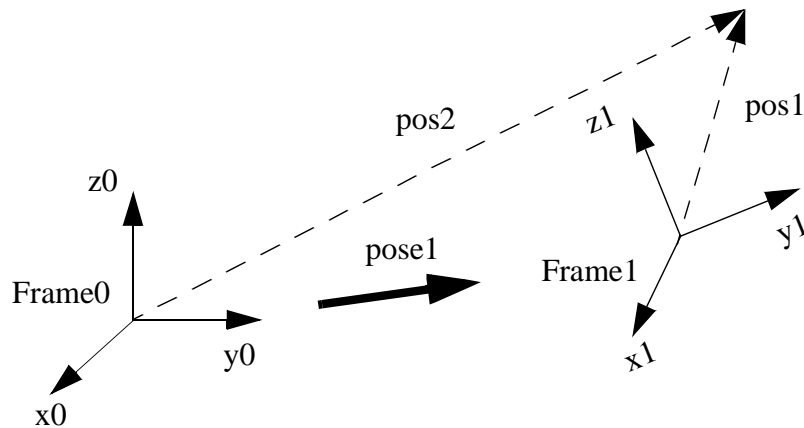
---

## PoseVect Applies a transformation to a vector

*PoseVect (Pose Vector)* is used to calculate the product of a pose and a vector. It is typically used to calculate a vector as the result of the effect of a displacement on an original vector.

---

### Example



pose1 represents the coordinates of Frame1 related to Frame0.  
pos1 is a vector related to Frame1.

The corresponding vector related to Frame0 is obtained by the product:

```
VAR pose pose1;
VAR pos pos1;
VAR pos pos2;
.
.
pos2:= PoseVect(pose1, pos1);
```

---

### Return value

Data type: *pos*

The value of the product of the pose and the original pos.

**Arguments**

**PoseVect (Pose Pos)**

**Pose** Data type: *pose*

The transformation to be applied.

**Pos** Data type: *pos*

The pos to be transformed.

**Syntax**

```
PoseVect('
  [Pose ':='] <expression (IN) of pose> ',
  [Pos ':='] <expression (IN) of pos>
')
```

A function with a return value of the data type *pos*.

**Related information**

	<u>Described in:</u>
Mathematical instructions and functions	RAPID Summary - <i>Mathematics</i>

---



---

## Pow Calculates the power of a value

*Pow* (*Power*) is used to calculate the exponential value in any base.

---

### Example

```
VAR num x;
VAR num y
VAR num reg1;
.
reg1:= Pow(x, y);
```

*reg1* is assigned the value  $x^y$ .

---

### Return value

Data type: *num*

The value of the base  $x$  raised to the power of the exponent  $y$  ( $x^y$ ).

---

### Arguments

#### **Pow** (Base Exponent)

##### **Base**

Data type: *num*

The base argument value.

##### **Exponent**

Data type: *num*

The exponent argument value.

---

### Limitations

The execution of the function  $x^y$  will give an error if:

- .  $x < 0$  and  $y$  is not an integer;
- .  $x = 0$  and  $y \leq 0$ .

---

### Syntax

```
Pow('
  [Base ':=' ] <expression (IN) of num> ',
  [Exponent ':=' ] <expression (IN) of num>
')
```



A function with a return value of the data type *num*.

---

**Related information**

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*

## Present      Tests if an optional parameter is used

*Present* is used to test if an optional argument has been used when calling a routine.

An optional parameter may not be used if it was not specified when calling the routine. This function can be used to test if a parameter has been specified, in order to prevent errors from occurring.

---

### Example

```
PROC feeder (\switch on | \switch off)
```

```
  IF Present (on) Set do1;  
  IF Present (off) Reset do1;
```

```
ENDPROC
```

The output *do1*, which controls a feeder, is set or reset depending on the argument used when calling the routine.

---

### Return value

Data type: *bool*

TRUE = The parameter value or a switch has been defined when calling the routine.

FALSE = The parameter value or a switch has not been defined.

---

### Arguments

**Present**    (**OptPar**)

**OptPar**                      (*Optional Parameter*)      Data type: Any type

The name of the optional parameter to be tested.

---

**Example**

```

PROC glue (\switch on, num glueflow, robtargtopoint, speeddata speed,
          zonedata zone, PERS tooldata tool, \PERS wobjdata wobj)

  IF Present (on) PulseDO glue_on;
  SetAO gluesignal, glueflow;
  IF Present (wobj) THEN
    MoveL topoint, speed, zone, tool \WObj=wobj;
  ELSE
    MoveL topoint, speed, zone, tool;
  ENDIF

ENDPROC

```

A glue routine is made. If the argument `\on` is specified when calling the routine, a pulse is generated on the signal `glue_on`. The robot then sets an analog output `gluesignal`, which controls the glue gun, and moves to the end position. As the `wobj` parameter is optional, different MoveL instructions are used depending on whether this argument is used or not.

---

**Syntax**

```
Present '('
  [OptPar':='] <reference (REF) of any type> ')'
```

A REF parameter requires, in this case, the optional parameter name.

A function with a return value of the data type *bool*.

---

**Related information**

Routine parameters

Described in:

Basic Characteristics - *Routines*

---

---

## ReadBin Reads from a binary serial channel or file

*ReadBin (Read Binary)* is used to read a byte (8 bits) from a binary serial channel or file.

---

### Example

```
VAR iodev inchannel;  
.   
Open "siol:", inchannel\Bin;  
character := ReadBin(inchannel);
```

A byte is read from the binary channel *inchannel*.

---

### Return value

Data type: *num*

A byte (8 bits) is read from a specified serial channel. This byte is converted to the corresponding positive numeric value. If the file is empty (end of file), the number -1 is returned.

---

### Arguments

#### ReadBin (IODevice [\Time])

**IODevice**

Data type: *iodev*

The name (reference) of the current serial channel or file.

**[\Time]**

Data type: *num*

The max. time for the reading operation (timeout) in seconds. If this argument is not specified, the max. time is set to 60 seconds.

If this time runs out before the reading operation is finished, the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler, the execution will be stopped.

The timeout function is in use also during program stop and will be noticed in RAPID program at program start.

---

### Program execution

Program execution waits until a byte (8 bits) can be read from the binary serial channel.

**Example**

```
Open "flp1:myfile.bin", file\Bin;
.
Rewind file;
bindata := ReadBin(file);
WHILE bindata <> EOF_BIN DO
    TPWrite ByteToStr(bindata\Char);
    bindata := ReadBin(file);
ENDWHILE
```

Read the contents of a binary file *myfile.bin* from the beginning to the end of the file and display the binary data received on the teach pendant, converted to ASCII characters (one char on each line).

---

**Limitations**

The function can only be used for channels and files that have been opened for binary reading and writing.

---

**Error handling**

If an error occurs during reading, the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

---

**Predefined data**

The constant `EOF_BIN` can be used to stop reading at the end of the file.

```
CONST num EOF_BIN := -1;
```

---

**Syntax**

```
ReadBin('
    [IODevice ':='] <variable (VAR) of iodev>
    ['\Time' := <expression (IN) of num>]')
```

A function with a return value of the type *num*.

---

**Related information**

Opening (etc.) serial channels  
Convert a byte to a string data  
Byte data

Described in:

RAPID Summary - *Communication*  
Functions - *ByteToStr*  
Data Types - *byte*



---



---

## ReadMotor                      Reads the current motor angles

*ReadMotor* is used to read the current angles of the different motors of the robot and external axes. The primary use of this function is in the calibration procedure of the robot.

---

### Example

```
VAR num motor_angle2;

motor_angle2 := ReadMotor(2);
```

The current motor angle of the second axis of the robot is stored in *motor\_angle2*.

---

### Return value

Data type: *num*

The current motor angle in radians of the stated axis of the robot or external axes.

---

### Arguments

#### **ReadMotor** [**MecUnit**] **Axis**

##### **MecUnit**

(*Mechanical Unit*)

Data type: *mecunit*

The name of the mechanical unit for which an axis is to be read. If this argument is omitted, the axis for the robot is read. (Note, in this release only robot is permitted for this argument).

##### **Axis**

Data type: *num*

The number of the axis to be read (1 - 6).

---

### Program execution

The motor angle returned represents the current position in radians for the motor and independently of any calibration offset. The value is not related to a fix position of the robot, only to the resolver internal zero position, i.e. normally the resolver zero position closest to the calibration position (the difference between the resolver zero position and the calibration position is the calibration offset value). The value represents the full movement of each axis, although this may be several turns.



**Example**

```
VAR num motor_angle3;
```

```
motor_angle3 := ReadMotor(\MecUnit:=robot, 3);
```

The current motor angle of the third axis of the robot is stored in *motor\_angle3*.

---

**Syntax**

```
ReadMotor(''  
  ['\MecUnit ':=' < variable (VAR) of mecunit>',']  
  [Axis ':=' ] < expression (IN) of num>  
  ''
```

A function with a return value of the data type *num*.

---

**Related information**

Reading the current joint angle

Described in:

Functions - *CJointT*

---



---

## ReadNum Reads a number from a file or the serial channel

*ReadNum (Read Numeric)* is used to read a number from a character-based file or the serial channel.

---

### Example

```
VAR iodev infile;
.
Open "flp1:file.doc", infile\Read;
reg1 := ReadNum(infile);
```

*Reg1* is assigned a number read from the file *file.doc* on the diskette.

---

### Return value

Data type: *num*

The numeric value read from a specified file. If the file is empty (end of file), the number 9.999E36 is returned.

---

### Arguments

#### ReadNum (IODevice [Time])

**IODevice**

Data type: *iodev*

The name (reference) of the file to be read.

[Time]

Data type: *num*

The max. time for the reading operation (timeout) in seconds. If this argument is not specified, the max. time is set to 60 seconds.

If this time runs out before the read operation is finished, the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler, the execution will be stopped.

The timeout function is also in use during program stop and will be noticed in RAPID program at program start.

---

### Program execution

The function reads a line from a file, i.e. reads everything up to and including the next line-feed character (LF), but not more than 80 characters. If the line exceeds 80 characters, the remainder of the characters will be read on the next reading.

The string that is read is then converted to a numeric value; e.g. "234.4" is converted to the numeric value 234.4. If all the characters read are not digits, 0 is returned.

---

## Example

```
reg1 := ReadNum(infile);
IF reg1 > EOF_NUM THEN
  TPWrite "The file is empty"
..
```

Before using the number read from the file, a check is performed to make sure that the file is not empty.

---

## Limitations

The function can only be used for files that have been opened for reading.

---

## Error handling

If an access error occurs during reading, the system variable ERRNO is set to ERR\_FILEACC. If there is an attempt to read non numeric data, the system variable ERRNO is set to ERR\_RCVDATA. These errors can then be dealt with by the error handler.

---

## Predefined data

The constant *EOF\_NUM* can be used to stop reading, at the end of the file.

```
CONST num EOF_NUM := 9.998E36;
```

---

## Syntax

```
ReadNum '('  
  [IODevice ':='] <variable (VAR) of iodev>  
  ['\Time':=' <expression (IN) of num>']')
```

A function with a return value of the type *num*.

---

## Related information

Opening (etc.) serial channels

Described in:

RAPID Summary - *Communication*

---



---

## ReadStr      Reads a string from a file or serial channel

*ReadStr* (*Read String*) is used to read text from a character-based file or from the serial channel.

---

### Example

```
VAR iodev infile;
.
Open "flp1:file.doc", infile\Read;
text := ReadStr(infile);
```

*Text* is assigned a text string read from the file *file.doc* on the diskette.

---

### Return value

Data type: *string*

The text string read from the specified file. If the file is empty (end of file), the string "EOF" is returned.

---

### Arguments

#### **ReadStr** (IODevice [**\Time**])

##### **IODevice**

Data type: *iodev*

The name (reference) of the file to be read.

##### **[\Time]**

Data type: *num*

The max. time for the reading operation (timeout) in seconds. If this argument is not specified, the max. time is set to 60 seconds.

If this time runs out before the read operation is finished, the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler, the execution will be stopped.

---

### Program execution

The function reads a line from a file, i.e. reads everything up to and including the next line-feed character (LF), but not more than 80 characters. If the line exceeds 80 characters, the remainder of the characters will be read on the next reading.

## Example

```
text := ReadStr(infile);
IF text = EOF THEN
  TPWrite "The file is empty";
.
```

Before using the string read from the file, a check is performed to make sure that the file is not empty.

---

## Limitations

The function can only be used for files that have been opened for reading.

---

## Error handling

If an error occurs during reading, the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

---

## Predefined data

The constant `EOF` can be used to check if the file was empty when trying to read from the file or to stop reading at the end of the file.

```
CONST string EOF := "EOF";
```

---

## Syntax

```
ReadStr '('  
  [IODevice ':='] <variable (VAR) of iodev>  
  ['\Time':=' <expression (IN) of num>']')'
```

A function with a return value of the type *string*.

---

## Related information

Opening (etc.) serial channels

Described in:

RAPID Summary - *Communication*

---



---

## RelTool    Make a displacement relative to the tool

*RelTool (Relative Tool)* is used to add a displacement and/or a rotation, expressed in the tool coordinate system, to a robot position.

---

### Example

```
MoveL    RelTool (p1, 0, 0, 100), v100, fine, tool1;
```

The robot is moved to a position that is 100 mm from p1 in the direction of the tool.

```
MoveL    RelTool (p1, 0, 0, 0 \Rz:= 25), v100, fine, tool1;
```

The tool is rotated 25° around its z-axis.

---

### Return value

Data type: *robtarget*

The new position with the addition of a displacement and/or a rotation, if any, relative to the active tool.

---

### Arguments

**RelTool (Point Dx Dy Dz [\Rx] [\Ry] [\Rz])**

**Point**

Data type: *robtarget*

The input robot position. The orientation part of this position defines the current orientation of the tool coordinate system.

**Dx**

Data type: *num*

The displacement in mm in the x direction of the tool coordinate system.

**Dy**

Data type: *num*

The displacement in mm in the y direction of the tool coordinate system.

**Dz**

Data type: *num*

The displacement in mm in the z direction of the tool coordinate system.

**[\Rx]**

Data type: *num*

The rotation in degrees around the x axis of the tool coordinate system.

**[Ry]**Data type: *num*

The rotation in degrees around the y axis of the tool coordinate system.

**[Rz]**Data type: *num*

The rotation in degrees around the z axis of the tool coordinate system.

In the event that two or three rotations are specified at the same time, these will be performed first around the x-axis, then around the new y-axis, and then around the new z-axis.

## Syntax

```
RelTool'(
  [ Point ':=' ] <expression (IN) of robtarg>',
  [ Dx ':=' ] <expression (IN) of num> ',
  [ Dy ':=' ] <expression (IN) of num> ',
  [ Dz ':=' ] <expression (IN) of num>
  [ '\Rx ':=' <expression (IN) of num> ]
  [ '\Ry ':=' <expression (IN) of num> ]
  [ '\Rz ':=' <expression (IN) of num> ]')
```

A function with a return value of the data type *robtarg*.

## Related information

Mathematical instructions and functions

Positioning instructions

Described in:

RAPID Summary - *Mathematics*

RAPID Summary - *Motion*

---

---

**Round****Round is a numeric value**

*Round* is used to round a numeric value to a specified number of decimals or to an integer value.

---

**Example**

```
VAR num val;
```

```
val := Round(0.38521\Dec:=3);
```

The variable *val* is given the value 0.385.

```
val := Round(0.38521\Dec:=1);
```

The variable *val* is given the value 0.4.

```
val := Round(0.38521);
```

The variable *val* is given the value 0.

---

**Return value**Data type: *num*

The numeric value rounded to the specified number of decimals.

---

**Arguments****Round** ( **Val** [**\Dec**])**Val***(Value)*Data type: *num*

The numeric value to be rounded.

**\Dec***(Decimals)*Data type: *num*

Number of decimals.

If the specified number of decimals is 0 or if the argument is omitted, the value is rounded to an integer.

The number of decimals must not be negative or greater than the available precision for numeric values.



---

**Syntax**

```
Round('
  [ Val ':=' ] <expression (IN) of num>
  [ \Dec ':=' <expression (IN) of num> ]
')
```

A function with a return value of the data type *num*.

---

**Related information**

	<b>Described in:</b>
Mathematical instructions and functions	RAPID Summary - <i>Mathematics</i>
Truncating a value	Functions - <i>Trunc</i>

---



---

## RunMode                      Read the running mode

*RunMode (Running Mode)* is used to read the current running mode of the system.

---

### Example

```
IF RunMode() = RUN_CONT_CYCLE THEN
.
.
ENDIF
```

The program section is executed only for continuous or cycle running.

---

### Return value

Data type: *symnum*

The current running mode as defined in the table below.

Return value	Symbolic constant	Comment
0	RUN_UNDEF	Undefined running mode
1	RUN_CONT_CYCLE	Continuous or cycle running mode
2	RUN_INSTR_FWD	Instruction forward running mode
3	RUN_INSTR_BWD	Instruction backward running mode
4	RUN_SIM	Simulated running mode

---

### Syntax

RunMode(' ')

A function with a return value of the data type *symnum*.

---

### Related information

Reading operating mode

Described in:

Functions - *OpMode*



---

---

## Sin Calculates the sine value

*Sin* (*Sine*) is used to calculate the sine value from an angle value.

---

### Example

```
VAR num angle;  
VAR num value;  
. .  
value := Sin(angle);
```

---

### Return value

Data type: *num*

The sine value, range [-1, 1] .

---

### Arguments

**Sin** (**Angle**)

**Angle**

Data type: *num*

The angle value, expressed in degrees.

---

### Syntax

```
Sin '('  
  [Angle':=' ] <expression (IN) of num>  
  ')'
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*



---

---

## Sqrt Calculates the square root value

*Sqrt* (*Square root*) is used to calculate the square root value.

---

### Example

```
VAR num x_value;  
VAR num y_value;  
.  
.  
y_value := Sqrt( x_value);
```

---

### Return value

Data type: *num*

The square root value.

---

### Arguments

#### Sqrt (Value)

##### Value

Data type: *num*

The argument value for square root ( $\sqrt{\quad}$ ); it has to be  $\geq 0$ .

---

### Syntax

```
Sqrt(''  
  [Value':=''] <expression (IN) of num>  
  ''')
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions

Described in:

RAPID Summary - *Mathematics*



---



---

## StrFind      Searches for a character in a string

*StrFind (String Find)* is used to search in a string, starting at a specified position, for a character that belongs to a specified set of characters.

---

### Example

```
VAR num found;
```

```
found := StrFind("Robotics",1,"aeiou");
```

The variable *found* is given the value 2.

```
found := StrFind("Robotics",1,"aeiou"\NotInSet);
```

The variable *found* is given the value 1.

```
found := StrFind("IRB 6400",1,STR_DIGIT);
```

The variable *found* is given the value 5.

```
found := StrFind("IRB 6400",1,STR_WHITE);
```

The variable *found* is given the value 4.

---

### Return value

Data type: *num*

The character position of the first character, at or past the specified position, that belongs to the specified set. If no such character is found, String length +1 is returned.

---

### Arguments

**StrFind (Str ChPos Set [\NotInSet])**

<b>Str</b>	( <i>String</i> )	Data type: <i>string</i>
------------	-------------------	--------------------------

The string to search in.

<b>ChPos</b>	( <i>Character Position</i> )	Data type: <i>num</i>
--------------	-------------------------------	-----------------------

Start character position. A runtime error is generated if the position is outside the string.

<b>Set</b>		Data type: <i>string</i>
------------	--	--------------------------

Set of characters to test against.



[**NotInSet**]Data type: *switch*

Search for a character not in the set of characters.

---

**Syntax**

```
StrFind'( '  
  [ Str ':=' ] <expression (IN) of string> ', '  
  [ ChPos ':=' ] <expression (IN) of num> ', '  
  [ Set ':=' ] <expression (IN) of string>  
  [ '\NotInSet ]  
)'
```

A function with a return value of the data type *num*.

---

**Related information**

String functions

Definition of string

String values

Described in:RAPID Summary - *String Functions*Data Types - *string*Basic Characteristics -  
*Basic Elements*

---

---

## StrLen Gets the string length

*StrLen (String Length)* is used to find the current length of a string.

---

### Example

```
VAR num len;
```

```
len := StrLen("Robotics");
```

The variable *len* is given the value 8.

---

### Return value

Data type: *num*

The number of characters in the string ( $\geq 0$ ).

---

### Arguments

**StrLen** (**Str**)

**Str**

(*String*)

Data type: *string*

The string in which the number of characters is to be counted.

---

### Syntax

```
StrLen('
  [ Str := ] <expression (IN) of string>
')
```

A function with a return value of the data type *num*.

---

### Related information

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*



---



---

## StrMap Maps a string

*StrMap (String Mapping)* is used to create a copy of a string in which all characters are translated according to a specified mapping.

---

### Example

```
VAR string str;
```

```
str := StrMap("Robotics","aeiou","AEIOU");
```

The variable *str* is given the value "RObOtIcs".

```
str := StrMap("Robotics",STR_LOWER, STR_UPPER);
```

The variable *str* is given the value "ROBOTICS".

---

### Return value

Data type: *string*

The string created by translating the characters in the specified string, as specified by the "from" and "to" strings. Each character, from the specified string, that is found in the "from" string is replaced by the character at the corresponding position in the "to" string. Characters for which no mapping is defined are copied unchanged to the resulting string.

---

### Arguments

#### StrMap ( Str FromMap ToMap)

**Str** (String) Data type: *string*

The string to translate.

**FromMap** Data type: *string*

Index part of mapping.

**ToMap** Data type: *string*

Value part of mapping.

---

**Syntax**

```
StrMap'( '  
  [ Str ':=' ] <expression (IN) of string> ', '  
  [ FromMap ':=' ] <expression (IN) of string> ', '  
  [ ToMap ':=' ] <expression (IN) of string>  
)'
```

A function with a return value of the data type *string*.

---

**Related information**

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

---

---

## StrMatch Search for pattern in string

*StrMatch* (*String Match*) is used to search in a string, starting at a specified position, for a specified pattern.

---

### Example

```
VAR num found;
```

```
found := StrMatch("Robotics",1,"bo");
```

The variable *found* is given the value 3.

---

### Return value

Data type: *num*

The character position of the first substring, at or past the specified position, that is equal to the specified pattern string. If no such substring is found, string length +1 is returned.

---

### Arguments

#### StrMatch (Str ChPos Pattern)

**Str** (String) Data type: *string*

The string to search in.

**ChPos** (*Character Position*) Data type: *num*

Start character position. A runtime error is generated if the position is outside the string.

**Pattern** Data type: *string*

Pattern string to search for.

---

### Syntax

```
StrMatch(''  
[ Str ':=' ] <expression (IN) of string> ', '  
[ ChPos ':=' ] <expression (IN) of num> ', '  
[ Pattern ':=' ] <expression (IN) of string>  
'')
```

A function with a return value of the data type *num*.

---

**Related information**

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

---



---

## StrMemb Checks if a character belongs to a set

*StrMemb* (*String Member*) is used to check whether a specified character in a string belongs to a specified set of characters.

---

### Example

```
VAR bool memb;
```

```
memb := StrMemb("Robotics",2,"aeiou");
```

The variable *memb* is given the value TRUE, as o is a member of the set "aeiou".

```
memb := StrMemb("Robotics",3,"aeiou");
```

The variable *memb* is given the value FALSE, as b is not a member of the set "aeiou".

```
memb := StrMemb("S-721 68 VÄSTERÅS",3,STR_DIGIT);
```

The variable *memb* is given the value TRUE.

---

### Return value

Data type: *bool*

TRUE if the character at the specified position in the specified string belongs to the specified set of characters.

---

### Arguments

#### StrMemb (Str ChPos Set)

**Str** (String) Data type: *string*

The string to check in.

**ChPos** (Character Position) Data type: *num*

The character position to check. A runtime error is generated if the position is outside the string.

**Set** Data type: *string*

Set of characters to test against.



---

**Syntax**

```
StrMemb '('  
  [ Str ':=' ] <expression (IN) of string> ','  
  [ ChPos ':=' ] <expression (IN) of num> ','  
  [ Set ':=' ] <expression (IN) of string>  
)'
```

A function with a return value of the data type *bool*.

---

**Related information**

String functions

Definition of string

String values

**Described in:**

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

---

---

## StrOrder Checks if strings are ordered

*StrOrder (String Order)* is used to check whether two strings are in order, according to a specified character ordering sequence.

---

### Example

```
VAR bool le;
```

```
le := StrOrder("FIRST","SECOND",STR_UPPER);
```

The variable *le* is given the value TRUE, because "FIRST" comes before "SECOND" in the character ordering sequence STR\_UPPER.

---

### Return value

Data type: *bool*

TRUE if the first string comes before the second string ( $Str1 \leq Str2$ ) when characters are ordered as specified.

Characters that are not included in the defined ordering are all assumed to follow the present ones.

---

### Arguments

#### StrOrder ( Str1 Str2 Order)

**Str1** (String 1) Data type: *string*

First string value.

**Str2** (String 2) Data type: *string*

Second string value.

**Order** Data type: *string*

Sequence of characters that define the ordering.

---

**Syntax**

```
StrOrder'( '  
  [ Str1 ':=' ] <expression (IN) of string> ','  
  [ Str2 ':=' ] <expression (IN) of string> ','  
  [ Order ':=' ] <expression (IN) of string>  
' )'
```

A function with a return value of the data type *bool*.

---

**Related information**

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

---



---

## StrPart Finds a part of a string

*StrPart* (*String Part*) is used to find a part of a string, as a new string.

---

### Example

```
VAR string part;
part := StrPart("Robotics",1,5);
```

The variable *part* is given the value "Robot".

---

### Return value

Data type: *string*

The substring of the specified string, which has the specified length and starts at the specified character position.

---

### Arguments

#### StrPart (Str ChPos Len)

**Str** (String) Data type: *string*

The string in which a part is to be found.

**ChPos** (Character Position) Data type: *num*

Start character position. A runtime error is generated if the position is outside the string.

**Len** (Length) Data type: *num*

Length of string part. A runtime error is generated if the length is negative or greater than the length of the string, or if the substring is (partially) outside the string.

---

### Syntax

```
StrPart('
  [ Str := ] <expression (IN) of string> ',
  [ ChPos := ] <expression (IN) of num> ',
  [ Len := ] <expression (IN) of num>
')
```

A function with a return value of the data type *string*.

---

**Related information**

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

---

---

## StrToByte      Converts a string to a byte data

*StrToByte* (*String To Byte*) is used to convert a *string* with a defined byte data format into a *byte* data.

---

### Example

```
VAR string con_data_buffer{5} := ["10", "AE", "176", "00001010", "A"];  
VAR byte data_buffer{5};
```

```
data_buffer{1} := StrToByte(con_data_buffer{1});
```

The content of the array component *data\_buffer{1}* will be 10 decimal after the *StrToByte ...* function.

```
data_buffer{2} := StrToByte(con_data_buffer{2}\Hex);
```

The content of the array component *data\_buffer{2}* will be 174 decimal after the *StrToByte ...* function.

```
data_buffer{3} := StrToByte(con_data_buffer{3}\Okt);
```

The content of the array component *data\_buffer{3}* will be 126 decimal after the *StrToByte ...* function.

```
data_buffer{4} := StrToByte(con_data_buffer{4}\Bin);
```

The content of the array component *data\_buffer{4}* will be 10 decimal after the *StrToByte ...* function.

```
data_buffer{5} := StrToByte(con_data_buffer{5}\Char);
```

The content of the array component *data\_buffer{5}* will be 65 decimal after the *StrToByte ...* function.

---

### Return value

Data type: *byte*

The result of the conversion operation in decimal representation.

---

**Arguments**

**StrToByte** (ConStr [\Hex] | [\Okt] | [\Bin] | [\Char])

**ConStr** (Convert String) Data type: *string*

The string data to be converted.

If the optional switch argument is omitted, the string to be converted has *decimal* (Dec) format.

**[\Hex]** (Hexadecimal) Data type: *switch*

The string to be converted has *hexadecimal* format.

**[\Okt]** (Octal) Data type: *switch*

The string to be converted has *octal* format.

**[\Bin]** (Binary) Data type: *switch*

The string to be converted has *binary* format.

**[\Char]** (Character) Data type: *switch*

The string to be converted has *ASCII* character format.

---

**Limitations**

Depending on the format of the string to be converted, the following string data is valid:

Format:	String length:	Range:
Dec .....: '0' - '9'	3	"0" - "255"
Hex .....: '0' - '9', 'a' - 'f', 'A' - 'F'	2	"0" - "FF"
Okt .....: '0' - '7'	3	"0" - "377"
Bin .....: '0' - '1'	8	"0" - "11111111"
Char ....: Any ASCII character	1	ASCII table

RAPID character codes (e.g. "\07" for BEL control character) cannot be used as arguments in ConStr.

---

**Syntax**

```
StrToByte'(
  [ConStr ':='] <expression (IN) of string>
  ['\ Hex] | ['\ Okt] | ['\ Bin] | ['\ Char]
)' ;'
```

A function with a return value of the data type *byte*.

---

**Related information**

Convert a byte to a string data

Other bit (byte) functions

Other string functions

Described in:

Instructions - *ByteToStr*

RAPID Summary - *Bit Functions*

RAPID Summary - *String Functions*





---

---

## StrToVal                      Converts a string to a value

*StrToVal* (*String To Value*) is used to convert a string to a value of any data type.

---

### Example

```
VAR bool ok;  
VAR num nval;  
  
ok := StrToVal("3.85",nval);
```

The variable *ok* is given the value TRUE and *nval* is given the value 3.85.

---

### Return value

Data type: *bool*

TRUE if the requested conversion succeeded, FALSE otherwise.

---

### Arguments

#### StrToVal ( Str Val )

<b>Str</b>	( <i>String</i> )	Data type: <i>string</i>
------------	-------------------	--------------------------

A string value containing literal data with format corresponding to the data type used in argument *Val*. Valid format as for RAPID literal aggregates.

<b>Val</b>	( <i>Value</i> )	Data type: <i>ANYTYPE</i>
------------	------------------	---------------------------

Name of the variable or persistent of any data type for storage of the result from the conversion. The data is unchanged if the requested conversion failed.

---

### Example

```
VAR string str15 := "[600, 500, 225.3]";  
VAR bool ok;  
VAR pos pos15;  
  
ok := StrToVal(str15,pos15);
```

The variable *ok* is given the value TRUE and the variable *p15* is given the value that are specified in the string *str15*.

---

---

**Syntax**

```
StrToVal'(  
  [ Str ':=' ] <expression (IN) of string> ','  
  [ Val ':=' ] <var or pers (INOUT) of ANYTYPE>  
)'
```

A function with a return value of the data type *bool*.

---

**Related information**

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

---

---

## Tan Calculates the tangent value

*Tan (Tangent)* is used to calculate the tangent value from an angle value.

---

### Example

```
VAR num angle;  
VAR num value;  
. .  
value := Tan(angle);
```

---

### Return value

Data type: *num*

The tangent value.

---

### Arguments

**Tan** (**Angle**)

**Angle**

Data type: *num*

The angle value, expressed in degrees.

---

### Syntax

```
Tan(' [  
  [Angle ':='] <expression (IN) of num>  
  ')
```

A function with a return value of the data type *num*.

---

### Related information

Mathematical instructions and functions  
Arc tangent with return value in the  
range [-180, 180]

Described in:

RAPID Summary - *Mathematics*

Functions - *ATan2*



---

---

## TestDI Tests if a digital input is set

*TestDI* is used to test whether a digital input is set.

Examples

IF TestDI (di2) THEN . . .

If the current value of the signal *di2* is equal to 1, then . . .

IF NOT TestDI (di2) THEN . . .

If the current value of the signal *di2* is equal to 0, then . . .

WaitUntil TestDI(di1) AND TestDI(di2);

Program execution continues only after both the *di1* input and the *di2* input have been set.

---

### Return value

Data type: *bool*

TRUE = The current value of the signal is equal to 1.

FALSE = The current value of the signal is equal to 0.

---

### Arguments

**TestDI (Signal)**

**Signal**

Data type: *signal**di*

The name of the signal to be tested.

---

### Syntax

```
TestDI '('  
  [ Signal ':=' ] < variable (VAR) of signaldi > ')'
```

A function with a return value of the data type *bool*.

---

**Related information**

Reading the value of a digital input signal  
Input/Output instructions

Described in:

Functions - *DInput*  
RAPID Summary -  
*Input and Output Signals*

---



---

## Trunc Truncates a numeric value

*Trunc (Truncate)* is used to truncate a numeric value to a specified number of decimals or to an integer value.

---

### Example

```
VAR num val;
```

```
val := Trunc(0.38521\Dec:=3);
```

The variable *val* is given the value 0.385.

```
reg1 := 0.38521
```

```
val := Trunc(reg1\Dec:=1);
```

The variable *val* is given the value 0.3.

```
val := Trunc(0.38521);
```

The variable *val* is given the value 0.

---

### Return value

Data type: *num*

The numeric value truncated to the specified number of decimals.

---

### Arguments

**Trunc** ( **Val** [**\Dec**] )

**Val** (Value) Data type: *num*

The numeric value to be truncated.

**\Dec** (Decimals) Data type: *num*

Number of decimals.

If the specified number of decimals is 0 or if the argument is omitted, the value is truncated to an integer.

The number of decimals must not be negative or greater than the available precision for numeric values.



---

**Syntax**

```
Trunc'(
  [ Val ':=' ] <expression (IN) of num>
  [ \Dec ':=' <expression (IN) of num> ]
  )'
```

A function with a return value of the data type *num*.

---

**Related information**

Mathematical instructions and functions

Rounding a value

**Described in:**

RAPID Summary - *Mathematics*

Functions - *Round*

---



---

## ValToStr                      Converts a value to a string

*ValToStr* (*Value To String*) is used to convert a value of any data type to a string.

---

### Example

```
VAR string str;
VAR pos p := [100,200,300];
```

```
str := ValToStr(1.234567);
```

The variable *str* is given the value "1.23457".

```
str := ValToStr(TRUE);
```

The variable *str* is given the value "TRUE".

```
str := ValToStr(p);
```

The variable *str* is given the value "[100,200,300]".

---

### Return value

Data type: *string*

The value is converted to a string with standard RAPID format. This means in principle 6 significant digits. If the decimal part is less than 0.000005 or greater than 0.999995, the number is rounded to an integer.

A runtime error is generated if the resulting string is too long.

---

### Arguments

**ValToStr** ( **Val** )

**Val**

(*Value*)

Data type: *ANYTYPE*

A value of any data type.

---

### Syntax

```
ValToStr('
  [ Val ':=' ] <expression (IN) of ANYTYPE>
')
```

A function with a return value of the data type *string*.

---

**Related information**

String functions

Definition of string

String values

Described in:

RAPID Summary - *String Functions*

Data Types - *string*

Basic Characteristics -  
*Basic Elements*

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## *Predefined Data and Programs*

---



---

## 1 System Module *User*

In order to facilitate programming, predefined data is supplied with the robot. This data does not have to be created and, consequently, can be used directly.

If this data is used, initial programming is made easier. It is, however, usually better to give your own names to the data you use, since this makes the program easier for you to read.

---

### 1.1 Contents

*User* comprises five numerical data (registers), one work object data, one clock and two symbolic values for digital signals.

<u>Name</u>	<u>Data type</u>	<u>Declaration</u>
<b>reg1</b>	num	VAR num reg1:=0
<b>reg2</b>	.	.
<b>reg3</b>	.	.
<b>reg4</b>	.	.
<b>reg5</b>	num	VAR num reg5:=0
<b>wobj1</b>	wobjdata	PERS wobjdata wobj1:=wobj0
<b>clock1</b>	clock	VAR clock clock1
<b>high</b>	dionum	CONST dionum high:=1
<b>low</b>	dionum	CONST dionum low:=0

*User* is a system module, which means that it is always present in the memory of the robot regardless of which program is loaded.

---

### 1.2 Creating new data in this module


This module can be used to create such data and routines that must always be present in the program memory regardless of which program is loaded, e.g. tools and service routines.

- Choose **View: Modules** from the Program window.
- Select the system module *User* and press Enter .
- Change, create data and routines in the normal way (see *Programming and Testing*).

### 1.3 Deleting this data

**Warning: If the Module is deleted, the CallByVar instruction will not work.**

*To delete all data (i.e. the entire module)*

- Choose **View: Modules** from the Program window.
- Select the module *User*.
- Press Delete .

*To change or delete individual data*

- Choose **View: Data** from the Program window.
- Choose **Data: In All Modules**.
- Select the desired data. If this is not shown, press the **Types** function key to select the correct data type.
- Change or delete in the normal way (see *Programming and Testing*).

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## ***Programming off-line***

# Programming Off-line

---

---

## 1 Programming Off-line

RAPID programs can easily be created, maintained and stored in an ordinary office computer. All information can be read and changed directly using a normal text editor. This chapter explains the working procedure for doing this. In addition to off-line programming, you can use the computer tool, QuickTeach.

---

### 1.1 File format

The robot stores and reads RAPID programs in TXT format (ASCII) and can handle both DOS and UNIX text formats. If you use a word-processor to edit programs, these must be saved in TXT format (ASCII) before they are used in the robot.

---

### 1.2 Editing

When a program is created or changed in a word-processor, all information will be handled in the form of text. This means that information about data and routines will differ somewhat from what is displayed on the teach pendant.

Note that the value of a stored position is only displayed as an \*on the teach pendant, whereas the text file will contain the actual position value (x, y, z, etc.).

In order to minimise the risk of errors in the syntax (faulty programs), you should use a template. A template can take the form of a program that was created previously on the robot or using QuickTeach. These programs can be read directly to a word-processor without having to be converted.

---

### 1.3 Syntax check

Programs must be syntactically correct before they are loaded into the robot. By this is meant that the text must follow the fundamental rules of the RAPID language. One of the following methods should be used to detect errors in the text:

- Save the file on diskette and try to open it in the robot. If there are any syntactical errors, the program will not be accepted and an error message will be displayed. To obtain information about the type of error, the robot stores a log called PGMCP1.LOG on the internal RAM disk. Copy this log to a diskette using the robot's File Manager. Open the log in a word-processor and you will be able to read which lines were incorrect and receive a description of the error.
- Open the file in QuickTeach or ProgramMaker.
- Use a RAPID syntax check program for the PC.

When the program is syntactically correct, it can be checked and edited in the robot.

## Programming Off-line

To make sure that all references to routines and data are correct, use the command **File: Check Program**. If the program has been changed in the robot, it can be stored on diskette again and processed or stored in a PC.

---

### 1.4 Examples

The following shows examples of what routines look like in text format.

```
%%%
  VERSION: 1
  LANGUAGE: ENGLISH
%%%
MODULE main
VAR intnum process_int ;
! Demo of RAPID program
PROC main()
  MoveL p1, v200, fine, gun1;
ENDPROC

TRAP InvertDo12
! Trap routine for TriggInt
  TEST INTNO
  CASE process_int:
    InvertDO do12;
  DEFAULT:
    TPWrite "Unknown trap , number=" \Num:=INTNO;
  ENDTEST
ENDTRAP

LOCAL FUNC num MaxNum(num t1, num t2)
  IF t1 > t2 THEN
    RETURN t1;
  ELSE
    RETURN t2;
  ENDIF
ENDFUNC
ENDMODULE
```

---

### 1.5 Making your own instructions

In order to make programming easier, you can customize your own instructions. These are created in the form of normal routines, but, when programming and test-running, function as instructions:

- They can be taken from the instruction pick list and programmed as normal instructions.
- The complete routine will be run during step-by-step execution.

- Create a new system module where you can place your routines that will function as instructions. Alternatively, you can place them in the USER system module.
- Create a routine in this system module with the name that you want your new instruction to be called. The arguments of the instruction are defined in the form of routine parameters. Note that the name of the parameters will be displayed in the window during programming and should therefore be given names that the user will understand.
- Place the routine in one of the Most Common pick lists.
- If the instruction is to behave in a certain way during backward program execution, this can be done in the form of a backward handler. If there is no such handler, it will not be possible to get past the instruction during backward program execution (see Chapter 13 in this manual - Basic Characteristics). A backward handler can be entered using the command **Routine: Add Backward Handler** from the *Program Routines* window.
- Test the routine thoroughly so that it works with different types of input data (arguments).
- Change the module attribute to NOSTEPIN. The complete routine will then be run during step-by-step execution. This attribute, however, must be entered off-line.

Example: To make the gripper easier to handle, two new instructions are made, *GripOpen* and *GripClose*. The output signal's name is given to the instruction's argument, e.g. *GripOpen gripper1*.

```
MODULE My_instr (SYSMODULE, NOSTEPIN)
PROC GripOpen (VAR signaldo Gripper)
    Set Gripper;
    WaitTime 0.2;
ENDPROC
PROC GripClose (VAR signaldo Gripper)
    Reset Gripper;
    WaitTime 0.2;
ENDPROC
ENDMODULE
```

## *Programming Off-line*

## INDICE

---

---

seamdata	Seam data
weavedata	Weave data
welddata	Weld data
ArcC	Arc welding with circular motion
ArcL	Arc welding with linear motion
ArcKill	Kill the AW process
ArcRefresh	Refresh arcweld data



---

---

**seamdata****Seam data**

*Seamdata* is used to control the start and end of the weld. *Seamdata* is also used if the process is restarted after a welding operation has been interrupted.

The actual weld phase is controlled using *welddata*.

---

**Description**

Seam data describes data, the values of which, as a rule, can be maintained unaltered when welding a complete run and often also when welding several seams. Seam data is used when preparing for the welding operation, when igniting the arc, when heating after the ignition and also when ending the weld.

Seam data is included in all arc welding instructions to facilitate controlled end and start phases irrespective of where the interrupts or restarts occur.

**Note.** Some of the components of seam data depend on the configuration of the robot. If a given feature is omitted, the corresponding component is left out of the seam data. The conditions that must be met for components to exist are described in the system parameters.

All voltages can be expressed in two ways (determined by the welding equipment):

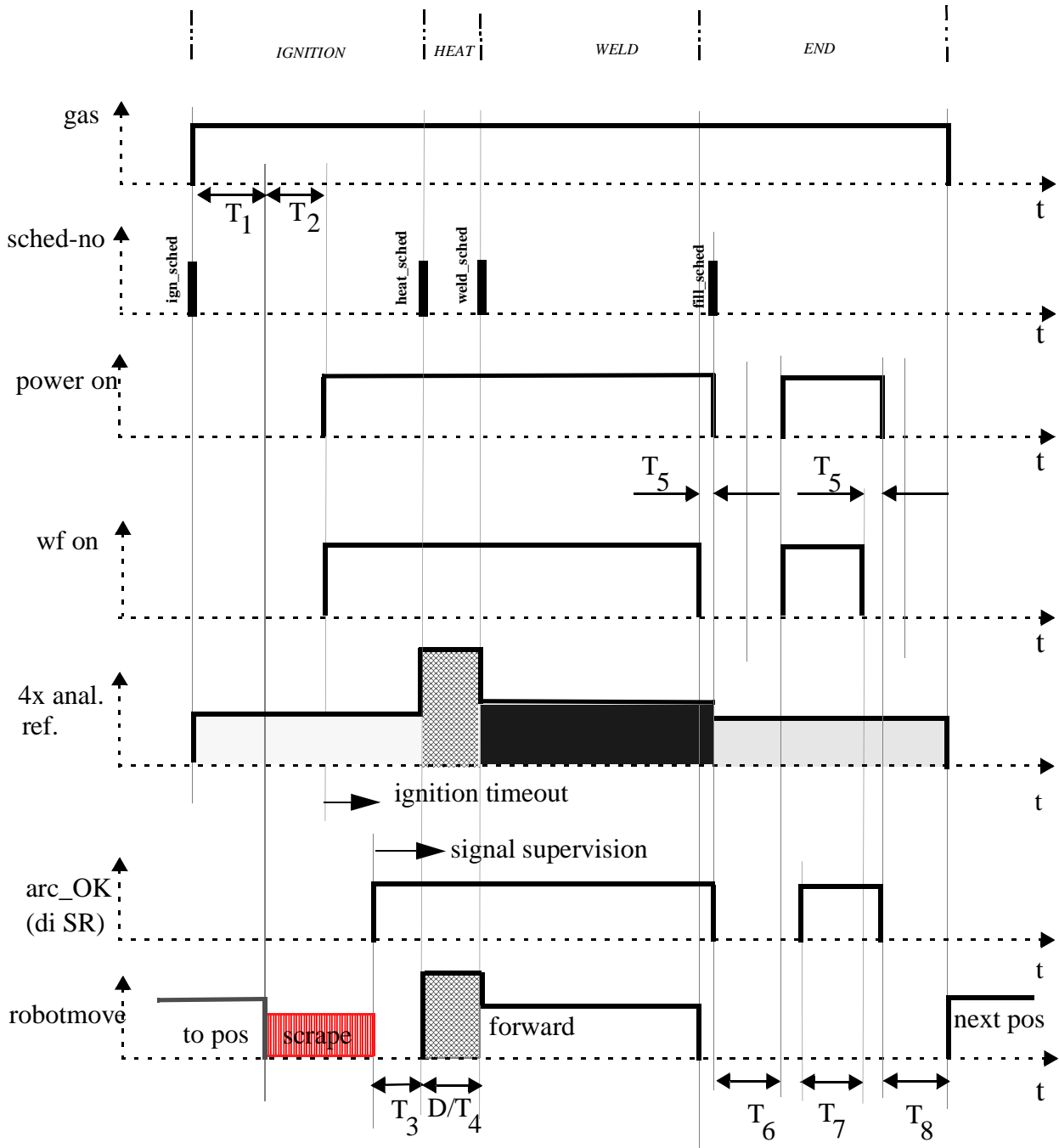
- As absolute values (only positive values are used in this case).
- As corrections of values set in the process equipment (both positive and negative values are used in this case).

*Feeding the weld electrode* in this section refers to MIG/MAG welding. In the case of TIG welding:

- A *cold* wire is supplied to the *wire feed*.
- The necessary *welding current* reference value can be connected to any of the three analog outputs that are not used. (The *Welding voltage* reference is not used.)



The welding sequence



T1: max. gas\_purge/arc\_preset time  
 T2: gas\_preflow time  
 T3: ignition\_movement\_delay time  
 D/T4: heating distance/time

T5: burnback time  
 T6: max cooling/arc\_preset time  
 T7: filling time  
 T8: max cooling/gas\_postflow time

---

## Components

### Component group: Ignition

**purge\_time**Data type: *num*

The time (in seconds) it takes to fill gas lines and the welding gun with protective gas, so-called “gas purging”.

If the first weld instruction contains the argument *\On* (flying start), the gas flow is activated at the specified gas purge time before the programmed position is reached.

If the positioning time to the start position of the weld is shorter than the gas purge time, or if the *\On* argument is not used, the robot waits in the weld start position until the gas purge time has expired.

**preflow\_time**Data type: *num*

The time (in seconds) it takes to preflow the weld object with protective gas, so-called “gas preflowing”.

The robot is stationary in position during this time before the arc is ignited.

**ign\_sched***(ignition schedule)*Data type: *num*

The identity (expressed as a number) of a weld program in connected welding equipment. It is sent to the welding equipment to be used during ignition of the arc.

See System Parameter *Arc Welding - Equipment - schedport\_type*.

**ign\_voltage**Data type: *num*

The welding voltage (in volts) during ignition of the arc.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**ign\_wirefeed**Data type: *num*

The feed speed of the weld electrode during ignition of the arc.

The unit is defined in the system parameter *Arc Welding - Units - unit\_feed* and, as a rule, is m/minute or inches per minute.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**ign\_current**Data type: *num*

The welding current during ignition of the arc.

The value specified is scaled and send to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**ign\_volt\_adj** (*ignition voltage adjustment*) Data type: *num*

The welding voltage adjustment during ignition of the arc.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

**ign\_curr\_adj** (*ignition current adjustment*) Data type: *num*

The current adjustment during ignition of the arc.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

**ign\_move\_delay** (*ignition movement delay*) Data type: *num*

The delay (in seconds) from the time the arc is considered stable at ignition until the heating phase is started. The ignition references remain valid during the ignition movement delay.

**scrape\_start** (*scrape start type*) Data type: *num*

Type of scrape at weld start. Scrape type at restart will not be affected (it will always be Weaving scrape).

Scrape types:

0 No scrape. No scrape will occur at weld start.

1 Weaving scrape.

2 Fast scrape. The robot does not wait for the arc OK signal at the start point. However, the ignition is considered incorrect if the ignition timeout has been exceeded.

### Component group: Heat

**heat\_speed** Data type: *num*

The welding speed during heating at the start of the weld phase.

The unit is defined in the system parameter *Arc Welding - Units- velocity\_unit* and, as a rule, is mm/s or inches per minute.

**heat\_time** Data type: *num*

The heating time (in seconds) at the start of the weld phase.

*Heat\_time* is only used during timed positioning and when *heat\_distance* or *heat\_speed* equal zero.

**heat\_distance** Data type: *num*

The distance along which heat data must be active at the start of the weld.

The unit is defined in *System Parameters - Arc Welding - Units - length\_unit* and as a rule, is mm or inches.

**heat\_sched** (*heating schedule*) Data type: *num*

The identity (expressed as a number) of a weld program in connected welding equipment. It is sent to the welding equipment when the arc has been ignited and is used during heating.

See System Parameter *Arc Welding - Equipment - schedport\_type*.

**heat\_voltage** Data type: *num*

The welding voltage (in volts) during heating.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**heat\_wirefeed** Data type: *num*

The feed speed of the weld electrode during heating.

The unit is defined in the system parameter *Arc Welding - Units - unit\_feed* and, as a rule, is m/minute or inches per minute.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**heat\_current** Data type: *num*

The welding current during heating.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog output.

**heat\_volt\_adj** (*heating voltage adjustment*) Data type: *num*

The voltage adjustment for heating.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

**heat\_curr\_adj**                    (*heating current adjustment*)    Data type: *num*

The current adjustment during heating.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

**Component group: End**

**cool\_time** (cooling time) Data type: *num*

The time (in seconds) during which the process is closed before other terminating activities (filling) take place.

**fill\_time** Data type: *num*

The crater-filling time (in seconds) at the end phase of the weld.

**bback\_time** (burnback time) Data type: *num*

The time (in seconds) during which the weld electrode is burnt back when electrode feeding has stopped. This to prevent the electrode getting stuck to the hardening weld when a MIG/MAG process is switched off.

Burnback time is used twice in the end phase; first when the weld phase is being finished, the second time after crater-filling.

**rback\_time** (rollback time) Data type: *num*

The time (in seconds) during which a cold wire is rolled back after the power source has been switched off. This to prevent the wire getting stuck to the hardening weld when a TIG process is switched off.

The functions *burnback* and *rollback* are mutually exclusive.

**postflow\_time** Data type: *num*

The time (in seconds) required for purging with protective gas after the end of a process. The purpose of gas postflow is to prevent the weld electrode and the seam from oxidizing during cooling.

**fill\_sched** (finish schedule) Data type: *num*

The identity (expressed as a number) of a weld program in connected welding equipment. It is sent to the welding equipment when the weld phase is completed and is used when crater-filling.

See System Parameter *Arc Welding - Equipment - schedport\_type*.

**fill\_voltage** (crater-filling voltage) Data type: *num*

The welding voltage (in volts) during crater-filling at the end phase of a process.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**fill\_wirefeed** (crater-filling wirefeed) Data type: *num*

The feed speed of the weld electrode when crater-filling.

The unit is defined in the system parameter *Arc Welding - Units - unit\_feed* and, as a rule, is m/minute or inches per minute.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**fill\_current** (crater-filling current) Data type: *num*

The welding current during crater-filling at the end phase of a process.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

**fill\_volt\_adj** (filling voltage adjustment) Data type: *num*

The voltage adjustment during crater-filling.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

**fill\_curr\_adj** (filling current adjustment) Data type: *num*

The current adjustment during crater-filling.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

## Structure

```

<data object of seamdata>
  <gas_purge_time of num>
  <gas_preflow_time of num>
  <ign_sched of num>
  <ign_voltage of num>
  <ign_wirefeed of num>
  <ign_current of num>
  <ign_volt_adj of num>
  <ign_curr_adj of num>
  <ign_move_delay of num>
  <heat_speed of num>
  <heat_time of num>
  <heat_distance of num>
  <heat_sched of num>
  <heat_voltage of num>
  <heat_wirefeed of num>

```

```

heat_current of num>
<heat_volt_adj of num>
<heat_curr_adj of num>
<cool_time of num>
<fill_time of num>
<bback_time of num>
<rback_time of num>
<gas_postflow_time of num>
<fill_sched of num>
<fill_voltage of num>
<fill_wirefeed of num>
<fill_current of num>
<fill_volt_adj of num>
<fill_curr_adj of num>

```

Note that the structure changes depending on the configuration of the robot.

---

## Related information

	<u>Described in:</u>
Weld data	Data Types - <i>welddata</i>
Installation parameters for welding equipment and functions	System Parameters - <i>Arc Welding</i>
Process phases and time diagrams	RAPID Summary- <i>Arc Welding</i>
Arc welding instructions	Instructions - <i>ArcL, ArcC</i>





---

---

**weavedata****Weave data**

*Weavedata* is used to define any weaving carried out during arc welding.

Weaving can be used during the heat and weld phases of a seam.

---

**Description**

Weaving is a movement, superimposed on the basic path of the process.

There are three types of weaving pattern to choose from: zigzag, V-shaped and triangular weaving. These are illustrated in Figure 1 to Figure 3.

All weave data components apply to both the heat phase and the weld phase.

The unit for weave data components that specify a distance is defined in the parameter *Arc Welding - Units - length\_unit* and, as a rule, is mm or inches. (These components are *weave\_length*, *\_width*, *\_height*, *\_bias* and *dwel* lengths.)

**Note.** Some of the components of weave data depend on the configuration of the robot. If a given feature is omitted, the corresponding component is left out of the weave data. The conditions that must be met for components to exist are described in the system parameters.

---

**Components**

**weave\_shape** (*weld weave shape*) Data type: *num*

The shape of the weaving pattern in the weld phase.

Specified value    Weaving pattern

0                  No weaving.

1                  Zigzag weaving as illustrated in Figure 1.

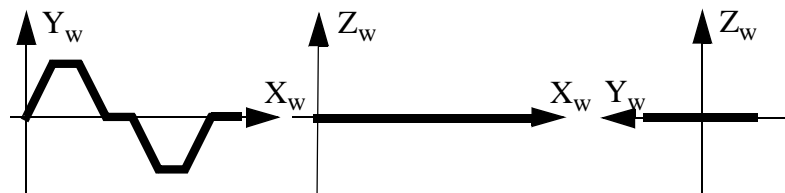


Figure 1 Zig-zag weaving results in weaving horizontal to the seam.

<u>Specified value</u>	<u>Weaving type</u>
2	V-shaped weaving as illustrated in Figure 2.

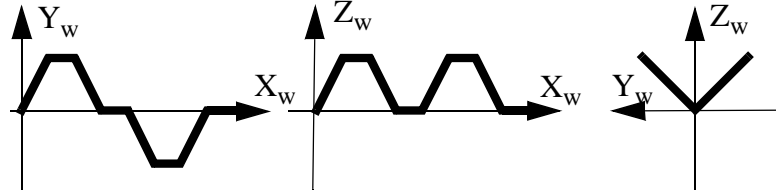


Figure 2 V-shaped weaving results in weaving in the shape of a "V", vertical to the seam.

3	Triangular weaving as illustrated in Figure 3.
---	--

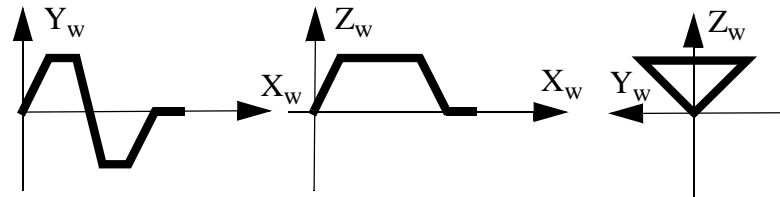


Figure 3 Triangular weaving results in a triangular shape, vertical to the seam.

**weave\_type** (weld weave interpolation type) Data type: num

The type of weaving in the weld phase.

<u>Specified value</u>	<u>Weaving type</u>
0	Geometric weaving. All axes are used during weaving.
1	Wrist weaving.

**weave\_length** Data type: num

The length of the weaving cycle in the weld phase (see Figure 4).

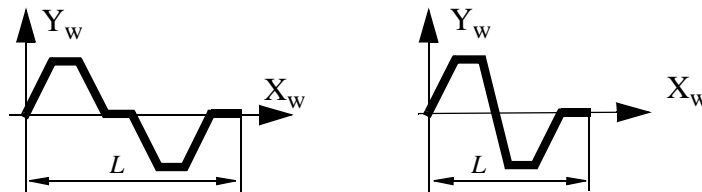


Figure 4 The length (L) of the weaving cycle for zig-zag, V-shaped and triangular weaving.

**weave\_width** Data type: num

The width of the weaving pattern in the weld phase (see Figure 5).

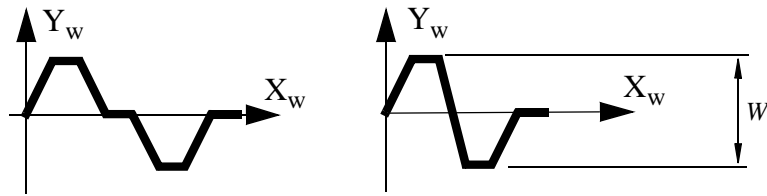


Figure 5 The width ( $W$ ) of the weaving pattern for all weaving patterns.

### weave\_height

Data type: *num*

The height of the weaving pattern during V-shaped and triangular weaving (see Figure 6).

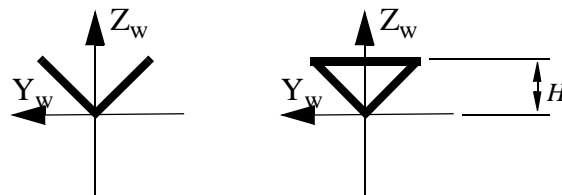


Figure 6 The height ( $H$ ) of the weaving pattern for V-shaped and triangular weaving.

### dwell\_left

Data type: *num*

The length of the dwell used to force the TCP to move only in the direction of the seam at the left turning point of the weave (see Figure 7).

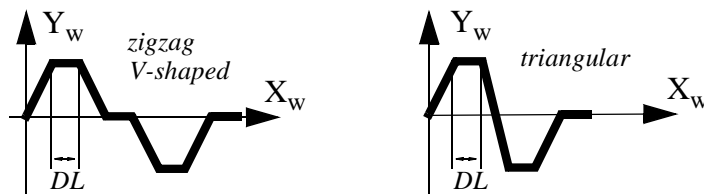


Figure 7 The length of the left dwell ( $DL$ ) for different types of weaving patterns.

### dwell\_center

Data type: *num*

The length of the dwell used to force the TCP to move only in the direction of the seam at the centre point of the weave (see Figure 8).

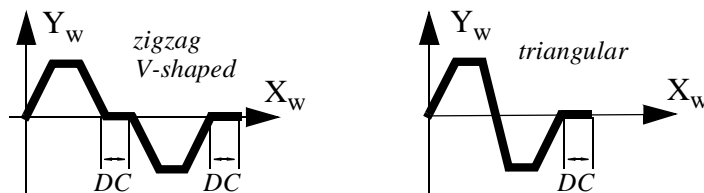


Figure 8 The length of the central dwell ( $DC$ ) for different types of weaving patterns.

### dwell\_right

Data type: *num*

The length of the dwell used to force the TCP to move only in the direction of the seam at the right turning point of the weave (see Figure 9).

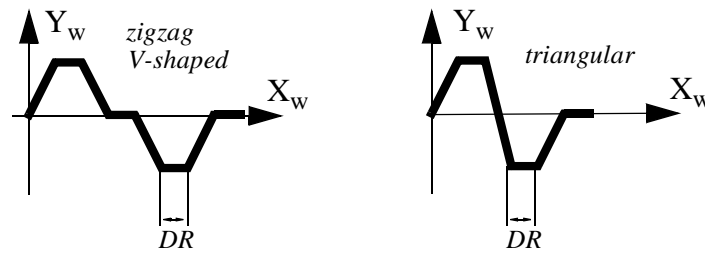


Figure 9 The length of the right dwell (DR) for different types of weaving patterns.

**weave\_dir** (weave direction angle) Data type: num

The weave direction angle horizontal to the seam (see Figure 10). An angle of zero degrees results in a weave vertical to the seam.

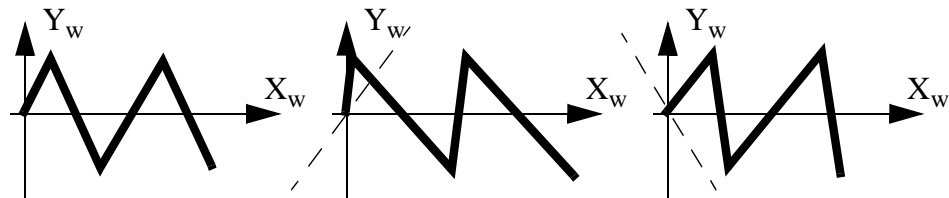


Figure 10 The shape of the weaving pattern at 0 degrees and at a positive and negative angle.

**weave\_tilt** (weave tilt angle) Data type: num

The weave tilt angle, vertical to the seam (see Figure 11). An angle of zero degrees results in a weave which is vertical to the seam.

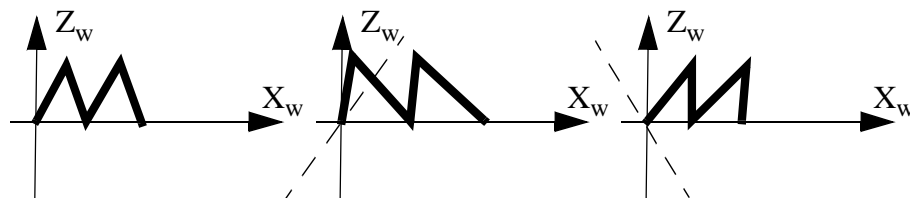


Figure 11 V-weaving at 0 degrees and at a positive and negative angle.

**weave\_ori** (weave orientation angle) Data type: num

The weave orientation angle, horizontal-vertical to the seam (see Figure 12). An angle of zero degrees results in symmetrical weaving.

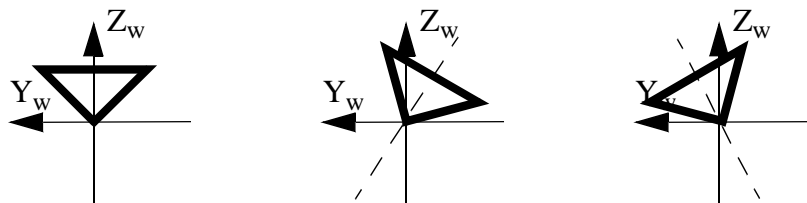


Figure 12 Triangular weaving at 0 degrees and at a positive and negative angle.

**weave\_bias***(weave centre bias)*Data type: *num*

The bias horizontal to the weaving pattern (see Figure 13). The bias can only be specified for zig-zag weaving and may not be greater than half the width of the weave.

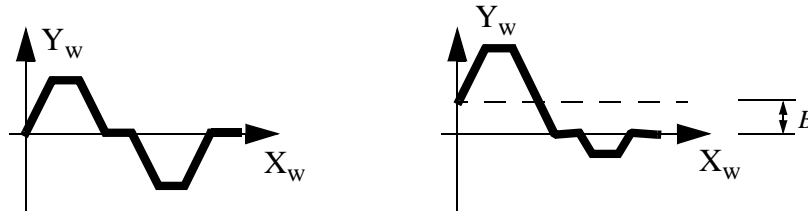


Figure 13 Zig-zag weaving with and without bias (*B*).

**weave\_sync\_left**Data type: *num*

The coordination position to the left of the weaving pattern. It is specified as a percentage of the width on the left of the weaving centre. When weaving is carried out beyond this point, a digital output signal is automatically set to one, as illustrated in Figure 14. This type of coordination is intended for seam tracking using WeldGuide.

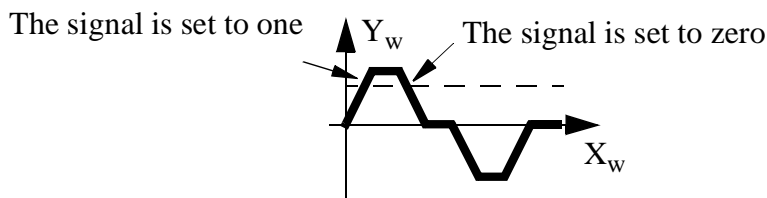


Figure 14 When WeldGuide is used, a sync. signal is required.

**weave\_sync\_right**Data type: *num*

The coordination position to the right of the weaving pattern. It is specified as a percentage of the width on the right of the weaving centre. When weaving is carried out beyond this point, a digital output signal is automatically set to one, as illustrated in Figure 15. This type of coordination is intended for seam tracking using WeldGuide.

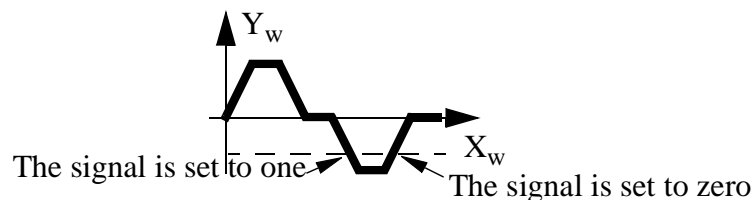


Figure 15 When WeldGuide is used, a sync. signal is required.

**wg\_track\_on**Data type: *num*

Activate the weldguide seam tracker.

**Limitations**

The maximum weaving frequency is 2 Hz.

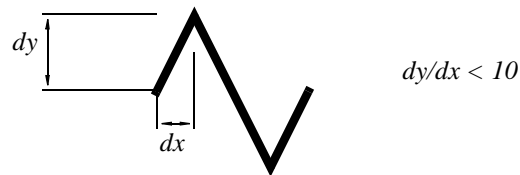
The inclination of the weaving pattern must not exceed the ratio 1:10 (84 degrees).  
(See Figure 16).

Figure 16 The weaving pattern may not be inclined more than in the ratio 1:10.

**Structure**

```

<data object of weavedata>
  <weave_shape of num>
  <weave_type of num>
  <weave_length of num>
  <weave_width of num>
  <weave_height of num>
  <dwel_left of num>
  <dwel_center of num>
  <dwel_right of num>
  <weave_dir of num>
  <weave_tilt of num>
  <weave_ori of num>
  <weave_bias of num>
  <weave_sync_left of num>
  <weave_sync_right of num>
  <wg_track_on of num>

```

**Related information**

	<u>Described in:</u>
Installation parameters for welding equipment and functions	System Parameters - <i>Arc Welding</i>
Process phases and timing schedules	RAPID Summary - <i>Arc Welding</i>
Arc-welding instructions	Instructions - <i>ArcL, ArcC</i>

---

---

**welddata****Weld data**

*Welddata* is used to control the weld during the weld phase, that is, from when the arc is established until the weld is completed.

Other phases, such as the start and end phases, are controlled using *seamdata*.

---

**Description**

Weld data describes data that is often changed along a seam. Weld data used in a given instruction along a path affects the weld until the specified position is reached. Using instructions with different weld data, it is thus possible to achieve optimum control of the welding equipment along an entire seam.

Weld data affects the weld when fusion has been established (after heating) at the start of a process.

In the case of a *flying start*, the arc is not ignited until the destination position of the arc welding instruction with the *\On* argument is reached, which means that weld data does not have any effect on the weld in this instruction.

If one arc welding instruction is exchanged for another during a weld, new weld data will occur in the middle of the corner path.

**Note.** Some of the components of weld data depend on the configuration of the robot. If a given feature is omitted, the corresponding component is left out of the weld data. The conditions that must be met for components to exist are described in the system parameters.

All voltages can be expressed in two ways (determined by the welding equipment):

- As absolute values (only positive values are used in this case).
- As corrections of values set in the process equipment (both positive and negative values are used in this case).

*Feeding the weld electrode* in this section refers to MIG/MAG welding. In the case of TIG welding:

- A *cold* wire is supplied to the *wire feed*.
- The necessary *welding current* reference value can be connected to any of the three analog outputs that are not used. (The *Welding voltage* reference is not used.)



**Example**

```

MoveJ p1, v100, z10, gun1;
MoveJ p2, v100, fine, gun1;
ArcL \On, p3, v100, seam1, weld1, weave1, fine, gun1;
ArcL p4, v100, seam1, weld2, weave1, z10, gun1;
ArcL \Off, p5, v100, seam1, weld3, weave3, fine, gun1;
MoveJ p6, v100, z10, gun1;
    
```

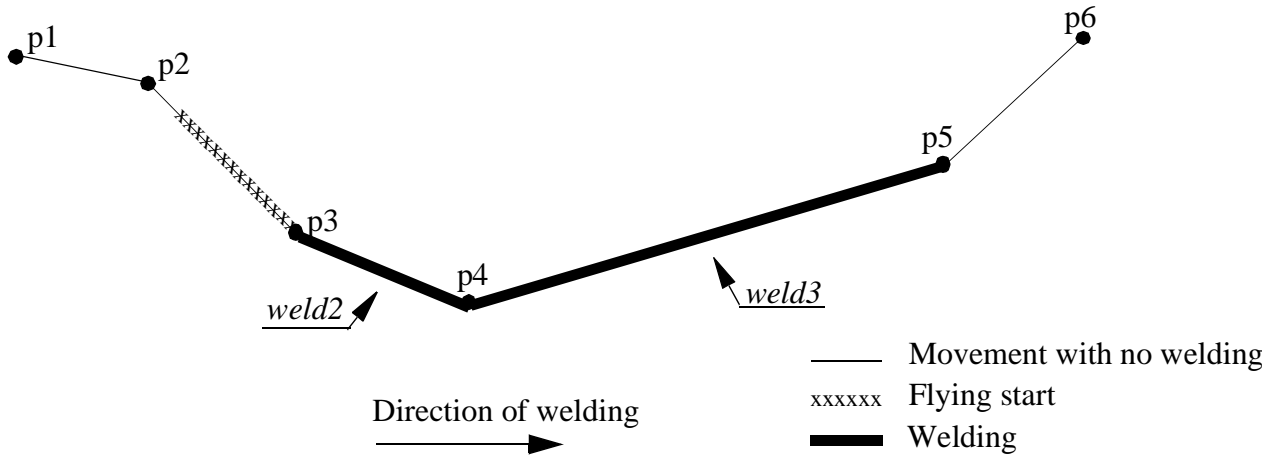
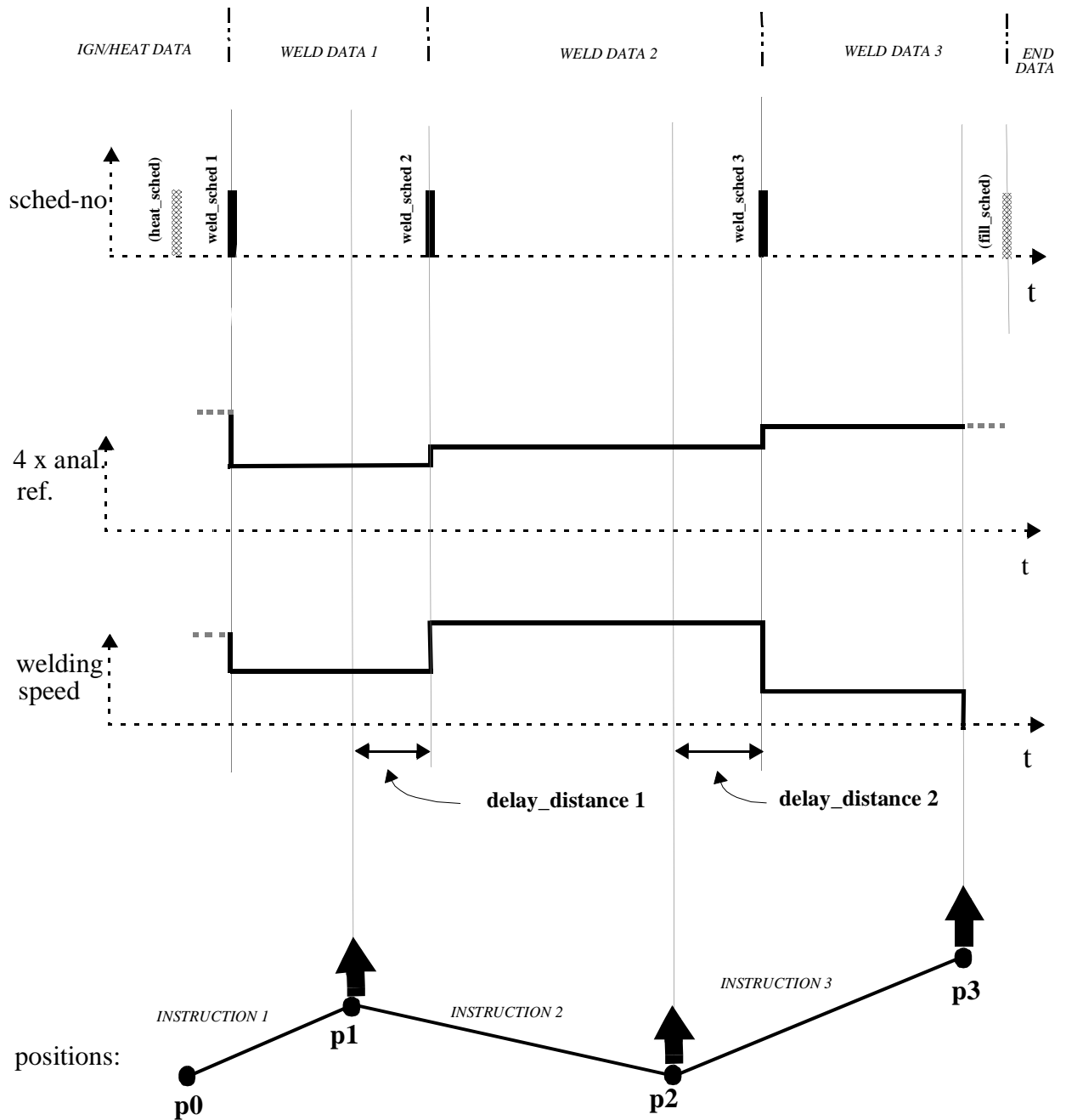


Figure 1 Weld data, such as speed and welding voltage, can be changed at each position.

Weld data is changed in every instruction. As the argument `\On` is used in the first instruction, the first weld data is never used.

### The welding sequence



---

**Components**

<b>weld_sched</b>	( <i>weld schedule</i> )	Data type: <i>num</i>
<p>The identity (expressed as a number) of weld programs to send to the welding equipment.</p> <p>See System Parameter <i>Arc Welding - Equipment- schedport_type</i>.</p>		
<b>weld_speed</b>		Data type: <i>num</i>
<p>The desired welding speed.</p> <p>The unit is defined in the system parameter <i>Arc Welding - Units- velocity_unit</i> and, as a rule, is mm/s or inches per minute.</p> <p>If the movements of external axes are coordinated, the welding speed is the relative speed between the tool and the object.</p> <p>If the movements of external axes are not coordinated, the welding speed is the TCP speed. The speed of the external axes is then described in the instruction's speed data. The slowest axis determines the speed to enable all axes to reach the destination position at the same time.</p>		
<b>weld_voltage</b>		Data type: <i>num</i>
<p>The welding voltage (in volts) during the weld phase.</p> <p>The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.</p>		
<b>weld_wirefeed</b>		Data type: <i>num</i>
<p>The feed speed of the weld electrode during the weld phase.</p> <p>The unit is defined in the system parameter <i>Arc Welding - Units - unit_feed</i> and, as a rule, is metres per minute or inches per minute.</p> <p>The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.</p>		
<b>weld_current</b>		Data type: <i>num</i>
<p>The welding current during the weld phase.</p> <p>The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.</p>		
<b>delay_distance</b>		Data type: <i>num</i>
<p>The delay distance (after the <i>destination</i> position) for a changeover to new weld data in the next arc welding instruction.</p>		

The unit is defined in *System Parameters - Arc Welding - Units - length\_unit* and as a rule, is mm or inches.

Usually, when changing from one arc welding instruction to another, a fly-by point is used. This results in a changeover point in the middle of the corner path. By using delay distance, the new weld data starts to take effect somewhat later (see Figure 2).

In a weld *end* instruction the delay distance will have no effect.

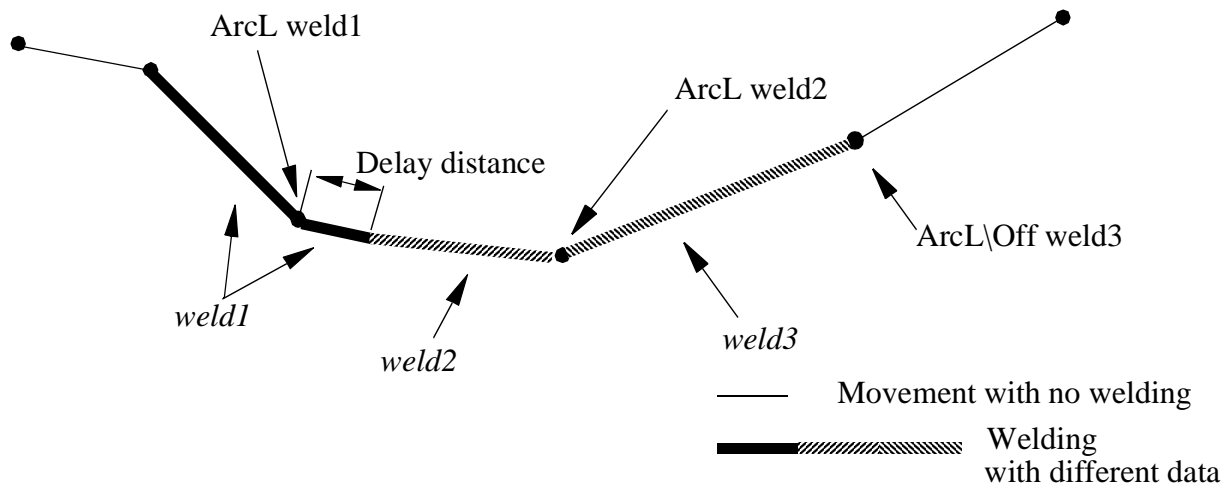


Figure 2 In the above example, the weld data changeover from weld1 to weld2 is delayed and weld2 has a *delay\_distance*=0. The *delay\_distance* in weld3 will thus have no effect.

*Delay\_distance* can, for example, be used in *ArcC* instructions to move the changeover of weld data without reprogramming the circle positions.

**weld\_volt\_adj** (*welding voltage adjustment*) Data type: *num*

The voltage adjustment during the weld phase.

The value specified is scaled and sent to the corresponding analog output, in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

**weld\_curr\_adj** (*weld current adjustment*) Data type: *num*

The current adjustment during the weld phase.

The specified value is scaled and sent in accordance with the setting in the system parameters for analog signals.

This signal can be used for arbitrary purposes when something needs to be controlled using an analog output signal.

**org\_weld\_speed** (original weld speed) Data type: num

The original weld speed during the weld phase.

**Note!** Used internally by tuning functions.

**org\_weld\_voltage** (original weld voltage) Data type: num

The original weld voltage during the weld phase.

**Note!** Used internally by tuning functions.

**org\_weld\_wfeed** (original weld wirefeed speed) Data type: num

The original weld wirefeed speed during the weld phase.

**Note!** Used internally by tuning functions.

### Examples

The type of weld shown in Figure 3 is desired, with a welding voltage of 30 V and a wire feed speed of 15 m/min. The welding speed is 20 mm/s.

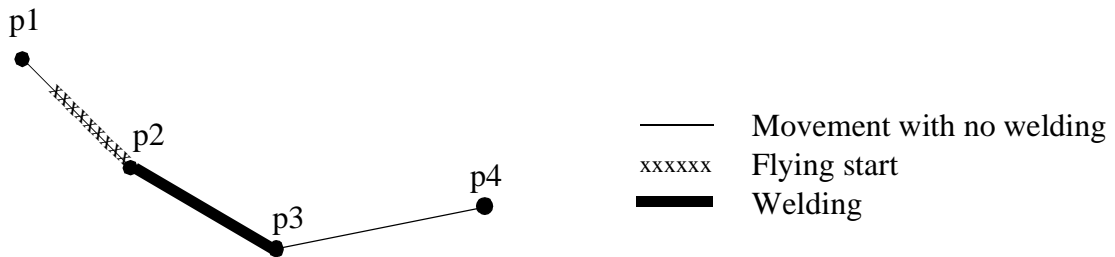


Figure 3 Welding between two points.

```
PERS welddata weld1 := [20,30,15,0];
```

```
MoveJ p1, v100, z20, gun1;
ArcL \On, p2, v100, seam1, weld1, nowave, fine, gun1;
ArcL \Off, p3, v100, seam1, weld1, nowave, fine, gun1;
MoveJ p4, v100, z20, gun1;
```

The weld data values for a weld such as the one in Figure 3 are as follows:

<u>Component</u>	<u>weld1</u>	
weld_speed	20 mm/s	Speed in relation to the seam
weld_voltage	30 V	Sent to an analog output signal
weld_wirefeed	15 m/min.	Sent to an analog output signal
delay_distance	0 mm	No delay

The weld schedule identity, weld voltage adjustment and weld current adjustment

components are not active in this example.

The weld data argument does not have any effect in the ArcL \On instruction.

The type of weld shown in Figure 4 is required. The first section is to be welded using a voltage of 50 V and a wire feed speed of 20 m/min. After a specified distance on the circular arc, the voltage is to be increased to 55 V. The welding speed is 30 mm/s in each section.

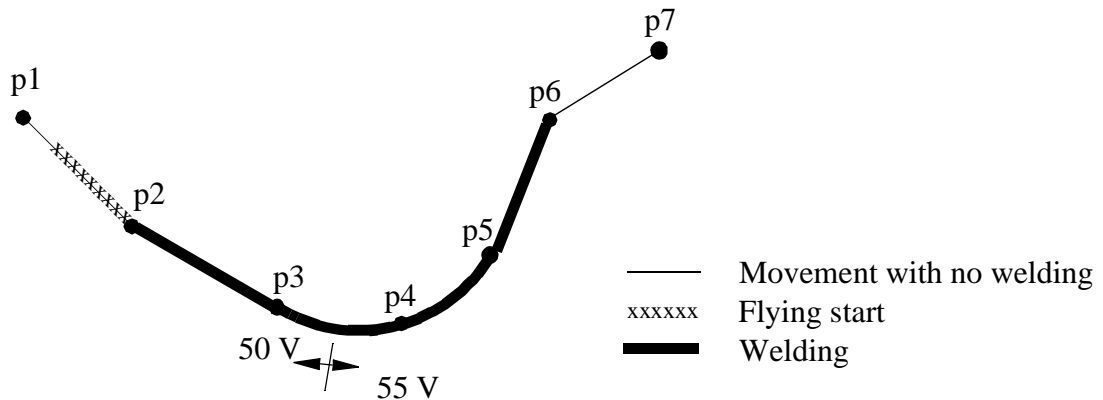


Figure 4 The weld data is changed after a specified distance on the circular path.

```
PERS welddata weld1 := [10,30,50,20,0];
PERS welddata weld2 := [10,30,55,20,17];
```

```
MoveJ p1, v100, z20, gun1;
ArcL \On, p2, v100, seam1, weld1, nowave, fine, gun1;
ArcL p3, v100, seam1, weld1, nowave, z10, gun1;
ArcC p4, p5, v100, seam1, weld2, nowave, z10, gun1;
ArcL \Off, p6, v100, seam1, weld2, nowave, fine, gun1;
MoveJ p7, v100, z20, gun1;
```

The weld data values for a weld such as the one in Figure 4 are as follows:

Component	weld1	weld2	
weld_sched	10	10	Identity sent to the welding equipment
weld_speed	30 mm/s	30 mm/s	
weld_voltage	50 V	55 V	
weld_wirefeed	20 m/min.	20 m/min.	
delay_distance	0 mm	17 mm	weld2 is delayed 17 mm

The weld voltage adjustment and weld current adjustment components are not active in this example.

The weld data argument does not have any effect in the ArcL \On instruction.

---

**Structure**

<data object of *welddata*>  
<weld\_sched of *num*>  
<weld\_speed of *num*>  
<weld\_voltage of *num*>  
<weld\_wirefeed of *num*>  
<weld\_current of *num*>  
<delay\_distance of *num*>  
<weld\_volt\_adj of *num*>  
<weld\_curr\_adj of *num*>  
<org\_weld\_speed of *num*>  
<org\_weld\_voltage of *num*>  
<org\_weld\_wfeed of *num*>

Note that the structure changes depending on the configuration of the robot.

---

**Related information**

	<u>Described in:</u>
Seam data	Data Types - <i>seamdata</i>
Installation parameters for welding equipment and functions	System Parameters - <i>Arc Welding</i>
Process phases	RAPID Summary- <i>Arc Welding</i>
Arc welding instructions	Instructions - <i>ArcL, ArcC</i>

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## ArcC      Arc welding with circular motion

### ArcC1

### ArcC2

*ArcC* (*Arc Circular*) is used to weld along a circular path. The instruction controls and monitors the entire welding process as follows:

- The tool centre point is moved in a circle to the specified destination position.
- All phases, such as the start and end phases, of the welding process are controlled.
- The welding process is monitored continuously.

The only difference between *ArcC*, *ArcC1* and *ArcC2* is that they are connected to different process systems configured in the System Parameters. Although *ArcC* is used in the examples, *ArcC1* or *ArcC2* could equally well be used.

---

### Example

```
MoveL . . . .
ArcL \On, p1, v100, seam1, weld5, noweave, fine, gun1;
ArcC \Off, p2, p3, v100, seam1, weld5, noweave, fine, gun1;
MoveL . . . .
```

This welds a circular seam between points *p1* and *p3* (via point *p2*) as illustrated in Figure 1.

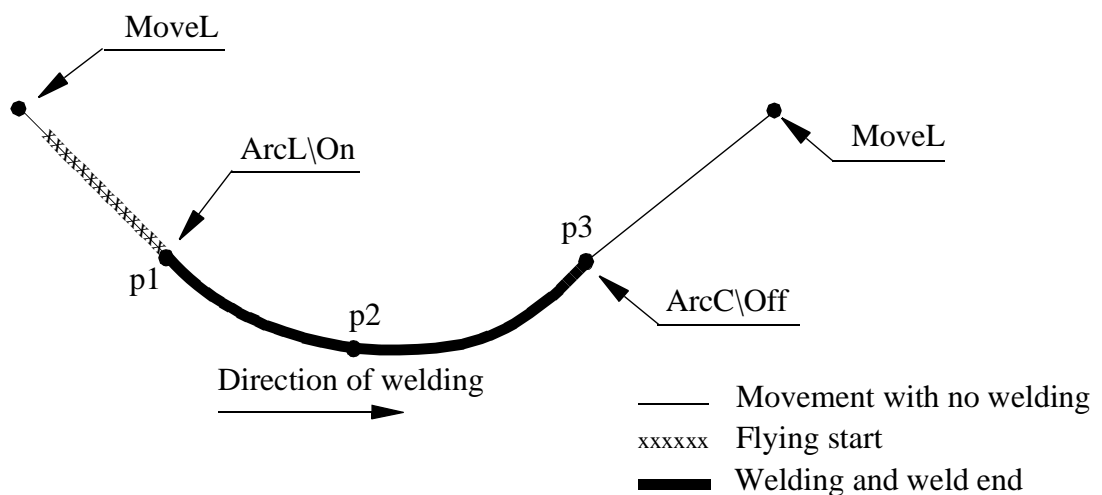


Figure 1 Welding with flying start.

On the way to *p1*, preparations for the weld start, such as gas preflowing, are carried out. The process and the actual weld movement then start at position *p1* and end at *p3*. The start and end processes are determined by *seam1* and the welding process by *weld5*. Weaving data is carried out according to *noweave*. (No weaving if the *weave\_shape* component value is zero.)

*V100* specifies the speed attained during the flying start to *p1*.



---

**Arguments**

**ArcC** [**\On**] | [**\Off**] **CirPoint ToPoint Speed** [**\T**] **Seam Weld**  
**Weave Zone** [**\Z**] **Tool** [**\WObj**]

**[\On]**

Data type: *switch*

The argument *\On* is used to get a *flying start* (see Figure 1) which, in turn, results in shorter cycle times.

The argument *\On* may only be used in the first of the arc welding instructions to result in a seam. As the end instructions cannot include the argument *\On*, welding with a flying start must include at least two instructions.

The start preparations at a flying start, e.g. gas purging, are carried out on the way to the weld start position.

When the argument *\On* is not used, the weld starts at the position before the *ArcC* instruction (see Figure 2) and the robot remains stationary at the previous position whilst *all* weld start activities are in progress.

Whether or not a flying start is used, the start position for the weld will always be a stop point – regardless of what is specified in the *Zone* argument for that position.

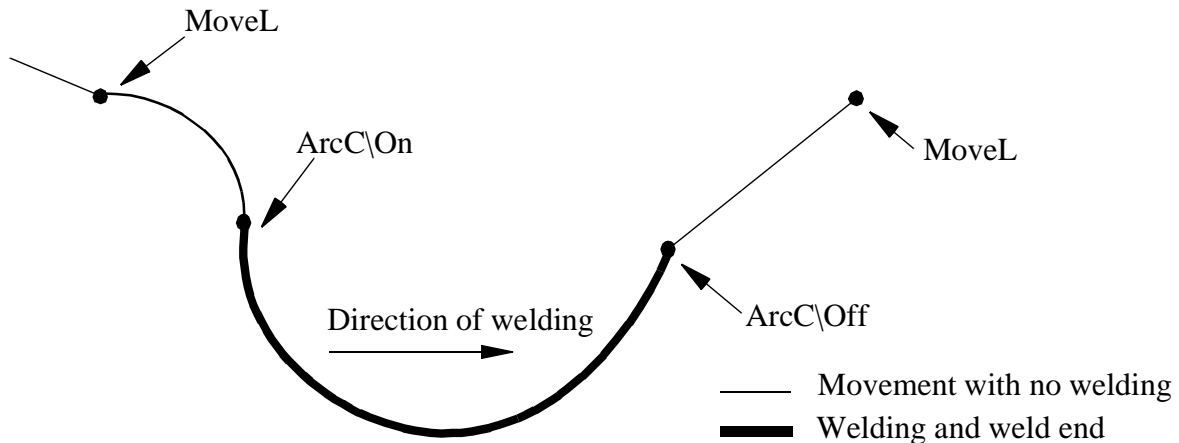


Figure 2 If welding is started without the argument *\On*, the weld is begun at the previous position.

**[\Off]**

Data type: *switch*

If the argument *\Off* is used, welding ends when the robot reaches the destination position. Regardless of what is specified in the *Zone* argument, the destination position will be a stop point.

If an *ArcC* instruction without the argument *\Off* is followed by *MoveJ*, for example, welding will end, but in an uncontrolled fashion. Logical instructions, such as *Set doI*, however, can be used between two arc welding instructions without ending the welding process.

**CirPoint**Data type: *robtargt*

The circle point of the robot. The circle point is a position on the circle between the start point and the destination point. To obtain the best accuracy, it should be placed about halfway between the start and destination points. If it is placed too close to the start or destination point, the robot may give a warning. The circle point is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**ToPoint**Data type: *robtargt*

The destination position of the robot and external axes. This is either defined as a named position or stored directly in the instruction (indicated by an \* in the instruction).

**Speed**Data type: *speeddata*

The speed of the TCP is controlled by the argument *Speed* in the following cases:

- When the argument *\On* is used (weld start preparations at a flying start).
- When the program is run instruction-by-instruction (no welding).

The speed of the TCP *during welding* is the same as for the arguments *Seam* and *Weld* (see Figure 3).

Speed data also describes the speed of the tool's reorientation and the speed of any uncoordinated external axes.

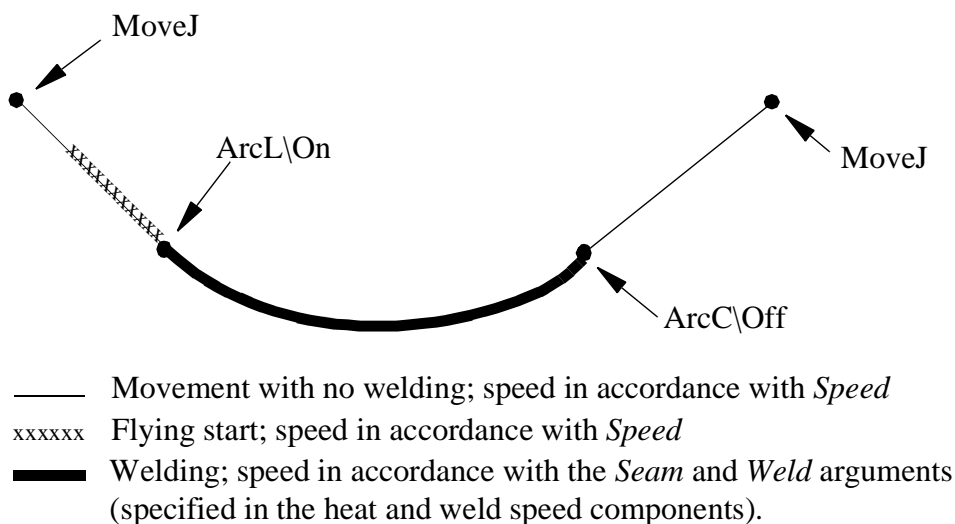


Figure 3 The speed at different phases of the welding process.

**[\T]**

(Time)

Data type: *num*

The argument *\T* is used to specify the total time of movement in seconds, directly in the instruction. Time is thus substituted for the speed specified in the arguments *Speed*, *Seam* and *Weld*.

This argument can be used when, for example, one or more uncoordinated external axes participate in the movement. Uncoordinated external axes should be avoided because when they are used, the program becomes more difficult to adjust. Use coordinated external axes instead. Weaving is deactivated during execution of ArcX instructions with \T arguments.

**Seam** Data type: *seamdata*

Seam data describes the start and end phases of a welding process.

The argument *Seam* is included in all arc welding instructions so that, regardless of the position of the robot when the process is interrupted, a proper weld end and restart are achieved.

Normally the same seam data is used in all instructions of a seam.

**Weld** Data type: *welddata*

Weld data describes the weld phase of the welding process.

Weld data is often changed from one instruction to the next, along a seam.

**Weave** Data type: *weavedata*

Weave data describes the weaving that is to take place during the heat and weld phases. Welding without weaving is obtained by specifying, for example, the weave data *noweave*. (No weaving if the *weave\_shape* component value is zero.)

**Zone** Data type: *zonedata*

Zone data defines how close the axes must be to the programmed position before they can start moving towards the next position.

In the case of a fly-by point, a corner path is generated past that position. In the case of a stop point (*fine*), the movement is interrupted until all axes have reached the programmed point.

A stop point is always generated automatically at the start position of a weld (even in the case of a *flying start*) and at a *controlled* weld end position. Fly-by points, such as *z10*, should be used for all other weld positions.

Weld data changes over to the next arc welding instruction at the centre point of the corner path (if not delayed by the *delay\_distance* component in the *Weld* argument).

[ \Z ] (Zone) Data type: *num*

This argument is used to specify the positional accuracy of the robot's TCP directly in the instruction. The size of the zone is specified in mm and is thus substituted in the corresponding zone specified in the zone data. The \Z argument is also useful when trimming individual corner paths.

<b>Tool</b>		Data type: <i>tooldata</i>
	The tool used in the movement. The TCP of the tool is the point moved to the specified destination position. The z-axis of the tool should be parallel with the torch.	
<b>[\WObj]</b>	( <i>Work Object</i> )	Data type: <i>wobjdata</i>
	The work object (coordinate system) to which the instruction's robot position is referenced.	
	When this argument is omitted, the robot position is referenced to the world coordinate system. It must, however, be specified if a stationary TCP or coordinated external axes are used.	
	\WObj can be used if a coordinate system is defined for either the object in question or the weld seam.	

## Program execution

### Controlling process equipment

The process equipment is controlled by the robot in such a way that the entire process and each of its phases are coordinated with the robot's movements.

### Motion

Robot and external axes are moved to the destination position as follows:

- The TCP of the tool is moved circularly at a constant programmed speed. When coordinated axes are used, they are moved circularly at constant programmed speed relative to the work object.
- The tool is reorientated at even intervals throughout the entire course.
- Uncoordinated external axes are executed at a constant speed which means that they reach their destination at the same time as the robot axes.

If the programmed speed of reorientation or of the external axes is exceeded, these speeds will be limited, thereby reducing the speed of the TCP.

The destination position is referenced to:

- the specified object coordinate system if the argument \WObj is used;
- the world coordinate system if the argument \WObj is not used.

## Limitations

When weaving, the distance between the programmed positions should be longer than the periodic time of weaving. If the distance is shorter and if there is a significant

change of angle in the path, the weaving pattern will be distorted.

The instruction *ArcC* should never be restarted after the circle point has been passed. Otherwise the robot will not take the programmed path (positioning around the circular path in another direction compared with that programmed).

---

## Error management

The process is supervised by a number of signal inputs. If anything abnormal is detected, program execution will stop. If, however, an error handler is programmed, the errors defined below can be remedied without stopping production. See the example in the *RestoPath* instruction.

<u>Error constant (ERRNO value)</u>	<u>Description</u>
AW_START_ERR	Start condition error; torch, gas or water supervision
AW_IGNI_ERR	Ignition error; arc supervision
AW_WELD_ERR	Weld error; arc supervision
AW_EQIP_ERR	Weld equipment error; voltage, current, water or gas supervision during welding
AW_WIRE_ERR	Wire stick error; wire stick supervision
AW_STOP_ERR	Welding interrupted with the stop process input

The process supervision is determined as a part of the process equipment configuration.

At the *start* of the process the robot checks that the following *preconditions* have been met:

- stop\_process
- water\_OK
- gas\_OK
- torch\_OK

If, after the start command is given, no approved start profile is indicated on the digital input, *arc\_OK*, within a predetermined time period, the process start will be interrupted.

When the process is started, all supervision inputs selected are monitored continuously:

- stop\_process, water\_OK, gas\_OK, arc\_OK, volt\_OK, curr\_OK, feed\_OK.

The wirestick\_err supervision is checked at the end of the weld.

---

**Example**

```

MoveL ...
ArcL  \On, *,v100, seam1, weld5, weave1, fine, gun1\Wobj:=wobj1;
ArcC  *, *, v100, seam1,weld5, weave1, z10, gun1\Wobj:=wobj1;
ArcL  *, v100, seam1,weld5, weave1, z10, gun1\Wobj:=wobj1;
ArcC  \Off, *, *, v100, seam1,weld3, weave3, fine, gun1\Wobj:=wobj1;
MoveL...

```

In this example, a weld is performed in which weld data and weave data are changed in the final part of the weld, which is illustrated in Figure 4. Note that an arc welding instruction must be used to change the direction of the path despite the fact that no weld data is changed.

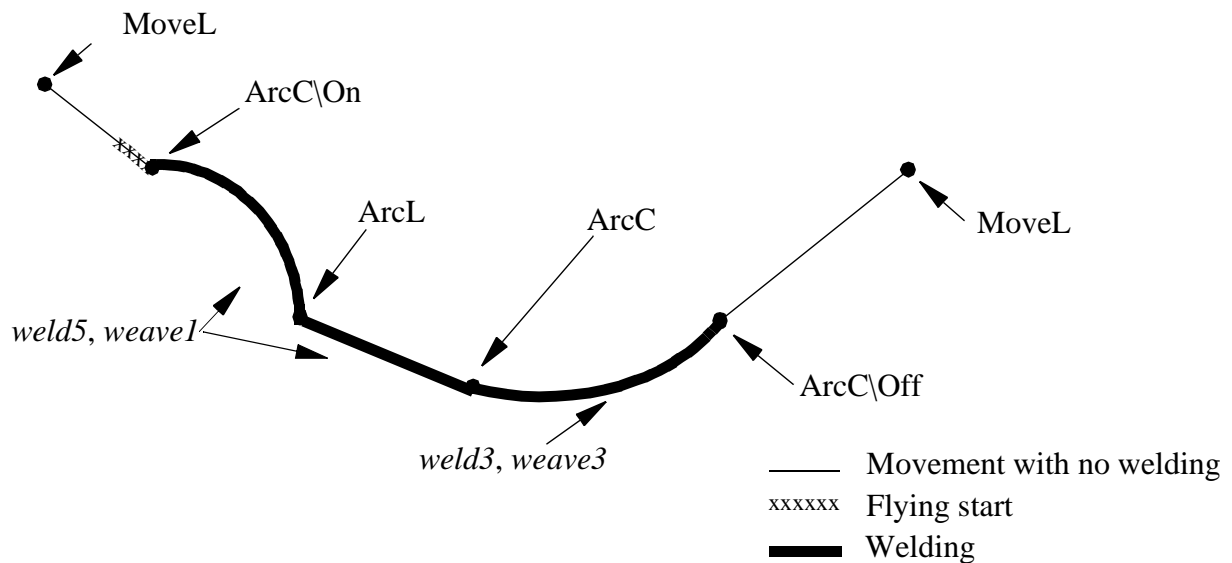


Figure 4 The direction and weld data can be changed by programming several arc welding instructions.

It is assumed, in this example, that a coordinated external axis is used in the movement. In this case, the *wobj1* work object must be specified in the instruction.

---

## Syntax

### ArcC

```
[ '\On', ' ] | [ '\Off', ' ]
[ CirPoint ':=' ] < expression (IN) of robtarget > ', '
[ ToPoint ':=' ] < expression (IN) of robtarget > ', '
[ Speed ':=' ] < expression (IN) of speeddata >
  [ ( '\ T ':=' < expression (IN) of num > ) ] ', '
[ Seam ':=' ] < persistent (PERS) of seamdata > ', '
[ Weld ':=' ] < persistent (PERS) of welddata > ', '
[ Weave ':=' ] < persistent (PERS) of weavedata > ', '
[ Zone ':=' ] < expression (IN) of zonedata >
  [ '\ Z ':=' < expression (IN) of num > ] ', '
[ Tool ':=' ] < persistent (PERS) of tooldata >
[ '\ WObj ':=' < persistent (PERS) of wobjdata > ] ', '
```

---

## Related information

	<u>Described in:</u>
Performing a linear weld	Instructions - <i>ArcL</i>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of speed	Data Types - <i>speeddata</i>
Definition of zone data	Data Types - <i>zonedata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Definition of seam data	Data Types - <i>seamdata</i>
Definition of weld data	Data Types - <i>welddata</i>
Definition of weave data	Data Types - <i>weavedata</i>
Installation parameters for welding equipment and welding functions	System Parameters - <i>Arc Welding</i>
Movements in general	Motion Principles
Coordinate systems	Motion Principles - <i>Coordinate Systems</i>
Process phases and sub-activities	RAPID Summary - <i>Arc Welding</i>

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**arcdata****Arc process data**

*Arcdata (Arc Process Data)* is used to define a number of arc welding process parameters that are essential for the process:

- The latest used parameters (velocity, wirefeed speed and voltage).
- Statistical data (mean and min/max values for voltage and current in the latest seam).

This data type does not normally have to be used since these values can be accessed using the system variable ARC\_DATA.

---

**Description**

The latest used parameters (stored in the system variable ARC\_DATA) are affected in any circumstances.

The following requirements are applicable for affecting the statistical data:

- The system is an ARCITEC system.
- The system is configured so it uses the analog inputs for voltage and current. In this case external measuring equipment must be used.

---

**Components**

**req\_vel** Data type: *num*

Latest requested velocity.

**req\_volt** Data type: *num*

Latest requested weld voltage.

**req\_wfd\_sp** Data type: *num*

Latest requested weld wirefeed speed.

**act\_volt** Data type: *num*

Current measured weld voltage.

**min\_volt** Data type: *num*

Lowest measured value of the weld voltage during the current seam (or latest seam).



<b>max_volt</b>	Data type: <i>num</i>
Highest measured value of the weld voltage during the current seam (or latest seam).	
<b>mean_volt</b>	Data type: <i>num</i>
Mean value of the measured weld voltage during the current seam (or latest seam).	
<b>act_curr</b>	Data type: <i>num</i>
Measured weld current at this time.	
<b>min_curr</b>	Data type: <i>num</i>
Lowest measured value of the weld current during the current seam (or latest seam).	
<b>max_curr</b>	Data type: <i>num</i>
Highest measured value of the weld current during the current seam (or latest seam).	
<b>mean_curr</b>	Data type: <i>num</i>
Mean value of the measured weld current during the current seam (or latest seam).	

---

## Example

```
ArcL\On ...
ArcL\Off ...
TPWrite "Voltage mean value for the latest seam = "\Num:=ARC_DATA.mean_volt;
```

When the seam is finished, the mean value of the process parameter voltage will be displayed on the TeachPendant.

---

## Structure

```
<data object of arcdata>
  <req_vel of num>
  <req_volt of num>
  <req_wfd_sp of num>
  <act_volt of num>
  <min_volt of num>
  <max_volt of num>
  <mean_volt of num>
  <act_curr of num>
  <min_curr of num>
```

<max\_curr of *num*>  
<mean\_curr of *num*>

---

**Related information**

Installation parameters for welding  
equipment and functions  
Process phases and timing schedules  
Arc welding instructions

Described in:

System Parameters - *Arc Welding*  
RAPID Summary - *Arc Welding*  
Instructions - *ArcL, ArcC*



---



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## ArcL                      Arc welding with linear motion

### ArcL1

### ArcL2

*ArcL* (*Arc Linear*) is used to weld along a straight seam. The instruction controls and monitors the entire welding process as follows:

- The tool centre point is moved linearly to the specified destination position.
- All phases of the welding process, such as the start and end phases, are controlled.
- The welding process is monitored continuously.

The only difference between *ArcL*, *ArcL1* and *ArcL2* is that they are connected to different process systems configured in the System Parameters. Although *ArcL* is used in the examples, *ArcL1* or *ArcL2* could equally well be used.

---

### Example

```
MoveJ . . . .
ArcL  \On, p1, v100, seam1, weld5, noweave, fine, gun1;
ArcL  \Off, p2, v100, seam1, weld5, noweave, fine, gun1;
MoveJ . . . .
```

This welds a straight seam between points *p1* and *p2*, as illustrated in Figure 1.

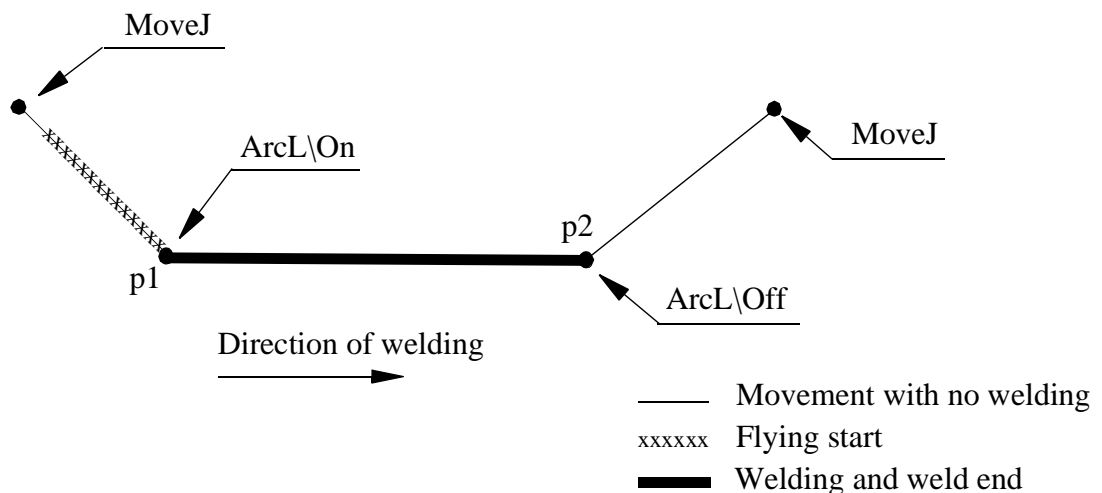


Figure 1 Welding with flying start.

On the way to *p1*, preparations for the weld start, such as gas preflowing, are carried out. The process and the actual weld movement then start at position *p1* and end at *p2*. The start and end processes are determined by *seam1* and the welding process by *weld5*. Weaving data is carried out according to *noweave*. (No weaving if the *weave\_shape* component value is zero.)

*V100* specifies the speed attained during the flying start to *p1*.

---

**Arguments**

**ArcL** `[\On] | [\Off] ToPoint Speed [\T ] Seam Weld Weave Zone`  
`[\Z] Tool [\WObj]`

**[\On]**

Data type: *switch*

The argument `\On` is used to obtain a *flying start* (see Figure 1) which, in turn, results in shorter cycle times.

The argument `\On` may only be used in the first of the arc welding instructions to result in a seam. As the end instructions cannot include the argument `\On`, welding with a flying start must include at least two instructions.

The start preparations at a flying start, e.g. gas purging, are carried out on the way to the weld start position.

When the argument `\On` is not used, the weld starts at the position before the *ArcL* instruction (see Figure 2) and the robot remains stationary at the previous position whilst *all* weld start activities are in progress.

Whether or not a flying start is used, the start position for the weld will always be a stop point – regardless of what is specified in the *Zone* argument for that position.

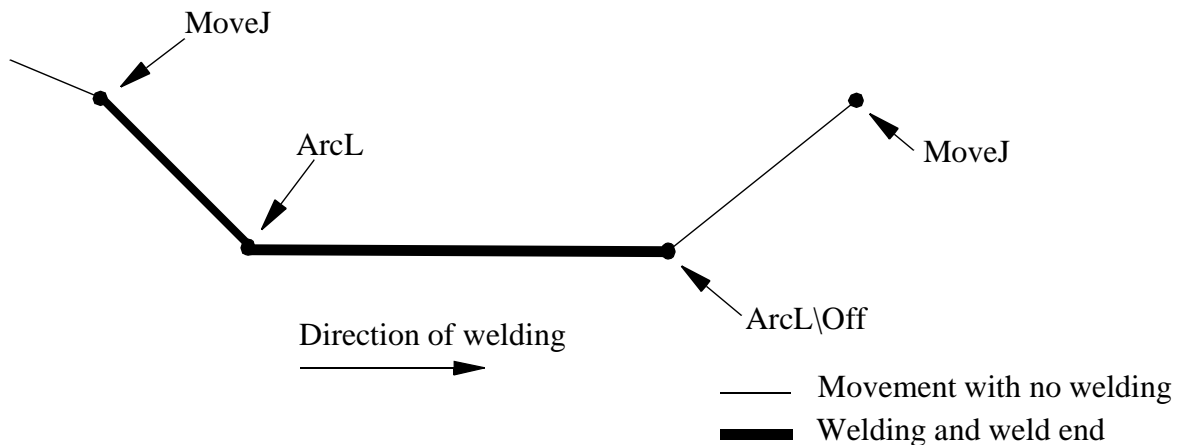


Figure 2 If welding is started without the argument `\On`, the weld is begun at the previous position.

**[\Off]**

Data type: *switch*

If the argument `\Off` is used, welding ends when the robot reaches the destination position. Regardless of what is specified in the *Zone* argument, the destination position will be a stop point.

If an *ArcL* instruction without the argument `\Off` is followed by *MoveJ*, for example, welding will end, but in an uncontrolled fashion. Logical instructions, such as *Set doI*, however, can be used between two arc welding instructions without ending the welding process.

**ToPoint**Data type: *robtarget*

The destination position of the robot and external axes. This is either defined as a named position or stored directly in the instruction (indicated by an \* in the instruction).

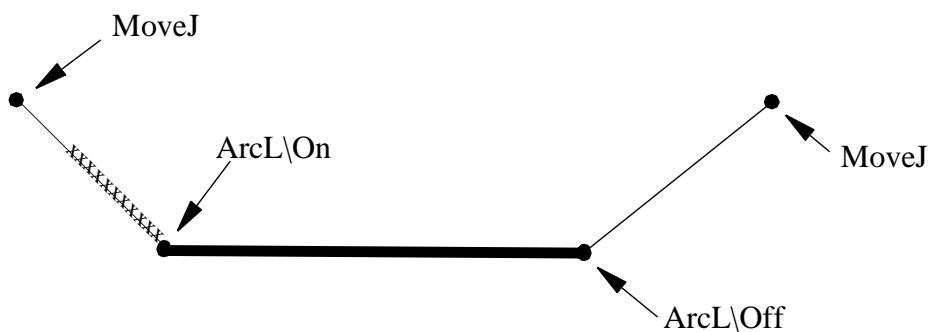
**Speed**Data type: *speeddata*

The speed of the TCP is controlled by the argument *Speed* in the following cases:

- When the argument *\On* is used (weld start preparations at a flying start).
- When the program is run instruction-by-instruction (no welding).

The speed of the TCP *during welding* is the same as for the arguments *Seam* and *Weld*. (See Figure 3)

Speed data also describes the speed of the tool's reorientation and the speed of any uncoordinated external axes.



- Movement with no welding; speed in accordance with *Speed*
- xxxxxx Flying start; speed in accordance with *Speed*
- Welding; speed in accordance with the *Seam* and *Weld* arguments (specified in the heat and weld speed components).

Figure 3 The speed at different phases of the welding process.

**[ \T ]**

(Time)

Data type: *num*

The argument *\T* is used to specify the total time of movement in seconds directly in the instruction. Time is thus substituted for the speed specified in the arguments *Speed*, *Seam* and *Weld*.

This argument can be used when, for example, one or more uncoordinated external axes participate in the movement. Uncoordinated external axes should, however, be avoided since, if used, the program becomes more difficult to adjust. Use coordinated external axes instead. Weaving is deactivated during execution of ArcX instructions with *\T* arguments.

**Seam**Data type: *seamdata*

Seam data describes the start and end phases of a welding process.

The argument *Seam* is included in all arc welding instructions so that, regardless of the position of the robot when the process is interrupted, a proper weld end and restart is achieved.

Normally the same seam data is used in all instructions of a seam.

**Weld** Data type: *welddata*

Weld data describes the weld phase of the welding process.

Weld data is often changed from one instruction to the next along a seam.

**Weave** Data type: *weavedata*

Weave data describes the weaving that is to take place during the heat and weld phases. Welding without weaving is obtained by specifying, for example, the weave data *noweave*. (No weaving if the *weave\_shape* component value is zero.)

**Zone** Data type: *zonedata*

Zone data defines how close the axes must be to the programmed position before they can start moving towards the next position.

In the case of a fly-by point, a corner path is generated past that position. In the case of a stop point (*fine*), the movement is interrupted until all axes have reached the programmed point.

A stop point is always generated automatically at the start position of a weld (even in the case of a *flying start*) and at a *controlled* weld end position. Fly-by points, such as *z10*, should be used for all other weld positions.

Weld data changes over to the next arc welding instruction at the centre point of the corner path (if not delayed by the *delay\_distance* component in the *Weld* argument).

[ \Z ] (Zone) Data type: *num*

This argument is used to specify the positional accuracy of the robot's TCP directly in the instruction. The size of the zone is specified in mm and is thus substituted in the corresponding zone specified in the zone data. The \Z argument is also useful when trimming individual corner paths.

**Tool** Data type: *tooldata*

The tool used in the movement. The TCP of the tool is the point moved to the specified destination position. The z-axis of the tool should be parallel with the torch.

[ \WObj ] (Work Object) Data type: *wobjdata*

The work object (coordinate system) to which the instruction's robot position is referenced.

When this argument is omitted, the robot position is referenced to the world coordinate system. It must, however, be specified if a stationary TCP or coordinated external axes are used.

`\WObj` can be used if a coordinate system is defined for either the object in question or the weld seam.

---

## Program execution

### Controlling process equipment

The process equipment is controlled by the robot in such a way that the entire process and each of its phases are coordinated with the robot's movements.

### Motion

Robot and external axes are moved to the destination position as follows:

- The TCP of the tool is moved linearly at a constant programmed speed. When coordinated axes are used, they are moved linearly at constant programmed speed relative to the work object.
- The tool is reorientated at even intervals throughout the entire course.
- Uncoordinated external axes are executed at a constant speed which means that they reach their destination at the same time as the robot axes.

If the programmed speed of reorientation or of the external axes is exceeded, these speeds will be limited, thereby reducing the speed of the TCP.

The destination position is referenced to:

- the specified object coordinate system if the argument `\WObj` is used;
- the world coordinate system if the argument `\WObj` is not used.

---

## Limitations

When weaving, the distance between the programmed positions should be longer than the periodic time of weaving. If the distance is shorter and if there is a significant change of angle in the path, the weaving pattern will be distorted.

---

## Fault management

The process is supervised by a number of signal inputs. If anything abnormal is detected, program execution will stop. If, however, an error handler is programmed, the errors defined below can be remedied without stopping production. See the exam-



ple in the *RestoPath* instruction.

<u>Error constant (ERRNO value)</u>	<u>Description</u>
AW_START_ERR	Start condition error; torch, gas or water supervision
AW_IGNI_ERR	Ignition error; arc supervision
AW_WELD_ERR	Weld error; arc supervision
AW_EQIP_ERR	Weld equipment error; voltage, current, water or gas supervision during welding
AW_WIRE_ERR	Wire stick error; wire stick supervision
AW_STOP_ERR	Welding interrupted using the stop process input

The process supervision is determined as a part of the process equipment configuration.

At the *start* of the process the robot checks that the following *preconditions* have been met:

- stop\_process
- water\_OK
- gas\_OK
- torch\_OK

If, after the start command is given, no approved start profile is indicated on the digital input, *arc\_OK*, within a predetermined time period, the process start will be interrupted.

When the process is started, all supervision inputs selected are monitored continuously:

- stop\_process, water\_OK, gas\_OK, arc\_OK, volt\_OK, curr\_OK, feed\_OK

The wirestick\_err supervision is checked at the end of the weld.

---

## Example

```

MoveL ...
ArcL  \On, *, v100, seam1, weld5, weave1, fine, gun1\Wobj:=wobj1;
ArcL  *, v100, seam1,weld5, weave1, z10, gun1\Wobj:=wobj1;
ArcL  *, v100, seam1,weld5, weave1, z10, gun1\Wobj:=wobj1;
ArcL  \Off, *, v100, seam1,weld3, weave3, fine, gun1\Wobj:=wobj1;
MoveL ...

```

In this example, a weld is performed in which weld data and weave data are changed in the final part of the weld, which is illustrated in Figure 4. Note that an arc welding instruction must be used to change the direction of the path despite the fact that no weld data is changed.

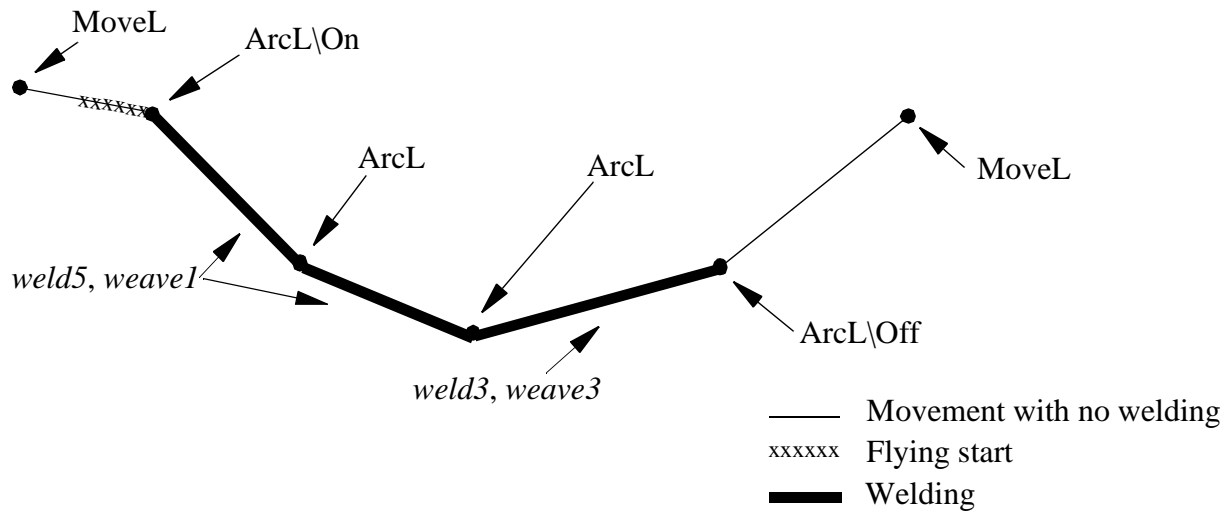


Figure 4 The direction and weld data can be changed by programming several ArcL instructions.

It is assumed, in this example, that a coordinated external axis is used in the movement. In this case, the *wobj1* work object must be specified in the instruction.

---

## Syntax

```

ArcL
  [ '\On', ] | [ '\Off', ]
  [ ToPoint ':=' ] < expression (IN) of robtarg > ', '
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ ( '\ T ':=' < expression (IN) of num > ) ] ', '
  [ Seam ':=' ] < persistent (PERS) of seamdata > ', '
  [ Weld ':=' ] < persistent (PERS) of welldata > ', '
  [ Weave ':=' ] < persistent (PERS) of weavedata > ', '
  [ Zone ':=' ] < expression (IN) of zonedata >
  [ '\ Z ':=' < expression (IN) of num > ] ', '
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\ WObj ':=' < persistent (PERS) of wobjdata > ', '

```

---

**Related information**

	<u>Described in:</u>
Performing a circular weld	Instructions - <i>ArcC</i>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of speed	Data Types - <i>speeddata</i>
Definition of zone data	Data Types - <i>zonedata</i>
Definition of tools	Data Types - <i>tooldata</i>
Definition of work objects	Data Types - <i>wobjdata</i>
Definition of seam data	Data Types - <i>seamdata</i>
Definition of weld data	Data Types - <i>welldata</i>
Definition of weave data	Data Types - <i>weavedata</i>
Installation parameters for welding equipment and welding functions	System Parameters - <i>Arc Welding</i>
Movements in general	Motion Principles
Coordinate systems	Motion Principles - <i>Coordinate Systems</i>
Process phases and sub-activities	RAPID Summary - <i>Arc Welding</i>

---



---

## ArcKill Kill the AW process

*ArcKill* is used in advanced error handlers to kill the AW process.

---

### Example

```

PROC main()

    WeldSeam1;
    WeldSeam2;

ERROR
    TPreadFk ans "The weld failed", "", "", "", "Service", "OK";

    TEST ans
    CASE 4:
        service_routine;
        TRYNEXT;

    DEFAULT:
        TRYNEXT
    ENDTEST

ENDPROC

PROC WeldSeam1()

    ! Weld the seam
    ArcL \On, p1, v100, seam1, weld5, nowave, fine, gun1;
    ArcL \Off, p2, v100, seam1, weld5, nowave, fine, gun1;

ERROR
    TEST ERRNO
    CASE AW_IGNI_ERR:
    !    Try to restart the process if this was an ignition error.
        RETRY;

    DEFAULT:
    !    Kill the aw process and raise the error to the main routine
        ArcKill;
        RAISE
    ENDTEST

ENDPROC

```

---

**Syntax**

ArcKill ‘;’

---

**Related information**

Performing a circular weld

Performing a linear weld

Described in:

Instructions - *ArcC*

Instructions - *ArcL*

---



---

## ArcRefresh Refresh arcweld data

*ArcRefresh* is used to tune aw process parameters during program execution.

---

### Example

```

PROC PulseWeld()

! Setup a two Hz timer interrupt
CONNECT intno1 WITH TuneTrp;
ITimer ,0.5 ,intno1;

! Weld the seam
ArcL \On, p1, v100, seam1, weld5, noweave, fine, gun1;
ArcL \Off, p2, v100, seam1, weld5, noweave, fine, gun1;

IDelete intno1;

ENDPROC

TRAP TuneTrp

! Modify the weld_voltage component of active welddata.

IF HighValueFlag =TRUE THEN
weld5.weld_voltage := 10;
HighValueFlag := FALSE;
ELSE
weld5.weld_voltage := 15;
HighValueFlag := TRUE;
ENDIF

! Order the process control to refresh process parameters
ArcRefresh;

ENDTRAP

```

The weld voltage will be switched between 10 and 15 volts by the trap routine at a two Hz rate.

---

### Syntax

```
ArcRefresh ‘;’
```

---

**Related information**

Performing a circular weld  
Performing a linear weld  
Definition of weld data  
Definition of weave data  
Installation parameters for welding  
equipment and welding functions

Described in:

Instructions - *ArcC*  
Instructions - *ArcL*  
Data Types - *welddata*  
Data Types - *weavedata*  
System Parameters - *Arc Welding*

CONTENTS

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---

gundata	Spot weld gun data
spotdata	Spot weld data
SpotL	Spot Welding with motion
System Module	SWUSRC
System Module	SWUSRF
System Module	SWTOOL





---

---

**gundata****Spot weld gun data**

*Gundata* is used to define spot weld gun specific data, to control the gun in an optimal way in the weld process.

---

**Description**

Gundata is used in spot weld instructions and has the following structure:

- Number of electrode pairs.
- Number of pressure levels.
- Flag to indicate if a signal is required to test accurate gun closure.
- Flag to indicate if a signal is required to test accurate gun opening.
- Counter for the number of welds done and maximum allowed number (one counter and maximum value for each pair).
- Closing times.
- Opening times.

---

**Components**

**nof\_tips** (number of tips) Data type: *num*

Number of electrode pairs (1 or 2)

**nof\_levels** (number of pressure levels) Data type: *num*

Number of pressure levels (1 - 4)

**close\_request** (closure request) Data type: *bool*

If the flag is TRUE, the ordered pressure level is tested before the weld may start.

**open\_request** (opening request) Data type: *bool*

If the flag is TRUE, the gun open signal is tested before the next motion is released. The time out is defined by *sw\_go\_timeout*.

(See Predefined Data and Programs - *System Module SWUSER*)

**Note.** The **open\_time** must elapse before the test is done (see below).

If the flag is FALSE, the next motion is always released after **open\_time** (see below).

- tip1\_counter** Data type: *num*  
Counter for the number of welds done with the first pair of electrode tips. The counter is automatically incremented. Use of counter is optional. The zeroing shall be handled by the user program.
- tip2\_counter** Data type: *num*  
Counter for the number of welds done with the second pair of electrode tips. The counter is automatically incremented. Use of counter is optional. The zeroing shall be handled by the user program.
- tip1\_max**<sup>1</sup> Data type: *num*  
Maximum number of welds to be made by the first pair of electrode tips before tip service is required. This parameter may be used for automatic tip dressing etc.
- tip2\_max**<sup>1</sup> Data type: *num*  
Maximum value for number of welds allowed with the second pair of electrode tips before tip service shall be performed. To be used if desired by the user program.
- close\_time1** Data type: *num*  
Time [s] to close the gun if pressure p1 is activated.
- close\_time2** Data type: *num*  
Time [s] to close the gun if pressure p2 is activated.
- close\_time3** Data type: *num*  
Time [s] to close the gun if pressure p3 is activated.
- close\_time4** Data type: *num*  
Time [s] to close the gun if pressure p4 is activated.
- build\_up\_p1**<sup>1</sup> Data type: *num*  
Time [s] elapsed to build up the pressure from the moment when the gun has just about closed. The pressure p1 has to be set in advance. This parameter may be used to measure the closing time automatically.
- build\_up\_p2**<sup>1</sup> Data type: *num*  
Time [s] elapsed to build up the pressure from the moment when the gun has just about closed. The pressure p2 has to be set in advance.

---

1. To be defined only if used by the user program.

**build\_up\_p3<sup>1</sup>**Data type: *num*

Time [s] elapsed to build up the pressure from the moment when the gun has just about closed. The pressure p3 has to be set in advance.

**build\_up\_p4<sup>1</sup>**Data type: *num*

Time [s] elapsed to build up the pressure from the moment when the gun has just about closed. The pressure p4 has to be set in advance.

**open\_time**Data type: *num*

The time [s] that always elapses between the gun opening order and the release of the next motion or the test of gun open (see above).

---

**Structure**

```

< dataobject of gundata>
  <nof_tips of num>
  <nof_plevels of num>
  <close_request of bool>
  <open_request of bool>
  <tip1_counter of num>
  <tip2_counter of num>
  <tip1_max of num>
  <tip2_max of num>
  <close_time1 of num>
  <close_time2 of num>
  <close_time3 of num>
  <close_time4 of num>
  <build_up_p1 of num>
  <build_up_p2 of num>
  <build_up_p3 of num>
  <build_up_p4 of num>
  <open_time of num>

```

---

**.Related information**

Spot weld instruction

Definition of tool TCP, weight etc.

Described in:Instructions - *SpotL*Data types - *tooldata*


---

1. To be defined only if used by the user program.



---

---

**spotdata****Spot weld data**

*Spotdata* is used to define the parameters that control a weld timer and weld gun for welding a certain spot.

---

**Description**

Spotdata is referred to spot weld instructions and contains data which controls the welding in the actual instruction.

Spotdata has the following structure:

- Program number for the program in the weld timer to be used.
- Electrode tip to be activated (in case of a double gun).
- Desired gun pressure (if connected).
- Weld timer number (if more than one).

---

**Components**

**prog\_no** (program number) Data type: num

Defines the internal program in the weld timer to be used for the welding.

The allowed range is 0..**sw\_prog\_max** (defined in the system module *SWUSER*).

**tip\_no** (electrode pair number) Data type: num

Defines the electrode pair to be activated. The following alternatives are available:

- 1: Electrode pair 1
- 2: Electrode pair 2
- 12: Electrode pairs 1 and 2. Both pairs are closing at the same time. The welding is done in sequence, pair 1 first and pair 2 second. Then, both electrodes are opening together.
- 21: Electrode pairs 2 and 1. Both pairs are closing at the same time. The welding is done in sequence, pair 2 first and pair 1 second. Then, both electrodes are opening together.

For guns with only one pair of electrodes the value shall be 1.

**gun\_pressure** (gun pressure) Data type: *num*

Defines the gun pressure to use.

The following alternatives are available: Gun pressure 1-4

**timer\_no** (weld timer number) Data type: *num*

Defines the weld timer to be used. Only used for certain type of weld timers.

If only one timer is used (normal case) the value shall be 1.

---

## Example

PERS spotdata spot1:= [16, 1,4,1];

The spotdata spot1 is programmed for an equipment containing one single gun and one weld timer. When spot1 is used the following occurs:

- The program number 16 is controlling the welding.
- The gun pressure must reach level 4 before the weld is allowed to start.

---

## Structure

<dataobject of *spotdata*>  
<prog\_no of *num*>  
<tip\_no of *num*>  
<gun\_pressure of *num*>  
<timer\_no of *num*>

---

## Related information

The Spot weld instruction  
Gundata

### Described in:

Instructions - *SpotL*  
Data Types - *Gundata*

---

---

## SpotL Spot Welding with motion

*SpotL (SpotLinear)* is used in spotwelding to control the motion, gun closure/opening and the welding process. *SpotL* moves the TCP linearly to the end position.

---

### Example

```
SpotL p100, vmax, spot10, gun7, tool7;
```

This is the only instruction needed to implement a complete welding operation.

The TCP for *tool7* is moved on a linear path to the position *p100* with the speed given in *vmax*. The weld position is always a stop position since the welding is always performed while the robot is standing still. The gun closes in advance on it's way to the position. The welding is started and supervised until finished and the gun is reopening.

**Note.** The program continues to execute after the weld has started and is not blocked until the next order that contains a robot motion. This may be inhibited by the switch `\NoConc` (see below).

*Spotdata spot10* contains parameters to the welding equipment.

*Gundata gun7* contains gun specific weld data.

---

### Arguments

```
SpotL ToPoint Speed Spot [\InPos] [\NoConc] [\Retract]  
Gun Tool [\WObj]
```

**ToPoint** Data type: *robtarget*

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an \* in the instruction).

**Speed** Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity for the tool centre point, the tool reorientation and external axes.

**Spot** Data type: *spotdata*

Spot data that is associated with the weld process equipment.



**[\InPos]**Data type: *switch*

The optional argument \InPos inhibits the preclosing of the gun. The gun is closed first when the robot has reached the end position. This argument will increase the execution time but is useful in narrow situations.

**[\NoConc]**Data type: *switch*

The optional argument \NoConc prevents the program from continuing the execution until the actual weld is finished. It should be used when the next instruction is a logical instruction.

**[\Retract]**Data type: *switch*

The optional argument \Retract will make the gun open to its large gap (retract) after the weld. If the argument is omitted the gun opens to its small gap (work).

**Gun**Data type: *gundata*

Weld specific tool data for the gun in use.

**Tool**Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point moved to the specified destination position, and should be the position of the tips when the gun is closed.

**[\WObj]**Data type: *wobjdata*

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified in order to perform a linear movement relative to the work object.

**Customising**

The SpotWare package gives the user plenty of scope for customising the *SpotL* instruction:

- by user defined data which affects the internal behaviour in *SpotL*. (See Predefined Data and Programs - *System Module SWUSRF, SWUSRC*).
- by user defined routines which are called at predefined spots in the internal sequence. (See Predefined Data and Programs - *System Module SWUSRF, SWUSRC*).
- by changing the I/O configuration. (See System Parameters - *Spot Welding*).

However, the main subject of this *SpotL* instruction description is the default setup.

---

## Program execution

Internal sequence in a *SpotL* instruction:

- The gun starts to move towards the position.
- The weld program number is set for the external weld timer.
- The gun pressure is set.
- The preweld supervision is done.
- The gun starts to close at a defined time before the position (if argument \InPos is not used).
- The gun is closed when it reaches the position.
- The OK signal for pressure reached is expected.
- The weld counter is incremented.
- The movement to the next position is blocked.
- The start signal is sent to the weld timer.
- The program execution continues to the next movement instruction (unless argument \NoConc is used).
- When the ready signal from the timer is reached, the gun is opened.
- The motion is released on a release signal or a certain time after the gun opening and after successful post weld supervision.

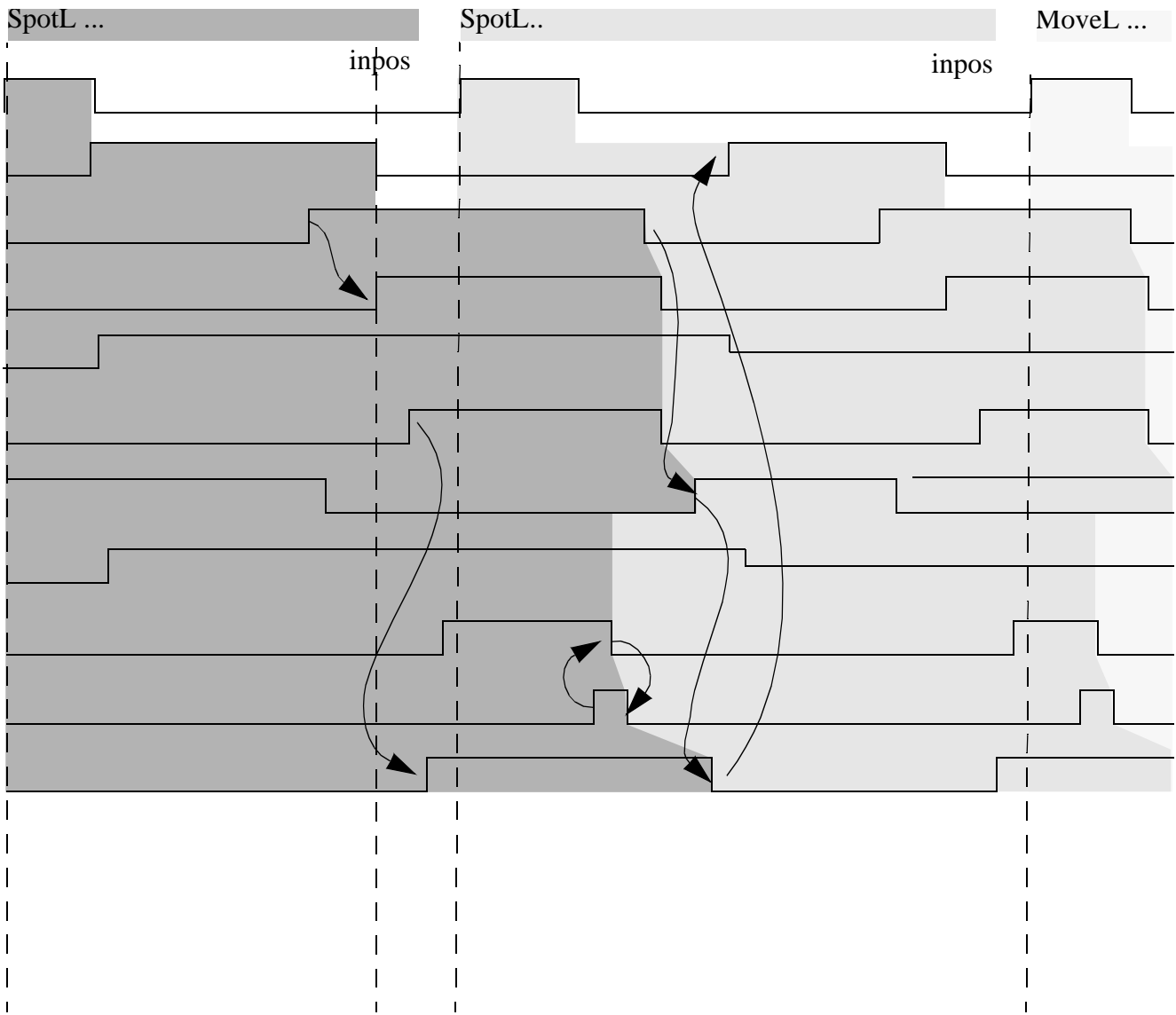


Figure 1 Spot weld sequence.

### ***Gun closure***

The gun closure is activated at a defined time before the weld position, irrespective of the actual speed. Closure shall be finished when the gun arrives at the end position. The close time is defined in the gun data. It relates to the time for closing the gun from the work stroke and is dependent on the chosen gun pressure (in spot data).

A maximum of four discrete gun pressures can be chosen in spot data. The gun pressure is set as soon as the motion towards the position starts. A check is made on whether or not the gun pressure has been attained, if so demanded by gun data.

When the gun is closing, the *work\_select* is set to 1, if desired. See Predefined Data and Programs.

### ***Welding***

The start signal is sent to the timer as soon as the robot has reached the end position. Before the start signal is sent, a number of supervisions must also be acknowledged. These are user defined routines. See Predefined Data and Programs.

The start signal is high during the entire welding period. It is reset either after weld ready or weld timeout.

When the option for program triggered timers is used the program number is set with the start signal and reset to zero after a successful weld or timeout.

### ***Gun opening***

The gun opens to a small or large stroke, after the welding has finished, depending on the parameter \Retract. The opening is supervised in such a way that a gun open signal is expected. This will release the next motion.

The gun is also opened after a weld error and other error situations.

### ***Motion***

To gain time the program pointer goes on to the next motion instruction while the welding is still performing. This makes it possible to perform the next motion immediately on a release order.

This means that instructions after *SpotL*, other than motional, such as logical instructions, will be performed concurrently with the welding. If this is not the intention the parameter *NoConc* shall be used.

A move enable for the next motion can be configured to be a signal from the gun or a certain time after weld ready.

The end position is related to the used object coordinate system in *WObj*.

### *Customising*

There is a wide range of tools for customising the SpotWare package by offering RAPID user routines. These are straight forward routines hooked into the base software. The following functions can be programmed freely by the user:

Preweld supervision - sw\_preweld\_sup

Postweld supervision - sw\_postweld\_sup

Gun closure - sw\_close\_gun

Gun opening - sw\_open\_gun

Pressure setting - sw\_set\_pressure

Preclose time calculation - sw\_close\_time

Error recovery - sw\_error\_recover

Note that the default code gives the same behaviour as described in the SpotWare documentation.

See Predefined Data and Programs - *System Modules SWUSRC*.

Internal sequence: The start to the timer can be initiated immediately after the preweld supervision has been acknowledged, if so configured. See Predefined Data and Programs - *System Module SWUSRC*.

---

## **Program stop and restart**

### *Stop during the motion and restart*

The robot stops on the path. If the signal to close the gun has already been sent the gun reopens at the stop.

On restart, the robot continues towards the programmed position, closes the gun again and the sequence in *SpotL* carries on as normal.

### *Stop during welding and restart*

The welding is finished. The validation of the weld is done after the stop and the gun opens. If **\NoConc** was not used, the program pointer will leave the current instruction and will point to the next instruction containing a robot motion.

---

## **Instruction by instruction execution**

### *Forwards*

The motion and the welding are done.

### ***Backwards***

The gun is set to work or retract stroke depending on \Retract.  
The motion is performed backwards.

---

## **Simulated welding**

### ***Full simulation of a timer.***

Activated by setting *sw\_sim\_weld* TRUE. This will inhibit the start signal to the timer.  
The simulation time is defined in *sw\_sim\_time*. No preweld supervision is performed.

### ***Simulation in the timer***

Activated by setting *sw\_inhib\_weld* TRUE. This will set the *current\_enable* signal low  
at the next weld. No preweld supervisions performed.

---

## **Error handling**

### ***Events in an error situation***

When *SpotL* is stopped by a supervision, the following take place:

- The signal *process\_error* is set.
- An error message is displayed.
- The error message is logged.

### ***Error situations***

The following error situations can occur:

- Instruction parameter error.
- Supervision error before welding.
- Weld error.
- Supervision error after welding and before the next motion.
- Supervision error for gun pressure.
- Supervision error for gun closure (SpotWare Plus)
- Supervision error for gun opening.

All the supervision behaviour described above, except weld error and parameter error,  
can be modified by the user.

To stop execution with an error message, simply put the desired message in the

assigned error string and it will show on the teach pendant.

The behaviour below is programmed as default.

See also Predefined Data and Programs.

### ***Instruction parameter error***

The error occurs when *SpotL* is called with faulty parameters. The program stops.

The parameter must be changed and the current instruction restarted from the beginning.

### ***Supervision before welding***

The supervisions in *sw\_preweld\_sup* are in progress. See Predefined Data and Programs - *System Module SWUSRC*.

### ***Weld error***

A weld error occurs if the ready signal from the weld timer has not been set to a certain time (*sw\_wr\_timeout*). *SpotL* can be configured to automatically reweld a certain number of times before the error is displayed and the execution stops, waiting for a manual action.

- The start signal is set low.
- The gun opens.
- The process error signal is set high.
- The following manual choices are available:

Automatic mode: ***Service / Reweld***

Manual mode: ***Service / Skip / Reweld*** (see the dialog box in Figure 2).

<b>Program Waiting for Data!</b>		
Weld_ready timeout		
Service	Skip	Reweld

Figure 2 Dialog box for weld error.

***Restart by choice Service***

This is not available in execution mode “stepwise forward”

- The process error signal is reset.
- The user defined routine *sw\_service\_wf* is executing, for instance moving to a home position.
- The robot moves back to the spot welding point.
- Back to the dialog as shown in Figure 2.

***Restart by choice Skip***

- The *reset\_fault* signal is pulsed.
- The process error signal is reset.
- The program execution is resumed but omitting the faulty weld.

***Restart by manual action SwRunProc***

- Same result as *Reweld*.

***Restart by choice Reweld***

- The *reset\_fault* signal is pulsed.
- The process error signal is reset.
- The gun closes.
- The start signal is set with a time delay of *sw\_reset\_time2* and the program execution is resumed.

***Supervision after the weld***

Supervisions in the user defined routine *sw\_postweld\_sup* are executing. See Predefined Data and Programs - *System Module SWUSRC*.

***Gun closure error***

The error occurs if the chosen pressure is not reached after a certain time. The signal *p1\_ok* is supervised if *gun\_pressure=1* i spotdata etc.

- The process error signal is set high.
- The following manual choice is available: ***Service / Retry***.
- Choice ***Service***: the user defined routine *sw\_service\_cg* is executing.
- Back to the manual choice: ***Service / Retry***.
- Choice ***Retry***: The gun is closing and the pressure is tested again.



***Gun opening error***

The error occurs if the gun has not opened after a certain time. The signal *tip1\_open* or *tip1\_open* and *tip2\_open* if *nof\_tips*=2 in gundata.

- The process error signal is set high.
- The following manual choice is available: ***Service / Retry***
- Choice ***Service***: the user defined routine *sw\_service\_og* is executing.
- Back to the dialog shown in Figure 2.
- Choice ***Retry***: The gun is opening and the signals are tested again.

***User defined error recovery***

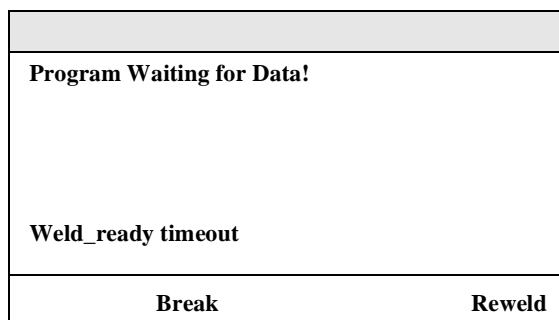
When user defined error recovery is switched on, the routine *sw\_user\_recover* is called if any of the above error cases occur, except for parameter error. The input parameters carry information about the error case and the chosen error text.

This routine allows customising the error handling response, i.e. the teach pendant layout and how to resume. See Predefined Data and Programs - *System Module SWUSRC*.

Note: no standard error logging is done by SpotWare when this option is used.

***Error recovery when program instance 0 is stopped***

When the program task 0 is stopped (user program stopped / stepwise execution / manual action) the service action is not a possible choice since it contains robot movements. Instead a “Break” choice is possible, which aborts the current process.



---

**Manual actions**

Manual actions allow the execution of spot weld functions without having to program a SpotL-instruction. It can be used as a tool to test user defined code before programming the line program.

The manual actions execute the same process code as when running SpotL, i.e. full

error recovery etc. is provided.

Manual actions execute in any system state except when a SpotL-instruction is in progress. Manual actions are activated by assigned virtual outputs.

See System Parameters - *Spot Welding*.

## Communication

*SpotL* communicates with its equipment using parallel signals.

For a complete description of the I/O configuration, see System Parameters - *Spot Welding*.

Some weld timers with serial interface are supported. In those cases the SpotL still faces a parallel interface and the serial communication messages are mapped internally. See separate documentation.

## Power failure handling

At system restart after power failure:

- All spotweld output signals are set to the old status, as well as gun close signals and weld start signals.

At program restart after power failure:

- The robot returns to the path and the program execution which was interrupted is continued.
- If a power failure occurred when a weld process was active, the current spot is automatically rewelded.

## Syntax

SpotL

```
[ ToPoint ':=' ] < expression (IN) of robtarg > ','
[ Speed ':=' ] < expression (IN) of speeddata > ','
[ Spot ':=' ] < persistent (PERS) of spotdata >
[ '\ InPos ]
[ '\ NoConc ]
[ '\ Retract ] ','
[ Gun ':=' ] < persistent (PERS) of gundata > ','
[ Tool ':=' ] < persistent (PERS) of tooldata >
[ '\ WObj ':=' ] < persistent (PERS) of wobjdata > ]';'
```

---

**Related information**

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of velocity	Data types - <i>speeddata</i>
Definition of zone data	Data types - <i>zonedata</i>
Definition of tool	Data types - <i>tooldata</i>
Definition of work objects	Data types - <i>wobjdata</i>
Definition of spot data	Data types - <i>spotdata</i>
Definition of gun data	Data types - <i>gundata</i>
Overview Spot welding	RAPID Summary - <i>Spot Welding</i>
Customising tools	Predefined data and programs - <i>System Module SwUsrF, SwUsrC</i>
I/O configuration	System parameters - <i>Spot Welding</i>
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - <i>Coordinate systems</i>

---



---

## System Module *SWUSRC*

The system module SWUSRC contains data and routines aimed at customising the behaviour of the SpotWare application. They are used and executed commonly by all RAPID tasks of SpotWare.

**NB. Any change of routines in SWUSRC requires the following three steps to affect the application (see also System Parameters Multitasking):**

- save to ramdisk
- touch the multitasking configuration
- WARM START to affect the application

The names are predefined and used internally when a *SpotL* instruction is used. They must therefore not be changed.

---

## Contents

### Data

The following global data are predefined:

<u>Name</u>	<u>Declaration</u>	<u>Description</u>
<b>sw_weld_counter</b>	PERS num sw_weld_counter := 0	Counter for welded spots. The counter is automatically incremented in the SpotL instruction.
<b>sw_gp_timeout</b>	PERS num sw_gp_timeout := 2	Gun pressure timeout [s]
<b>sw_wr_timeout</b>	PERS num sw_wr_timeout := 2	Weld ready timeout [s]
<b>sw_go_timeout</b>	PERS num sw_go_timeout := 2	Gun open timeout [s]
<b>sw_prog_max</b>	PERS num sw_prog_max := 63	Max. value for prog_no in spotdata.
<b>sw_inhib_weld</b>	PERS bool sw_inhib_weld := FALSE	Flag to set the weld timer in simulation mode. If TRUE: The signal current_enable is cleared when the next SpotL instruction is executed. If FALSE: The signal current_enable is set when the next SpotL instruction is executed.

<u>Name</u>	<u>Declaration</u>	<u>Description</u>
<b>sw_sim_weld</b>	PERS bool sw_sim_weld := FALSE	Flag to internally simulate the weld timer. If TRUE: Weld start signal is not activated.
<b>sw_spot_id_req</b>	PERS bool sw_spot_id_req := FALSE	Flag to request the spot identity of the programmed spots. If TRUE: It's possible to fetch the current spot identity (the spot parameter <i>name</i> of the current spotdata) using the function SwGetCurrSpotID. If the serial link for Bosch PSS 5000 is in use, the weld programs will be requested by the spotdata <i>name</i> instead of using the program number.
<b>sw_sim_time</b>	PERS num sw_sim_time := 0.5	Simulated weld time if sw_sim_weld = TRUE.
<b>sw_aut_reweld</b>	PERS num sw_aut_reweld := 0	Number of automatic tries to reweld after weld_ready timeout.
<b>sw_parity</b>	PERS num sw_parity:= 0	0 = none, 1 = odd, 2 = even
<b>sw_reset_time1</b>	PERS num sw_reset_time1 := 0.5	Reset pulse [s]
<b>sw_reset_time2</b>	PERS num sw_reset_time2 := 0.5	Wait time after the reset pulse and after each time current_enable is changed [s].
<b>sw_async_weld</b>	PERS num sw_async_weld := FALSE	TRUE means the start of the weld is set independently of inpos, i.e. immediately after closing the gun
<b>sw_servo_corr</b>	PERS num sw_servo_corr := 0.061	Correction time for internal delay. This value affects the preclosing time. The correct time which is dependent on motion configuration is automatically set at start up.

<u>Name</u>	<u>Declaration</u>	<u>Description</u>
<b>sw_start_type</b>	PERS num sw_start_type:=0	Tells the system how to start the weld process in the timer: 0: The weld process start is triggered by a specific start signal (e.g. start1). The program number is set in advance. 1: The weld process is triggered by the program number outputs. No presetting of the program number
<b>sw_user_recover</b>	PERS num sw_user_recover := FALSE	TRUE means the user function <i>sw_error_recover</i> is called in case of a process error. No error logging is performed by SpotWare. FALSE means standard error recovery is used.

The following predefined data is used by the manual actions to operate on:

<u>Name</u>	<u>Declaration</u>
<b>sw_man_gun</b>	PERS gundata gun1 := [1, 4, TRUE, TRUE, 0, 0, 20000, 20000, 0.050, 0.050, 0.050, 0.050, 0, 0, 0, 0]
<b>sw_man_spot</b>	PERS spotdata spot1 := [1, 1, 1, 1];
<b>sw_man_retr</b>	PERS num sw_man_retr := 0;

## Routines

The following predefined routines are installed with the application. They are all used by the *SpotL* instruction.

These routines have a default functionality but can easily be changed.

### *User defined supervision routines for SpotL:*

The following routines are called by the SpotL sequence.

#### **PROC sw\_preweld\_sup ()**

spotweld preweld supervision

The routine is executed before each start of the weld process.

If an error text is assigned to the text string *errtext*, then the system is automatically stopped with the error text on the display and with a possibility to restart the

supervision routine and continue the program execution.

Default functionality:

If the simulate weld or inhibit weld functions are not activated, then the following digital input signals are tested:

timer\_ready  
flow\_ok  
temp\_ok  
current\_ok

In the event of an error, a suitable error text is assigned to the text string errtext.

If timer\_ready = 0, then one attempt to reset the timer is made and a new check of the input is made before an error is indicated.

***PROC sw\_postweld\_sup ()***

spotweld postweld supervision

The routine is executed after the weld process before movement to the next position.

If an error text is assigned to the text string errtext, then the system is automatically stopped with the error text on the display and with a possibility to restart the supervision routine and continue the program execution.

Default functionality:

The work\_select signal is set or reset according to the Retract switch in the instruction.

***User defined independent supervision routines:***

The following routines are called independently of the SpotL-sequence.

***PROC sw\_sup\_init ()***

spotweld supervision init

The routine is executed at warm start. Here the user interrupt numbers used by sw\_sup\_trap should be initialised.

Default functionality:

Connection and activation of signals and interrupts used by sw\_sup\_trap.

***PROC sw\_motor\_on ()***

spotweld motor on

Routine called by the trap sw\_sup\_trap.

Default functionality:

Connected to interrupt number imotor\_on. Set weld\_power and pulse water\_on outputs.

**PROC sw\_motor\_off ()**

spotweld motor off

Routine called by the trap *sw\_sup\_trap*.

Default functionality:

Connected to interrupt number *imotor\_off*. Reset *weld\_power* output.

**PROC sw\_proc\_ok ()**

spotweld process ok

Routine called by the trap *sw\_sup\_trap*.

Default functionality:

Connected to interrupt number *iproc\_ok*. Set *weld\_power* and pulse *water\_on* outputs.

**PROC sw\_proc\_error ()**

spotweld process error

Routine called by the trap *sw\_sup\_trap*.

Default functionality:

Connected to interrupt number *iproc\_error*. Reset *weld\_power* output.

**PROC sw\_sup\_curren ()**

spotweld supervise current enable

Routine called by the trap *sw\_sup\_trap*.

Default functionality:

Connected to interrupt number *icurr\_enable*. Set *weld\_power* and pulse *water\_on* outputs.

**PROC sw\_sup\_currdis ()**

spotweld supervise current disable

Routine called by the trap *sw\_sup\_trap*.

Default functionality:

Connected to interrupt number *icurr\_disable*. Reset *weld\_power* output.

**User defined trap routines:**

The interrupts in these trap routines will always be alert to execute independently of the actual system state.

**TRAP sw\_sup\_trap ()**

spotweld supervision trap



Trap routine connected to the supervision.

Default functionality:

Control of the output signals `water_start` and `weld_power` depending on the system state. See System Parameters - *Spotwelding*.

***User defined process routines and functions for SpotL:***

The following routines are called by the SpotL sequence.

***PROC sw\_close\_gun ()***

spotweld close gun

The routine is executed each time a closing of the gun is ordered. N.B. also the manual action.

If an error text is assigned to the text string `errtext_close`, then the system is automatically stopped with the error text on the display and with a possibility to restart the supervision routine and continue the program execution.

Default functionality:

See Instructions - *SpotL*.

***PROC sw\_open\_gun (num context)***

spotweld open gun

The routine is executed each time an opening of the gun is ordered. N.B. also the manual action.

Parameters:

- **context:** reason for opening. A negative value is used to leave out the gun open tests and to ignore the `errtext_open` when a quick open is needed in an error situation.

If an error text is assigned to the text string `errtext_open`, then the system is automatically stopped with the error text on the display and with a possibility to restart the supervision routine and continue the program execution.

Default functionality:

See Instructions - *SpotL*.

***PROC sw\_set\_pressure ()***

spotweld set pressure

The routine is executed in the preparation phase of the spot weld process.

Default functionality:

Sets the pressure output group according to `gun_pressure`. See Instructions - *SpotL*.

***FUNC num sw\_error\_recover (num error\_type, string err\_text)***

spotweld error recover

The function is called in an error situation if the variable *sw\_user\_recover* is set TRUE.

Parameters:

- **error\_type**: type of error that occurred. Possible cases are:
  - SW\_WELD\_ERR: weld error timeout
  - SW\_OG\_ERR: open gun error. Error reported by *sw\_open\_gun*
  - SW\_CG\_ERR: close gun error. Error reported by *sw\_close\_gun*
  - SW\_PRESUP\_ERR: preweld supervision error. Error reported by *sw\_preweld\_sup*.
  - SW\_POSUP\_ERR: postweld supervision error. Error reported by *sw\_postweld\_sup*.
- **err\_text**: text string that was returned by the function that reported the error. In case of a weld error it is the standard “weld ready timeout” message.

The return value of this function defines how the SpotWare shall resume after this error. There are three possible return values:

- SW\_RETRY: the action that produced the error is re-executed.
- SW\_CANCEL: the current spot weld process is abandoned and cleaned up.
- SW\_SERVICE: the service routine corresponding to the error produced is executing. Note that no service routines exist for preweld and postweld supervision.



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## System Module

## SWUSRF

The system module SWUSRF contains data and routines aimed at customising the behaviour of the SpotWare application. They are used and executed by the RAPID foreground task of SpotWare.

The routine names are predefined and used internally when a *SpotL* instruction is used. They must therefore not be changed.

---

## Contents

### Data

The following global data are predefined:

<u>Name</u>	<u>Declaration</u>	<u>Description</u>
<b>sw_inpos</b>	PERS bool sw_inpos := FALSE	If TRUE: Gun preclosing is deactivated.
<b>sw_close_corr</b>	VAR num sw_close_corr := 100	Correction factor used when the next gun preclose time is calculated [%]. Is automatically reset to 100 after each preclose calculation. Preferably this data can be changed in a separate assignment instruction just before the influenced SpotL instruction.

Normally it is suitable to use the module SWUSRF to store variables of the type spotdata, gundata and tooldata, used for the application. The following variables are predefined but their names and values can be changed freely.

<u>Name</u>	<u>Declaration</u>
<b>gun1</b>	PERS gundata gun1 := [1, 4, TRUE, TRUE, 0, 0, 20000, 20000, 0.050, 0.050, 0.050, 0.050, 0, 0, 0, 0]
<b>toolg1</b>	PERS tooldata toolg1 := [TRUE, [[0, 0, 0], [1, 0, 0, 0]], [-1, [0, 0, 0],[1, 0, 0, 0], 0, 0, 0]]
<b>spot1</b>	PERS spotdata spot1 := [1, 1, 1, 1]

## Routines

The following predefined routines are installed with the application. They are all used by the *SpotL* instruction.

These routines have a default functionality but can easily be changed.

### *User defined service routines:*

After execution of a service routine, the robot moves to the interrupted weld position with reduced speed. The text “Service routine ready” and the old function keys are shown.

***PROC sw\_service\_cg ();***

spotweld service close gun

The routine is executed when the gun error “Gun pressure not reached” occurs and the function key “Service” is pressed.

By pressing Retry back from the service routine, a new attempt to close the gun is made and then program execution continues.

Default functionality:

No functions, only an information text and a “Return” key are shown. The service routine is ended when “Return” is pressed.

***PROC sw\_service\_og ();***

spotweld service open gun

The routine is executed when the gun error “Gun open timeout” occurs and the function key “Service” is pressed.

By pressing Retry back from the service, a new test will be made if the gun is open, and then program execution continues.

Default functionality:

No functions, only an information text and a “Return” key are shown. The service routine is ended when “Return” is pressed.

***PROC sw\_service\_wf ();***

spotweld service weld fault

The routine is executed when the error “Weld ready timeout” occurs and the function key “Service” is pressed.

By pressing Reweld back from the service, a new attempt to weld the spot is made and then program execution is continued.

Default functionality:

No functions, only an information text and a “Return” key are shown. The service routine is ended when “Return” is pressed.

***General user routines and functions:***

The following routines are connected to different entries in the SpotWare RAPID base software.

***FUNC num sw\_close\_time (spotdata spot, gundata gun);***

spotweld close time calculation

The function is executed during motion preparation. It returns the preclosing time for the gun.

Input parameters:

spot of type spotdata: actual spot given in the SpotL-instruction in preparation

gun of type gundata: actual gun given in the SpotL-instruction in preparation

Default functionality:

The resulting time is dependent on the four pressure levels in gundata.



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## System Module *SWTOOL*

The system module SWTOOL contains data functions and routines. The module is declared NOVIEW and contains utilities to be used as a toolbox when customising SpotWare. This module is accessible commonly by all RAPID tasks of SpotWare.

---

### Contents

#### Function return values

SW\_OK

SW\_RETRY

SW\_SERVICE

SW\_ERROR

SW\_TIMEOUT

SW\_CANCEL

#### User error recovery types (see function *sw\_user\_recover* in *SWUSRC*)

SW\_WELD\_ERR

SW\_CG\_ERR

SW\_OG\_ERR

SW\_PRESUP\_ERR

SW\_POSUP\_ERR



**Routines**

The following predefined routines are installed with the application. They are used to influence *SpotL* instruction.

***PROC SwSetCurrSpot (spotdata spot)***

SpotWeldSetCurrentSpot.

The function changes the spotdata parameter of the running spotware process.

***PROC SwSetCurrGun (gundata gun)***

SpotWeldSetCurrentGun

The function changes the gundata parameter of the running spotware process.

***PROC SwSetCurrRetr (num retr)***

SpotWeldSetCurrentRetract

The function changes the retract switch parameter of the running spotware process.

retr 0: work stroke

retr 1: retract stroke

***PROC SwGetCurrNoConc (bool noconc)***

SpotWeldSetCurrentNoConcurrency

The function changes the NoConc switch parameter of the running spotware process.

noconc TRUE: NoConc is present

noconc FALSE: NoConc is not present

***PROC SwSetCurrSpotID (string spot\_id)***

SpotWeldSetCurrentSpotIdentity

The function changes the spotdata parameter *name* of the running spotware process.

**Functions**

The following predefined functions are installed with the application.

***FUNC spotdata SwGetCurrSpot***

SpotWeldGetCurrentSpot.

The function returns the content of the spotdata parameter of the running spotware process.

***FUNC gundata SwGetCurrGun***

SpotWeldGetCurrentGun

The function returns the content of the gundata parameter of the running spotware process.

***FUNC num SwGetCurrRetr***

SpotWeldGetCurrentRetract

The function returns the content of the retract switch parameter of the running spotware process.

Return value 0: work stroke

Return value 1: retract stroke

***FUNC bool SwGetCurrNoConc***

SpotWeldGetCurrentNoConcurrency

The function returns the content of the NoConc switch parameter of the running spotware process.

Return value TRUE: NoConc is present

Return value FALSE: NoConc is not present

***FUNC string SwGetCurrSpotID***

SpotWeldGetCurrentSpotIdentity

The function returns the spotdata parameter *name* of the running spotware process.

**FUNC num SwWaitInput (VAR signaldi input, num value \num MaxWait)**

SpotWeldWaitInput

Waits until the signal *input* has reached *value*. A max. time *MaxWait* can be added as an optional parameter. When running a user routine called by the spot weld process, in which the process is supposed to wait for an input signal, this function is used to let the system abandon the current process.

Return value SW\_OK: Signal was set to output *value*.

Return value SW\_TIMEOUT: The time specified in *MaxWait* has been exceeded.

Return value SW\_CANCEL: The SpotWare process has received an abort and wants to cancel the current process. It shall cause a return from the current user routine.

**FUNC num SwWaitOutput (VAR signaldo output, num value \num MaxWait)**

SpotWeldWaitOutput

Waits until the signal output has reached *value*. A maximum time *MaxWait* can be added as an optional parameter. When running a user routine called by the spotweld process, in which the process is supposed to wait for an output signal, this function is used to let the system abandon the current process.

Return value SW\_OK: Signal was set to *value*.

Return value SW\_TIMEOUT: The time specified in *MaxWait* has been exceeded.

Return value SW\_CANCEL: The SpotWare process has received an abort and wants to cancel the current process. It shall cause a return from the current user routine.

**FUNC num SwErrorAck (VAR num input\_key, string alert, string ktxt1, string ktxt2, string ktxt3, string ktxt4, string ktxt5)**

SpotWeldErrorAcknowledge

This function is a modified TPreadFK which can be aborted by the SpotWare kernel. The parameters are consistent with the standard TPreadFK. When this routine is not used for teach pendant dialogs, the SpotWare is hung up until released from the TP. The function is used by *sw\_error\_recover* in the module *SWUSRC*.

Return value SW\_OK: normal execution, the result of the pushing a function key resides in *input\_key*.

Return value SW\_CANCEL: the spot weld process was aborted. Return from the calling user routine.

CONTENTS

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ggundata	Gluing gun data
GlueC	Gluing with circular motion
GlueL	Gluing with linear motion
System Module	GLUSER

*GlueWare*

---



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## ggundata      Gluing gun data

*Ggundata* is used to define gluing gun specific data, which is then to be used to control the gun in an optimal way during the gluing process.

Note that the TCP and weight of the gluing gun are defined in *tooldata*.

---

### Description

Ggundata is used in glue instructions and has the following structure:

- Which gun is to be used (1 or 2).
- Time for preopening and preclosing the gun.
- Type of flow1 and flow2.
- Times for presetting of flow1 and flow2 on.
- Times for presetting flow1 and flow2 changes.
- Times for presetting of flow1 and flow2 off.
- Times for lag in glue gun for speed dips
- Value for the speed, at which the logical maximum value for the analog outputs shall be set.

---

### Components

<b>ggun_no</b>	<i>(number of gun to use)</i>	Data type: <i>num</i>
	Number to define if this ggundata is for gun 1 or gun 2.	
<b>gl_on_time</b>	<i>(preopen time for the gun)</i>	Data type: <i>num</i>
	Time in s needed for the gun to open.	
<b>gl_off_time</b>	<i>(preclose time for the gun)</i>	Data type: <i>num</i>
	Time in s needed for the gun to close.	
<b>fl1_type</b>	<i>(type of flow1)</i>	Data type: <i>num</i>
	Type of flow1 signal, set to none, fixed or speed proportional, where none = 0, fixed = 1 and speed proportional = 2.	
<b>fl1_on_time</b>	<i>(preset on time flow1)</i>	Data type: <i>num</i>
	Time in s needed to set up the flow1 in the gun when the instruction is programmed with the <i>\On</i> argument.	

- fl1\_time** (preset change time flow1) Data type: *num*  
 Time in s needed to set up the flow1 in the gun when the instruction is programmed without the *\On* and *\Off* argument (i.e. time needed to change the flow from one specific value to another).
- fl1\_off\_time** (preset off time flow1) Data type: *num*  
 Time in s needed to reset the flow1 in the gun when the instruction is programmed with the *\Off* argument.
- fl1\_delay** (lag delay flow1) Data type: *num*  
 Time in s to compensate for the lag in the gluegun for TCP speed dips.
- fl1\_refspped** (glue reference speed) Data type: *num*  
 Glue reference speed in mm/s. Normally the max. used glue speed for this gun. Used in calculation of the flow1 value for speed proportional signals. This value must be > 0 also when flow type=fixed.
- fl2\_type** (type of flow2) Data type: *num*  
 Type of flow2 signal, set to none, fixed or speed proportional, where none = 0, fixed = 1 and speed proportional = 2.
- fl2\_on\_time** (preset on time flow2) Data type: *num*  
 Time in s needed to set up the flow2 in the gun when the instruction is programmed with the *\On* argument.
- fl2\_time** (preset change time flow2) Data type: *num*  
 Time in s needed to set up the flow2 in the gun when the instruction is programmed without the *\On* and *\Off* argument (i.e. time needed to change the flow from one specific value to another).
- fl2\_off\_time** (preset off time flow2) Data type: *num*  
 Time in s needed to reset the flow2 in the gun when the instruction is programmed with the *\Off* argument.
- fl2\_delay** (lag delay flow2) Data type: *num*  
 Time in s to compensate for the lag in the gluegun for TCP speed dips.
- fl2\_refspped** (glue reference speed) Data type: *num*  
 Glue reference speed in mm/s. Normally the tax. used glue speed for this gun. Used in calculation of the flow2 value for speed proportional signals. This value must be > 0 also when flow type=fixed.

---

## Limitations

Max. number of guns: 2

Max. real lag compensation (*fl1\_delay* and *fl2\_delay*) is normally: 40 - 60ms

If the system parameter (*EventPresetTime*) is changed, the compensation for lag will increase to a corresponding degree.

The values for the different times within the dataset must be between 0 to 1 seconds.

The value for the reference speed has to be > 0.

---

## Predefined data

The predefined data *ggun1* defines the use of gun no 1, a flow1 and flow2 of type 2, i.e. proportional flow values are used, all belonging times are set to zero and the reference speed is 1000 mm/s for each flow.<sup>1</sup>

PERS *ggun1* := [1,0,0,2,0,1,0,0,0,1000,2,0,1,0,0,0,1000];

---

## Structure

```
< dataobject of ggundata>
  <ggun_no of num>
  <gl_on_time of num>
  <gl_off_time of num>
  <fl1_type of num>
  <fl1_on_time of num>
  <fl1_time of num>
  <fl1_off_time of num>
  <fl1_delay of num>
  <fl1_refspeed of num>
  <fl2_type of num>
  <fl2_on_time of num>
  <fl2_time of num>
  <fl2_off_time of num>
  <fl2_delay of num>
  <fl2_refspeed of num>
```

---

1. The preset on time for flows 1 and 2 is set to 0.1s. (The flow signals will normally be activated before the gun is opened).



---

**Related information**

Glue instruction

Described in:

Instructions - *GlueL / GlueC*

## GlueC      Gluing with circular motion

*GlueC (GlueCircular)* is used in gluing to control the motion, gun opening and the gluing process. *GlueC* moves the TCP on a circular path to the end position.

### Example 1

```
GlueL \On, p1, v250, ggun1 \F1:=100 \F2:=80, z30, tool7;
GlueC p2, p3, v250, ggun1 \F1:=90 \F2:=70, z30, tool7;
GlueL \Off, p4, v250, ggun1, z30, tool7;
```

1. The TCP for *tool7* is moved on a linear path to the position *p1* with the speed given in *v250*. Due to the `\On` argument the gun opens and the glue flow is started according to the data given in *ggun1* in advance on its way to *p1*. The glue flow is started with the percentage values given by the `\F1:=100` and `\F2:=80` parameters.
2. The TCP is then moved from *p1* towards *p3* with the flow values given by the preceding glue instruction. Before *p3* is reached, the flow values are changed to 90% and 70% respectively. The time when that is performed is specified in *ggun1*.
3. The TCP is then moved from *p3* towards *p4* with the flow values given by the preceding glue instruction. Due to the `\Off` argument the outputs will be reset according to the times given in *ggun1* before *p3* is reached.

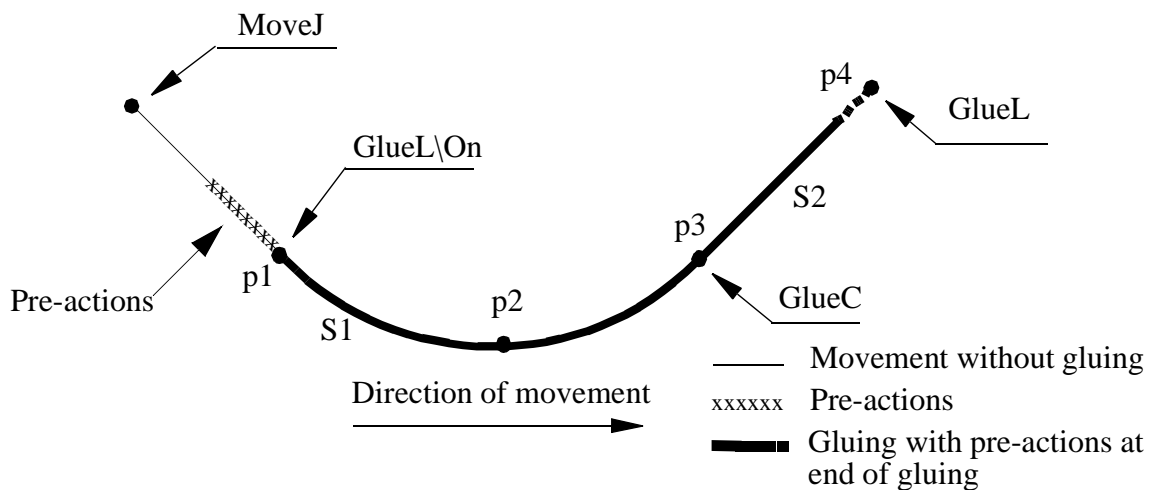


Figure 1 Glue example 1

S1: Flow1=100, Flow2=80, i.e. the glue values given by the first instruction are active.  
 S2: Flow1=90, Flow2=70, i.e. the glue values given by the second instruction are active.

---

**Arguments**
**GlueC [\On][\Off] [\Conc] CirPoint ToPoint Speed Gluegun [\F1]  
[\F2] [\D] Zone Tool [\WObj]**
**[\On]**Data type: *switch*

The argument `\On` is used in the first Glue instruction to start the glue process (see Figure 1).

The argument may only be used in the first glue instruction to perform the necessary gun opening and setting of the flow in advance. Executing two consecutive instructions with `\On` argument will result in an error message.

As the instruction cannot contain the arguments `\On` and `\Off` together, the gluing path must have at least 2 instructions, one containing the `\On` and one containing the `\Off` argument.

The pre-actions, which are performed on the path to the programmed position, are setting of the gun opening output and setting of the analog glue outputs.

**[\Off]**Data type: *switch*

The argument `\Off` is used in the last gluing instruction to terminate the gluing when the programmed position is reached. On the way to the end position the output for opening the gun as well as the flow outputs will be reset according to the given time within the specified `ggundata`.

So it is not possible to terminate gluing without using the `\Off` argument during movements.

**[\Conc]***(Concurrent)*Data type: *switch*

Subsequent instructions are executed while the robot is moving. This argument is used in the same situations as corresponding argument in other Move instructions but for gluing it is also useful to permit higher speeds when consecutive glue instructions are close to each other.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes *StorePath-RestoPath*, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted, the subsequent instruction is only executed after the robot has reached the specified zone.

**CirPoint**Data type: *robtarger*

The circle point of the robot. The circle point is a point on the circle between the start point and the destination point. To obtain the best accuracy, it should be placed about halfway between the start and destination points. If it is placed too close to the start or end point, the robot may give a warning. The circle point is defined as a named position or stored directly in the instruction (if marked with

an \* in the instruction).

**ToPoint** Data type: *robtarget*

The destination point of the robot and the external axes. It is defined as a named position or stored directly in the instruction (if marked with an \* in the instruction).

**Speed** Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity for the tool centre point, the tool reorientation and external axes.

**GlueGun** Data type: *ggundata*

Gun specific data, e.g. the reaction time for setting a flow etc., for the gun in use.

**[\F1]** (*Flow1*) Data type: *num*

The argument *\F1* gives a value in percent to adjust the flow1 for the next part of the path. If no value is programmed the same value as in previous glue instruction is used. If no value is programmed in a glue instruction with *\On* argument the value 0 is used.

**[\F2]** (*Flow2*) Data type: *num*

The argument *\F2* gives a value in percent to adjust the flow2 for the next part of the path. If no value is programmed the same value as in previous glue instruction is used. If no value is programmed in a glue instruction with *\On* argument the value 0 is used.

**[\D]** (*Distance*) Data type: *num*

The optional argument *\D* gives the possibility to perform all pre-actions during the instruction the given distance (mm) in advance of the programmed position.

**Zone** Data type: *zonedata*

Zone data for the movement. Zone data describes the size of the generated corner path.

**Tool** Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point moved to the specified destination position, and should be the position of the tip when the gun is open.

**[\WObj]** (*Work Object*) Data type: *wobjdata*

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified in order to perform a linear movement relative to the work object.

---

## Customizing

The GlueWare package provides opportunities for the user to customize the *GlueC* instruction:

- by user defined data which affects the internal behaviour in *GlueC*. (See Predefined Data and Programs - *System Module GLUSER*).
- by changing the I/O configuration. (See System Parameters - *Gluing*).

However, the main subject of this *GlueC* instruction description is the default setup.

---

## Program execution

Internal sequence in a *GlueC* instruction:

- The gun starts to move towards the position.
- If the argument *\On* is used the gun opening output *DO\_Ggun1* or *DO\_Ggun2* is set at the specified time before the position is reached. If the argument *\D* is used the output is set at the specified distance plus the specified times before the position is reached.
- The values for flow1 and flow2 are set at the analog outputs *AO\_G1Flow1* and *AO\_G1Flow2*, and *AO\_G2Flow1* and *AO\_G2Flow2* respectively at the specified time before the position is reached. If the argument *\D* is used the outputs are set at the specified distance plus the specified times before the position is reached.
- When the programmed position is reached, the program execution continues with the next instruction.

---

## Calculation of the glue flow values

See corresponding description of *GlueL*

---

## Program stop and restart

### *Stop during the glue process*

If a stop occurs when the glue process is active, the gluing outputs are cleared and an error message is displayed. When the restart is ordered, the remaining instructions in the current set of glue instructions are performed as normal positioning instructions. The gluing is restarted with the next glue instruction with an *\On* argument.

## Instruction by instruction execution

### *Forwards*

The gun is closed and motion without gluing is done.

### *Backwards*

The gun is closed and the motion is performed backwards without gluing.

---

## Simulated gluing

Activated by setting the variable *gl\_sim\_glue* to TRUE. This will inhibit the gun opening and the flow signals. (See Predefined Data and Programs - *System Module GLUSER*)

---

## Limitations

It is not possible to restart the current glue sequence after a stop. The gluing is restarted with the next glue instruction with an *\On* argument.

The max. gluing speed is dependent on the distance between the programmed positions. If the speed programmed is too high, the error message 50082 will appear. Avoid this error message by:

- changing the positions so that they are not so close to each other
  - using the argument *\Conc* in the gluing instructions
  - decreasing the speed.
- 

## Error handling

### *Error situations*

The following error situations are handled:

- Instruction argument error.
- Wrong *ggundata* values.
- Start without *\On* argument.
- Start with two instructions with *\On* argument.
- End with *\Off* argument without having started with *\On* argument.
- Stop during execution of glue instructions.

The faulty instruction or data must be changed and the current set of glue instructions

must be restarted from the beginning.

---

## Syntax

### GlueC

```

[[ '\On ] [ '\Off ]
[ '\ Conc ], ]
[CirPoint ':=' ] <expression (IN) of robtarg> ', '
[ToPoint ':=' ] <expression (IN) of robtarg> ', '
[Speed ':=' ] <expression (IN) of speeddata> ', '
[Gluegun ':=' ] <persistent (PERS) of ggundata>
    [ '\F1 ':=' ] <expression (IN) of num> ]
    [ '\F2 ':=' ] <expression (IN) of num> ]
    [ '\D ':=' ] <expression (IN) of num> ], '
[Zone ':=' ] <expression (IN) of zonedata> ', '
[Tool ':=' ] <persistent (PERS) of tooldata>
[ '\WObj ':=' ] <persistent (PERS) of wobjdata> ], '

```

---

## Related information

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of velocity	Data types - <i>speeddata</i>
Definition of zone data	Data types - <i>zonedata</i>
Definition of tool	Data types - <i>tooldata</i>
Definition of work objects	Data types - <i>wobjdata</i>
Definition of gluegun data	Data types - <i>ggundata</i>
Overview Gluing	RAPID Summary - <i>GlueWare</i>
Customizing tools	Predefined data and programs - System Module <i>GLUSER</i>
I/O configuration	System parameters - <i>GlueWare</i>
Motion in general	Motion and I/O Principles

## GlueL                      Gluing with linear motion

*GlueL* (*GlueLinear*) is used in gluing to control the motion, gun opening and the gluing process. *GlueL* moves the TCP linearly to the end position.

### Example 1

```
GlueL \On, p1, v250, ggun1 \F1:=100 \F2:=80, z30, tool7;
GlueL p2, v250, ggun1 \F1:=90 \F2:=70, z30, tool7;
GlueL \Off, p3, v250, ggun1, z30, tool7;
```

1. The TCP for *tool7* is moved on a linear path to the position *p1* with the speed given in *v250*. Due to the `\On` argument the gun opens and the glue flow is started according to the data given in *ggun1* in advance on its way to *p1*. The glue flow is started with the percentage values given by the `\F1:=100` and `\F2:=80` parameters.
2. The TCP then is moved from *p1* towards *p2* with the flow values given by the preceding glue instruction. Before *p2* is reached, the flow values are changed to 90% and 70% respectively. The time when that is performed is specified in *ggun1*.
3. The TCP then is moved from *p2* towards *p3* with the flow values given by the preceding glue instruction. Due to the `\Off` argument the outputs will be reset according to the times given in *ggun1* before *p3* is reached.

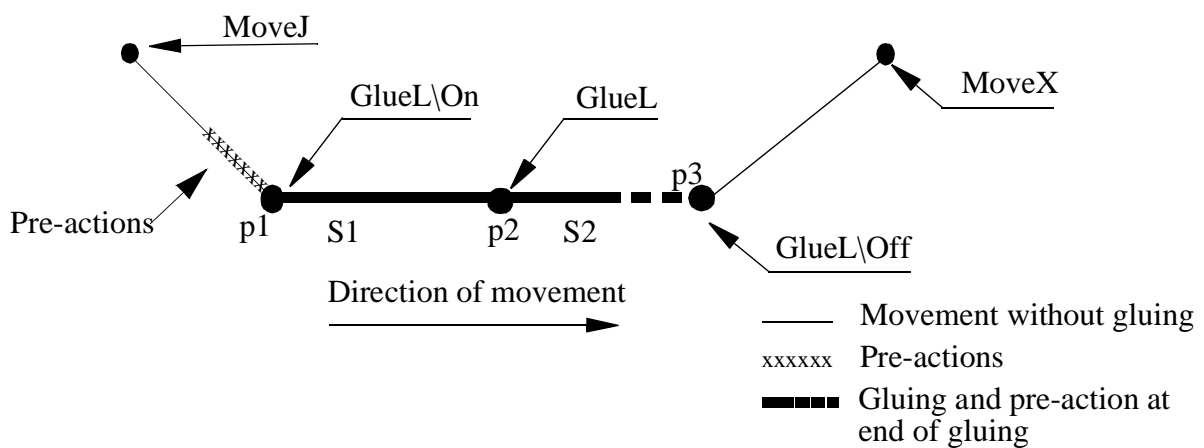


Figure 1 Glue example 1

S1: Flow1=100, Flow2=80, i.e. the glue values given by the first instruction are active.

S2: Flow1=90, Flow2=70, i.e. the glue values given by the second instruction are active.



---

**Arguments**
**GlueL [\On][\Off] [\Conc] ToPoint Speed GlueGun [\F1] [\F2] [\D]  
Zone Tool [\WObj]**
**[\On]**Data type: *switch*

The argument `\On` is used in the first Glue instruction to start the glue process (see Figure 1).

The argument may only be used in the first glue instruction to perform the necessary gun opening and setting of the flow in advance. Executing two consecutive instructions with `\On` argument will result in an error message.

As the instruction cannot contain the arguments `\On` and `\Off` together, the gluing path must have at least 2 instructions, one containing the `\On` and one containing the `\Off` argument.

The pre-actions, which are performed on the path to the programmed position, are setting of the gun opening output and setting of the analog glue outputs.

**[\Off]**Data type: *switch*

The argument `\Off` is used in the last gluing instruction to terminate the gluing when the programmed position is reached. On the way to the end position the output for opening the gun as well as the flow outputs will be reset according to the given time within the specified gundata.

So it is not possible to terminate gluing without using the `\Off` argument during movements.

**[\Conc]***(Concurrent)*Data type: *switch*

Subsequent instructions are executed while the robot is moving. This argument is used in the same situations as corresponding argument in other Move instructions but for gluing it is also useful to permit higher speeds when consecutive glue instructions are close to each other.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes *StorePath-RestoPath*, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted, the subsequent instruction is only executed after the robot has reached the specified zone.

**ToPoint**Data type: *robtaraget*

The destination point of the robot and the external axes. It is defined as a named position or stored directly in the instruction (if marked with an \* in the instruction).

**Speed**Data type: *speeddata*

The speed data that applies to movements. Speed data defines the velocity for the tool centre point, the tool reorientation and external axes.

**GlueGun**Data type: *ggundata*

Gun specific data, e.g. the reaction time for setting a flow etc., for the gun in use (see *Datatypes - Ggundata*).

**[\F1]***(Flow1)*Data type: *num*

The argument *\F1* gives a value in percent to adjust the flow1 for the next part of the path. If no value is programmed the same value as in previous glue instruction is used. If no value is programmed in a glue instruction with *\On* argument the value 0 is used.

**[\F2]***(Flow2)*Data type: *num*

The argument *\F2* gives a value in percent to adjust the flow2 for the next part of the path. If no value is programmed the same value as in previous glue instruction is used. If no value is programmed in a glue instruction with *\On* argument the value 0 is used.

**[\D]***(Distance)*Data type: *num*

The optional argument *\D* gives the possibility to perform all pre-actions given the distance (mm) in advance of the programmed position.

**Zone**Data type: *zonedata*

Zone data for the movement. Zone data describes the size of the generated corner path.

**Tool**Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point moved to the specified destination position, and should be the position of the tip when the gun is open.

**[\WObj]***(Work Object)*Data type: *wobjdata*

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted, and if it is, the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified in order to perform a linear movement relative to the work object.

---

## Customizing

The GlueWare package provides opportunities for the user to customize the *GlueL* instruction:

- by user defined data which affects the internal behaviour in *GlueL*. (See Predefined Data and Programs - *System Module GLUSER*).
- by changing the I/O configuration. (See System Parameters - *Gluing*).

However, the main subject of this *GlueL* instruction description is the default setup.

---

## Program execution

Internal sequence in a *GlueL* instruction:

- The gun starts to move towards the position.
- If the argument *\On* is used the gun opening output *DO\_Ggun1* or *DO\_Ggun2* is set at the specified time before the position is reached. If the argument *\D* is used the output is set at the specified distance plus the specified times before the position is reached.
- The values for flow1 and flow2 are set at the analog outputs *AO\_G1Flow1* and *AO\_G1Flow2*, and *AO\_G2Flow1* and *AO\_G2Flow2* respectively at the specified time before the position is reached. If the argument *\D* is used the outputs are set at the specified distance plus the specified times before the position is reached.
- When the programmed position is reached, the program execution continues with the next instruction.

---

## Calculation of the glue flow values

The following data is used when the logical flow1 value is calculated (The logical flow2 is calculated in a similar way):

F1	instruction parameter (0-100)
gl_fl1_ovr	global override (Default: 100). (See Predefined Data and Programs - <i>System Module GLUSER</i> )
gl_fl1_ref	logical max. value (Default: 1000). (See Predefined Data and Programs - <i>System Module GLUSER</i> )
current speed	current robot speed (mm/s).
fl1_refspeed	glue reference speed (mm/s). (See Data Types- <i>ggundata</i> )

Calculation of logical flow1 when fl1\_type = 1 (fixed):

$$\text{logical flow1} = F1 * \text{gl\_fl1\_ovr} * \text{gl\_fl1\_ref} / 10000$$

Calculation of logical flow1 when fl1\_type = 2 (proportional):

$$\text{logical flow1} = (F1 * \text{gl\_fl1\_ovr} * \text{gl\_fl1\_ref} / 10000) * \text{current speed} / \text{fl1\_refspeed}$$

This means: With the default values above and with the default setup for logical max. and min. for the analog glue outputs (See System Parameters - *GlueWare*) we get following result:

If flow1\_type = 1 (fixed): Physical max. value is activated if F1 = 100 (%) in the instruction.

If flow1\_type = 2 (proportional): Physical max. value is activated if F1 = 100 (%) in the instruction and the actual speed is the same as fl1\_refspeed in current ggundata.

**Example 2**

```
GlueL \On, p1, v250, ggun1 \F1:=100 \F2:=80 \D:=50, z30, tool7;
GlueL p2, v250, ggun1 \F1:=90 \F2:=70 \D:=50, z30, tool7;
GlueL \Off, p3, v250, ggun1 \D:=50, z30, tool7;
```

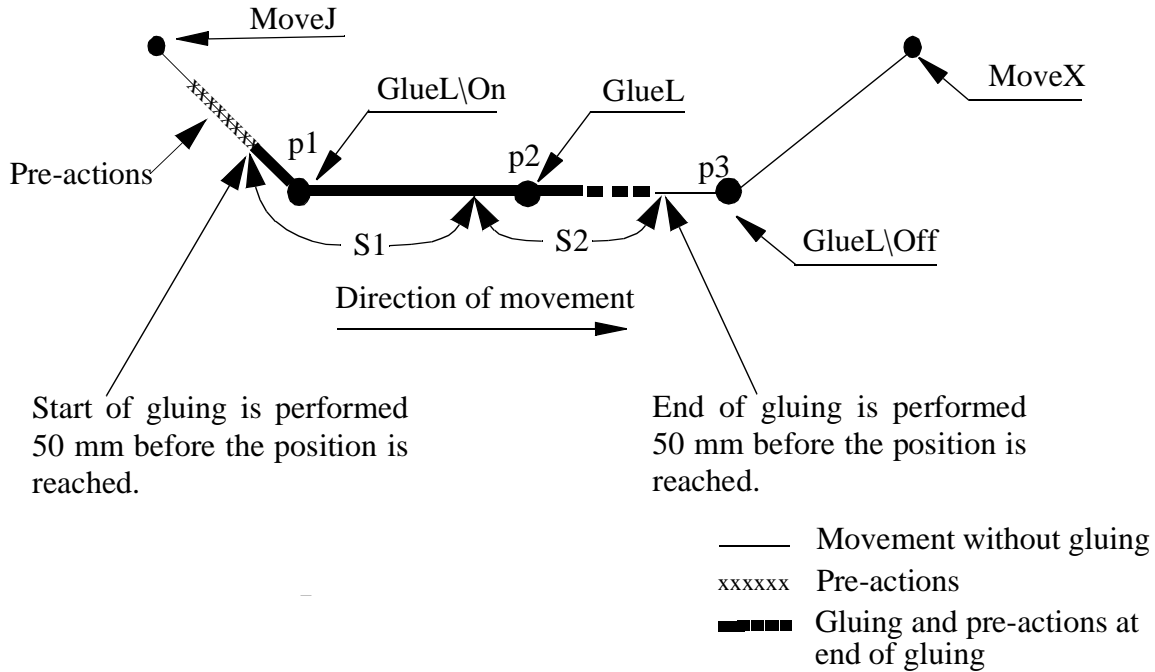


Figure 2 Glue example 2

In this example everything is the same as in example 1 except that all glue specific actions are executed an additional distance (50 mm) before the programmed positions are reached.

Assume that the logical maximum value for the signals is 10. When fl1\_type=1 (fixed) and gl\_fl1\_our=100 (normal value for glue flow override), the values 10 on stretch S1 and 9 on stretch S2 are obtained for flow 1. When gl\_fl1.our is changed to 50, the values 500 and 450 respectively will be obtained. When fl2\_type=2 (proportional) and gl\_fl2\_our=100, the values 800 on stretch S1 and 700 on stretch S2 are obtained for flow 2, if the current speed is the same as the reference speed (fl2\_refspped).

When the speed is reduced, e.g. in a corner path, the flow will also be reduced correspondingly. The physical values of the signals are also determined by how the analog signals are configured in the system parameters (relationship between physical and logical values).

**Program stop and restart**

*Stop during the glue process*

If a stop occurs when the glue process is active, the gluing outputs are cleared and an error message is displayed. When the restart is ordered, the remaining instructions in the current set of glue instructions are performed as normal positioning instructions.

The gluing is restarted with the next glue instruction with an `\On` argument.

---

## Instruction by instruction execution

### *Forwards*

The gun is closed and motion without gluing is done.

### *Backwards*

The gun is closed and the motion is performed backwards without gluing.

---

## Simulated gluing

Activated by setting the variable `gl_sim_glue` to TRUE. This will inhibit the gun opening and the flow signals. (See Predefined Data and Programs - *System Module GLUSER*)

---

## Limitations

It is not possible to restart the current glue sequence after a stop. The gluing is restarted with the next glue instruction with an `\On` argument.

The max. gluing speed is dependent on the distance between the programmed positions. If the speed is programmed too high, the error message 50082 will appear. Avoid this error message by:

- changing the positions so they are not so close to each other
  - using the argument `\Conc` in the gluing instructions
  - decreasing the speed.
- 

## Error handling

### *Error situations*

The following error situations are handled:

- Instruction argument error.
- Wrong `ggundata` values.
- Start without `\On` argument.
- Start with two instructions with `\On` argument.

- End with `\Off` argument without having started with `\On` argument.
- Stop during execution of glue instructions.

The faulty instruction or data must be changed and the current set of glue instructions must be restarted from the beginning.

---

## Syntax

GlueL

```
[[ '\On ] [ '\Off ]
[ '\ Conc' , ' ]
[ToPoint' := ' ] <expression (IN) of robtarg> , '
[Speed' := ' ] <expression (IN) of speeddata> , '
[Gluegun' := ' ] <persistent (PERS) of ggundata>
    [ '\F1' := ' <expression (IN) of num> ]
    [ '\F2' := ' <expression (IN) of num> ]
    [ '\D' := ' <expression (IN) of num > ] , '
[Zone' := ' ] <expression (IN) of zonedata> , '
[Tool' := ' ] <persistent (PERS) of tooldata>
[ '\WObj' := ' <persistent (PERS) of wobjdata> ] , '

```

---

## Related information

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - <i>Motion</i>
Definition of velocity	Data types - <i>speeddata</i>
Definition of zone data	Data types - <i>zonedata</i>
Definition of tool	Data types - <i>tooldata</i>
Definition of work objects	Data types - <i>wobjdata</i>
Definition of gluegun data	Data types - <i>ggundata</i>
Overview Gluing	RAPID Summary - <i>GlueWare</i>
Customizing tools	Predefined data and programs - System Module <i>GLUSER</i>
I/O configuration	System parameters - <i>GlueWare</i>
Motion in general	Motion and I/O Principles

---



---

## System Module *GLUSER*

The system module GLUSER contains data and routines aimed to customising the behaviour of the GlueWare application.

The names are predefined and used internally when a *GlueL* or *GlueC* instruction is used. The names must therefore not be changed.

---

### Contents

#### Data

The following global data are predefined:

Name	Declaration	Description
<b>gl_fl1_ovr</b>	CONST num gl_fl1_ovr := 100	Global override for flow1 signal Range: 0-200%
<b>gl_fl2_ovr</b>	CONST num gl_fl2_ovr := 100	Global override for flow2 signal Range: 0-200%
<b>gl_fl1_ref</b>	CONST num gl_fl1_ref := 1000	Reference value used in calculation of glue flow1. Normally the same value as Logical Max for the analog output signal for flow 1.
<b>gl_fl2_ref</b>	CONST num gl_fl2_ref := 1000	Reference value used in calculation of glue flow2. Normally the same value as Logical Max for the analog output signal for flow 2.
<b>gl_sim_glue</b>	CONST bool gl_sim_glue := FALSE	Flag to simulate the gluing. If TRUE: No glue signals are activated.
<b>ggun1</b>	PERS ggundata ggun1 := [1,0,0,2,0,0,0,0,1000,2,0,0,0,0,1000]	Predefined ggundata with default values.

#### Routines

There are some predefined routines installed with the application. These routines have no default functionality, but can be changed to customise the behaviour of GlueWare.

##### **routine gl\_err\_actions**

This routine is executed when an error detected by the GlueWare occurs.



**routine gl\_preglue\_actions<sup>1</sup>**

This routine is executed when the motion to a Glue\On instruction is started (when the signal *DO\_GL\_Active* is set to 1).

**routine gl\_postglue\_actions<sup>1</sup>**

This routine is executed when the glue phase is ended (when the signal *DO\_GL\_Active* is set to 0).

**routine gl\_power\_on**

This routine is executed each time the system is switched on.

**routine gl\_start**

The routine is executed each time the execution of a program is started from the beginning. (From Main)

**routine gl\_restart**

The routine is executed each time the execution of a stopped program is continued.

**routine gl\_stop**

This routine is executed when a normal stop during program execution is performed.

**routine gl\_qstop**

This routine is executed when an emergency stop during program execution is performed.

---

1. The routines *gl\_preglue\_actions* and *gl\_postglue\_actions* are executed during the motion phase. If there is too much time-consuming code in these routines, the maximum possible glue speed will be reduced.

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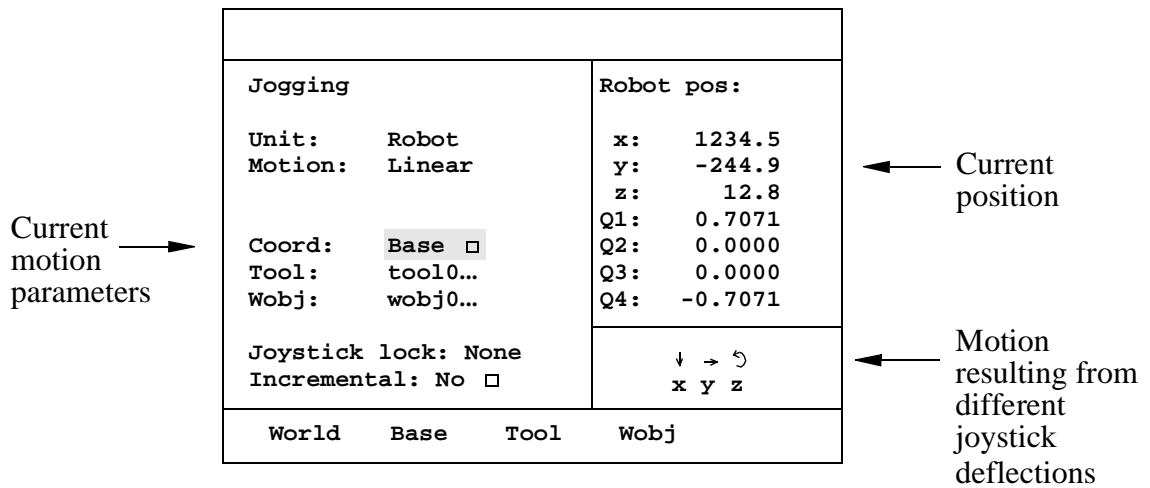
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## ***Quick Reference***

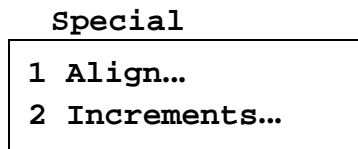
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# 1 The Jogging Window

## 1.1 Window: Jogging



### 1.1.1 Menu: Special



Command

**Align**

**Increments**

Used to:

Align the tool

Specify the sizes of the user defined increments

## 2 The Inputs/Outputs Window

### 2.1 Window: Inputs/Outputs

File			Edit			View		
Inputs/Outputs								
All signals								
Name		Value		Type				
4(64)								
di1		1		DI				
di2		0		DI				
grip1		0		DO				
grip2		1		DO				
grip3		1		DO				
grip4		1		DO				
progno		13		GO				
welderror		0		DO				
0			1					

#### 2.1.1 Menu: File

File	
1	Print...
2	Preferences...

Command

**Print**

**Preferences**

Used to:

print the current I/O list

make preferences in the Inputs/Outputs window

2.1.2 Menu: Edit

```
Edit
1 Goto...
2 Goto Top
3 Goto Bottom
```

Command:

**Goto**

**Goto Top**

**Goto Bottom**

Used to:

go to a specific line in the list

go to the first line in the list

go to the last line in the list

---

2.1.3 Menu: View

```
View
1 Most Common
2 All Signals
3 Digital In
4 Digital Out
5 Analog
6 Groups
7 Safety
8 Units
```

Command:

**Most Common**

**All Signals**

**Digital In**

**Digital Out**

**Analog**

**Groups**

**Safety**

**Units**

Used to view:

the most common list

all user signals

all digital inputs

all digital outputs

all analog signals

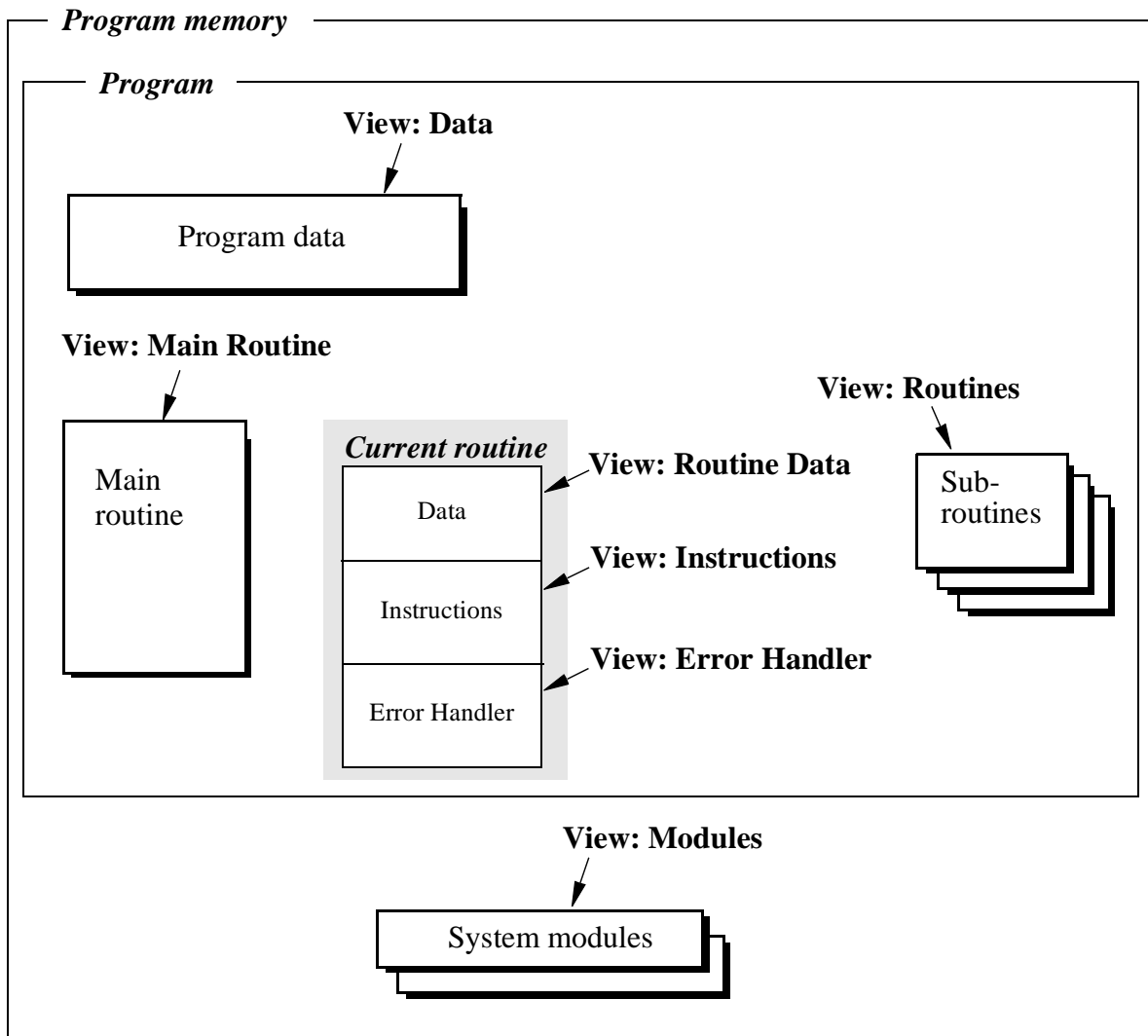
all groups of digital signals

all safety signals

all I/O units

### 3 The Program Window

#### 3.1 Moving between different parts of the program



---

## 3.2 General menus

---

### 3.2.1 Menu: File

File	
1 Open...	
2 New...	
3 Save Program	
4 Save Program As...	
<hr/>	
5 Print...	
6 Preferences...	
7 Check Program	
8 Close Program	
<hr/>	
9 Save Module	} Only shown in the module window
0 Save Module As...	

Command:

**Open**

**New**

**Save Program**

**Save Program As**

**Print**

**Preferences**

**Check Program**

**Close Program**

**Save Module**

**Save Module As**

Used to:

read programs from mass storage

create new programs

save programs on mass storage

save programs on mass storage with new names

print the program

make preferences in the Program window

check that the program is correct

erase the program from the program memory

save a module on mass storage

save a module on mass storage with a new name



**3.2.2 Menu: Edit**

**Edit**

```

    Undo "Latest action"
1  Cut
2  Copy
3  Paste
4  Goto Top
5  Goto Bottom
6  Mark
7  Change Selected
8  Value
9  ModPos
0  Search...
    Show/Hide IPL
    
```

Command

Used to:

**Undo**

perform an undo on the latest action possible to undo in selected window

**Cut**

cut selected lines to the clipboard buffer

**Copy**

copy selected lines to the clipboard buffer

**Paste**

paste the contents of the clipboard buffer into a program

**Goto Top**

go to the first line

**Goto Bottom**

go to the last line

**Mark**

select several lines

**Change Selected**

change an instruction argument

**Value**

show the current value (for the selected argument)

**ModPos**

modify a position

**Search**

search for/replace a specific argument

**Show/Hide IPL**

show/hide an instruction pick list

---

### 3.2.3 Menu: View

## View

1 Instr."<latest routine>"
2 Routines
3 Data "<latest type>"
4 Data Types
5 Test
6 Modules
7 Main Routine
8 Selected Routine
9 Error Handler

Command**Instr.****Routines****Data****Data Types****Test****Modules****Main Routine****Selected Routine****Error Handler**Used to view:instructions for the current routine – *Program Instruction* window –all routines – *Program Routines* window –program data – *Program Data* window –all data types – *Program Data Types* window –the *Program Test* windowall modules – *Program Modules* window –

instructions for the main routine

instructions for the selected routine

error handler of the current routine

### 3.3 Window: Program Instr

File	Edit	View	IPL1	IPL2
Program Instr			WELDPIPE/main	
				1(26)
<pre>!Init data counter:=0; !Go to start position MoveL pstart,v500,fine,gripper; WaitUntil dil=1; !Start Set startsignal; open_gripper; MoveJ *,v500,z10,gripper;</pre>				
Copy			Paste	OptArg (Modpos) Test →

Instructions →

Go to the window *Program Test*

#### 3.3.1 Menu: IPL1 (shows different instruction pick lists)

IPL1

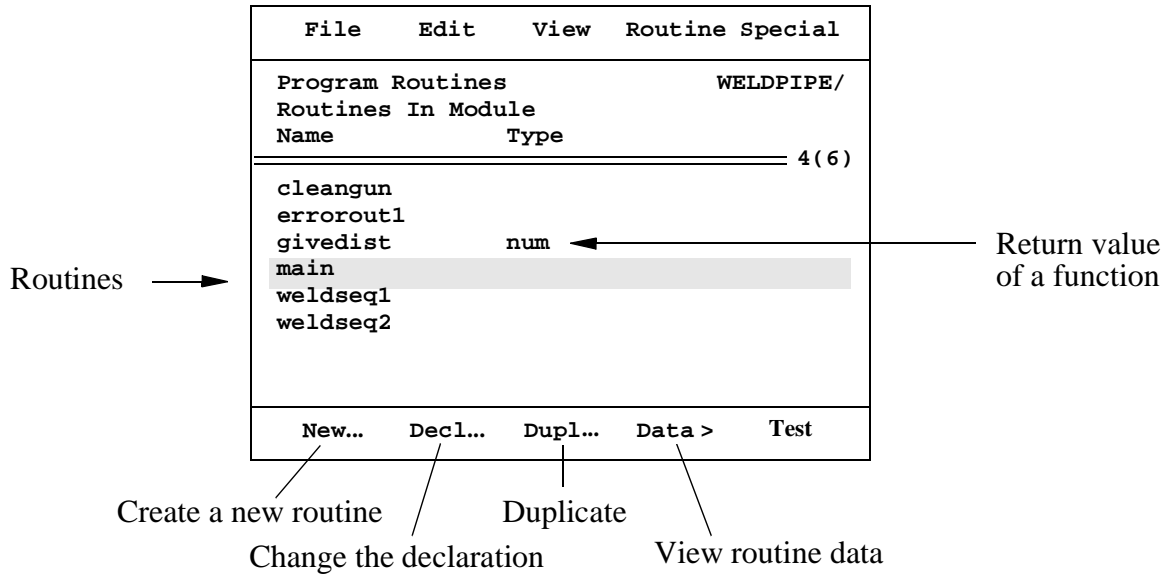
1 Common
2 Prog. Flow
3 Various
4 Motion Settings
5 Motion&Process
6 IO
7 Communicate
8 Interrupts
9 Error Recovery
0 System&Time
Mathematics

#### 3.3.2 Menu: IPL2 (shows different instruction pick lists)

IPL2

1 Most Common 1
2 Most Common 2
3 Most Common 3
4 Motion Set Adv
5 Motion Adv
6 Ext. Computer
7 Multi Tasking
8 RAPID Support
9 Service

### 3.4 Window: Program Routines



3.4.1 Menu: Routine

Routine
1 Routine Data
2 Instructions (Error Handler) (Backward Handler)
5 In Module 6 In System
7 Add Error Handler 8 Add Backward Handler

Command:

**Routine Data**

**Instructions**

**Error Handler**

**Backward Handler**

**In Module**

**In System**

**Add/Remove Error Handler**

**Add/Remove Backward Handler**

Used to:

create a new routine

view the instructions of the selected routine

view the error handler of the selected routine

view the backward handler of the selected routine

view only the routines in the current module

view all routines in all modules

add/remove an error handler to the selected routine

add/remove a backward handler to the selected routine (see RAPID Reference Manual - *Programming off-line*)

3.4.2 Menu: Special

Special

Mirror...
-----------

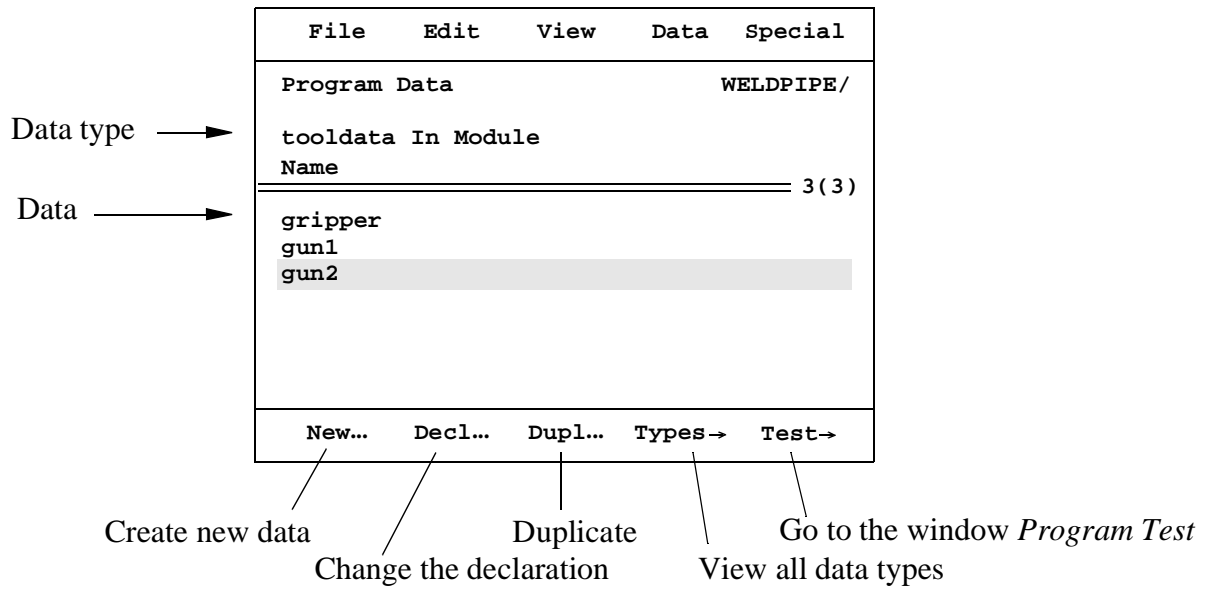
Command:

**Mirror**

Used to:

mirror a routine or a module

### 3.5 Window: Program Data



#### 3.5.1 Menu: Data

Data	
1	Value
2	Types
3	In Module
4	In System
5	In Routine "routine name"
6	New Array

Command:

**Value**

**Types**

**In Module**

**In System**

**In Routine**

**New Array**

Used to:

read or change the current value of selected data

call up the list with all data types

call up only the data in the current module

create new data

call up all routine data

declare a new array data

**3.5.2 Menu: Special**

**Special**

<b>1 Define Coord...</b>
<b>2 Go to selected position</b>

Command:

**Define Coord**

**Go to selected position**

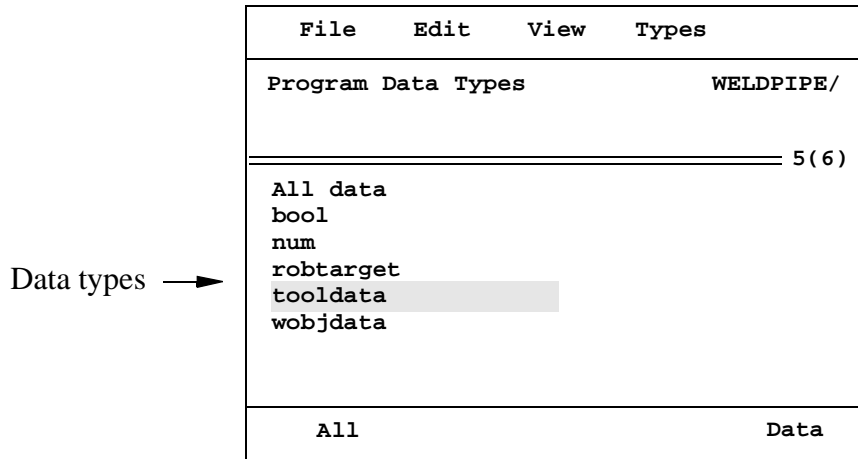
Used to:

define a tool, work object or program displacement

go to a selected position

---

### 3.6 Window: Program Data Types



---

#### 3.6.1 Menu: Types

Types	
1	Data
2	Used Types
3	All Types

Command:

**Data**

**Used Types**

**All Types**

Used to:

call up all data of a selected type

call up only those data types that are used

call up all data types



### 3.7 Window: Program Test

Test running parameters →

Program pointer →

Instructions →

Go to the *Program Instr* window

#### 3.7.1 Menu: Test

Special	
1	Move Cursor to PP
2	Move PP to Cursor
3	Move PP to Main
4	Move PP to Routine
5	Go to selected position...
6	Simulate...

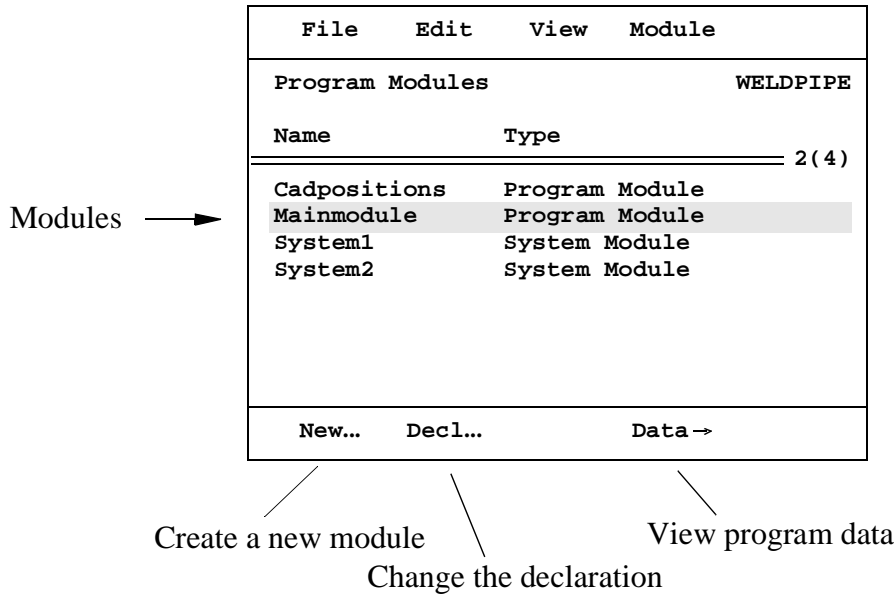
Command:

- Move Cursor to PP**
- Move PP to Cursor**
- Move PP to Main**
- Move PP to Routine**
- Go to selected position**
- Simulate**

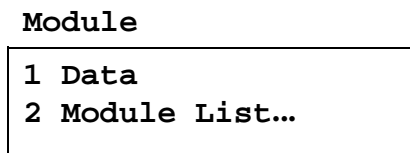
Used to:

- start from the latest stopped instruction
- start from the selected instruction
- start from the main routine
- start from any routine
- go to a selected position
- allow program execution in MOTORS OFF mode

### 3.8 Window: Program Modules



#### 3.8.1 Menu: Module



Command:

**Data**

**Module List**

Used to:

view program data

view the complete module in a list

## 4 The Production Window

### 4.1 Window: Production

File	Edit	View
Production Info		CAR_LIN1
Routine	: main :	
Status	: Stopped	
Speed:=	75	<input type="checkbox"/> %
Running mode:=	Continuous	<input type="checkbox"/>
2 (39)		
MoveL p1, v500, z20, tool1;		
» MoveL p2, v500, z20, tool1;		
MoveL p3, v500, z20, tool1;		
Set do1;		
Set do2;		
Start	FWD	BWD

Program pointer →

Program list →

#### 4.1.1 Menu: File

##### File

1 Load Program...

Command

**Load Program**

Used to:

load a program

#### 4.1.2 Menu: Edit

##### Edit

1 Goto...  
2 Start from Beginning

Command

**Goto**

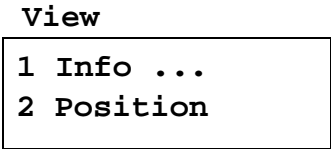
**Start from Beginning**

Used to:

go to a specific instruction

go to the first instruction in the program

4.1.3 Menu: View



Command

**Info**

**Position**

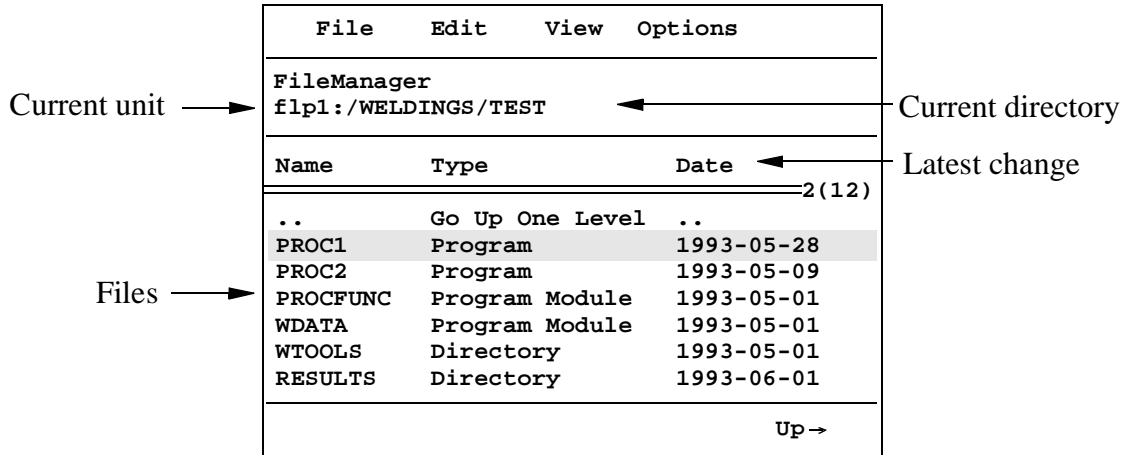
Used to:

display the program in the lower part of the window

tune a position

## 5 The FileManager

### 5.1 Window: FileManager



#### 5.1.1 Menu: File

File	
1	New Directory...
2	Rename...
3	Copy...
4	Move...
5	Print File...

Command:

Used to:

**New Directory**

create a new directory

**Rename**

change the name of a selected file

**Copy**

copy a selected file or directory to another mass memory or directory

**Move**

move a selected file or directory to another mass memory or directory

**Print File**

print a file on a printer

### 5.1.2 Menu: Edit

```
      Edit
  1 Goto...
  2 Goto Top
  3 Goto Bottom
```

Command:

**Goto**

**Goto Top**

**Goto Bottom**

Used to:

go to a specific line in a list

go to the first file in a list

go to the last file in a list

---

### 5.1.3 Menu: View

```
      View
  1 [ram1disk:]
  2 [flp1:] Disc#12
```

Command:

**ram1disk:**

**flp1:**

Used to view:

the files on the RAM disk

the files on the diskette

---

### 5.1.4 Menu: Options

```
      Options
  1 Format...
  2 Rapid Converters...
```

Command:

**Format**

**Rapid Converters**

Used to:

format a diskette

convert old program versions

---

---



---

## 6 The Service Window

---

### 6.1 General menus

---

#### 6.1.1 Menu: File

File
1 Save logs as...
2 Save all logs as...
3 Backup...
4 Restore...
Restart...

Command

**Save logs as**

**Save all logs as**

**Backup**

**Restore**

**Restart**

Used to:

save logs on a diskette or other mass memory

save all logs on a diskette or other mass memory

perform a backup

perform a restore

restart the robot

---

#### 6.1.2 Menu: Edit

Edit
1 Goto...
2 Goto Top
3 Goto Bottom
4 Info...

Command

**Goto**

**Goto Top**

**Goto Bottom**

**Info**

Used to:

go to a specific line in a list

go to the first line in a list

go to the last line in a list

view information about selected log messages

---

### 6.1.3 Menu: View

## View

1	Log
2	Date & Time
3	Calibration
4	Commutation
5	BaseFrame
6	Two Axes Definition
7	System Info

Command**Log****Date & Time****Calibration****Commutation****BaseFrame****Two Axes Definition****System Info**Used to:

display the different logs

set the date and time

calibrate the robot

commutate the motors

calibrate the base coordinate system

calibrate the base coordinate system for a two axes manipulator

display system information



## 6.2 Window Service Log

File		Edit	View	Special
Service Log				
Name			Messages #	Latest
				4(9)
Common		10	0810	20:30.32
Operational status		20	0810	20:25.14
System		0		
Hardware		1	0810	20:30.32
Program		0		
Motion		3	0810	19:15.12
Operator		4	0809	12:30.00
Process		0		
Msg->				

Log list →

No. of messages  
Time of most recent message

Displays the messages in selected log

### 6.2.1 Menu: Special

Special
1 Erase Log
2 Erase All Logs
3 Update log on Event

Command:

**Erase Log**

**Erase All Logs**

**Update log on Event**

Used to:

erase contents in selected log

erase contents in all logs

update the log directly when a message is sent – the command is changed to “**Update log on Command**” when selected, which means that the log is not updated until the function key **Update** is pressed

---

## 6.3 Window Service Calibration

File	Edit	View	Calib
Service Calibration			
Unit		Status	
		1(4)	
Robot	Synchronized		
Manip1	Synchronized		
Manip2	Synchronized		
Trackm	Synchronized		

Calibration status →

---

### 6.3.1 Menu: Calib

#### Calib

- |   |                       |
|---|-----------------------|
| 1 | Rev.Counter Update... |
| 2 | Calibrate...          |

Command:

**Rev.Counter Update**

**Calibrate**

Used to:

update the counter

calibrate using the measurement system

### 6.4 Window Service Commutation

File	Edit	View	Com
Service Commutation			
Unit	Status	1(4)	
Robot	Commutated		
Manip1	Commutated		
Manip2	Commutated		
Trackm	Commutated		

Status →

#### 6.4.1 Menu: Com

Com
1 Commutate...

Command:

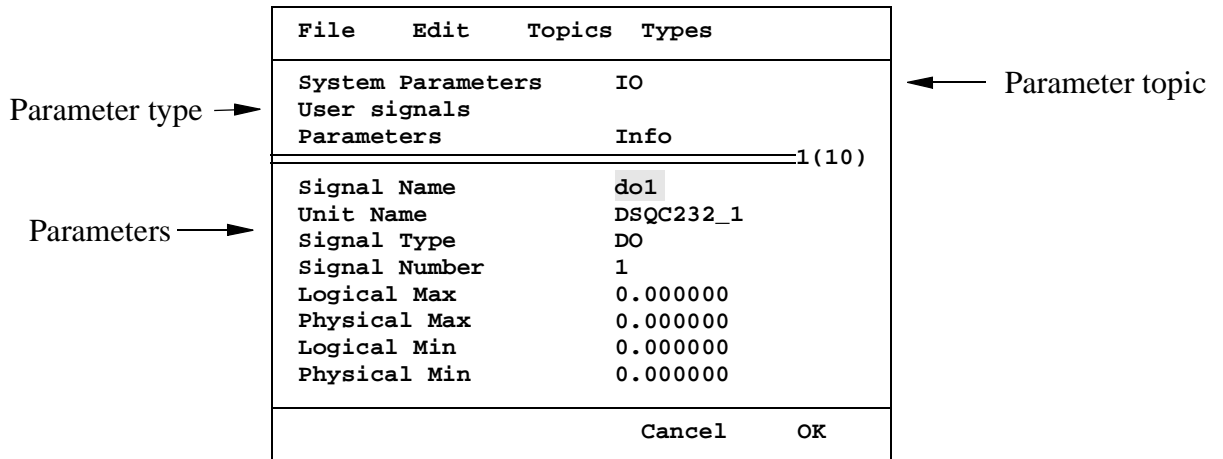
**Commutate**

Used to:

commutate using the measurement system

## 7 The System Parameters

### 7.1 Window: System Parameters



#### 7.1.1 Menu: File

##### File

1 Load Saved Parameters...
2 Add New Parameters...
3 Save All As...
4 Save As...
5 Check Parameters
Restart...

Command:

**Load Saved Parameters**

**Add New Parameters**

**Save All As**

**Save As**

**Check Parameters**

**Restart**

Used to:

load parameters from mass storage

add parameters from mass storage

save all parameters on mass storage

save parameters on mass storage

check parameters before restart

restart the robot

7.1.2 Menu: Edit

Edit	
2	Goto Top
3	Goto Bottom
3	Goto...
<hr/>	
4	Show Change Log...
5	Change Pass Codes...

Command:

Used to:

**Goto Top**

go to the first line in a list

**Goto Bottom**

go to the last line in a list

**Goto**

go to a specific line in a list

**Show Change Log**

view information about the latest modifications made

**Change Pass Codes**

change pass codes

7.1.3 Menu: Topics

Topics	
1	Controller
2	Communication
3	IO Signals
4	Manipulator
5	Arc Weld
6	Teach Pendant
<hr/>	
	All Topics

Command:

Used to view:

**Controller**

the parameter of the Controller topic

**Communication**

the parameter of the Communication topic

**IO Signals**

the parameters of the IO topic

**Manipulator**

the parameters of the Manipulator topic

**Arc Weld**

the parameters of the Arc Weld topic

**Teach Pendant**

the parameters of the Teach Pendant topic

**All Topics**

all topics



---



---

## 8 Special ArcWare windows

---

### 8.1 Window: Production

File	Edit	View	Arcweld
Production Info			WELDPIPE
Routine	:	main	
Status	:	Stopped	
Speed:=		100 <input type="checkbox"/> %	
Running mode:=		Continuous <input type="checkbox"/>	
Blocked:		Weave Track	
			1(26) ==
>> !Init data			
counter:=0;			
!Go to start position			
MoveL pstart,vfast,fine,weldgun1;			
WaitUntil DInput(ready)=1;			
Start	FWD	BWD	

#### *Menu: Arcweld*

#### Arcweld

- |   |
|---|
| <ul style="list-style-type: none"> <li>1 Manual wirefeed...</li> <li>2 Gas on/off...</li> <li>3 Select AW system...</li> <li>4 Increments...</li> </ul> |
|---|

#### Command

**Manual wirefeed**

**Gas on/off**

**Select AW system**

**Increments**

#### Used to:

feed the wire forwards or backwards

activate/deactivate the gas manually

choose arcwelding system

change the tuning increments

## 8.2 Window: Program Test

File	Edit	View	Test	Arcweld
Program Test		WELDPIPE/main		
Speed:		100%		
Running:=		Continuous		
Blocked:		Weave Track		
1(26)				
<b>&gt;&gt; !Init data</b>				
counter:=0;				
!Go to start position				
MoveL pstart,vfast,fine,weldgun1;				
WaitUntil DInput(ready)=1;				
Start		(Modpos)	Instr	>

### Menu: Arcweld

#### Arcweld

- 1 Weld Tuning...
- 2 Weave Tuning...
- 3 Sensor...
- 4 Blocking...
- 5 Manual wirefeed...
- 6 Gas on/off...
- 7 Select AW system...
- 8 Increments...

#### Command

**Weld Tuning**

**Weave Tuning**

**Sensor**

**Blocking**

**Manual wirefeed**

**Gas on/off**

**Select AW system**

**Increments**

#### Used to:

tune weld data

tune weave data

communicate with seamtracker sensor

block certain parts of the process

feed the wire forwards or backwards

activate/deactivate the gas manually

choose arcwelding system

change the tuning increments



### 8.3 Window when executing

Test		Arcweld	
Program Run	WELDPIPE		
Speed:	100%		
Running:=	Continuous		
Blocked:	Weave Track		
Welddata:	welddata1		
	Tuning	Present	
			1(3)
weld_speed	+ 5.5	105.5	mm/s
weld_wirefeed	- 0.15	2.30	m/min
weld_voltage	+ 3.50	33.50	Volts
			Tuning

*Menu: Arcweld*

**Arcweld**

- 1 Weld Tuning...
- 2 Weave Tuning...
- 3 Meas. values...

Command:

**Weld Tuning**

**Weave Tuning**

**Meas. values**

Used to:

tune current weld data

tune current weave data

read measurement values

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## Glossary

<b>Argument</b>	The parts of an instruction that can be changed, i.e. everything except the name of the instruction.
<b>Automatic mode</b>	The applicable mode when the operating mode selector is set to  .
<b>Component</b>	One part of a record.
<b>Configuration</b>	The position of the robot axes at a particular location.
<b>Constant</b>	Data that can only be changed manually.
<b>Corner path</b>	The path generated when passing a fly-by point.
<b>Declaration</b>	The part of a routine or data that defines its properties.
<b>Dialog/Dialog box</b>	Any dialog boxes appearing on the display of the teach pendant must always be terminated (usually by pressing <b>OK</b> or <b>Cancel</b> ) before they can be exited.
<b>Error handler</b>	A separate part of a routine where an error can be taken care of. Normal execution can then be restarted automatically.
<b>Expression</b>	A sequence of data and associated operands; e.g. <i>reg1+5</i> or <i>reg1&gt;5</i> .
<b>Fly-by point</b>	A point which the robot only passes in the vicinity of – without stopping. The distance to that point depends on the size of the programmed zone.
<b>Function</b>	A routine that returns a value.
<b>Group of signals</b>	A number of digital signals that are grouped together and handled as one signal.
<b>Interrupt</b>	An event that temporarily interrupts program execution and executes a trap routine.
<b>I/O</b>	Electrical inputs and outputs.
<b>Main routine</b>	The routine that usually starts when the <b>Start</b> key is pressed.
<b>Manual mode</b>	The applicable mode when the operating mode switch is set to  .
<b>Mechanical unit</b>	A group of external axes.
<b>Module</b>	A group of routines and data, i.e. a part of the program.
<b>Motors On/Off</b>	The state of the robot, i.e. whether or not the power supply to the motors is switched on.
<b>Operator's panel</b>	The panel located on the front of the control system.
<b>Orientation</b>	The direction of an end effector, for example.
<b>Parameter</b>	The input data of a routine, sent with the routine call. It corresponds to the argument of an instruction.
<b>Persistent</b>	A variable, the value of which is persistent.
<b>Procedure</b>	A routine which, when called, can independently form an instruction.

## *Glossary*

<b>Program</b>	The set of instructions and data which define the task of the robot. Programs do not, however, contain system modules.
<b>Program data</b>	Data that can be accessed in a complete module or in the complete program.
<b>Program module</b>	A module included in the robot's program and which is transferred when copying the program to a diskette, for example.
<b>Record</b>	A compound data type.
<b>Routine</b>	A subprogram.
<b>Routine data</b>	Local data that can only be used in a routine.
<b>Start point</b>	The instruction that will be executed first when starting program execution.
<b>Stop point</b>	A point at which the robot stops before it continues on to the next point.
<b>System module</b>	A module that is always present in the program memory. When a new program is read, the system modules remain in the program memory.
<b>System parameters</b>	The settings which define the robot equipment and properties; configuration data in other words.
<b>Tool Centre Point (TCP)</b>	The point, generally at the tip of a tool, that moves along the programmed path at the programmed velocity.
<b>Trap routine</b>	The routine that defines what is to be done when a specific interrupt occurs.
<b>Variable</b>	Data that can be changed from within a program, but which loses its value (returns to its initial value) when a program is started from the beginning.
<b>Window</b>	The robot is programmed and operated by means of a number of different windows, such as the Program window and the Service window. A window can always be exited by choosing another window.
<b>Zone</b>	The spherical space that surrounds a fly-by point. As soon as the robot enters this zone, it starts to move to the next position.